

**PHYTOECOLOGICAL AND ETHNOBOTANICAL STUDIES OF KALASH VALLEY,
DISTRICT CHITRAL, HINDUKUSH RANGE, PAKISTAN**



BY

FAZAL HADI

**DEPARTMENT OF BOTANY
UNIVERSITY OF PESHAWAR
PESHAWAR, PAKISTAN
SESSION (2013-14)**

DEDICATION

Sincerely dedicated to my beloved and great mother (late), she
contributed a lot in my personality building and career
development

**University of Peshawar
Peshawar, Pakistan**

**PHYTOECOLOGICAL AND ETHNOBOTANICAL STUDIES OF KALASH VALLEY,
DISTRICT CHITRAL, HINDUKUSH RANGE, PAKISTAN**

A Dissertation submitted in partial fulfillment of the requirement for the Degree of

Doctor of Philosophy

in

BOTANY

By

FAZAL HADI

Supervisor: Prof. Dr. Muhammad Ibrar

Graduate Studies Committee:

1. Prof. Dr. Siraj-ud-Din (Convener)
2. Prof. Dr. Muhammad Ibrar (Member)
3. Prof. Dr. Muhammad Nafees (Member)
4. Prof. Dr. Bashir Ahmad (Member)
5. Dr. Zahir Muhammad (Member)

APPROVAL SHEET

The Ph. D. dissertation of Mr. Fazal Hadi, Ph.D. Scholar, Department of Botany, University of Peshawar is hereby approved.

(External Examiner)

Dr. Barkat Ullah
Assistant Professor
Department of Botany
Islamia College University Peshawar

(Internal Examiner and Supervisor)

Prof. Dr. Muhammad Ibrar
Department of Botany
University of Peshawar

(Chairman)

Prof. Dr. Siraj-ud-Din
Department of Botany
University of Peshawar

Date: 05/04/2017

PUBLICATION OPTION

I hereby reserve all rights of publication, including

Right of reproduce this thesis in any form for a

Period of 5 years from the date of submission

FAZAL HADI

ACKNOWLEDGEMENTS

I am very thankful to Almighty Allah (the one and the only), who helped me to complete this work and compilation of the thesis. His help is needed in each and every movement of life.

This research work has been done with the support and efforts of my Research Supervisor Prof. Dr. Muhammad Ibrar, Department of Botany, University of Peshawar. I am extremely grateful to him for his support, respect, valuable guidance, useful suggestion, ideas and care from initial conception of the research to the final preparation of dissertation. He has always been easy to approach and willing to help with any problem.

I am thankful to Prof. Dr. Siraj-Ud-Din, Chairman Department of Botany University of Peshawar for his guidance, help and all administrative support.

I acknowledge the support and every possible help of all the teaching and supportive staff of the Department of Botany, University of Peshawar especially Mr. Ghulam Jelani (Curator) for his help in identification of plant species.

I am thankful to my lab fellows specially Ms. Ulfat Samreen for every possible help.

I am obliged to my colleagues of Center of Plant Biodiversity for their every possible support, help and cooperation in completion of this research work.

I am greatly thankful to my Brother-in-Law (Mr. Abdul Khaliq) and nephew (Mr. Rafi Ahmad) for their logistic and moral support in the collection of plant specimens and data for the research work. The help and security provided by the Pakistan Army, Chitral Police and Boarder force during the field visits to different localities of Kalash valley are also highly appreciated.

I am very thankful to the local community in all the three localities of Kalash valley for their logistic support, guidance and full cooperation in the collection of all types of data during the field studies.

I greatly acknowledge the everlasting love, moral support and prayers of my very loving mother during my entire career and in the completion of this research work. Her prayers and support in my personality building will never be forgotten. Her sudden dead few months before really shocked me and my family as she was a source of inspiration and unity for us. May her departed soul be at eternal rest with high place in the paradise (Amin).

I am also very thankful to my wife, my brothers and sisters for their full moral support and encouragement in my life and in the completion of my research work.

At last I am thankful from core of my heart to all those who helped me in any form during my research work and compilation of my thesis.

FAZAL HADI

VITAE

February 04, 1980- Born- Peshawar- Khyber Pakhtunkhwa- Pakistan

B. Sc.-2001- Islamia College Peshawar, University of Peshawar, Peshawar, Pakistan

M. Sc.-2003- Department of Botany, University of Peshawar, Peshawar, Pakistan

M.Phil-2012- Department of Botany, University of Peshawar, Peshawar, Pakistan

November 1st, 2005- Lecturer in Botany, Center of Plant Biodiversity, University of Peshawar

Major Fields: **Rangeland Ecology, Plant Systematic and Ethnobotany**

Courses Studies:

1. Bot. 811	Intensive studies in Physiology	Prof. Dr. Muhammad Ibrar
2. Bot. 807	Environmental Health and Problems	Prof. Dr. Ghulam Dastagir
3. Bot. 808	Environmental Health and Problems (Lab.)	Prof. Dr. Ghulam Dastagir
4. Bot. 701	Fresh Water Algae	Dr. Nadeem Ahmad
5. Bot. 702	Fresh Water Algae Lab.	Dr. Nadeem Ahmad
6. Bot. 810	Intensive Studies in Phycology	Dr. Nadeem Ahmad
7. Bot. 713	Vegetation Ecology	Dr. Lal Badshah
8. Bot. 714	Vegetation Ecology Lab.	Dr. Lal Badshah
9. Bot. 805	Physiology of Plants under stress	Dr. Barkat Ullah
10. Bot. 806	Physiology of Plants under stress Lab.	Dr. Barkat Ullah

Abstract

Phytoecological and Ethnobotanical Studies of Kalash Valley, District Chitral, Hindukush Range, Pakistan

By

Fazal Hadi

The present study was conducted to document the plant resources and their ecological characteristics in Kalash valley, district Chitral during years 2013-2015. The floristic composition revealed 389 species belonging to 273 genera and 88 families. It includes 62 dicots, 11 monocots, 7 pteridophytes, 4 bryophytes and 3 gymnosperms families and one fungus family. The species diversity showed 307 dicots, 55 monocots, 12 pteridophytes, 10 gymnosperms, 4 bryophytes and one fungus species. Asteraceae was leading family with 49 species followed by Poaceae 36 species, Brassicaceae 25, Lamiaceae and Rosaceae 22 species each, Fabaceae 16, Apiaceae 13 and Boraginaceae and Polygonaceae 12 species each. The remaining families have 10 or less species. Biological spectra showed that therophytes were dominated with 205 species followed by geophytes 56 species and hemicryptophytes 46 species. Nanophylls were dominating leaf size spectrum with 178 species followed by mesophylls with 72 species, leptophylls 53 and microphylls 44 species. 328 species of the valley were deciduous, 48 evergreen and 13 were leafless species. The simple leaved species dominated with 266 species followed by 66 species with compound leaves and 44 with dissected leaves. 369 species were spineless and only 20 were spiny species. There were 291 terrestrial and 98 wet/moist habitat loving species. The result showed 363 heliophytes and 26 sciophytes. 340 species were wild and 49 were cultivated. Ethnobotanical studies of the plants showed that all the species have some kind of local uses i.e. 338 species were used as fodder, 93 medicinal, 63 firewood, 27 vegetables, 32 fruit species, 23 timber woods, 21 for thatching purpose, 20 condiment, 08 ornamental and 5 species were used for making snuffs.

Phytosociological studies were carried out in all the three sub-valleys viz: Bumburet, Rumbor and Birir and each sub-valley was divided into two portions like Foothills/plains and uphill mountains/alpines. Total of 21 plant communities were established 7 in each sub-valley

including 3 in foothills and 4 in uphill mountains. Similarly, 3 associations were established in the entire valley to group all the 21 plant communities through cluster analysis. Edaphology of the valley showed that the soil was mostly sandy loam with poor organic matter, normal or slightly alkaline and low nutrient status.

The palatability studies of the valley showed that cow grazed on 47 species and were mostly (59.57%) herbaceous. Of them, 20 species were highly palatable, 18 mostly palatable and 9 less palatable. Parts of the plants grazed showed that 25 whole plants species, leaves of 19, shoots of 2 and flowers of one species were used as forage. Goats grazed on 65 species having mostly (50.76%) herbs. Of these, 20 species each were highly palatable and less palatable, 21 mostly palatable and 4 species were rarely palatable for cow. Whole plants of 26 species, leaves of 24, shoot of 14 and fruit of one species were grazed by goats. Sheep grazed on 42 species and mostly (61.90%) were herbs. 18 species were mostly palatable, 13 highly palatable, 10 less palatable and one species was rarely palatable. The whole plants of 17 species, leaves of 13, shoots of 10 and fruit of one species was preferred by sheep for grazing. The total biomass productivity of the valley was 127484 kg/ha. Shrubs/ trees having more contribution and yielded 79649 kg/ha of the forage, herbs to 46595 kg/ha and grasses to 1240 kg/ha. Highest productivity (9445 kg/ha) was recorded for the community *Salix-Salix-Ailanthus* followed by *Salix-Tamarix-Mentha* community (9065 kg/ha) and *Artemisia-Rosa-Quercus* community (8775 kg/ha).

Thirteen medicinal/palatable plant species were selected for chemical analysis at three phenological stages. The elemental analysis showed the presence of micronutrients i.e. Al, Fe, Si, S, Cd, Zn, Cu and Mn and macronutrients N, O, C, P, Mg, Na, P and Ca in different proportions at different phenological stages. Nutritional analysis of these plants indicated a slight variation in the quantity of moisture, ash contents, crude protein, crude fiber, crude fat, carbohydrate and NFE contents at three phenological stages. Conservation study of 323 wild plant species of the Kalash valley revealed that 8 species were rare, 60 were endangered and 255 were vulnerable species.

The plants of the valley are facing great pressure due to over grazing and browsing, over exploitation for fire and timber wood, over collection for medicinal purposes, floods, land sliding and habitat loss.

TABLE OF CONTENTS

S. No.	Table of Contents	Page No.
	Dedication	i
	Graduate Studies Committee	ii
	Approval	iii
	Publication option	iv
	Acknowledgement	v
	Vitae	vii
	Abstract	viii
1.	General Introduction	1
	Geographic location of Chitral	1
	Boundaries	1
	Mountains	1
	History	1
	Climate	2
	Soil of the area	2
	Topography	2
	Agriculture and Horticulture	3
	Forests and Livestock	3
	Wildlife	3
	Religion and languages	4
	Tradition and Education	4
	The study area	5
2.	Review of Literature	11
	Floristic Composition and its Ecological Characteristics	11
	Ethnobotany	17
	Phytosociology/Vegetation Structure	25
	Palatability of Vegetation	31
	Rangeland Productivity	35

Chemical Evaluation of forage Plants	36
Conservation status of plants	41
3. Aims and Objectives	44
4. Materials and Methods	45
Floristic Composition with ecological characteristics	45
Biological spectra	45
Leaf size spectra	46
Ecological Characteristics	47
Ethnobotanical profile of plants	47
Phytosociology/Vegetation Structure	47
Edaphology	50
Degree of Palatability of Vegetation	51
Measurement of Rangeland productivity	51
Chemical Evaluation of some selected Plants	52
Conservation Status of Plants	54
5. Results and Discussion	55
Floristic composition with ecological characteristics	55
Ethnobotanical Profile	59
Traditional medicinal plants	61
Vegetation structure along plains/foothills	111
Vegetation structure along uphill mountains/Alpine vegetation	121
Degree of Palatability	137
Forage productivity	149
Chemical evaluation of selected Plants	151
Conservation status of plants	195
6. Conclusion and Recommendations	210
7. References	225
8. Appendices	254

LIST OF TABLES

Table No.	Page No.
1. Climatic data of District Chitral	8
2. Climatic data of Kalash valley District Chitral	9
3. Floristic composition and ecological characteristics	62
4. Summary of ecological characteristics	76
5. Ethnobotanical classification of plants	84
6. Medicinal uses of the plants	100
7. Plant species used for treatment of a particular disease	108
8. Plant parts used for treatment of a particular disease	110
9. Importance values of plant communities in plains/foothills	115
10. Physico-chemical analysis of soils of plains/foothill communities	120
11. Importance values of plant communities of uphill mountain communities	126
12. Physico-chemical analysis of soils of uphill mountain communities	131
13. Similarity Index between different plant communities	133
14. Palatability of forage plants by cow	139
15. Palatability of forage plants by goats	141
16. Palatability of forage plants by sheep	144
17. Forage/Biomass (Kg/ha) of different plant communities	151
18. Plant Species selected for chemical analysis	153
19. Calcium contents in the plant species	155
20. Potassium contents in the plant species	156
21. Sodium contents in the plant species	159
22. Magnesium contents in the plant species	160
23. Phosphorus contents in the plant species	163
24. Carbon contents in the plant species	164
25. Oxygen contents in the plant species	166
26. Nitrogen contents in the plant species	167
27. Aluminum contents in the plant species	171
28. Iron contents in the plant species	172

29. Silicon contents in the plant species	173
30. Sulphur contents in the plant species	175
31. Cadmium contents in the plant species	176
32. Zinc contents in the plant species	177
33. Copper contents in the plant species	179
34. Statistical analysis of the elements present in selected species	180
35. Proximate analysis of the plant species	192
36. Conservation status of plants	197

LIST OF FIGURES

Figure No.	Page No.
1. Map of District Chitral	10
2. Map of research area	10
3. Number of species in each plant group	78
4. Number of genera in each plant group	78
5. Number of families in each plant group	79
6. Number of species in each life form class	79
7. Number of species in each leaf size class	80
8. Number of species on the basis of leaf persistence	80
9. Number of spiny species	81
10. Habitat of the species	81
11. Light loving plants	82
12. Nature of growth	82
13. Leaf shapes	83
14. Ethnobotanical uses of plants	83
15. Cluster Dendrogram Analysis of 21 plant communities	136
16. Plants palatability by Cow	146
17. Plant parts preferred by Cow	146
18. Plants palatability by Goat	147
19. Plant parts preferred by Goat	147
20. Plants palatability by Sheep	148
21. Plant parts preferred by Sheep	148
22. Conservation status of plants	209
23. Forest view	212
24. <i>Tragopogon gracilis</i>	212
25. Local house	213
26. Plant identification	213
27. Ethnobotanical information	214
28. <i>Arum jacquemontii</i>	214

29. <i>Asplenium trichomanes</i>	215
30. Hedges	215
31. Graveyard	216
32. Graveyard	216
33. Graveyard	217
34. Local dress	217
35. Typical Kalash house	218
36. Weeding	218
37. <i>Carum copticum</i>	219
38. <i>Artemisia sp.</i>	219
39. <i>Kickxia ramossissima</i>	220
40. <i>Rheum emodi</i>	220
41. <i>Descurainea Sophia</i>	221
42. <i>Bellis perennis</i>	221
43. <i>Urtica dioica</i>	222
44. Deforestation	222
45. Deforestation	223
46. Plant collection	223
47. Nomads	224
48. High pasture	224

GENERAL INTRODUCTION

Geographic location of Chitral

District Chitral lies between $35^{\circ} 15' 06''$ to $36^{\circ} 55' 32''$ north latitudes and $71^{\circ} 11' 32''$ to $73^{\circ} 51' 34''$ east longitudes. The district has total area of 14850 km^2 with lowest elevation of 1396 m at Arandu and maximum of 7685 m at Trichmir in the Hindukush mountaneous range (DCR, 1998).

Boundaries

District Chitral has important stragetie and geographic location. It is bounded on the east with district Ghizer of Gilgit-Baltistan, on the south with districts of Dir and Swat. To the west lies the Nooristan province of Afghanistan while the Wakhan corridor (Afghanistan) is located to the north-west of Chitral which separates Pakistan and Tajikistan.

Mountains

District Chitral is surrounded by mountainous series of Hindukush and Hindu Raj ranges. The former separates Chitral from Afghanistan while the latter one seperates it from district Dir and Gilgit-Baltistan. Some famous mountainous peaks of Chitral include Sada Istragh (24500 ft) situated in Ankari valley, Trichmir (23355 ft) which is always covered with snow throughout the year, Pal Zom (21500 ft) in Laspur valley, Daspur (21409 ft) in Darkhot Yarkhun valley, Wasum (21000 ft) in Yarkhun valley and Doan (20800 ft) near Trichmir (Murtaza, 1962).

History

District Chitral has very ancient human history and the peoples are living here from about 4000 years. It remained an important route for many invaders to South Asia, including the Alexander the Great, Scythians, Changez Khan and many others (Shah, 2014). Chitral was inhabited by the Aryans followed by the Chinese in 750 A.D. In the same time the Afghanis pushed the Kalash people living in southern Afghanistan to Chitral in the 4th century. The Kalash occupied the southern parts of the Ayun and Drosh areas of Chitral at that time and remained the rulers of this part of Chitral for about 500 years. The Arabs invaded Chitral in 8th Century from north of Baroghill pass and occupied the northern parts (upper) Chitral and introduced Islam

there. In 9th Century the Buddhists occupied Chitral. In 14th century Shah Nadir Raees from Turkistan attacked Chitral and occupied it. Raees family was replaced by the Kator dynasty in 1570 which remained till 1947 when the last Mehtar Amir-ul-Mulk had acceded Chitral into Pakistan. Chitral state was merged as a distinct district into Pakistan in 1969 (Shah, 2014).

Climate

District Chitral has great altitudinal variations from subtropical to alpine regions due to which the climate varies in different localities of the district. The summers are usually dry and hot with maximum temperatures of 38 °C to 40 °C in July, while the winters are very cool and snowy with minimum temperatures of -10 °C to -8 °C in the month of January. The annual rainfall ranges from 250 to 1000 mm while heavy snowfall occurs and covers most parts of the valley from December to March every year (Shah, 2014). The recorded climatic data of the district in 2014 and 2015 is presented in table 1, while the climatic data of Kalash valley is presented in table 2.

Soil of the area

The soil of the district varies in texture and structures at different localities. The soil along the water courses and foothills is usually sandy and stony while the mountainous parts are composed of bare rocks with some soil in cracks and crevices. The valley has alluvial soil which has been transported and deposited by the avalanches, hill torrents and glaciers. The soil is usually deficient in organic matter contents due to sparse vegetation, great erosion and degradation (Shah, 2014). About 72 % of the land is covered with bare mountains and rocks and only 24 % of the land is covered with small patches of forests, alpine and pasture meadows, while the croplands cover is only 1-2 % of the total land of the district (Haserodt, 1996).

Topography

Total area of district Chitral is composed of 14850 km² which is 90 % hilly and only 10 % is plain. The north and east facing slopes of mountains are cool with thick vegetation while south and west facing slopes are exposed to sun resulting in dry mountains with sparse vegetation. The alpine regions have characteristic short lived ephemeral plants due to snow covered soil, chilling temperature and short growing season (Shah, 2014). About 10 % of Chitral

is covered by glaciers and a total of 22 glaciers are reported, each of which is more than 10 km long including the longest Chianter glacier which is 32 km long (Gruber, 1977).

Agriculture and Horticulture

Small farms are present near almost every house for cultivation of crops while the irrigation is done by water flowing in streams or by springs. Tractor plough is carried out in some plain places, but the traditional bullocks plough is still practiced in majority of places. The main agricultural crops of the district Chitral include wheat, maize, rice and barley. Many fruits like walnuts, peach, pears, figs, plum, grapes, apples and apricots etc. are produced in the valley which not only provide income resources to the locals, but also are good source of timber wood, fire wood and fodder. Proper collection and packing of these fruits may increase the productivity, marketing and income of the local peoples.

Forests and Livestock

District Chitral has rich natural resources of forests composed of *Cedrus deodara*, *Pinus gerardiana*, *Pinus wallichiana*, *Quercus baloot*, *Quercus incana* and *Juniperus excelsa* etc. But due to harsh environmental conditions and lack of alternate energy resources, deforestation is going on with great speed. Collection and cutting of plants for timber wood, fire wood, fodder and medicines are the serious treats for Biodiversity of the district. Afforestation has been done at different localities of the district by planting of plants like *Ailanthus altissima*, *Elaeagnus angustifolia*, *Populus nigra*, *Salix* species and *Rubinia psuedoacacia* to meet the fuel and timber wood needs of the locals to some extent.

Livestock herding is one of the major income source of the valley. Alpine pastures and lower lands are vigorously grazed during summers by livestock including sheep, goats, cows, bullocks, horses and donkeys. Sheep wool (Chitali Patti) and its finished products are the sufficient source of identity and income of the people of Chitral.

Wildlife

The wildlife of Chitral includes non-domesticated and naturally occurring animals that maintain the ecosystem. These animals have been lavishly killed or hunted by influential peoples and local hunters. Some important wildlife animals includes Himalayan pit vipers, foxes, wolf,

bear, leopard, markhor, deer, reptiles, fishes, local and migratory birds, amphibians and arthropods etc. Markhor is the significant goat, which is now only hunted by trophy hunting.

Religion and languages

District Chitral is a Sunni Muslim district along with some Ismaeli Muslims in the upper Chitral. Some non Muslim groups, like Wakhi in the Pamir and Kalasha in the Kalash valley are also living in Chitral. The district Chitral is influenced by Chinese, Greek, Iranian, Mongolian, Tatars and Turk cultures. Due to its unique location and history, the main tongue *Kohwar (Chitrali)* has many words from all these languages. Some other languages like *Dameli, Eastern Katviri, Gawar Bati, Gujar, Kalasha, Madaghlashi, Pashto, Phalura, Persian, Shikani, Wakhi* and *Yidga* are also spoken at different and restricted places of Chitral (Murtaza, 1962).

Traditions and Education

The peoples of Chitral have their unique traditions and customs. Generally, the men wear Shalwar kameez, woolen overall (Shoogha), waistcoats and Pakool (Chitrali caps) during winters and Shlawar kameez and pakool in summers. The ladies have shalwar kameez with doputta and old ladies in the past also weared traditional colored caps, which can still be seen in the some remote parts of the district. Soccer, cricket and traditional games like “Polo” and “Pheendik” are played in the entire district.

In primary education the district is much advance with large number of Govt. and private sector educational institutions and a reasonable number of girls are also school-going. About 54.17 %, 16.58 % and 5.39 % of the students belong to primary, matric and intermediate levels respectively (DCR, 1998).

The study area

The present study area “Kalash valley” is located to the extreme south-west of district Chitral. The valley is bounded in west with Nooristan province of Afghanistan and to other parts of Chitral by three sides. The valley receives heavy snowfall in winter and most of its area and vegetation remain buried in snow from December to March. The Kalash valley comprises of major Muslim community alongwith minority Kalash that are still practicing an old, unique, indigenous and polytheistic religion, called “Kalasha”. The Kalasha people ruled Chitral for about five centuries (332-712 AD), but are now confined only to three valleys viz: Birir, Bumburet and Rumbor, collectively known as Kalash valley or Kafiristan. They have three festivals in a year viz: “Chilimjush” from 15 to 16 May (on account of celebrations of arrival of spring), “Uchal” on 22 August (preparations for arrival of winter and the locals start collection of fruits like walnuts, apples and mulberry etc. after this festival) and “Chitir Mass” from 15 to 22 December (the festival for prayers and religious parties). The Kalash people are considered as the descendants of Alexander the Great, living in these rugged and dry mountainous series of Hindukush for thousands of years. For Kalash people the universe was divided into three ranks, with the world of the divine at the top, the human world in the middle and the underworld at the bottom. The Kalash elders insisted that the Kalash theology revolves around the concept of heaven and hell. When a man dies his soul or breath “*shon*” transform into a shadow and become “*partir*” and wander as the shades in heaven “*yurdesh*” and sinners will burn in “*zozuk*” hell. They owe this to Naga Dehar, the religious shaman, who proclaims that the soul went to the other world of peaks, mid way between the divine and human. They regard it “*as a promotion, since it is at those altitudes that the fairies live*”. Kalash funerals ceremonies offer a chance for display of wealth which will show the importance of the deceased and his or her family. Death is mostly celebrated as a joyous occasion where it is believed that it is a union of soul with the creator and is now seeking favors and blessing for their living relatives. In Kalash the graveyard is considered as an impure area and due to the concept of *Bhut* people are discouraged to go there alone. In the past, the Kalasha, used to leave the corpses in “*Mandoajoa*” graveyard in open lid coffins for the vultures and wild species following a Parsi tradition rather than burying them in the “*Mandoajoa*” graveyards. They believed that by doing so they were being grateful to nature for the blessings that the deceased received in his life. Birth and death are treated as special

proceedings in Kalash Valley due to its cultural and religious significance. The people of the area considered the soul and departed persons as gift of the God and a blessing. The inhabitants of the area celebrate death and soul and the departure of a person and related events, rituals with special arrangement and they believe that there is a life after death but one cannot fully realize it until one achieves a certain kind of maturity. Death itself is regarded as a rite of passage in which the dying person becomes an ancestor who will continue to have a social personality. The general experience is that the body after death undergoes degradation would decompose into smallest components of which it is composed hence the body is perishable (Sheikh *et al.* 2014).

The Kalash people are living in three sub-valleys viz: Birir, Bumburet and Rumbor that are lying parallel to each other in the Hindukush Mountain range above the “Ayun” valley of Chitral (Fig. 1). The Kalash valley is located in the dry temperate zone at 71° 46' 55" east longitudes and 35° 50' 32" north latitudes having pleasant summers and very cold winters characterized by heavy snow fall and the annual average rain is 250-400 mm. The elevation of the valley is about 1,800 m to 3,800 m above sea (DCR, 1998).

Kalash peoples are mostly dependant on different agricultural and forest products for their common and economic needs. The most commonly cultivated crops of the area are wheat, maize, potato, bean and various vegetables. The natural forest mainly consists of *Cedrus deodara*, *Juniperus communis*, *Juniperus exelsa*, *Pinus wallichiana*, *Pinus gerardiana*, *Quercus baloot* and *Quercus incana*. Cattle rearing are also good source of food and income generations for the locals. The hard climatic conditions and lack of alternate energy resources have resulted extensive deforestation in the area and the estimated annually forest wood use of the area is 20 to 25 thousands metric tons. Similarly, about 13 % of the population is dependent on the forests for generating their first hand money.

The Kalash valley, like other parts of Chitral has rangeland resources, specific for the residents of the three valleys for seasonal grazing of animals and collection of plants for domestic and commercial uses. These alpine pastures and lower grazing lands are extensively grazed from March to October each year by grazing animals and remain useless for rest of the year due to low temperature and heavy snowfall. These extensive exploitations of rangelands of Kalash valley for medicines, firewood, fuelwood and fodder is causing serious ecological problems and adversely affecting the socio-economical status of the locals. Soil erosion is a major ecological problem in the valley and in the entire district. Soil is eroded by rain water,

melting of glaciers, rivers flow during summer, strong winds and land sliding. From last few years drastic changes occurred in the climate of kalash valley, which not only increased the annual temperature but also caused heavy floods almost every summer from 2003 till present. Recently in 2015, from May to August many floods occurred in the valley, which severely damaged the service raods, irrigation channels, cultivation lands and infrastructures. Thus, the local community and Government spend huge amount each year for rehabilitation services.

Keeping in view the crucial importance of plant natural resources for the Kalash people and the fast decline in the plant biodiversity due to various natural and anthropogenic hazards, the present study is proposed to trigger out the ecological, ethnobotanical and conservational aspects of plant natural resources of the area. This study will provide a comprehensive record of the plants resources of the area for any future studies and planning.

Table 1. Monthly mean temperature, rain fall and humidity of District Chitral, Pakistan (During years 2014-2015).

MONTHLY MEAN MIN TEMP. (°C)												
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2014	-1.0	0.0	2.1	6.9	11.3	15.1	19.8	15.9	13.2	7.9	1.0	-1.0
2015	-0.4	0.5	4.0	8.8	10.6	17.4	20.8	17.8	12.2	8.2	4.3	-1.6

MONTHLY TOTAL RAIN (MM) [-1=TRACE]												
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2014	1.4	55.0	174.5	43.3	42.2	6.3	0.5	23.7	1.0	18.2	51.4	0.0
2015	35.8	132.6	89.2	31.8	48.7	0.0	24.8	41.2	3.1	31.7	64.4	0.0

MONTHLY MEAN HUMIDITY (%) AT 0800 AM												
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2014	71	84	85	76	77	53	66	81	87	90	89	66
2015	74	84	75	72	74	49	71	88	89	86	78	61.0

MONTHLY MEAN HUMIDITY (%) AT 0500 PM												
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2014	36	47	54	35	41	26	30	43	33	50	53	39
2015	41	50	49	40	37	25	37	40	35	45	54	37.0

Source: Pakistan Meteorological Department, Peshawar

Table 2. Soil temperature, light intensity, humidity and air temperature of different localities of Kalash valley, district Chitral, Pakistan

Sites	Soil pH	Soil temperature (°C)						Light intensity (L)			Humidity (%)			Air temperature (°C)		
		Soil surface			Below surface											
		Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av
a. Bamburet																
Anesh	7	42	24	33	41	22	31.5	886	334	610	62	55	58.5	40	31	35.5
Krakal	6.7	40	22	31	38	21	29.5	902	288	595	81	70	75.5	38	34	36
Shekhanan deh	7.5	38	21	29.5	37	19	28	933	349	641	77	53	65	36	26	31
Otakawo	6.8	38	21	29.5	36	19	27.5	987	687	837	75	48	61.5	33	18	25.5
Bronzik Gol	7.2	36	18	27	34	16	25	1030	788	909	68	59	63.5	32	6	19
b. Rumbor																
Gombak	7	40	22	31	38	21	29.5	902	400	651	60	52	56	41	30	35.5
Baladesh	7.2	36	20	28	33	18	25.5	944	545	744	75	67	71	36	29	32.5
Piakaar	6	33	21	27	32	15	23.5	987	613	800	66	55	60.5	33	22	27.5
Shekhanan deh	6	29	17	23	29	12	20.5	1187	712	949	71	58	64.5	31	15	23
Gangal wat	8	28	15	21.5	28	9	18.5	1319	871	1095	65	51	58	27	5	16
c. Birir																
Birir Gol	7	40	23	31.5	38	20	29	879	453	666	53	48	50.5	39	28	33.5
Garambeth Gol	6	38	22	30	35	18	26.5	956	540	748	66	54	60	35	23	29
Bial	5.8	34	18	26	33	15	24	1077	732	904	61	51	56	32	18	25
Chesh-betegan	6	28	16	22	30	11	20.5	1239	876	1058	71	59	65	26	12	19
Chondovech	6.3	27	13	20	26	8	17	1543	612	1077	77	68	72.5	22	5	13.5



Figure 1. Map of Pakistan on the globe showing Chitral Valley in Black Square box

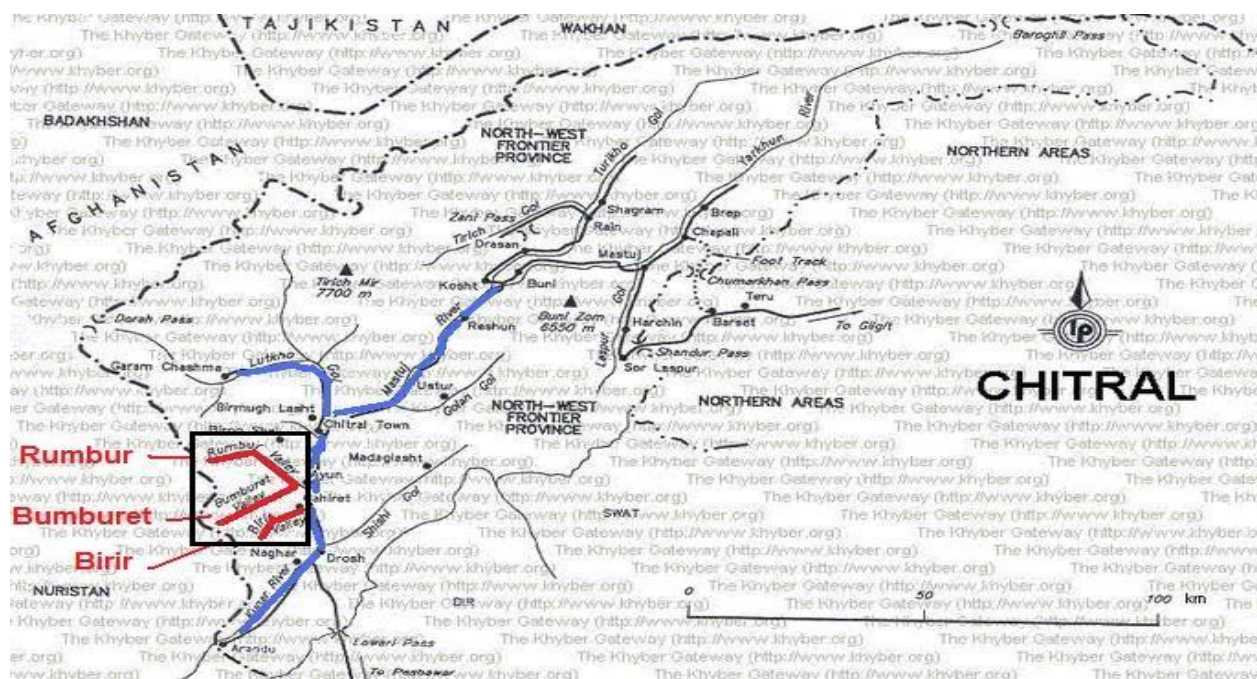


Figure 2. Map of district Chitral showing the study area in black square box

REVIEW OF LITERATURE

1. Floristic composition and its ecological characteristics

Golluscio *et al.* (2005) studied the flora of Patagonian steppe and reported herbs, shrubs and grasses from the area. Mendez (2005) carried out floristic studies on Laguna de Llanqueto Provincial Reserve and reported 240 species belonging to 156 genera and 52 families. Asteraceae was the leading family with 82 species and *Baccharis* and *Stipa* were the most abundant genera. Muoghalu & Okeesan (2005) described 49 climber species of 41 genera and 28 families. Out of these 35 species (34 %) were lianas and 14 (13.7 %) vine species. Climber basal area, density, number of species, genera and families increased with altitude.

Estrella *et al.* (2006) collected 124 species belonging to 52 genera of Ceasalpinoideae group from Equatorial Guinea. Muthuramkumar *et al.* (2006) studied five tropical rain forest communities in the Valparai plateau, Western Ghats and prepared checklist of 312 species. Among these species 144 species were trees, 60 lianas and 108 understory plants. Segawa & Nakuutu (2006) surveyed the Victoria Lake Uganda and prepared a list of 179 species belonging to 70 families in which Rubiaceae was the leading family with 14 species followed by Euphorbiaceae (13 spp.), Apocynaceae (10 spp.) and Moraceae (9 spp.). Similarly, 72 species were trees, 58 were herbs, 39 were lianas and 10 species were shrubs.

Alelign *et al.* (2007) collected 113 woody species and recorded their density and population structure in peninsula of Zegie, northwestern Ethiopia. Costa *et al.* (2007) studied the deciduous thorn woodland of Brazil and found 133 species of 47 families. The life-form spectrum showed that 42.9 % species were therophytes, 26.3% phanerophytes, 15.8% chamaephytes, 12.8% hemicryptophytes and 2.3% species were cryptophytes. Davidar *et al.* (2007) recorded 83 species of 68 genera and 40 families from Palni hills, India. Laidlaw *et al.* (2007) studied the tropical rainforest of Queensland and stated that the major families on the basis of species distribution were Meliaceae, Euphorbiaceae, Lauraceae, Myrtaceae and Apocynaceae. Yadav and Gupta (2007) listed 82 species in the Sariska Tiger Project, India and suggested that only the *in situ* conservation can protect the herbaceous species richness diversity of the area.

Francisco *et al.* (2009) studied family Commelinaceae of Equatorial Guinea and prepared a checklist having 46 species. *Palisota* was the leading genus (11 species) of the family. Gwali *et al.* (2009) studied the Kasagala woodlands, Uganda and enlisted 274 trees and shrubs. Ray & George (2009) carried out phytosociological survey of south India and reported 85 plants belonging to 27 families.

Al-Yemeni and Sher (2010) surveyed Asir Mountains in Saudi Arabia and reported 189 plants distributed in 74 families. Djuikouo *et al.* (2010) studied the flora of Dja Biosphere reserve, Cameroon and reported 281 species. Manhas *et al.* (2010) surveyed Hoshiarpur, Garhshanker and Pathankot in India and found 206 species belonging to 59 families, in which 77.7% species were dicotyledons, 20.4% were monocotyledons and 1.9% were pteridophytes and life form spectrum showed that therophytes (52%) were dominant followed by Phanerophytes (27%). Parswan *et al.* (2010) reported 80 species belonging to 36 families from alpine meadows of kedarnath area and also studied the biological spectrum.

Almeida Jr. *et al.* (2011) studied flora of Restinga, Brazil and reported 51 species of 31 families in which Myrtaceae was dominant family followed by Fabaceae. Kotresha *et al.* (2011) studied the flora of Karnataka, India and reported 303 species belonging to 238 genera and 75 families. Rawat *et al.* (2013) prepared a floristic list of Kandi region, Hoshiarpur, India and reported 176 plant species of 133 genera belonging to 57 families, of these 137 species were dicots, 38 monocots and one species was gymnosperm. Poaceae was the leading family with 30 species.

Fatna *et al.* (2014) studied the vegetation of North-west Algeria and reported 90 species with therophytes as dominant life form. Asteraceae and Poaceae had maximum number of species; the soil of the area was characterized by salinity. Osman *et al.* (2014) reported 196 species of 31 families from Wadi Arar, Saudi Arabia, in which Asteraceae, Poaceae and Leguminosae were the leading families. Life form indicated that therophytes and chamaephytes were the most frequent classes. Sharma *et al.* (2014) studied the flora of Sangla valley, Northern Himalaya and reported 320 species of 199 genera and 75 families, in which Asteraceae, Rosaceae, Apiaceae, and Ranunculaceae were the dominant families.

Dad & Reshi (2015) carried floristic study on Gurez valley, Kashmir and found 111 species belonging to 86 genera and 36 families. They suggested proper conservation of plants of the area.

In Pakistan various researchers have worked on floristic compositions and their characteristics in various parts of the country, which are listed below.

Malik & Malik (2004) reported 9 woody species, 13 shrubs and 36 herbs from Kotli Hills, Kashmir. The study showed heavy overgrazing and deforestation in the area.

Ahmad *et al.* (2005) studied the aquatic plants of Islamabad and reported 29 species. Durrani *et al.* (2005) described plants of Harboi rangeland, Kalat and reported 202 species belonging to 45 families. Therophytes and hemicryptophyte were dominant life forms while dominant leaf sizes were nanophylls, microphylls and leptophylls. Qureshi and Bhatti (2005) studied the Nara Desert and reported 160 plants belonging to 45 families. Out of the species one was gymnosperm, three were sedges, 20 were grasses and the remaining were dicots.

Khan and Sardar (2008) carried out floristic study of Shakargarh, Narowal and reported 317 species belonging to 83 families. Perveen *et al.* (2008) surveyed the Dureji Game Reserve, Khirthar Range and collected 79 plants belonged to 66 genera and 32 families and also reported three rare species from the area. Phenology and Phytosociology of the flora were also recorded. Qureshi & Bhatti (2008b) first time reported five species of the genera *Anticharis*, *Bacopa*, *Kickxia* and *Schweinfurthia* from Nara Desert. These species were narrowly distributed and therefore need proper conservation.

Afzal *et al.* (2009) studied 76 plant species used in different way by different ethnic groups and having distinct life style in the different areas of northern Pakistan. They also added that the unsustainable exploitation of natural habitats have caused great reduction in medicinal plants in the study areas. Hussain and Perveen (2009) studied plants of Tiko Baran, Khirtik Range and recorded 70 species belonging to 59 genera and 31 families. Hussain *et al.* (2009) enlisted 20 grasses, 12 trees species, 31 shrubs and 6 under shrubs and herbs from rangelands of district Chakwal.

Durrani *et al.* (2010) studied the flora of Aghberg rangelands Quetta and reported 123 plant species belonging to 36 families. Asteraceae, Boraginaceae, Brassicaceae, Fabaceae, Lamiaceae and Poaceae were important families of the area.

Bhellum (2012) studied the taxonomic status of genus *Bupleurum* from Kashmir Himalayan and reported 10 species of the genus from different climatic zones of the area.

Wariss *et al.* (2013) enlisted 154 species belonging to 106 genera and 38 families from Cholistan. Out of these 115 species were dicots, 38 monocots and one species was of

gymnosperm. Poaceae was the leading family with 34 species followed by Papilionaceae and Zygophyllaceae with 10 species each. The life forms showed 74 therophytes species, 40 Chamaephytes, 19 Phanerophytes, 18 Hemicryptophytes and 3 Cryptophytes species.

Noor *et al.* (2014) conducted floristic survey of semi-arid areas of different habitats of Chakwal district and found 42 species belonging to 39 genera and 25 families. Of these families three were monocots and 22 were dicots. Shaheen *et al.* (2014) prepared a checklist of 186 plants species belonging to 63 families from Kotli Sattian, Rawalpindi and found that Poaceae was the largest family with 24 species, followed by Asteraceae (20 species), Fabaceae (16 species), Euphorbiaceae (8 species), Lamiaceae & Solanaceae (7 species each) and Brassicaceae (6 species) while remaining 56 families had species between 1 to 5. Similarly, on the basis of life form 45.99% species were therophytes, 29.95% were Phanerophytes, 18.18% were Hemicryptophytes, 4.81% were Chamaephytes and 1.07% species were Cryptophytes. Shaheen *et al.* (2014) worked out the flora of Thal deserts and found 248 species belonging to 166 genera and one pteridophyte, 4 monocots and 33 dicots families. Poaceae was the leading family with 52 species (21.49%) followed by Fabaceae 34 species (13.05%) and Amaranthaceae and Asteraceae with 17 species (7.02%) each. Wariss *et al.* (2014) enlisted the plants of Lal Suharna National Park, Bahawalpur, Pakistan and mentioned 212 species belonging to 41 dicot, 5 monocots, 3 Pteridophytes and one Bryophytes families. Poaceae was the leading family with 43 species, Fabaceae had 16 species, Asteraceae 15, Chenopodiaceae 10, Euphorbiaceae 9, Boraginaceae 8, Amaranthaceae 7, Aizoaceae, Cucurbitaceae, Mimosaceae and Solanaceae had 6 species each. Capparidaceae, Caryophyllaceae and Scrophulariaceae had 5 species each.

Similarly lot of floristic work has been done in different parts of Khyber Pakhtunkhwa, as given below.

Hussain *et al.* (2005) studied the flora of Ghalegay Hills, District Swat and recorded 92 species from 56 families, of these, gymnosperm had one family, pteridophytes and monocotyledons 3 families each while dicotyledons had 49 families. Similarly, Rosaceae was leading family with 10 Species followed by Asteraceae, Lamiaceae and Poaceae with 6 Species each. Nanophanerophytes with 33.6% and microphyllous with 46.6% species were dominant biological classes.

Shah and Hussain (2007) studied saline and water logged habitats of Chamkani area, Peshawar and reported 42 species and 31 families. Sher & Khan (2007) surveyed Chagharzai

Valley, District Buner and reported 222 species belonging to 78 Dicots, 7 Monocots, 3 Pteridophytes and one Gymnosperm families. Asteraceae was leading family with 21 species. Zabiullah *et al.* (2007) studied the flora of Manzaray Baba valley, district Malakand and enlisted 279 species belonging to 81 families.

Fazal *et al.* (2010) worked out flora of district Haripur and reported 211 species belonging to 170 genera and 66 families, in which 7 families were monocots with 26 species and 55 families were dicotyledonous having 180 species. Saima *et al.* (2010) reported 167 species of 139 genera and 65 families from Ayubia National Park Abbottabad. Rashid *et al.* (2011) enlisted 200 plant species of 75 families from Malam Jabba, Swat and established 11 plant communities. They found that therophytes and hemicryptophytes were dominant life forms and microphylls and nannophylls were the leading leaf size classes. The air and soil temperatures were relatively higher in south slopes than on the northeast slopes.

Fawad *et al.* (2013) collected 32 aquatic plant species belonging to 23 families from different water bodies and wetlands of district Swabi. Out of these species 38% species were present in water streams and river banks, 20 % in irrigation channels, 14% in wet land and marshy places and 23% occurred in ponds and stagnant water bodies. Ilyas *et al.* (2013) prepared a checklist of the vascular plants of Kabal valley, Swat and reported 593 species belonging 408 genera and 130 families. Out of these pteridophytes have 20 species, gymnosperms have 8, monocots have 128 and dicots have 437 species. Poaceae was the largest family with 65 species followed by Asteraceae with 44 species. Khan and Shah (2013) listed 27 species of family Brassicaceae from district Mardan and reported that 13.7% species were xerophytes, 82.7% mesophytes and 3.4% were hydrophytes. Similarly, 41% species were non palatable, 23% were less palatable and 38% highly palatable and life form classes showed 66% therophytes, 17% chamaephytes, 14% hemicryptophytes and 3% Geophytes species.

Khan *et al.* (2014) studied the flora of Ashaab Baba graveyard, Peshawar and reported 66 plant species of 32 families. Poaceae was the leading family with 12 species followed by Asteraceae with 9 species, Chenopodiaceae and Moraceae 4 species each, Amaranthaceae 3 species, Brassicaceae, Malvaceae, Papilionaceae, Scrophulariaceae, Solanaceae, Verbenaceae and Zygophyllaceae having 2 species each. Life form spectra showed 40 (60.60%) therophytes, 7 (10.60%) hemicryptophytes, 5 (7.57%) chaemophytes, 4 (6.06%) microphanerophytes, 3 (4.54%) geophytes, megaphanerophytes and macrophanerophytes each and 1(1.51%)

nanophanerophytes. Leaf-size spectra indicated 25 species (37.87%) microphylls, 17 (25.75%) nanophylls, 12 (19.69%) mesophylls and 5 species (9.09%) were macrophylls and leptophylls each. Qureshi *et al.* (2014) studied the flora of Khanpur Dam and reported 221 species belonging to 169 genera and 66 families. Poaceae was the leading family with 33 species (14.86%) followed by Asteraceae with 26 spp. (11.71%), Fabaceae 13 spp. (5.86%), Amaranthaceae & Lamiaceae 9 spp. each (4.05% each), Euphorbiaceae & Solanaceae 8 spp. each (3.60% each), Polygonaceae 7 spp. (3.15%) and Brassicaceae 6 spp. (2.70%) while the remaining families had less than 6 species. 49.32 % of species were perennials, 47.51 % annuals and 3.17% were biennial. The life form spectra showed 42.53% therophytes, 27.15% Phanerophytes, 18.55% hemicryptophytes, 7.24% chamaephytes and 4.52 % cryptophytes.

Ali *et al.* (2015) studied the plants of Mahaban and Malka area of district Buner and found 91 species belonging to 80 genera and 44 families. The hemicryptophytes and therophytes were dominant life form sharing 24.4% species each, while microphyll (34.4%) was dominant leaf size class followed by nanophyll with 26.6% species. Mehmood *et al.* (2015) enlisted the flora of district Torghar and reported 331 vascular plant species belonging to 246 genera and 101 families. There were 12 Pteridophytes species, 6 gymnosperms, 46 monocots and 267 dicot species. Asteraceae was dominant family with 25 species followed by Leguminosae with 24 Poaceae 21 species, Lamiaceae 17 species, Rosaceae 14, Ranunculaceae and Brasicaceae with 10 each, Euphorbiaceae 9 and Apiaceae, Moraceae and Polygonaceae had 8 species each. Remaining families either included 7 or less species.

Some floristic studies on Chitral have also been reported, as given below.

Shah *et al.* (2006) did floristic studies of Mastuj valley and reported 218 species belong to 63 families. Therophyte was dominant life form while leptophyll was leading leaf size class.

Hussain *et al.* (2015) studied the floral diversity of Mastuj valley, district Chitral and found 571 species of 82 families including 65 dicots, 13 monocots, 2 gymnosperms and 2 pteridophyte families. Asteraceae was leading family with 91 species (15.95 %), followed by Poaceae 58 species (10.16 %), Papilionaceae 38 species (6.65 %), Lamiaceae & Rosaceae each with 26 species (4.55 %), Polygonaceae 25 species (4.38%), Caryophyllaceae 23 species (4.03%), Apiaceae 21 Species (3.68 %), Boraginaceae and Brassicaceae 20 species each (3.50 %). There were 45 (13.47%), 32 (9.58%), 19 (5.69%), 18 (5.39%) and 16 (4.79%) genera in Asteraceae, Poaceae, Brassicaceae, Apiaceae and Papilionaceae, respectively.

The review indicates that no reference is available on the floristic composition and ecological characteristics of Kalash valley, district Chitral. Thus there is need to bring on the record the flora and its ecological features from this remote area.

2. Ethnobotany

Ethnobotanical information provides knowledge on the use of plants for the welfare of man and gives a base for scientific investigation on the pharmacological usefulness of folkloric medicinal plants. Thus, lot of work has been done in this field of science.

Basnet and Chhetri (2004) studied Darjeeling Himalayan and reported 32 plants used for fiber. Kakudidi (2004) enlisted 89 plants of western Uganda and used for cultural and social purposes. Macia (2004) investigated Huaorani area of Amazonian Ecuador and reported that the locals use 37 palm species for different purposes such as 64.9% species are used as human food and construction material, 59.4% species for making domestic utensils and 54.6% species as hunting and fishing implements. Rathod and Chaudhary (2004) studied medicinal plants of Patnadevi forest of Maharashtra, India and collected 40 species. Yuming *et al* (2004) highlighted the traditional uses of different types of Bamboo in Yunnan, China.

Tardío *et al.* (2006) reported 419 species of 67 families in Spain that are used for seven different food categories including preparation of beverages, as wild fruits, as sweets, preservatives and so many other such uses.

Adhikari *et al.* (2007) studied 222 medicinal and aromatic shrubs used in Uttaranchal State of India. Arenas and Scarpa (2007) enlisted 57 plant species used by Chorote people as a food in about 118 different ways. Bebbier *et al.* (2007) described the ethnobotanical data about flowering plants of Great Britain. Mizaraite *et al.* (2007) examined the possibilities of increasing the use of wood from private forests in Lithuania for bioenergy purposes. Potential wood fuel supply and consumption were investigated using a literature review and analysis of statistical data. Costs of wood chips production were calculated applying economic simulation.

Miah *et al.* (2009) studied the fuel wood consumption in Bangladesh and reported that about 4.24 tons of fuel wood was consumed per family annually. Mao *et al.* (2009) studied the ethnobotanical profile of various tribes in Northern India and observed that the plants were used for different diseases and helped in the economy of locals. Poonam and Sing (2009) studied the

medicinal plants of Terai Arc Landscape, India and reported 116 species, out of which 23 were used against skin diseases, 16 for rheumatism and 14 to cure fever.

Kumar *et al.* (2011) reported 61 medicinally important plants from Garhwal Himalaya, India. Uysal *et al.* (2012) studied medicinal plants of Ayvacik, Turkey and reported 43 species used as stomachic, in kidney diseases and in cough. Korkmaz *et al.* (2014) studied the genotypes of Ergan Mountain, Erzican, Turkey and documented 25 species of 14 genera and 9 families along with their local name, parts used and the ethnobotanical uses.

Koca *et al.* (2015) studied 13 wild edible plant species used for their dietary fiber contents in Turkey and found that *Trachystemon orientalis* and *Nasturdium officinale* had the lowest amounts of insoluble fiber while the highest was found in *Polygonum cognatum*. *Nasturdium officinale* had the lowest amount of soluble fiber, whereas *Trachystemon orientalis* had the highest. The edible wild plants are rich sources of both soluble and insoluble fibers which have been proven to have positive health effects and help prevent many frequently seen diseases. Korkmaz and Karakus (2015) found 64 species of 53 genera and 29 families while studying medicinal plants of Uzumlu district, Erzincan, Turkey and added that decoction was the main method for using of plants. Majority of species were used as remedies for respiratory system diseases such as cold, cough, asthma, and bronchitis. Saranya *et al.* (2015) studied Mangrove Plant, *Acanthus ilicifolius* and found that the plant is traditional used as blood purifier, diuretic, for treatment of asthma, diabetes, dyspepsia, hepatitis, leprosy, neuralgia, paralysis, ringworm, rheumatism, skin diseases, snakebite, stomach pains, leucorrhoea and leukemia. Qasem (2015) studied halophytic medicinal plants of Jordan and reported 263 species of 59 families used for various ailments. Compositae was leading family with 48 species followed by Gramineae 18 species and Chenopodiaceae 15 species.

Many ethnobotanical studies have also been carried out in Pakistan. Review of some recent references is as follows:

Hussain *et al.* (2004) enlisted 11 species used for various timber purposes in South Waziristan and declared *Populus afghanica*, *Cedrus deodara*, and *Pinus wallichiana* as the best timber wood in the area. Wazir *et al.* (2004) collected 41 ethnobotanically important species from Chapursan Valley, District Gilgit used as medicinal plants by the inhabitants in the valley.

Jabbar *et al.* (2006) enlisted 29 species including *Lamium amplexicaule* L., *Mallotus philippinensis*, *Withania somnifera*, *Azadirachta indica* and *Citrullus colocynthis* from southern Punjab, used to treat helminthosis in ruminants.

Ishtiaq *et al.* (2007) reported that *Solanum miniatum* was used to cure urinary calculi, heart pain and in rheumatism, *Momordica balsamina* leaves as wound healer, *Allium sativum* bulb juice to cure blood pressure, cancer and as contraceptive, *Boerhavia diffusa* roots as anti jaundice, anemia, edema, *Capsicum annuum* fruit as omen against evil eye and giant, yellow fever, *Corriandrum sativum* seeds as diuretic, anti spermatogenesis and *Raphanus sativus* seeds against syphilis. Khan and Khatoon (2007) collected 48 species from Bugrote Valley, District Gilgit, used for medicine, shelter, agricultural tools and fuel. The population of the region primarily depends upon plant resources for their domestic needs. However, some plants are cultivated for these purposes. Qureshi *et al.* (2007) collected 26 species of the vascular plants from the Mianwali district and stated that 21 species were used as medicine and 5 species as food, agricultural implements and in furniture.

Sardar & Khan (2009) worked out the ethnobotanically important plants of Tehsil Shakargarh, District Narowal and recorded 102 species belonging to 93 genera and 62 families, used by locals as fodder, fuel, furniture, brushing teeth, making baskets and mats, medicinal, vegetables and edible fruits. Qamar *et al.* (2010) collected 67 medicinal plants Neelum Valley, Azad Kashmir, traditionally used to cure 32 diseases in and reported that out of these plants, 14 were used as antiseptics, 9 tonics, 8 anti-worm and 7 were commercially extracted and sold in the market. Qasim *et al.* (2010) enlisted 48 coastal plants from Hub, Baluchistan used by inhabitants for different purposes.

Mahmood *et al.* (2011) studied the medicinal plants of district Sialkot and recorded 25 species belonging to 17 families. Noor and Kalsoom (2011) reported 43 plant species of 33 families used for different purposes in Ratwal valley, district Attock.

Khan *et al.* (2012) carried out ethnobotanical survey in Poonch valley, Azad Kashmir and collected 56 medicinal plants belonging to 36 families. They reported that 13 species were used in treatment of urinary tract infection and kidney stone, 12 in diarrhea, 10 in respiratory infections, 9 in Asthma and 6 species in rheumatic problem. Shaheen *et al.* (2012) studied the alpine pastures of district Bagh, Azad Kashmir and reported 71 ethnobotanically important herbs. Zereen & Khan (2012) carried study on trees of central Punjab, Pakistan and collected 48

ethnobotanically important trees species from Vehari, Pakpattan, Lahore, Faisalabad, Nankana Sahib, Sahiwal, Sialkot and Narowal districts of central Punjab, where these trees were used as timber, fuel, medicine, vegetables, fodder and fruits etc.

Ishtiaq *et al.* (2013) carried ethnobotanical survey of Neelum and Muzaffarabad valleys and found 12 species of gymnosperms used by locals as timber, fire wood and as medicines. Noman *et al.* (2013) studied the wild medicinal plants of Ormara, Gawadar and reported 31 medicinal plants of 21 families. 45% of the species were used as medicine, 26% species have multiple uses and 29 % species were utilized as fodder. Pervaiz *et al.* (2013) carried out ethnobotanical study in Dinga, district Gujrat, Pakistan and mentioned 50 species of 29 families, which were used by local peoples as medicines for the treatment of different diseases. Qaiser *et al.* (2013) collected 88 medicinally important plants used by Wazir and Daur tribes in North Waziristan agency of Pakistan and stated that 19 species were tonic, 18 were astringent, 16 were anthelmintic, 14 diuretic, 13 purgative, 12 antirheumatic, 10 stimulant, 6 sedatives and 5 each were carminative and antispasmodic. Zereen *et al.* (2013) collected 35 shrubby plants from central Punjab, Pakistan. They stated that these plants were locally used as medicines, fuel wood, shelter and forage/fodder, etc. and most of the shrubs had a single use at a time.

Nisar *et al.* (2014) enlisted 56 species of medicinal plants from Bahawalnagar that were used for treatment of different diseases. Noor *et al.* (2014) reported 42 plant species of 39 genera and 3 monocots and 22 dicots families from Chakwal district. Out of these, 20.93 % were vegetables/edible, 18.60 % were shading species, 16.2 % were fodder and 9.30% were Forage, potted herbs, fuel and ornamental. Ullah *et al.* (2014) reported 34 ethnobotanically important plants of 21 families from Landi Kotal, Khyber Agency and stated that Lamiaceae and Solanaceae had 4 species each, Asteraceae 3 and Asclepiadaceae, Chenopodiaceae, Mimosaceae, Moraceae and Oleaceae were represented by 2 species each and the remaining families were represented by 1 species each. All these plants were used locally for treatment of 29 different diseases, while over exploitation, over harvesting, grazing, soil erosion and unscientific collection have damaged the local flora.

Ikram *et al.* (2015) reviewed the folklore medicinal plants of family Apiaceae and reported 66 species of the family were used medicinally. Gastrointestinal tract and liver disorders were treated with 28 % species, followed by 11% species for cough, cold and respiratory tract problems. The roots (22%) were frequently used parts followed by whole plant material (19%),

leaf material (18%), fruit (13%), seed (12%), stem, flower, aerial parts (5%) each and sap (1%). Mustafa *et al* (2015) enlisted 62 plants used as cosmetics in Quetta and also worked out the chemical nature of the 15 most important cosmetic plants. Shinwari *et al.* (2015) studied 10 ethnobotanically important plants from Ghazi Barotha, Attock and found that the plants were utilized as food, fodder, medicine, veterinary medicines, timbers, households, oilseeds and also for socio-religious and various other purposes. They also carried out different activities of these plants. Ali *et al.* (2016) enlisted 30 plants from Khyber Agency used for various ethnobotanical purposes i.e. medicine, timber wood, construction, fodder and making different tools.

In Khyber Pakhtunkhwa province lot of work has been done on ethnobotany, which is described below:

Manan *et al.* (2007) enlisted 52 medicinal plants belonging to 35 families from Wari, Dir (upper). Ibrar *et al.* (2007) studied the ethnobotanical wealth of Ranyal Hills, district Shangla, Pakistan and reported 97 plant species out of which 37 species were used each for fuel and forage, 31 as medicines, 18 edible species, 12 for shelter, 10 as vegetables, 9 were poisonous species, 7 ornamental, 6 for timber wood. Shah & Hussain (2008) reported 76 ethnobotanically important species from mount Elum, district Buner.

Kamal *et al.* (2009) reported that 50 plant species of 30 families used for medicinal and other purposes in District Bannu. Khan *et al.* (2009) reported 50 plant species from F.R. Bannu used locally for medicinal and other purposes. The largest families were Poaceae and Moraceae with 5 species each. *Agaricus campestris* was the only fungus used as food. Jan *et al.* (2009) collected 11 gymnosperm species from Dir-Kohistan used locally as medicine, fire and timber wood. Zahoor *et al.* (2009) enumerated the traditional uses of 52 plant species belonging to 45 genera and 30 families from Darra-e-Pezo, District Lakki Marwat for various purposes. Out of these 47 were medicinal plants. Some of useful species were under serious threat due to unsustainable utilization.

Ahmad *et al* (2011) reported 140 ethnobotanically important plants from Tehsil Kabal, district Swat and reported that 133 species were angiosperms, 3 gymnosperms and 2 species each were pteridophytes and fungi. They also added that Lamiaceae was the largest family with 11 species followed by Rosaceae 9 species. The plants were generally used as medicine, food, timber wood, fire wood and as fodder. Alam *et al.* (2011) recorded 141 medicinal plant species from 22 villages of Chagharzai valley, District Buner, where these were used for treatment of

different diseases. Marwat *et al.* (2011) collected 11 wild edible fruit plants from D.I. Khan used by inhabitants for different ethnobotanical purposes. Sher *et al.* (2011) reported 216 plants from Chagharzai Valley, district Buner and mentioned that among these 138 were medicinal, 72 as multi-purpose plants, 66 were fodder and forage species, 51 were fuel wood species, 36 were used as vegetable/pot-herbs, 25 each were fruit and thatching/ roofing species, 21 were timber species, 19 as ornamentals, 15 poisonous plants, 14 fencing/ hedges species, 12 were agricultural tools making species, 9 were honeybee keeping species and one was used to repel bad evils.

Haq (2012) worked out plants of Allai valley, western Himalaya and enlisted 172 plants used as medicines for different purposes in the area, in which 24 species were also used as veterinary medicines. He reported that these plants are generally threatened due to urbanization, deforestation, habitat loss, exotic species, over grazing and non-scientific collection of medicinal plants. Murad *et al.* (2012) carried out ethnobotanical studies on plants of Hazar Nao Forest, district Malakand and collected 90 vascular plant species, in which 72 species were used as medicines, 50 fuel wood species, 32 fodder, 22 edible fruits, 29 attractive to honey bees, 10 utilized in agricultural tools, 11 fencing, 8 each as timber wood, ornamental and thatching species, 7 as vegetable and pot herb, 6 species were poisonous, 4 were veterinary medicines and 20 species had miscellaneous uses. Nasrullah *et al.* (2012) enlisted ethnobotanically important plants of Jandool Valley, Lower Dir and found 67 plants species of 39 families were used as food, medicines, fuel and timber wood and as fodder.

Akhtar *et al.* (2013) collected 106 ethno-medicinal plants from Swat region and concluded that most frequently used plant parts were leaves, fruits and underground parts respectively. 80 plants were indigenous and *Aconitum violaceum*, *Colchicum luteum* and *Jasminum humile* were vulnerable due to excessive collection. Murad *et al.* (2013) collected 58 plants from Banda Daud Shah Area of district Karak, Pakistan and stated that 40 species were used as medicinal, of which 19 were stomachic and 3 each were expectorant and antipyretic, 25 were fuel plants and 18 species were used as fodder. Razzaq *et al.* (2013) reported 32 medicinal plants belonging to 26 families from district Shangla, where these plants were used locally for the cure of different ailments.

Ahmad *et al.* (2014) reported 50 plant species of 35 families from Chail valley, Swat as ethnobotanically important plants, in which 58 % plants were herbs, 28 % shrubs, 12 % trees and 2 % were climbers. The leaves (33%) were the mostly used plant parts followed by roots (17%),

fruits (14%), whole plant (12%), rhizomes (9%), stems (6%), barks (5%) and seeds (4%). Diseases like urinary disorders, skin infections, digestive disorders, asthma, jaundice, angina, chronic dysentery and diarrhea were the commonly treated diseases. Ajaib *et al.* (2014) enlisted 64 ethnobotanical herbs from Agra valley, Parachinar, including 1 Pteridophyte, 1 Gymnosperm and 62 Angiosperms species. 40 % plants were used as medicines, 19 % culinary, 14 % fodders, 5% essential oil, 4 % ornamental, 3 % fuel and 15 % plants were used for miscellaneous purposes. Badshah *et al.* (2014) studied the consumption of fuel and timber wood in rural area of district Tank and reported that annually 18371 metric tons of wood is consumed as fuel by the brick brewers, food sellers and domestic users in the region. Shuaib *et al.* (2014) documented 40 species of 30 families from district Dir (Upper) used for different ethnobotanical purposes by the locals. Raza and Ullah (2014) reported 121 tree species of 87 genera and 40 families from Peshawar Cantonment area. Out of 121 trees, 85 species were grown as ornamental, 55 as timber wood species, 29 species yield edible fruits, 18 species provide oils used for various purposes, 12 as medicinal plants and 3 species were used as vegetables.

Khan *et al.* (2015) studied the ethnobotanical plants of Barawal Valley, Dir (U) and reported 43 species of 25 families used for various purposes i.e. 38 species used for treatment of diseases, 5 species used as fuel, 9 as fodder, 3 as veterinary, 6 as vegetable and 3 species each were used timber wood and as fencing and hedges. Khan *et al.* (2015) documented 48 plant species of 33 families used locally in district Bannu for treatment of different gynecological disorders like gonorrhea, leucorrhoea and menses complications. Khan *et al.* (2015) reported 83 ethnoveterinary plants belonging to 44 families. Of these species one each belongs to fungi and gymnosperm and the remaining 81 species were angiosperm. Most frequently used plant parts were fruit 24(28.57%), seed 18(21.42 %), leaf 15(17.85%), rhizome 7(8.33%), bark 6(7.14%), seed oil 5(5.95%), whole plant 4(4.76%) root 3(3.57%), stem and bulb 2(2.38%) and flower 1(1.19%). Shah *et al.* (2015) found 150 species belonging to 50 families from district Tor Ghar. These plants were mostly used for treatment of wound healing and gastrointestinal problems.

Khan *et al.* (2016) carried out ethnobotanical studies of Tall Daryal, Swat and reported 200 weed species belonging to 164 genera and 72 families. These plants were locally used as fodder and forages, for thatching and construction purposes, for making agricultural tools, as vegetables and as indigenous medicines for treatment of various diseases. Uddin *et al.* (2016)

enlisted 68 plants from Mardan district used for various ethnobotanical purposes i.e. fuel, medicine, timber wood, vegetable, shelter, ornamental, construction and fodder.

From Chitral district some references are also available on ethnomedicinal studies which are given below:

Khan *et al.* (2005) studied the ethnobotanically important plants of Buner, Swat and Chitral. Ahmad *et al.* (2006) worked out the medicinal plants of Booni valley, Chitral, Pakistan and reported 75 species belonging to 40 dicot families, 2 gymnosperm families and one each from monocot and fungi. These plants are used for treatment of different diseases.

Hussain *et al.* (2007) studied the local uses of 111 plant species in Mastuj valley, district Chitral. Ali & Qaiser (2009) listed 83 medicinal species from Chitral valley and concluded that roots were the most frequently used plant part. Khan *et al.* (2011) carried out studied on the medicinal plants of Chitral Gol National Park (CGNP) and recorded 31 species belonging to 21 families. Out of these species 13 were herbs, 10 trees, 7 shrubs and one species was of mushrooms. These plants were used to treat different diseases. Shah & Hussain (2012) listed 82 traditionally used medicinal plants from Mastuj valley, district Chitral.

Bano *et al.* (2013) reported 20 species of 14 families from Mastuj valley that were used as fodder (19 species), medicinal (16 species), fire wood (5 species), vegetable and ornamental (4 species) each, timber (2 species) and one species each used in basketry, musical instrument, paper production and soap production. Hadi *et al.* (2013) studied the ethnobotanical wealth of Rech valley, district Chitral, Pakistan and reported 29 woody plant species used for medicinal and other purposes. They also mentioned that leaves and fruits of these plants were mostly used and Rosaceae was the leading family with eight species.

Hadi *et al.* (2014) collected 31 medicinal weeds from wheat and maize crops of Rech valley, Chitral, which were used locally as astringent, diuretic, laxative, and as anthelmintic. The weeds were also considered useful to cure jaundice, ulcer, skin freckles, piles, abdominal pains and diabetes. Hadi and Ibrar (2014) for the 1st time enlisted the Gymnospermic flora of Kalash valley, district Chitral, Pakistan and mentioned nine species having ethnobotanical uses. The plants were mostly used as fuel and fire wood while few were used medicinal as well.

Hadi and Ibrar (2015) worked out the medicinal weeds of Kalash valley, district Chitral and reported 27 species of 23 genera and 17 families. Abdominal problems were treated by 17 (63%) species followed by 3 (5.43%) species each used as blood purifier and in jaundice, 2

(7.41%) species each were used as antipyretic and wound healer and one (3.70%) species each was used to treat cardiac problems, eye and kidney pains, mouth diseases and as sunburn.

The above review shows that no extensive ethnobotanical investigation has been carried in the Kalash valley, which has unique and ancient civilization and has traditional uses of their local flora. Therefore, the area needs more elaborate work on ethnobotany of this famous and important area.

3. Phytosociology/ Vegetation structure

DeWalt & Chave (2004) studied soil fertility and its effects on density and basal area of trees, palms and lianas in two sites viz: Cocha Cashu and La Selva, in Colorado Island. They found that Cocha Cashu had higher tree basal area and AGB than La Selva. Dondeyne *et al.* (2004) studied the soils and vegetation of nine sites in woodland of South Eastern Tanzania and enlisted 133 species. Eilu *et al.* (2004) worked out the distribution of tree species in Albertine Rift forests, western Uganda and reported 212 species belonging to 159 genera and 53 families. Hurka (2004) studied plant diversity of tropical dry forest of Northwestern Costa Rica and documented 328 plants of grasses, herbs, shrubs, lianas and trees belonging to 79 families and observed that non woody species increased in number after three years of succession. Katende (2004) reported 77 species of macrophytes from different lakes and rivers in Uganda. Walpole *et al.* (2004) studied the woodlands of the Masai Mara National Reserve in Kenya and concluded that these forests are under great pressure of elephant grazing and forest fire. They identified thirteen woody habitats on the basis of species composition, varying from species-rich closed thickets and forest to less diverse open grasslands. Yuming *et al.* (2004) studied the vegetation and uses of bamboo in different mountain communities of China and highlighted that Yunnan province has a great variety of naturally occurring bamboo forests.

Angassa (2005) studied the yield of herbaceous vegetation of encroached and non encroached sites and found that the grasses like *Cenchrus ciliaris*, *Chrysopogon aucheri* and *Panicum coloratum* were common in both sites, while the relative yield increased with non-encroached sites and varied at different altitude. Karsten *et al.* (2005) classified 549 species of plants in 39 plant communities and reported that *Stipa glareosa* and *Allium polyrrhizum* appeared in desert ecosystem while *Anabasis brevifolia*, *Salsola passerina*, *Zygophyllum xanthoxylon* and *Haloxylon ammodendron* were present in semi-arid areas as dominant species.

Mendez (2005) studied the vegetation of Laguna de Llanqueto provincial reserve and established 33 plant communities. Prakash (2005) stated that the density of threatened medicinal plant species varied with protected areas. The Valley of Flowers protected area had the highest number of threatened medicinal plant species. The "moist" habitat type was richest in these species among all 10 habitat types sampled. *Arnebia euchroma* and *Ephedra gerardiana* were the most common threatened medicinal plant species. Ruiz *et al.* (2005) studied the vegetation pattern and species richness in Providencia, Colombia. Srivastava *et al.* (2005) studied the tree vegetation of moist temperate forest of Kewars area.

Dharani *et al.* (2006) studied four sites of woody vegetation of Lake Nakuru National Park along rivers, lakeshores and flood plains and stated that these sites differed from each other in the relative density of *Acacia xanthophloea* trees. These plants regenerated with highest rates in the no fenced plots where browsing occurred. Fleischmann *et al.* (2006) studied the species composition and revealed a little change in forest structure, species diversity and regeneration in the permanent plots over the 13-year period. Kumar *et al.* (2006) studied the phytodiversity and changes in community composition in Western Ghats, India. Lovett *et al.* (2006) studied the changes occurred in woody vegetation over an altitudinal range of 470-1700 m in the Mwanika forests, Udzungwa Mountains National Park, Tanzania. Maestre *et al.* (2006) carried out microcosm experiment to check the individual plant and whole community responses to species richness, species composition and soil nutrient heterogeneity.

Devineau & Fournier (2007) collected 130 herbaceous species from Western African Sudan type Savanna and assessed the composition and richness of these species in the study area. Tripathi & Shukla (2007) compared the vegetation of a well managed and protected site with a moderately grazed, open natural site of University campus and found 100 species in both areas. Out of these 65 were common to both sites, 9 species occurred exclusively at site I and 26 species at site II. Tripathi & Sing (2009) worked on diversity and dominance of woody plants in different strata of natural and plantation forests in wildlife sanctuary, north India.

Adam & Crow (2010) by using TWINSpan analyzed the abundance and frequency from 106 study plots. Six cover types (CT) were defined: *Pinus strobus*–*Gaylussacia baccata* CT, *Fagus grandifolia*–*Ostrya virginiana* CT, *Pinus resinosa*–*Gaylussacia baccata*–*Vaccinium angustifolium* CT, *Tsuga canadensis* CT, *Acer rubrum*–*Dulichium arundinaceum* CT, and Ruderal CT. Sorensen's Index showed a 50.0% similarity with Bear Island, 51.1% with

Rattlesnake Island, and 52.7% with Three Mile Island. The Simple Matching Index showed higher levels of similarity. Sharma & Pandey (2010) studied the vegetation of Thar Desert, Rajasthan, India and reported that the entire region was hot and sandy with sparse xerophytic plants and suggested that study may be used for restoration of natural vegetation in such a desert ecosystem. Altay *et al.* (2012) studied the vegetation of Anatolia, Istanbul and established 13 plant communities.

Khalik *et al.* (2013) studied the vegetation of Wadi Al-Noman, Mecca, Saudi Arabia and found 126 species belonging to 39 families. Fabaceae, Poaceae and Boraginaceae were dominant families and therophytes and chamaephytes were leading life-form classes. The highest species richness value (23 species stand⁻¹) was recorded in the wadi bed and the lowest species richness value (18 species stand⁻¹) was recorded in the wadi plateau and fissures. Four vegetation groups were identified and named after the characteristic species. Rao *et al.* (2013) carried phytosociological study on red sand dunes of Visakhapatnam, India and listed 105 plant species belonging to 41 families and reported that Fabaceae was leading family in species distribution, while in herbs *Tephrosea purpurea*, in shrubs *Lantana camara* and in trees *Anacardium occidentale* showed maximum IVI values. Similarly, *Acalypha alnifolia*, *Waltheria indica* and *Sapindus emarginatus* in herbs, shrubs and trees respectively, have least IVI values and were considered as rare species in the study area. Saglam (2013) studied Phytosociology of forest, shrub, and steppe vegetation of Kızıldağ (Isparta province), Turkey and established plant associations and determined the life form and leaf size spectra of the plants.

Han *et al.* (2014) studied the vegetation of Sejila Mount, Tibet and found 99 species of 26 families and selected eleven sampling areas and the vegetation composition, species diversity, plant biomass and soil properties were measured in each one. Ighbareyeh *et al.* (2014) carried out phytosociological studies in Idna, Hebron area, Palestine and collected 237 species and proposed eight plant communities. Sharma *et al.* (2014) studied the vegetation of Sangla Valley of northwest Himalaya and recorded 15 plant communities having 320 species of 199 genera and 75 families, in which Asteraceae, Rosaceae, Apiaceae, and Ranunculaceae were dominant. Trees and shrubs showed density of 205 to 600 and 105 to 1030 individuals per hectare, respectively, whereas herbs ranged 22.08 to 78.95 individual per m². Similarly, 182 species were found native to the Himalaya and maximum species were found in northeast and north regions.

Pradhan *et al.* (2015) prepared checklist of flora of Bhitarkanika National Park, Odisha, India and found 10 plant species belonging to 9 families, of which 4 and 10 species each of mangroves were reported from the core and non-core zone of the Bagagahan Heronry. At the core of the Bagagahan Heronry their highest importance value index (IVI) (237.92) was recorded for *Excoecaria agallocha* and in the non-core the highest IVI was also recorded for *Excoecaria agallocha* (153.08) and least IVI was recorded for *Hibiscus tiliaceus* (4.37) in the core zone and *Salacia prinoidea* (2.47) in the outer non-core zone.

In Pakistan too extensive work has been done on vegetation structure and Phytosociology which is summarized below:

Malik & Malik (2004) reported 58 plant species and established seven plant communities in Kotli Hills, Azad Kashmir.

Arshad *et al.* (2008) analyzed vegetation types for density, frequency, cover and importance value index in rangelands of the Cholistan desert. The result showed marked important relationships between soil characteristics and plant species. Perveen *et al.* (2008) studied the species diversity and Phytosociology of Dureji game reserve and investigated life form, density, relative density, cover, relative cover frequency and relative frequency and concluded that vegetation structure and density was greatly influenced by the rainfall. One of the main threats to the vegetation of the study area was grazing. Qureshi (2008) established five plant communities based on Importance Value while studying vegetation of Sawan Wari of Nara Desert.

Abbas *et al.* (2009) studied Phytosociology of grey goral range and found 22 trees species, 24 shrubs, 31 herbs and 52 grasses. They reported that the plants formed different canopy covers in different stands viz: trees showed (3.80-44.42%), shrubs (6.20-68.73%) and herbs/grasses (9.89-59.54%). Trees and shrubs constituted perennial layers, while herbs and grasses dry up during autumn and winter. They established eight communities, each having its own species composition and distributed. Hussain & Perveen (2009) studied the plant biodiversity and Phytosociology in Tiko Baran, Khirthar range, district Dadu, Sind and described the life forms, species density, species cover, species relative density and frequency of the vegetation.

Siddiqui *et al.* (2010) carried out quantitative vegetation studies in moist temperate coniferous forest of Himalayan region of Pakistan and formed three groups on ordination, group-

I was dominated by *Pinus wallichiana* stands, group-II by *Abies pindrow* and group-III by *Cedrus deodara*. Akbar *et al.* (2010) established seven plant communities in Keenjhar Lake, Sindh, dominated by *Luffa echinata*, *Populus euphratica* and *Tamarix sarenensis*.

Farooq *et al.* (2010) established communities of Pinus-Abies-Sophora, Pinus-Abies, Abies-Cedrus, Abies-Pinus and Pinus-Abies in Push Ziarat, Waziristan and reported that the plants were used as valuable timber; firewood, medicinal and aromatic plants. The population explosion and use of forest land for agriculture purposes have caused reduction in vegetation cover in the area. Hussain *et al.* (2010) carried out phytosociological studies of Central Karakoram National Park (CKNP), Pakistan and recognized one tree, two forest types and three bushes communities.

Rahim *et al.* (2011) studied the vegetation of Agro Farm, Sheikhpura and identified 12 associations of different plant species. Nazir *et al.* (2012) studied the vegetation of Sarsawa Hills, Azad Kashmir and reported 40 species and established 10 plant communities. Saeed *et al.* (2012) while carrying phytosociological studies on Lahore city reported 52 chasmophytes and 35 epiphytes.

Amjad *et al.* (2013) studied Phytosociology of Pinus-Quercus forests of Nikyal hills, district Kotli, Azad Kashmir and mentioned thirteen plant communities. They observed that the altitude of the area was from 1535 – 1860m and the soil was loamy to clay loamy with slight basic pH. Shaukat *et al.* (2014) studied the vegetation structure, composition and diversity of Hub-dam catchment area and collected 106 species of which 57 were annuals and 49 were perennials. The vegetation was dominated by small trees and shrubs. Species diversity was measured and diversity was averaged for each group. Four major community types were recognized by Ward's cluster analysis, each of which was associated with particular topographic-edaphic factors, while one was mainly governed by anthropogenic disturbance. Biological spectrum constructed for the flora showed dominance of therophytes and chamaephytes.

Hussain & Perveen (2015) carried out phytosociological survey on plants of fort Ranikot (Kirthar range) and enlisted 107 taxa of 78 genera and 41 families. Poaceae was leading family with 9 species followed by Papilionaceae with 6 species and Asclepiadaceae, Mimosaceae and Solanaceae had 5 species each. Six plants communities were recognized from different sites of the study area. The study area was categorized into six ecological sites on the basis of

microclimatic conditions and topography. For comparison in these sites similarity index, beta diversity, diversity index, species evenness and maturity index was also calculated.

Shaheen *et al.* (2015) carried out botanical studies of Western Himalayan, Kashmir and reported 65 species belonging to 26 families and 6 plant communities. Average value of diversity recorded for the communities was 2.44, species richness 4.01 and evenness was found to be 0.48. *Themeda anathera* was dominant species with IV of 14.7% followed by *Pinus roxburghii* (9.6%), *Mallotus philippensis* (5.2%), *Malvastrum coromandelianum* (5.1%), *Acacia modesta* (5%), *Olea ferruginea* (3.8%) and *Oxalis corniculata* (3.2%). Therophytes was dominant life form with 30% species followed by megaphanerophytes having 23.3% species. Leptophyll was leading leaf size class with 31.6% species. Ullah *et al.* (2015) studied the Phytogeography and diversity of grasses in Northern Pakistan and found 117 species of 30 genera in three families of the order *Poales*. *Juncaceae* is represented by single genus *Juncus* with four species, *Cyperaceae* by 5 genera and 27 species and *Poaceae* being the dominant family with 25 genera and 86 species. *Carex* and *Poa* are the largest genera having 21 and 16 species respectively. Phytogeographic analysis of the *Poales* of temperate and alpine regions of Northern Pakistan shows twelve different phytogeographic elements. The highest percentage of species (30%) belongs to the western Himalayan floristic region (near endemics), with cosmopolitan elements (19%), Central Asian elements (17%) and Eurasian elements (12%) being the other significant elements.

In Khyber Pakhtunkhwa province the following research work is reported on phytosociological studies:

Hussain *et al.* (2005) established seven plant communities during phytosociological studies of Ghalegay Hills, district Swat. Shah and Hussain (2008) established six plant communities while studying the vegetation of Akberpura wetlands, Nowshera.

Ahmad *et al.* (2009b) identified 63 species and five major plant communities along the roadside vegetation of Abbottabad by using multivariate analysis techniques *i.e.* (DCA) and (CCA). Shah and Hussain (2009) worked out the vegetation of Hayatabad, district Peshawar and established 5 plant communities. Asteraceae, Brassicaceae, Poaceae and Solanaceae were the leading families. Therophytes (48%) and cryptophytes (19%) were dominant life form classes and microphyllous (40%) and leptophylls (22%) were dominant leaf size.

Ahmad *et al.* (2010c) studied the vegetation of selected graveyards of Swat and reported that these were comparatively less disturbed and the floristic composition was different from elsewhere due to religious sanctities. Wahab *et al.* (2010) carried phytosociological studies in district Dir and determined frequency, density, basal area and importance values for establishing communities.

Khan and Hussain (2013) studied vegetation structure of Tehsil Takht-e-Nusrati plains and established 11 plant communities and the cluster analysis resulted in 5 groups on the basis of important value and 4 groups on basis of soil. Shah & Rozina (2013) documented 72 plant species from Dheri baba hill and Peer Taab graveyard of district Swabi and established twelve different plant communities. Most of the communities were dominated by therophytes and were better adapted to dry climate. The life form and leaf size also showed that therophytes (30%) and chamaephytes (13%) were dominant in all the stands.

In district Chitral the following researchers have worked on Phytosociology:

Khan *et al.*, (2010) studied *Quercus* forests in Chitral and reported five Pure *Quercus* stands and three co-dominant stands at high altitude. Shah (2014) established 33 plant communities in the Mustuj valley, Chitral.

No other published reference is available on vegetation study of the area. Therefore, there is a dire need for such study in Chitral.

4. Palatability of vegetation

Evans *et al.* (2004) observed that seasonal changes occurred in cattle for diet selection in montane Riparian vegetation Northern Colorado. Hickman *et al.* (2004) stated that grazed area were rich in native plant diversity, in species richness and growth form as compared to ungrazed prairie. Lucas *et al.* (2004) mentioned grazing treatments appeared to have been successful at maintaining riparian communities and increase in grazing pressure did not have significant impact on cottonwood populations. Mapinduzi *et al.* (2004) concluded that calf-grazing pastures were rich in herbaceous species as compare to the non-calf pastures. They added that the indigenous systems of landscape classification provided a valuable basis for assessing rangeland biodiversity. Wang (2004) observed that the proportion of the total biomass as rhizomes increased considerably with increased grazing intensity, and peaked on the extremely high grazing treatment. Shoot and tiller densities, and the proportion of the total biomass as rhizomes

were strongly negatively correlated with soil organic matter content and soil moisture. Volesky *et al.* (2004) studied the appearance and composition of wet meadows having cool season vegetation affected by grazing frequency and stocking rate.

Chocarro *et al.* (2005) studied the effects of one severe winter-grazing of lucerne over 3 years in the Ebro Valley, Spain. The traditional practice, i.e. grazing lucerne with sheep once in the winter season resulted in only a limited reduction in yield in the spring. In addition, the spring crop has a higher nutritive value. Hirata *et al.* (2005) evaluated that the higher cover of herbaceous vegetation showed higher grazing impacts which reduced the total available forage at the end of the growing season by the end of the dry season. The importance of maintaining plant cover over the rangeland area to protect the land against soil erosion was stressed. Miller & Thompson (2005) stated that *Cortaderia pilosa* was the predominant species consumed during the cooler periods of the year. In the summer, when the highest live weight gains of sheep occur, the proportion of fine grass species, including *Poa spp.*, *Festuca magellanica* and *Agrostis capillaris*, and that of herbs and sedges in the diet was highest. Herbage intake was the highest during the summer periods when digestibility was also at its peak. Ross *et al.* (2005) stated that the impact of harvest timing on total yield decreased as the proportion of berseem clover in the intercrops increased. With decreasing density of oats, dry matter yield of first-cut intercrops and total dry matter yield of oats decreased, while regrowth and total dry matter yields of berseem clover increased. Oats–berseem clover intercrops showed potential to manipulate the pattern of annual forage yield and to provide flexibility of harvest without reducing annual yields.

Dalle *et al.* (2006) determined the density and cover of woody species in 192 plots of 500 m². Results showed that plant density was 3014 woody plants ha⁻¹. Cover of woody plants was 52%, indicating an increasing trend from ≤40% cover reported in the early 1990s. It was concluded that the increase of woody plants density and cover has crossed the critical threshold and has entered into the encroached condition. Knoop & Smith (2006) recorded changes in the extent of grazing of different grass species, height differences between grazed and ungrazed tillers and intensity of cropping per tuft. In the dry year, the extent of grazing in the upland exceeded that in the bottomland, and several upland grass species little used the previous year became heavily grazed. Milewski & Madden (2006) examined that intensive browser utilization were observed to lose shoot tips, produce long thorns, and have relatively few flowers and fruits. Browser utilization was associated with increased lateral branching and with an increased

occurrence of short, thickened spines. Pavlu *et al.* (2006) stated that delayed defoliation resulted in an increase in the number of forbs plants, particularly in the number of *Taraxacum* spp. most probably due to an enabling of its seed production. It is evident that increased plant density as a function of intensive defoliation was not restricted to the frequently documented effect on grass tillers but also can occur in many legume and forbs species in species-rich grasslands. Randall & Diaz (2006) experimentally tested plant community responses of spring-fed wetlands to two levels of grazing intensity (light and moderate) and no grazing over 10 years. An herbaceous cover over time was negative under moderate grazing but positive under light grazing and without grazing. Species composition was highly variable from year to year at springs. Rakotoarimanana & Grouzis (2006) studied the separate and combined effects of fire and grazing on species diversity, composition and richness in savanna dominated by *Heteropogon contortus* and *Poupartia caffra*. Smit *et al.* (2006) stated that grazing intensity was significantly higher in plots without unpalatable plants, and significantly higher in plots with *Cirsium* than with *Gentiana*. Large tree saplings survived significantly better than small ones, and depended less on the unpalatable plants for survival. This study shows that unpalatable plants can enhance tree regeneration in wooded pastures.

Loeser *et al.* (2007) concluded that high-impact grazing had strong directional effects leading to a decline in perennial forbs cover and an increase in annual plants, particularly the exotic cheatgrass (*Bromus tectorum*). Cattle removal resulted in little increase in native plant cover and reduced plant species richness relative to the moderate grazing control. Intermediate level of cattle grazing may maintain greater levels of native plant diversity than the alternatives of cattle removal or high-density, short-duration grazing. Peters (2007) stated that the gastropods and small mammals both were important controllers of California annual grassland that exert similar influences on production and composition. Selective consumption of grasses by gastropods and small mammals partially offsets the competitive advantages associated with their early germination.

Glindemann *et al.* (2009) studied the herbage mass affected by grazing intensity of sheep in China. Mohammad & Beleke (2010) reported 213 forage species Ethiopian Rift.

Bailey and Brown (2011) highlighted the effects of grazing behaviour and grazing systems on rangelands.

Very little work is available on palatability of range plants in Pakistan.

Neal & Miller (2007) studied the vegetation of Khirthar National Park and stated livestock grazing drastically affected some herbaceous species but many grass and herb species reappeared after rain, which suggests that through livestock grazing might have eliminated these plants during dry season, but in the soil seed or bud bank persists. Hussain & Durrani (2009) studied forage plants of Harboi range land and stated that the seasonal availability of forage, palatability and preferences of goats and sheep varied in their botanical composition throughout the growing season. There were 129 palatable species including 65 (50.4%) highly palatable species, 53 (41.1%) most palatable, 6 (4.65%) less palatable and 5 (3.87%) rarely palatable species. In 99 species (63%) shoots/whole plants were used, in 30 species (19%) foliage/leaves were used while in 29 Species (18%) floral parts were consumed. Goats browsed on 104 species including 60% herbs, 27% shrubs, 12% grasses and 1% tree species. Sheep consumed 98 species that included 54% herbs, 22% shrubs, 23% grasses and 1% tree species.

Amjad *et al.* (2014) enlisted 110 plant species from Nikyal, Kotli, Azad Kashmir and stated that 60 species (55%) were palatable and 50 species (45%) were non-palatable. Out of the palatable species 10 (16.66%) were highly palatable, 22 (36.66%) mostly palatable, 19 (31.66%) less palatable and 9 (15%) were rarely palatable species. The preferred plant parts were leaves (42, 53%) and least acceptable parts were flowers/fruits (14, 18 %). Similarly, the goat browsed on 52 species, sheep on 36 species, cow on 31 species and buffalo 37 on species.

Similarly limited published data is available on the plant palatability in Khyber Pakhtunkhwa.

Rafique (2005) worked on the forage plants of northern mountainous parts of Pakistan and stated the current use of these plants and their implications for sustainable development. Sher *et al.* (2010) stated that nomadic grazing on medicinal plants has created severe threats for the future of these plants in Miadam, Swat.

Khan and Hussain (2012) reported 161 plant species from Tehsil Takht-e-Nasrati, District Karak, of these 29 species were non palatable, 32 were highly palatable, 43 were mostly palatable, 34 were less palatable and 23 species were rarely palatable. 83 species were preferred in fresh, one species in dry and 48 in both forms. 118 species were palatable for goats, 79 for camels, 61 for cows, 51 for sheep and 43 species were palatable for donkeys.

No reference on forage palatable plants is available on the research area, therefore, the present study will be help to record information on this aspect.

5. Rangeland Productivity

Bebika & Sharma (2004) studied the net production of 34 different macrophytic species for one year on the basis of monthly intervals in Sanapat lake Manipur, India. They noticed highest production in *Alternanthera philoxeroides* followed by *Nelumbo nucifera*, *Ludwigia adscendens* and *Eichornia crassipes*. Dewalt & Chave (2004) studied the structure and biomass production of four different Neotropical forests.

Angassa (2005) studied the effects of woody encroachments on the herbage yield of grasses at three localities of Borana rangeland. Timothy *et al.* (2005) concluded that in western United States the timing and duration of grazing have dramatic influence on the cattle distribution in riparian and upland range areas, early in the season, cattle prefer south-facing aspects with more open canopies for grazing of forested rangelands while in the late-season they concentrate to northern aspects with denser canopies and more diverse food.

Starks *et al.* (2006) studied the pastures of three varieties viz: Midland, Ozarka and experimental hybrid of Bermuda grass (*Cynodon dactylon*) under same field management and stocking rate and determined the herbage biomass, nutritive value and canopy of these varieties.

Liddell *et al.* (2007) studied the canopy crane, crown and stem biomass of six major tree and palm species and determined their above ground biomass in complex tropical rain forest.

Armstrong *et al.* (2010) examined options for a dairy farm in the high rainfall area of Gippsland, Southern Victoria and identified (i) increased herd size without purchasing more land, (ii) increased milking area and (iii) purchasing non-milking area for production of conserved fodder. Dishi & Daniel (2010) obtained 2130 Kg DM/ha of forage product from Gongoshi grazing reserve, Nigeria. Torell *et al.* (2011) studied the effects of seasonal rainfall and moisture on grass yield in Blue Gana range.

In Pakistan some references can be traced for rangeland productivity.

Farooq (2003) reported that rangelands are spread on about 62 percent of total area of Pakistan and are the largest natural resources that support more than 91.091 million livestock and suggested that the conversion of grasslands of the country to sown pastures can improve the productivity. Abbasi & Khan (2004) studied the growth, vegetative yield and N uptake of white

clover in the mountainous areas of Azad Kashmir. Hussain & Durrani (2007) studied the forage productivity of harboi rangeland and stated that the annual average dry biomass production was 10772.5 Kg/ha. The months of July and August were the most productive months in the year. They observed that the range was suffering with overgrazing, over exploitation and soil erosion.

Kiyani (2008) reported that small and large farm sizes have high land productivity than middle farms, because small farms have intensive labor and irrigation system while the large farm has maximum capital. The middle farms have inefficient combinations of inputs that are used. Mirza *et al.* (2009) reported that continuous drought in Baluchistan has reduced the annual range productivity from 150-180 Kg DM/ha to 30-45 Kg DM/ha.

Chaudhry *et al.* (2010) worked on the forage production in Mari reserve forest, Potohar region and stated that treated/reseeded areas produced 7733 Kg/ha forage while untreated area gave only 491 Kg/ha of forage. Khan and Hussain (2012) studied shrub biomass of Takht-e-Nusrati and found that the average shrub biomass was decreasing with increasing altitude. The biomass of *Saccharum bengalense* was high 5020.38 Kg.hec⁻¹ in phase 1 and phase 2 (4331.58 Kg.hec⁻¹). The highest ground biomass 1125.1 Kg.hec⁻¹ of *Zizyphus nummularia* was found in Phase 3. Furthermore in Phase 4 the biomass of *Capparis decidua* was high 437.79 Kg.hec⁻¹. Along with shrubs average biomass of *Saccharum bengalense* was high 2665.12 Kg.hec⁻¹ and low 13.47 Kg.hec⁻¹ of *Cassia angustifolia*. With seasons the biomass of *Saccharum bengalense* (13800 Kg.hec⁻¹) was greater during winter at Phase 1 and *Periploca aphylla* (12.35 Kg.hec⁻¹) biomass was lower during spring at Phase 4. The biomass of shrubs is high in winter while it was low in summer as the grazing and palatability rate of shrubs was high in summer as well as low in winter.

No reference is available in this regard for district Chitral.

6. Chemical evaluation of forage species

Coskun *et al.* (2004) reported that metabolized energy concentration of 12.2, 11.9 and 12.7 kg⁻¹ dry matter (DM) was respectively estimated in whole plant, leaves and stems. This compares favorably with high quality forages commonly used in ruminant feeding. *Prangos ferulacea* was found to be energy rich forage, but its intake characteristics and the levels of animal preference should further be investigated. Sahito *et al.* (2004) found a considerable amount of Ca, K, Zn and Mg in whole plant parts of *Moringa oleifera*.

Carvalho & Saraiva (2005) reported that sugar, ash, both macro elements (Ca, Na, K, Mg) and microelements (Fe, Zn, Mn, Cu) and phytate contents increased in water stress condition. Rothschild *et al.* (2005) studied the chemical composition of two varieties of *Cannabis sativa* and found 68 different compounds in them. Smith *et al.* (2005) examined the indehiscent fruits of six tree species and found that *Acacia nilotica ssp. nilotica* contained high phenolics than *D. cinerea*, but less N and fiber (ADF and NDF. Staaland *et al.* (2006) analyzed some most important reindeer forage plants in Svalbard and found higher contents of Na, Ca, Mg, Cl, Fe and Co, than similar plants from Southern Norway. Starks *et al.* (2006) studied pastures of genotypes of *Cynodon dactylon* and found seasonal variation in neutral-detergent fiber (NDF), acid-detergent fiber (ADF), herbage mass and crude protein concentrations of herbage and canopy reflectance.

Dairo & Adanlawo (2007) examined the proximate composition, mineral and amino acid profile of two green leafy vegetables, *Crassocephalum crepidioides* (CC) and *Senecio bialfrae* (SB). The former contained $27.17 \pm 0.51\%$ crude protein while the latter has $28.93 \pm 0.68\%$. Similarly, the crude fiber contents of SB were $7.26 \pm 0.22\%$ and $8.13 \pm 0.06\%$ for CC. The ash content for SB was $16.30 \pm 0.21\%$ and $17.31 \pm 0.02\%$ for CC and nitrogen free extract (NFE) for SB was $20.81 \pm 1.36\%$ and $19.03 \pm 0.56\%$ for CC. Garg *et al.* (2007) analyzed the mineral composition of 15 wild herbs and found that majority of these were enriched in Ca, Co, Cu, Mg, P, Fe, Mn and Zn. Some of these were often used as antibacterial, antipyretic and heart tonic and were enriched in Co, Cr, Cu, Na, Mn, Fe, Rb and Zn. Phillips *et al.* (2007) found that with maturity the concentration of protein in the plants falls below the dietary nutrient requirement required to maintain animal growth, so the calves grazing of warm-season grass pastures reduced during the late summer as compared to earlier part of summer.

Chiesa *et al.* (2008) reported that organic matter, neutral detergent fiber and nitrogen intake, as well as rumen ammonia-N concentration decreased linearly with age of regrowth. Acid-detergent fiber and indigestible intakes were similar for all treatments. Apparent digestibility of organic matter NDF and N, as well as true digestibility of OM, microbial protein synthesis in the rumen, N retention, pH of rumen fluid and sugars, amino acids and peptide concentrations in rumen fluid were similar for all treatments. Gutierrez *et al.* (2008) studied the mineral, crude protein, fiber and total phenolic contents of 14 weed species in Mexico and found that the crude fiber and protein contents in most of the weeds have fulfilled the recommended

range required for cattle. Zhao *et al.* (2008) reported that forage nitrogen (N) and nonstructural carbohydrate (NSC) concentrations are important indicators of forage quality, and knowledge of N and NSC variation among grass germplasm is one element to be considered in developing a successful forage and livestock management program.

Andueza *et al.* (2010) studied the nutritive values of two different permanent grasslands and found that the grassland with rich forbs showed high level of organic matter digestibility than the grassland rich in grasses. Gjorgieva *et al.* (2011) studied nine elements in four medicinal plants and found that all the plants were rich in nutrients and in Mg, Ca and K.

Agili (2014) analyzed the chemical composition of *Thymus vulgaris* and found that the oil extract contains 54.26 % thymol, 9.50 % γ -terpinene, 7.61 % *p*-cymene, 4.42 % carvacrol, 3.27 % terpinolene, 2.36 % α -terpinene, 1.63 % α -terpineol and 1.52 % α -tujene as major constituents. Aryapak and Ziarati (2014) studied the nutritive values of *Juglans regia* in Karaj and Tehran areas of Iran and found high amount of calcium and copper in the fruits, 60.9 to 73.1% oil, 13.5 to 20.2% crude protein, 1.0 to 4.3% dietary fiber and 2.6 % starch content. They also added that oleic, linoleic, linolenic and palmitic acids were the main fatty acids of walnut kernel which might be the source of edible oil and other industrial applications.

Dominguez-Gomez *et al.* (2015) studied macro (Ca, K, Mg, Na and P) and micro (Cu, Fe, Mn and Zn) nutrients in foliar contents of *Acacia amentacea*, *Celtis pallida*, *Forestiera angustifolia* and *Parkinsonia texana* and found that *Celtis pallida* showed the highest values. Similarly *A. amentacea* had the lowest macronutrient content and *arkinsonia texana* has highest concentration of micronutrient content while *A. amentacea* was the poorest in this respect.

Ruizhi *et al.* (2015) analyzed the black soybean (*Glycine max* (L.) Merr. in China and found 24 trace elements of which K, Mg, Ca, Zn, Fe and Mn were beneficial for human health. Saranya *et al* (2015) analysed the chemical constituents of Mangrove Plant, *Acanthus ilicifolius* and found glycosides, alkaloids, flavonoids, triterpenoids, steroids, fatty acid derivatives and saponins. Wu *et al.* (2015) studied the effect of elevation on the chemical components of shoot and leaf of *Camellia oleifera* and found that in different elevations the ratio of bound water to free water of the leaf varied from 0.11-0.22, the contents of holocellulose, cellulose, lignin and benzene-ethanol extracts varied from 25.08%-62.72%, 7.72%-36.61%, 11.80%-30.29% and 7.66%-8.57% respectively. In the same elevation, the content of benzene-ethanol extracts of leaf was higher than that of shoot, and the contents of other materials were quite the contrary. The

elevation was positively correlated with the ratio of bound water to free water and the contents of holocellulose, cellulose, lignin and benzene-ethanol extracts.

In Pakistan the studies reported on the chemical and nutritional evaluation of forage plants are given below:

Pirzada *et al.* (2005) worked on the essential elements and antifungal activity *Fagonia critica*. Khan *et al.* (2006a) found that Fe, Zn, Co, and Se were higher in soil and Cu and Mn were lower during winter than during summer. Similarly, forage Zn levels was reduced to marginal deficient levels during summer while all other forage micro-minerals were within the required range for ruminants during both seasons. Khan *et al.* (2006b) studied the levels of macro and micro minerals of herbage forages of a grazing pasture of Leiah district of Punjab and found that the grazed forages had slightly higher concentration of Ca and Mg than the minimum recommended levels of diets for ruminants. The forages had lower levels of Cu and slightly low to moderate level of Zn as compared to recommended dietary requirements of ruminants.

Kiyani *et al.* (2007) analyzed 37 plant species of Quetta-Balochistan for secondary metabolites and found that only four species contained alkaloids, saponins, tannins and the phenolic contents. Hussain & Durrani (2008) worked on Harboi rangeland, Kalat and analyzed K, P, Cu, Mn, Fe and Zn in some grasses and shrubs at three Phenological stages. The Cu was higher in shrubs while Mn was higher in grasses and the differences in the K, P, Mn, Fe and Zn were insignificant among the various Phenological stages.

Khattak & Khattak (2012) found heavy trace metals in variable amount in 35 medicinal plants. Sher *et al.* (2012) analyzed eight forage shrubs for macro-nutrients at three Phenological stages and found the minerals in different concentration except Ca which almost remained at same level.

Ahmad *et al.* (2014) studied the nutritional composition of *Caralluma tuberculata* and found a good amount of proximate materials, mineral elements and phytotoxic properties. Ahmad *et al.* (2014) studied metals and metalloids in turnip cultivated in two areas in Peri-Urban, Khushab, irrigated with domestic waste water. They found Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Mo, Cd and Pb in different concentration in turnip of both sites.

Ahmad *et al.* (2014) analyzed spinach (*Spinacia oleracea*) of two different sites Phularwan and Chaba Purana of district Sargodha and found Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se,

Mo, Cd and Pb in different concentrations. It was also found that the concentration of Mo, Cd and Pb in spinach exceeded the permissible limit suggested by the World Health Organization.

Dastagir *et al.* (2014) evaluated the nutritive values of some members of family Zygophyllaceae viz: *Fagonia indica* Burm. f., *Peganum harmala* L., *Tribulus terrestris* L., and two members of family Euphorbiaceae viz: *Chrozophora tinctoria* (L.) Raf. and *Ricinus communis* L. They found that *P. harmala* had high fat, carbohydrate, protein and moisture contents than other species of the family and *C. tinctoria* had high moisture, ash contents, protein, fats, fibre, carbohydrate and gross energy than its counterpart *R. communis*. Lutfullah *et al* (2014) analyzed plants materials of *Aloe vera*, *Cucumis sativus*, *Citrus paradisi*, *Citrus aurantium*, *Punica granatum* and *Olive europaea* and concluded that *Olea europaea* has shown higher concentration of the crude fiber (22%) and crude fats (2.5%), while *P. granatum* had higher concentration of brix (2.5%).

Ashraf *et al.* (2015) analyzed chemical composition and biological activities of leaves *Ziziphus mauritiana* and found greater amount of total phenolics and flavonoids in leaves. They found methyl stearate (15.59%), palmitic acid (38.55%) and α -linolenic acid (26.45%) as the major components of methanol, chloroform and hexane extracts respectively in addition to presence of several other bioactives. Khan *et al.* (2015) analyzed Luffa irrigated with domestic waste water and found some heavy metals and metalloids like Cr, Mn, Ni, Cd, Co, Cu, Pb, Zn, Fe, Se, As, and Mo at two different sites of Jhang, Punjab. Khan *et al.* (2015) analyzed four varieties Karbala, Cobra, Aseel and Shimla Pakistan and two Muzawati (Iran) and Zaitoon (Saudi Arabia) of date palm and found moisture contents ranged from 20.9-22.0%, ash 1.7-2.0%, protein 1.7-2.0%, fats 0.4-0.5%, fiber 1.8-2.3% and carbohydrates ranged from 71.5-73.9% in Pakistani varieties, while in foreign varieties the moisture ranged from 19.7-21.0%, ash 2.1-2.2%, protein 2.1-2.3%, fats 0.6-0.6%, fiber 1.9-2.0% and carbohydrates from 72.2-73.3%. They concluded that Pakistani varieties displayed the same nutritional values as observed in several other foreign varieties.

Limited literature is available about the chemical and nutritional evaluation of forage plants of district Chitral.

Shah and Hussain (2014) studied the micro minerals and nutritional status of four forage grasses, *Cyanodon dactylon*, *Phragmites karka*, *Saccharum spontaneum* and *Calamagrostis pseudophragmites* and reported Cd, Co, Cu, Cr, Fe, Mn, Sr, Zn and NDF, ADF, lignin,

hemicellulose and cellulose at three phenological stages. The concentration of majority of these elements increased from vegetative to post reproductive stages except Cd, Cu and Mn.

No reference is available for Kalash valley of Chitral, so in the present study efforts will be made to analyze some forage plants of the area for their nutritional composition.

7. Conservation status of plants

Nickel (2002) reported 19 legally protected species and 37 threatened or rare species. Maria *et al.* (2005) reported more than 56,000 species (excluding fungi) from Brazil which make nearly 19% of the world flora. Angiosperms especially monocotyledons (of which 45% of the species are endemic) were more reliable than any other flora. Prakash (2005) enlisted 60 threatened medicinal plant species having 22 % as critically endangered, 16% endangered and 27% were vulnerable.

Eilu *et al.* (2007) studied the conservation status of plants in Tororo district of eastern Uganda. Ture & Bocuk (2007) studied the conservation status of plants of Eskişehir Province Turkey and found 20 (16.0%) species in Euro-Siberian, 12 (9.6%) in Irano-Turanian, 6 (4.8%) in Mediterranean and 3 (2.4%) in East Mediterranean. They observed that one species each was in VU (*Vulnerable*) and DD (*Data Deficient*) and 3 in LC (*Least Concern*) categories. Four (3.2%) species were endemic.

Addo-Fordjour *et al.* (2008) worked on the conservation status of medicinal plants in Ghana and reported reduction in richness and abundance of some of these plants.

Tandon *et al.* (2009) reported that human activities like fuel wood and shifting cultivation has reduced the forest cover to alarming rate in Northeast India. He recommended that proper measures are needed on urgent basis for the conservation, management and sustainable utilization of plant resources of the region to meet the increasing requirements of fiber, food, fodder, health and water in the area.

Bulut & Yilmaz (2010) reported that out of 3504 endemic plants of Turkey, 12 are known to be extinct and 3492 (99 %) are threatened. The study suggested conservation measures to be taken for the future of these plants.

Schlaepfer *et al.* (2011) studied the role of non-native plants in conservation objectives.

The available literature on conservation of plants in Pakistan is listed below:

Ahmad & Waseem (2004) reported the conservation status of some medicinal plants of salt range. Alam & Ali (2010) reported that *Androsace russellii*, which was previously endemic to district Gilgit, Pakistan, is now restricted to only two localities of Hunza (Gilgit) i.e. Ultar Nullah and Shatu Bar. Abbas *et al.* (2010) on the basis of their four years field studies including population size, geographic range and habitat concluded that *Cadaba heterotricha* is endangered (EN) species in Pakistan. Hussain *et al.* (2010b) reported eight extinct species including *Tecomella undulata*, ten endangered species, 25 rare species and 28 vulnerable species from Karachi.

Shah & Hussain (2012) carried out research work in Chakesar valley, district Shangla and evaluated the conservation status of 127 plant species, out of these 47 were endangered, 32 vulnerable, 36 rare and 12 species were infrequent. Zaidi *et al.* (2012) reported methods of micropropagation and conservation of *Juniperus excelsa*, *Juniperus horizontalis* and *Juniperus chinensis* in Baluchistan.

Bano *et al.* (2013) studied the flora of Himalayan range of Azad Kashmir and reported 168 species, out of which 140 were medicinal, 60 used as food, 109 fodder, 116 fuel species and 150 had miscellaneous uses. The Conservation studies according to IUCN criteria showed that 12 species were vulnerable, 4 endangered, 7 critically endangered, 8 rare and 2 species were extinct in the area. They recommended that the rapid decline of plants need proper conservation, sustainable use and proper marketing of medicinal plants.

Alam & Ali (2015) studied the distribution of *Astragalus clarkeanus* in Pakistan and reported that it is a critically endangered species and endemic to Gilgit-Baltistan. The main threats are limited population size and geographic range, habitat loss and over grazing.

Very few workers have contributed to conservation studies in Khyber Pakhtunkhwa province of Pakistan.

Hadi *et al.* (2009) collected *Aerva javanica*, *Capparis decidua*, *Prosopis farcta* and *Peganum harmala* from the graveyard of Palosi, District Peshawar that were absent in the surrounding areas. They stated that graveyards are excellent conservatories of local plant resources. Khan and Shah (2013) studied family Brassicaceae of district Mardan and reported 27 species, out of which 42.85% species were infrequent, 38.09% rare and 19.04% were vulnerable.

Hadi *et al.* (2014) elaborated flora of Dag Behsud graveyard, district Nowshera, Pakistan and reported 41 medicinal plants belonging to 24 families and concluded that the graveyards

were generally protected from anthropogenic activities and hence have conserved flora. They found that Dag Behsud graveyard has conserved *Aerva javanica*, *Matricaria camomilla*, *Calendula arvensis*, *Eruca sativa*, *Malcolmia cabulica*, and *Cymbopogon jwarancusa* species which were almost absent from surrounding areas. Jamshed *et al.* (2014) reported 106 tree species planted in Hayatabad Township Peshawar, Pakistan as ornamental and roadside plants. They also stated that due to over population, urbanization, industrialization and infra-structure building the number of native plants is quickly disappearing from the area and replaced by exotic and invasive plants. Ullah & Rashid (2014) studied the conservation status of medicinal plants of Mankial valley, Swat-Kohistan and reported that 13 species were vulnerable, 21 endangered and 11 were critically endangered species.

The only reference from district Chitral is that of Hadi and Ibrar (2013) in which they reported 15 species of non-flowering plants belonging to 10 families. Majority of these species were critically endangered due to anthropogenic hazards. Similarly, Ullah and Rehman (2016) worked on conservation issues of medicinal plants of Zewar valley and reported 42 species of 26 families. The plants of the valley are threatened due to deforestation, over grazing and exploitation, soil erosion and unscientific methods of collection.

Through the present study efforts will be made to record the present conservation status of the plants of the study area.

AIMS AND OBJECTIVES

Kalash valley has rich and unexplored plant natural resources. Therefore, the present study was carried out to explore the floristic, phytosociological, ethnobotanical and conservational aspects of plants with the following aims and objective.

1. To explore and enlist the diverse plant natural resources along with their ecological characteristics.
2. To study the vegetation structure and its characteristics.
3. To prepare ethnobotanical profile of the plants.
4. To determine the conservation status of the plants.
5. To propose concrete recommendations for conservation and sustainable use of the existing plant resources.
6. To analyze mineral composition and nutritional values of some key palatable plants.
7. To find out the grazing preferences of cattle and availability of palatable plant species.
8. To assist the possibility of introducing new plant species in the area with economic values to the local people.

MATERIALS AND METHODS

1. Floristic composition with ecological characteristics

The collection of plants from all the three areas of Kalash Valley viz: Bumburet, Rumbor and Birir were carried out during different seasons from 2013 to 2015. These plants were preserved and identified with the help of different volumes of Flora of Pakistan (Nasir and Ali, 1970-1989; Ali and Nasir, 1989-1991; Ali and Qaiser, 1993-2015) and were confirmed at Herbarium of Department of Botany, University of Peshawar. A comprehensive floristic list was compiled comprising plants of Fungi, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms groups found in the area. The plants were arranged alphabetically within each family and the families were also arranged on the same pattern.

1.1. Biological Spectra

Raunkiaer (1934) and Hussain (1989) were followed for classification of plants in different life forms and leaf size classes.

a. Life form classes

i. Therophytes (Th)

This group contained annual seed producing plants, which complete their life cycles in one year and reproduce by means of seeds and spores.

ii. Geophytes (G)

In this group the plants have their perennating buds present below the surface of soil. It contained plants with tubers, rhizomes, bulbs and corms and also submerged, semi-submerged, leaf floating and free floating water plants.

iii. Hemicryptophytes (H)

These are the herbaceous perennial plants in which the aerial parts of the plants died at the end of growing season and left the perennating buds at or just below the ground surface.

iv. Chamaephytes (Ch)

In these plants the perennating buds are located on stem up to 25 cm above the ground surface.

v. Phanerophytes (P)

In Phanerophytes the perennating buds are located above 25 cm from the ground surface. This group is further divided into following sub-groups.

a. Megaphanerophytes (MegP)

These are tree species in which the perennating buds are located above 30 m (100 ft) of ground level.

b. Mesophanerophytes (MesP)

These are small trees in which the perennating buds are located between 7.5 m to 30 m (25 ft to 100 ft) of ground level.

c. Microphanerophytes (MicP)

These shrubby plants have their perennating buds located between 2 m to 7.5 m (100 ft) of ground level.

d. Nanophanerophytes (NP)

In these plants the perennating buds are borne on shoots between 0.25 m to 2 m (0.8 ft to 6 ft) of ground level.

Raunkiaerian life form spectra were prepared as following formula:

$$\frac{\text{Number of species in each life-form class}}{\text{Total species}} \times 100$$

1.2. Leaf-Size classes

The following leaf-size classes were made after Raunkiaer (1934).

- i. Leptophyll (L) having leaf area up to 25 mm²
- ii. Nanophyll (N) having leaf area from 25 to 225 mm²
- iii. Microphyll (Mic) having leaf area from 225 to 2025 mm²
- iv. Mesophyll (Mes) having leaf area from 2025 to 18225 mm²
- v. Macrophyll (Mac) having leaf area from 18225 to 164025 mm²
- vi. Megaphyll (Meg) having leaf area larger than Macrophyll.

Raunkiaerian leaf form spectra were prepared as following:

$$\frac{\text{Number of species in each leaf size class}}{\text{Total species}} \times 100$$

1.3. Ecological characters

Various ecological characteristics were noted during the field study tips of the area, including habitat, habit, cultivated or wild, light requirement, leaf persistence, Spinyess and shape of leaf.

2. Ethnobotanical profile of plants

During the field trips ethnobotanical status of the collected plants was also studied. For this purpose the indigenous knowledge about plant uses was obtained by gathering information from traditional healers, experienced elders and midwives. The etnnobotanical data was presented as Botanical names, local names, part used and ethnobotanical uses.

3. Phytosociology/vegetation structure

Phytosociological studies were carried out at different areas of Bumburet, Birir and Rumbor of Kalash valley, district Chitral. Species composition, habitats, altitude and physiognomic characters were considered in selection of these areas. Quadrat method was used to record vegetation in these areas. The density and cover were determined by using midpoint

values of a 10-point scale while frequency was evaluated by observing the presence/absence of the species within the quadrat.

i. Density

Density is the number of individuals of a species per unit area (quadrat).

$$\text{Density} = \frac{\text{No. of individuals of a species}}{\text{Total No. of quadrates}}$$

$$\text{Relative Density (RD)} = \frac{\text{Density of a particular species}}{\text{Total densities of all the species}} \times 100$$

The mid values were calculated and used to establish the following density classes.

Range (No. of individuals)	Midpoint values
1-10	5
11-20	15
21-30	25
31-40	35
41-50	45
51-60	55
61-70	65
71-80	75
81-90	85
91-100	95

ii. Herbage Cover

Cover is the vertical projection of crown or shoots of a species to the ground surface expressed as percent of a surface area.

$$\text{Cover} = \frac{\text{Cover of a species}}{\text{Total No. of Quadrats}}$$

$$\text{Relative Cover (RC)} = \frac{\text{Cover of a species}}{\text{Total cover of all the species}} \times 100$$

Following ten cover classes were established for estimating plant cover. Midpoint values were used for calculation.

Range (No. of individuals)	Midpoint values
1-10	5
11-20	15
21-30	25
31-40	35
41-50	45
51-60	55
61-70	65
71-80	75
81-90	85
91-100	95

iii. Frequency

Frequency determines the percentage of Quadrats in which a species occurs.

$$\text{Frequency} = \frac{\text{No. of quadrats in which a species occur}}{\text{Total No. of quadrats}} \times 100$$

$$\text{Relative Frequency (RF)} = \frac{\text{Frequency of a species}}{\text{Total frequencies of all species}} \times 100$$

iv. Importance value

The sum of RD, RC and RF determines the importance values. On the basis of highest importance values the plant communities were established and named after three leading species.

v. Cluster analysis

Cluster analysis (CA) is a classification method for placing similar objects into cluster or groups. The objects are arranged in a hierarchical tree like structure called dendrogram. The clusters may represent different biotic communities. The community classification was made by following program “Multivariate Statistical Package (MVSP)”.

vi. Principal Coordinate analysis

It is a computer technique that is available in computer statistical packages (MVSP), used with the internal structure of matrices. It is a method of breaking down a resemblance matrix into a set of orthogonal axes. Principal Coordinate analysis provides information about the ecological resemblance between the communities. In the present study Cluster analysis and Principal Coordinate analysis was applied to dissimilarity data of 21 stands.

4. Edaphology

The soil samples were collected from all investigated sites to analyze the following physico-chemical characteristics.

i. Soil Texture

Hydrometer method (Bouyoucos, 1936) was used to determine the soil texture. Textural triangle method (Brady, 1990) was used to determine the textural classes.

ii. Organic matter

Soil organic matter was determined by oxidation with potassium dichromate in sulphuric acid medium under standard wet combustion method of Rayan *et al.* (1997).

iii. Calcium carbonate

Acid neutralization method (Rayan *et al.* 1997) was used for determination of soil calcium carbonate contents.

iv. Potassium (K)

Flame emission spectrometry (Rhoades, 1982) was used to determine potassium.

v. Nitrogen (N)

Soil nitrogen was determined after Kjeldahl method (Bremner & Mulvaney, 1982).

vi. Phosphorus (P)

Phosphorus was determined after Olsen & Sommers (1982).

vii. Soil pH and EC

pH meter and conductivity meter were used (Richard. 1954) to determine the soil pH and Electrical Conductivity (EC) respectively.

viii. Total soluble salts (TSS)

TSS was determined after AOAC (1984).

5. Degree of palatability of vegetation

Grazing cattle, sheep and goats and their preferences for plants were observed in the field to determine the degree of palatability of plant species. Two types of plant species, palatable and non-palatable were determined. Palatable plant species were further classified in four classes after Hussain and Durrani (2009).

- i. Highly Palatable (HP): Plants highly preferred by livestock.
- ii. Mostly Palatable (MP): Average liked plants by livestock.
- iii. Less Palatable (LP): Less preferred plants by livestock.
- iv. Rarely Palatable (RP): Plants grazed by livestock in absence of preferred species.

6. Measurement of Rangeland productivity

i. Herbaceous Biomass

Plant material of herbs and grasses was harvested above ground level by using 10 number of 1 x 1m quadrat. The same harvested material was weighed fresh in the field by using a field balance (Hussain & Durrani, 2007).

ii. Shrub/Tree Biomass

A representative branch / part of a shrub was cut and weight. Then all the branches / parts were counted and multiplied with this weight to get the estimated shrub biomass (Hussain & Durrani, 2007).

7. Chemical evaluation of some selected plants

Thirteen most important palatable plant species were collected from entire valley. The samples were dried, powdered and stored in plastic bags for mineral and proximate analysis.

7.1. Mineral composition

The samples were dried at 70 °C in a forced air oven for 48 hour (AOAC, 1990). Dry samples were ground to pass through 1mm sieve and then subjected to wet acid digestion according to AOAC (1990). The digested plant materials were analyzed in duplicate for mineral composition using Atomic Absorption Spectrometer (GBC, 908AA.Victoria Australia) for Ca, Mg, Fe, Mn, Zn, Cu, etc. Flame photometer (corning flame photometer 410) was used for potassium and sodium and UV/ visible Spectro Photometer (Shimadzu UV-1601PC) for phosphorus. The total nitrogen was analyzed by Semi-micro Kjeldal apparatus.

7.2. Proximate analysis

i. Dry Matter

Dry matter (DM) was obtained by oven drying the plant sample at 65 °C for 72 hours by AOAC (1984) method and percent dry matter was calculated as follows:

$$\text{Dry Matter (\%)} = \frac{\text{Weight of dried sample}}{\text{Weight of fresh sample}} \times 100$$

ii. Ash Contents

Two grams of plant sample was ignited in the muffle furnace at 550 °C to 600 °C for 8 hrs and ash contents of samples were determined by AOAC (1984) method.

$$\text{Ash Content (\%)} = \frac{\text{Weight of ash}}{\text{Weight of fresh Sample}} \times 100$$

iii. Organic Matter

Organic matter (OM) was calculated as follows:

$$\text{Organic Matter (\%)} = 100 - \% \text{ Ash}$$

iv. Nitrogen / Crude Protein

Nitrogen was determined by micro Kjeldahl procedures (AOAC, 1984). Nitrogen in the digested sample was collected in 4% boric acid solution by distillation. Boric acid was titrated against 0.02 normal standardized H₂SO₄ by a semi automatic titrator.

Crude protein in the sample was calculated as follows:

$$\text{Crude Protein (\%)} = \frac{(\text{ml H}_2\text{SO}_4 - \text{blank}) \times N \times 6.25 \times 14.01}{\text{Sample weight} \times 1000}$$

v. Crude Fiber

Crude fiber (CF) was determined by following AOAC (1984). The sample was digested with 1.25% H₂SO₄ for 30 minutes followed by 30 minutes with 1.25% NaOH. The insoluble residues were dried, weighed, ashed and the insoluble organic matter was reported as crude fiber as following formula.

$$\text{Crude Fiber (\%)} = \frac{\text{Loss in weight in ignition}}{\text{Weight of Sample}} \times 100$$

vi. Ether Extract (Crude Fat)

Ether extract (EE) procedure involves a reflux apparatus which boils ether, condenses it and allows it to pass through the sample (Galyean, 1985).

Ether extract was calculated as follows:

$$\text{Ether Extract (\%)} = \frac{\text{Weight of extract}}{\text{Weight of sample}} \times 100$$

xi. Total Carbohydrates

Total carbohydrates were calculated after Galyean (1985) as follows:

$$\text{Total Carbohydrates} = 100 - \% \text{ Moisture} - (\% \text{ Ash} + \% \text{ Crude Protein} + \% \text{ Ether Extract})$$

8. Conservation status of plants

IUCN (2001) was followed to classify plants into different conservation classes.

a. Availability

- 0- Uncommon or very rare
- 1- Less common or rare
- 2- Occasional
- 3- Abundant

b. Collection

- 0- More than 1000 kg/year
- 1- Consumed from 500-1000 kg/year
- 2- Consumed from 200-500 kg/year
- 3- Consumed from 100-200 kg/year

c. Part used

- 0- Root or whole plant
- 1- Bark
- 2- Seeds, fruits
- 3- Flowers
- 4- Gum, latex

d. Growth

- 0- Re-growth in more than three years
- 1- Re-growth in three years
- 2- Re-growth in two years
- 3- Re-growth in one year
- 4- Re-growth in a season

Total Score / status

0-4 = Endangered, 5-8 = Vulnerable, 9-12 = Rare, 12-14 = infrequent, 15-16 = Dominant.

RESULTS AND DISCUSSION

A. FLORISTIC COMPOSITION WITH ECOLOGICAL CHARACTERISTICS

1. Floristic composition

The floristic composition of Kalash valley, district Chitral indicates 389 species belonging to 273 genera and 88 families. It includes 62 (70.45%) dicots, 11 (12.50%) monocots, 7 (7.95%) pteridophytes, 4 (4.54%) bryophytes, 3 (3.41%) gymnosperms and one (1.13%) fungi families. Similarly, 208 (76.19%) genera were of dicot, 44 (16.11%) were monocots, 10 (3.66%) were pteridophytes, 6 (2.19%) were gymnosperms, 4 (1.47%) were bryophytes and one (0.37%) genus was of fungus. The species diversity showed 307 (78.92%) dicots, 55 (14.13%) monocots, 12 (3.08%) pteridophytes, 10 (2.57%) gymnosperms, 4 (1.03%) bryophytes and one (0.26%) fungus species. Asteraceae was leading family having 49 (12.60%) species followed by Poaceae with 36 (9.25%) species, Brassicaceae 25 (6.42%), Lamiaceae and Rosaceae 22 (5.65%) each, Fabaceae 16 (4.11%), Apiaceae 13 (3.34%), Boraginaceae and Polygonaceae 12 (3.08%) each, Schrophulariaceae and Caryophyllaceae 10 (2.57%) each, Ranunculaceae 9 (2.31%), Chenopodiaceae 8 (2.05%), Salicaceae 6 (1.54%) and Euphorbiaceae and Solanaceae with 5 (1.28%) species each. Aliaceae, Cucurbitaceae, Cupressaceae, Malvaceae, Pinaceae and Primulaceae were represented by 4 (1.03%) species each while Adiantaceae, Anacardiaceae, Cyperaceae, Geraniaceae, Moraceae, Onagraceae, Polygonaceae, Rubiaceae and Urticaceae had 3 (0.77%) species each. The remaining 57 families had two or one species (Tables 3 and 4).

Durrani *et al.* (2005) reported some similarly plants and same dominant families from Harboi rangeland, Kalat, Baluchistan.

Shah and Hussain (2007) studied saline and water logged habitats of Chamkani area, Peshawar and reported 42 species and 31 families with similar dominant families. Sher & Khan (2007) surveyed Chagharzai Valley, District Buner and reported 222 species belonging to 78 Dicots, 7 Monocots, 3 Pteridophytes and one Gymnosperm families. Asteraceae was leading family with 21 species.

Perveen *et al.* (2008) surveyed the Dureji Game Reserve and collected 79 plants belonged to 66 genera and 32 families and reported three rare species as well.

Hussain and Perveen (2009) studied plants of Tiko Baran, Khirtik Range and recorded 70 species belonging to 59 genera and 31 families. Hussain *et al.* (2009) enlisted 20 grasses, 12

trees species, 31 shrubs and 6 under shrubs and herbs from rangelands of district Chakwal. Durrani *et al.* (2010) studied the flora of Aghberg rangelands Quetta and reported 123 plant species 36 families. Asteraceae, Boraginaceae, Brassicaceae, Fabaceae, Lamiaceae and Poaceae were dominant families of the area. Fazal *et al.* (2010) worked out flora of district Haripur and reported 211 species belonging to 170 genera and 66 families. Out of 66 families, 7 families were monocots with 26 species and 55 families were dicotyledonous having 180 species.

Khan *et al.* (2011) studied the medicinal plants of Chitral Gol National Park (CGNP) and recorded 31 species belonging to 21 families.

Hadi *et al.* (2013) enlisted 29 woody plants of Rech valley, Torkow, district Chitral. Rafay *et al.* (2013) carried floristic study of rangelands of Cholistan desert and collected 27 grass species belonging to 16 genera. Khan *et al.* (2014) studied the flora of Asshab Baba graveyard and reported 66 plant species of 32 families. Poaceae was leading family with 12 species followed by Asteraceae with 9 species and Chenopodiaceae and Moraceae 4 species each. Shaheen *et al.* (2014) worked out the flora of Thal deserts and found 248 species belonging to 166 genera and one pteridophyte, 4 monocots and 33 dicots families. Poaceae was leading family with 52 species followed by Fabaceae, Amaranthaceae and Asteraceae. Wariss *et al.* (2014) enlisted the plants of Lal Suhana National Park, Bahawalpur, Pakistan and mentioned 212 species belonging to 41 dicot, 5 monocots, 3 Pteridophytes and one Bryophytes families. Poaceae was the leading family with 43 species followed by Fabaceae, Asteraceae and Chenopodiaceae.

Hussain *et al.* (2015) studied the floral diversity of Mastuj valley, district Chitral and found 571 species of 82 families including 65 dicots, 13 monocots, 2 gymnosperms and 2 pteridophyte families. Asteraceae was leading family followed by Poaceae, Fabaceae, Lamiaceae and Rosaceae. These findings support our results as Asteraceae, Poaceae, Fabaceae, Chenopodiaceae and Moraceae are leading families in areas of these researchers. Similarly, most of the species belong to dicots followed by monocots and pteridophytes as were in our findings.

Floristic composition of an area changes with altitudinal variation which can be observed by floristic list which provides an idea about the species diversity and its ecological behavior like life form, leaf size spectra, phenology and habitat.

1. Life form spectrum

The life form shows all the life processes of flora and vegetation. Life form usually represents climatic, microclimatic and bioclimatic habitat conditions of an area (Cain & Castro, 1959). The life form spectrum may be changed due to introduction of therophytes like annual weed, due to anthropogenic activities like agricultural practices, deforestation, grazing and trampling etc. (Malik *et al.*, 2007). Raunkiaer (1934) was followed to find the life form classes of flora of the valley and the results indicated that therophytes were dominant class having 205 (52.70%) species followed by geophytes with 56 (14.40%) species, hemicryptophytes 46 (11.82%), nanophanerophytes 29 (7.45%), chamaephytes 21 (5.40%), megaphanerophytes 19 (4.90%), climbers 6 (1.54%), mesophanerophytes and macrophanerophytes 5 (1.28%) species each and parasites had 3 (00.77%) species (Table 3 and 4). Cain & Castro (1959) and Shimwell (1971) stated that therophytes are characteristics of desert and dry climate. This favors our findings as therophytes were dominant in this dry temperate valley. The present findings were also supported by the similar findings of Durrani *et al.* (2005), Shah *et al.* (2006), Alelign *et al.* (2007), Manhas *et al.* (2010), Parswan *et al.* (2010), Khan and Shah (2013), Rawat *et al.* (2013), Wariss *et al.* (2013), Fatna *et al.* (2014), Osman *et al.* (2014), Qureshi *et al.* (2014), Shaheen *et al.* (2014), Sharma *et al.* (2014) and Hussain *et al.* (2015). Similarly, Sher & Khan (2007), Hussain *et al.* (2009), Ajaib *et al.* (2010), Fazal *et al.* (2010) and Al-Yemeni & Sher (2010) also reported that therophytes and hemicryptophytes as dominant classes in similar degraded, dry and arid environment.

The dominance of therophytes and hemicryptophytes in the valley indicates that the area is under great anthropogenic pressure like deforestation and overgrazing that is destroying the natural habitat for other classes and the vegetation is dominating by annual plants. Nazir & Malik 2006; Guo *et al.*, 2009; Kar *et al.* 2010; Manhas *et al.*, 2010; Osman *et al.* 2014; Shaheen *et al.* 2014 and Hussain *et al.* 2015 found that the degraded vegetation are usually dominated by therophytes in similar climatic conditions.

2. Leaf size spectrum

The leaf size spectrum showed that nanophylls were dominant with 178 (45.76%) species followed by mesophylls having 72 (18.51%) species, leptophylls 53 (13.62%) species, microphylls 44 (11.31%), macrophylls 29 (7.45%) species and 13 (3.34%) species were

aphyllous (Tables 3 and 4). Leaf size classes are considered to be useful in determination of plant associations. Microphylls usually represent the vegetation of steppes, while leptophylls and nanophylls dominate hot desert and saline habitats (Tareen & Qader, 1993; Nasir & Sultan 2002; Husain *et al.*, 2005). The domination of reduced leaf sized plants (nanophylls) in Kalash valley indicates it's dry and xeric conditions.

3. Leaf persistence

The leaf persistence shows the deciduous and evergreen species. The flora of Kalash valley includes 328 (84.32%) deciduous, 48 (12.34%) evergreen and 13 (3.34%) leafless species. This high percentage of deciduous plants indicates the xeric and dry conditions of the area (Tables 3 and 4).

4. Leaf appearance

266 (68.38%) plant species of the valley had simple leaves followed by 66 (16.97%) species with compound leaves. Similarly, 44 (11.31%) species had dissected leaves and 13 (3.34%) species were leafless (Tables 3 and 4).

5. Spinyess of the species

The flora of Kalash valley includes 369 (94.85%) spineless (non-spiny) and 20 (5.15%) spiny species (Tables 3 and 4).

6. Habitat of the plants

The soil conditions where the plants grow indicated that 291 (74.81%) species were terrestrial and 98 (25.19%) species were of moist/wet habitats. The most common moist loving plants of the area were *Funaria hygrometrica*, *Marchantia polymorpha*, *Adiantum venustum*, *Equisetum arvense*, *Selaginella indica*, *Phragmites karka*, *Mentha longifolia*, *Nasturtium officinale*, *Ranunculus muricatus* etc. The present findings show the dry climatic conditions of the valley and few localized points having aquatic/moist species (Tables 3 and 4).

7. Light and shade plants

The results showed that 363 (93.31%) species were heliophytes (light loving) and only 26 (6.69%) species were sciophytes (shade loving). The area is composed of scattered vegetation with open sunny environment so it is more favorable for sun loving plants (Tables 3 and 4).

8. Nature of growth/ Habit

The result showed 340 (87.40%) naturally growing species and 49 (12.60%) cultivated species. The cultivated plants include crops, vegetables and fruit plants (Tables 3 and 4).

B. ETHNOBOTANICAL PROFILE

Since the start of human life man has interaction and dependence on plants for his food, shelter, medicines and other uses. The present study includes 389 plant species and all of them have some kind of indigenous uses in the valley (Table 5). The results showed that 338 (86.89%) were fodder species, 92 (23.65%) were medicinal, 63 (16.19%) were firewood, 32 (8.22%) were vegetables, 27 (6.94%) were timber wood, 23 (5.91%) were fruit species, 21 (5.40%) were thatching species, 20 (5.14%) were condiment, 08 (2.06%) were ornamental and 5 (1.28%) species were used for making snuffs (Table 5). *Juniperus squamata*, *Aristida cynantha*, *Cynodon dactylon*, *Poa bulbosa*, *Artemisia brevifolia*, *Artemisia scoparia*, *Taraxacum officinale*, *Medicago sativa*, *Chenopodium foliosum*, *Astragalus leucocephalus*, *Marrubium vulgare*, *Thymus serpyllum* and *Rheum emodi* are some important fodder plants. *Ephedra gerardiana*, *Bomium persicum*, *Carum capticum*, *Artemisia parviflora*, *Artemisia scoparia*, *Capparis spinosa*, *Mentha longifolia*, *Ocimum basilicum*, *Thymus serpyllum*, *Paeonia emodi*, *Plantago major*, *Rheum emodi*, *Clematis orientalis*, *Verbascum thapsus*, *Urtica dioica* and *Viola canescens* were the most commonly used medicinal species. *Cedrus deodara*, *Pinus wallichiana*, *Tamarix dioica*, *Ailanthus altissima*, *Salix sp.* *Juniperus excelsa*, *Juniperus communis*, *Sophora mollis*, *Fraxinus xanthoxyloides*, *Ephedra gerardiana* and *Artemisia breviflora* were used as common fuel wood species. *Cedrus deodara*, *Pinus wallichiana*, *Picea smithiana*, *Platanus orientalis*, *Populus alba* and *Populus nigra* were the important timber wood plants. Similarly, *Juglans regia*, *Pinus gerardiana*, *Morus alba*, *Prunus armeniaca*, *Prunus persica*, *Pyrus communis*, *Pyrus malus* and *Vitis venifera* are the common cultivated fruit plants. Among vegetables *Brassica campestris*, *Brassica napus*, *Lycopersicum esculentun*, *Solanum melongena*,

Solanum tuberosum, *Pisum sativum* and *Portulaca oleracea* are mostly cultivated by the locals. *Allium cepa*, *Allium sativum*, *Bunium persicum*, *Foeniculum vulgare*, *Lycopersicum esculentum* and *Mentha longifolia* are used as condiments. For thatching purpose *Arundo donax*, *Phragmites karka*, *Typha longifolia*, *Rhus punjabensis*, *Saccharum spontaneum* and *Quercus baloot* were commonly used. *Juniperus excelsa*, *Ephedra gerardiana* and *Ephedra intermedia* are used as snuff species. *Althaea rosea*, *Vinca major*, *Tagetes erecta*, *Thuja orientalis* and *Rosa alba* are some cultivated ornamental species (Table 5). The present study suggests that the area is mainly dry alpine grazing land and most of the species i.e. 339 are used as fodder. Many workers like Hussain *et al.*, (2004 & 2006); Durrani & Hussain (2005); Arens & Scarpa, (2007); Khan & Khatoon (2007); Khan *et al.* (2009); Maoe *et al.*, (2009); Sardar & Khan (2009); Shaheen *et al.* (2012); Bano *et al.* (2013) and Shinwari *et al.* (2015) reported majority of similar species are used as fodder in their research areas. These findings are agreement of our results. The second major use of plant resources of Kalash valley is medicinal and 92 (24.66%) species are used directly or indirectly by the locals to cure different diseases. In district Chitral the peoples use plants for fulfilling of their needs and the plant resources are also source of income for them (Ali & Qaiser, 2009). The people know the medicinal plants and preparation of raw drugs through personal experience and ancestral prescription and long utility. The far flung and remote villages, representing more than 60% of the district's populations, are still depending on wild plants for their various needs (Ali & Qaiser, 2009). No comprehensive data is available on the uses of medicinal plants in Kalash valley. However, lot of work is available on the traditional medicinal uses of plants throughout the world i.e. Adhikari *et al.* (2007); Mao *et al.* (2009); Poonam and Sing (2009); Uysal *et al.* (2012); Korkmaz and Karakus (2015); Saranya *et al.* (2015) and Qasem (2015). Many workers also enlisted the medicinal plants from other parts of Pakistan i.e. Ishtiaq *et al.* (2007); Ali & Qaiser (2009); Kamal *et al.* (2009); Qamar *et al.* (2010); Sher *et al.* (2012); Khan *et al.* (2012); Murad *et al.* (2013); Noman *et al.* (2013); Pervaiz *et al.* (2013); Qaiser *et al.* (2013); Razzaq *et al.* (2013); Ahmad *et al.* (2014); Hadi *et al.* (2014); Ullah *et al.* (2014); Ikram *et al.* (2015) and Khan *et al.* (2015).

C. TRADITIONAL MEDICINAL PLANTS

The present findings showed ninety two species used by locals for treatment of different diseases. Majority of species i.e. 34 (36.96%) were used to relieve abdominal problems followed by 9 (9.78%) species used for respiratory tract diseases, 7 (7.61%) species were used in fever, 6 (6.52%) species each were used as pain killers and tonic, 5 (5.43%) were used to cure skin diseases, 4 (4.35%) were antiseptic, 3 (3.26%) each were used for blood pressure, mouth disease, wounds, toothache, as refrigent and as blood enricher. The remaining diseases were treated by using 2 or less species (Tables 6 and 7). During the treatments different parts of plants were used for various preparations. The fruits of 31 (33.70%) species had major share in treatment of different diseases followed by leaves of 24 (26.10%) species as medicines. Shoots of 13 (14.13%) species, roots/rhizomes of 10 (10.87%) species, seeds of 9 (9.78%) species, flowers of 8 (8.70%) species, bark and whole plants of 3 (3.26%) species each, bulb and stem of 2 (2.17%) species each and gum and tuber of one (1.08%) species each were used medicines for treatment of various diseases (Table 7). The shrubs were leading group with 38 (41.30%) species, herbs 34 (36.96%) species and trees 20 (21.73%) species were used as medicinal plants in the valley.

The Kalash valley is an isolated remote area and inhabiting very poor people that use plants for different utilitarian uses including treatment of different diseases. The locals have been using the medicinal plants since time immemorial and they are aware about preparation of the raw drugs from these plants. However, the urbanization and modernization has also changed the life style of Kalash peoples and the young generation is not taking interest in precious ancestral knowledge about the use of plants. Therefore, in the present study an attempt was made to enlist the medicinal plants of Kalash valley and also to bring in black and white the precious indigenous knowledge of experienced elders of the valley about the uses of these medicinal plants.

Table 3. Floristic list and ecological characteristics of plants of Kalash Valley, District Chitral, Hindukush range, Pakistan

S#	Plant name	Kalash valley			Plant characteristics								
		B	R	BR	1	2	3	4	5	6	7	8	
FUNGI													
1. Family Halveliaceae													
1.	<i>Morchella esculenta</i> (L.) Pers ex. Fr	+	+	+	Th	Ap	-	-	M	Sd	W	Ap	
BRYOPHYTES													
2. Family Funariaceae													
2.	<i>Funaria hygrometrica</i> Hedw.	+	+	+	Th	Ap	-	-	M	Sd	W	Ap	
3. Family Marchantiaceae													
3.	<i>Marchantia polymorpha</i> L.	+	-	+	Th	Ap	-	-	M	Sd	W	Ap	
4. Family Aytoniaceae													
4.	<i>Reboulia hemisphaerica</i> (L.) Raddi	+	-	-	Th	Ap	-	-	M	Sd	W	Ap	
5. Family Polytrichaceae													
5.	<i>Polytrichum</i> sp.	+	+	+	Th	Ap	-	-	M	Sd	W	Ap	
PTERIDOPHYTES													
6. Family Adiantaceae													
6.	<i>Adiantum capillus-veneris</i> L.	+	+	+	G	N	E	-	M	Sd	W	Com	
7.	<i>Adiantum venustum</i> D. Don.	+	-	+	G	N	E	-	M	Sd	W	Com	
8.	<i>Cheilanthes pteridioides</i> (Reichb.) C. Chr	-	-	+	G	N	E	-	M	Sd	W	Com	
7. Family Aspleniaceae													
9.	<i>Asplenium trichomanes</i> L.	-	-	+	G	N	E	-	M	Sd	W	Com	
8. Family Cystopteridaceae													
10.	<i>Cystopteris fragilis</i> (L.) Bernh.	-	+	+	G	N	E	-	M	Sd	W	Com	
9. Family Dryopteridaceae													
11.	<i>Dryopteris ramosa</i> (Hope) C. Chr.	-	-	+	G	L	E	-	M	Sd	W	Com	
10. Family Equisetaceae													
12.	<i>Equisetum arvense</i> L.	-	+	-	G	Ap	E	-	M	Sd	W	Ap	
13.	<i>Equisetum ramosissimum</i> Desf.	+	+	-	G	Ap	E	-	M	Sd	W	Ap	
11. Family Pteridaceae													
14.	<i>Cystopteris fragilis</i> (L.) Bernh.	-	-	+	G	N	E	-	M	Sd	W	Com	
15.	<i>Polystichum acanthophyllum</i> (Franch) Christ	-	-	+	G	N	E	-	M	Sd	W	Com	
16.	<i>Pteris cretica</i> L.	-	-	+	G	N	E	-	M	Sd	W	Com	
12. Family Selaginellaceae													
17.	<i>Selaginella indica</i> (Milde) Alston.	+	+	+	G	N	E	-	M	Sd	W	Com	

GYMNOSPERMS												
13. Family Cupressaceae												
18.	<i>Juniperus communis</i> L.	-	+	+	NP	L	E	-	D	L	W	Dis.
19.	<i>Juniperus excelsa</i> M. Bieb.	-	+	+	MegP	L	E	-	D	L	W	Dis.
20.	<i>Juniperus squamata</i> Buch.	-	-	+	NP	L	E	-	D	L	W	Dis.
21.	<i>Thuja orientalis</i> L.	+	-	-	NP	L	E	-	D	L	C	Dis.
14. Family Ephedraceae												
22.	<i>Ephedra gerardiana</i> Wall ex. Stapf.	-	+	+	Ch	Ap	E	-	D	L	W	Ap
23.	<i>Ephedra intermedia</i> Schrenk & Meyer	-	+	+	Ch	Ap	E	-	D	L	W	Ap
15. Family Pinaceae												
24.	<i>Cedrus deodara</i> (Roxb. Ex Lamb.) G. Don	+	+	+	Meg P	L	E	-	D	L	W	Com
25.	<i>Picea smithiana</i> (Wall.) Boiss.	+	+	+	MegP	L	E	-	D	L	W	Com
26.	<i>Pinus gerardiana</i> Wall. ex Lamb.	+	+	+	MegP	L	E	-	D	L	W	Com
27.	<i>Pinus wallichiana</i> A. B. Jackson	+	+	+	MegP	L	E	-	D	L	W	Com
MONOCOTYLEDANAE												
16. Family Alliaceae												
28.	<i>Allium carolinianum</i> DC.	+	-	+	G	Mes	Dec	-	D	L	W	S
29.	<i>Allium cepa</i> L.	+	+	+	G	Mes	Dec	-	D	L	C	S
30.	<i>Allium chitralicum</i> Wang & Tang	+	+	-	G	Mes	Dec	-	D	L	W	S
31.	<i>Allium sativum</i> L.	+	+	+	G	Mes	Dec	-	D	L	C	S
17. Family Amaryllidaceae												
32.	<i>Ixiolirion tataricum</i> (Pall.) Herb.	-	-	+	G	Mes	Dec	-	M	L	W	S
18. Family Araceae												
33.	<i>Arum jacquemontii</i> Blume	+	+	+	G	Mic	Dec	-	M	L	W	S
19. Family Colchicaceae												
34.	<i>Colchicum luteum</i> Baker	-	-	+	G	N	Dec	-	M	Sd	W	S
20. Family Cyperaceae												
35.	<i>Carex orbicularis</i> Boott.	-	+	-	G	L	E	-	M	L	W	S
36.	<i>Cyperus diluta</i> M. Bieb.	+	+	-	G	L	E	-	M	L	W	S
37.	<i>Scirpus setaceus</i> L.	+	+	-	G	Mes	E	-	M	L	W	S
21. Family Iridaceae												
38.	<i>Iris germinea</i> L.	-	+	+	G	Mes	Dec	-	D	L	C	S
39.	<i>Iris lacteal</i> Pallas	+	-	+	G	Mes	Dec	-	D	L	W	S
22. Family Juncaceae												
40.	<i>Juncus articulata</i> L.	+	+	+	H	Mic	E	-	M	L	W	S
23. Family Liliaceae												
41.	<i>Fritillaria imperialis</i> var. <i>chitralensis</i> Hort.	-	-	+	G	Mes	E	-	M	L	W	Com
42.	<i>Tulipa stellata</i> Hk. f.	+	+	+	G	L	Dec	-	M	L	W	S
24. Family Orchidaceae												
43.	<i>Epipactis wallichii</i>	+	-	-	G	N	Dec	-	M	Sd	W	S

	Schlech.											
44.	<i>Spiranthes lancea</i> (Thunb.) Backer	+	-	-	G	N	Dec	-	M	Sd	W	S
25. Family Poaceae												
45.	<i>Agropyron semicostatum</i> Nees ex Steud	-	+	+	Th	N	E	-	D	L	W	S
46.	<i>Agrostis viridis</i> Gouan.	-	+	-	Th	N	E	-	D	L	W	S
47.	<i>Aristida cynantha</i> Nees ex Steud	-	+	+	H	N	E	-	D	L	W	S
48.	<i>Arundo donax</i> L.	+	-	-	Ch	Mac	Dec	-	M	L	W	S
49.	<i>Avena fatua</i> L	+	-	+	Th	N	E	-	D	L	W	S
50.	<i>Avena sativa</i> L.	+	+	+	Th	N	E	-	D	L	W	S
51.	<i>Bromus danthoniae</i> Trin.	+	+	-	Th	Mes	Dec	-	D	L	W	S
52.	<i>Bromus tectorum</i> L.	+	+	-	Th	Mes	Dec	-	D	L	W	S
53.	<i>Calamagrostis emodensis</i> Griseb.	+	-	-	G	Mes	E	-	M	L	W	S
54.	<i>Chrysopogon echinulatus</i> (Nees ex Steud.) W. Wats	-	+	-	Th	Mes	E	-	D	L	W	S
55.	<i>Cynodon dactylon</i> (L.) Pers.	+	+	+	H	N	Dec	-	D	L	W	S
56.	<i>Dactylis glomerata</i> L.	+	-	+	Th	N	Dec	-	D	L	W	S
57.	<i>Dichanthium annulatum</i> (Forssk.) Stapf.	-	-	+	H	N	Dec	-	M	L	W	S
58.	<i>Echinochloa crusgalli</i> (L.) P. Beauv.	+	-	+	Th	N	Dec	-	M	L	W	S
59.	<i>Eragrostis poaeoides</i> P. Beave.	+	+	+	H	N	Dec	-	M	L	W	S
60.	<i>Hordeum murinum</i> L.	+	+	+	Th	N	Dec	-	D	L	W	S
61.	<i>Hordeum vulgare</i> L.	+	+	+	Th	N	Dec	-	D	L	C	S
62.	<i>Koeleria gracilis</i> Pers.	-	-	+	H	N	Dec	-	D	L	W	S
63.	<i>Lolium rigidum</i> Gaud.	+	+	-	Th	N	Dec	-	D	L	W	S
64.	<i>Lolium temulentum</i> L.	+	-	-	Th	N	Dec	-	D	L	W	S
65.	<i>Melica inaequiglumis</i> (Boiss.) Bor.	+	-	-	H	N	Dec	-	D	L	W	S
66.	<i>Oryza sativa</i> L.	-	+	+	G	Mic	Dec	-	M	L	C	S
67.	<i>Panicum antidotale</i> Retz.	-	-	+	Th	N	Dec	-	D	L	W	S
68.	<i>Phleum pretense</i> L.	+	-	-	Th	N	Dec	-	D	L	W	S
69.	<i>Phragmites karka</i> (Retz.) Trin. ex Steud	+	+	-	G	Mac	Dec	-	M	L	W	S
70.	<i>Piptatherum wendelboi</i> Bor	-	+	-	Th	N	Dec	-	D	L	W	S
71.	<i>Poa annua</i> L.	+	+	+	Th	N	Dec	-	D	L	W	S
72.	<i>Poa bulbosa</i> L.	-	-	+	Th	N	Dec	-	D	L	W	S
73.	<i>Poa pratensis</i> L.	-	-	+	H	N	Dec	-	D	L	W	S
74.	<i>Poa supina</i> Schrad.	-	+	-	Th	N	Dec	-	D	L	W	S
75.	<i>Polypogon fugax</i> Nees ex Steud	-	-	+	Th	Mic	Dec	-	M	L	W	S
76.	<i>Saccharum spontaneum</i> L.	+	-	-	Ch	Mac	Dec	-	D	L	W	S
77.	<i>Setaria viridis</i> (L.) P. Beauv.	+	-	-	Th	N	Dec	-	M	L	W	S

78.	<i>Triticum aestivum</i> L.	+	+	+	Th	Mes	Dec	-	D	L	C	S
79.	<i>Vulpia myuros</i> (L.) Gmel.	-	+	+	Th	N	Dec	-	D	L	W	S
80.	<i>Zea mays</i> L.	+	+	+	Th	Mac	Dec	-	D	L	C	S
26. Family Typhaceae												
81.	<i>Typha angustata</i> Bory & Chaub	-	+	+	G	Mac	E	-	M	L	W	S
DICOTYLEDONAE												
27. Family Aceraceae												
82.	<i>Acer pentapomicum</i> J.L. Stewart	-	+	+	MegP	Mic	E	-	D	L	W	Com
28. Family Amaranthaceae												
83.	<i>Amaranthus viridis</i> L.	+	+	+	Th	Mes	Dec	-	D	L	W	S
29. Family Anacardiaceae												
84.	<i>Pistacia integerrima</i> (L.) Steward ex Brandis	+	+	+	NP	Mes	Dec	-	D	L	W	S
85.	<i>Pistacia khinjuk</i> Stocks	+	-	+	NP	N	Dec	-	D	L	W	S
86.	<i>Rhus punjabensis</i> Steward ex Brandis	+	-	+	H	N	Dec	-	D	L	W	S
30. Family Apiaceae												
87.	<i>Ammi visnaga</i> (L.) Lamk.	+	-	-	Th	N	Dec	-	D	L	W	S
88.	<i>Bumium persicum</i> (Boiss.) B. Fedtsch.	+	+	+	G	N	Dec	-	D	L	W	S
89.	<i>Bupleurum exaltatum</i> Clarke	+	+	-	G	N	Dec	-	D	L	W	S
90.	<i>Bupleurum gilesii</i> Wolff	-	+	-	G	N	Dec	-	D	L	W	S
91.	<i>Carum capticum</i> L.	+	+	+	Th	N	Dec	-	D	L	W	Dis.
92.	<i>Carum carvi</i> L.	+	+	+	Th	N	Dec	-	D	L	W	Dis.
93.	<i>Coriandrum sativum</i> L.	-	-	+	Th	N	Dec	-	D	L	C	Dis.
94.	<i>Daucus carota</i> L.	+	+	+	G	Mes	Dec	-	D	L	C	Dis.
95.	<i>Foeniculum vulgare</i> Miller	+	+	+	Th	N	Dec	-	D	L	C	Dis.
96.	<i>Pimpinella stewartii</i> (Dunn) Wolff.	-	-	+	Th	N	Dec	-	D	L	W	Com
97.	<i>Pimpinella diversifolia</i> DC.	+	+	-	Th	N	Dec	-	D	L	W	Com
98.	<i>Prangos pabularia</i> Lindl.	+	-	-	H	N	Dec	-	D	L	W	Com
99.	<i>Trachyspermum ammi</i> (L.) Sprague	-	+	+	G	N	Dec	-	D	L	W	Com
31. Family Apocyanaceae												
100.	<i>Vinca major</i> L.	+	-	-	G	Mic	E	-	D	L	C	S
32. Family Asclepiadaceae												
101.	<i>Cynanchum acutum</i> L.	+	+	+	Ch	Mes	Dec	-	D	L	W	S
102.	<i>Periploca aphylla</i> Dcne.	-	-	+	Ch	Ap	E	-	D	L	W	Ap
33. Family Asteraceae												
103.	<i>Anaphalis contorta</i> L.	+	+	+	H	Mes	Dec	-	D	L	W	S
104.	<i>Anaphalis nepalensis</i> (Spreng.) Hand.	+	+	+	H	Mes	Dec	-	D	L	W	S
105.	<i>Artemisia brevifolia</i> Wall. Ex DC.	+	+	+	H	L	Dec	-	D	L	W	Dis.
106.	<i>Artemisia maritima</i> L.	+	+	-	H	L	Dec	-	D	L	W	Dis.
107.	<i>Artemisia parviflora</i> Roxb.	+	+	+	Th	Mic	Dec	-	D	L	W	Dis.

108.	<i>Artemisia sacrorum</i> Ledeb.	+	+	-	Th	Mic	Dec	-	D	L	W	Dis.
109.	<i>Artemisia scoparia</i> Waldst. & Kit.	+	+	+	H	N	Dec	-	D	L	W	Dis.
110.	<i>Aster flaccidus</i> var. <i>flaccidus</i> Bunge	-	-	+	Th	N	Dec	-	D	L	W	S
111.	<i>Bellis perennis</i> L.	+	-	-	Th	N	Dec	-	D	L	W	S
112.	<i>Bidens tripartita</i> L.	-	-	+	Th	Mes	Dec	-	D	L	W	Dis.
113.	<i>Calendula officinalis</i> L.	+	-	-	Th	Mes	Dec	-	D	L	C	S
114.	<i>Carduus edelbergii</i> Rech.	+	-	+	Th	Mes	Dec	+	D	L	W	Dis.
115.	<i>Centaurea iberica</i> Trev. ex Spreng.	+	+	+	Th	N	Dec	+	D	L	W	Dis.
116.	<i>Cichorium intybus</i> L.	+	+	+	Th	Mes	Dec	-	D	L	W	S
117.	<i>Cirsium arvense</i> (L.) Scop.	+	+	+	Th	Mac	Dec	+	D	L	W	S
118.	<i>Cirsium falconeri</i> (Hk. f.) Petrak	-	-	+	Th	Mac	Dec	+	D	L	W	S
119.	<i>Conyza bonariensis</i> (L.) Cronquist	+	+	-	Th	N	Dec	-	D	L	W	S
120.	<i>Conyza canadensis</i> (L.) Cronquist	+	+	+	Th	N	Dec	-	D	L	W	S
121.	<i>Conyza japonica</i> Less.	+	+	+	Th	N	Dec	-	D	L	W	S
122.	<i>Cousinia bupththalmoides</i> Regel & Schm.	+	-	-	Th	L	Dec	-	D	L	W	S
123.	<i>Cousinia matfeldii</i> Bornm.	+	-	-	Th	Mic	Dec	+	D	L	W	S
124.	<i>Cousinia racemosa</i> Boiss.	+	-	-	Th	L	Dec	+	D	L	W	S
125.	<i>Echinops cornigerus</i> DC.	+	+	+	Th	Mes	Dec	+	D	L	W	S
126.	<i>Erigeon canadensis</i> L.	+	-	+	Th	Mic	Dec	-	D	L	W	S
127.	<i>Filago arvensis</i> L.	-	-	+	Th	N	Dec	-	D	L	W	S
128.	<i>Filago desertorum</i> Pomel	-	-	+	Th	N	Dec	-	D	L	W	S
129.	<i>Galinsoga parviflora</i> Cav.	+	-	+	Th	N	Dec	-	D	L	W	S
130.	<i>Inula rhizocephala</i> Schrenk Enum.	-	+	+	Th	N	Dec	-	D	L	W	S
131.	<i>Lachnophyllum gossypinum</i> Bunge.	-	-	+	Th	Mic	Dec	+	D	L	W	S
132.	<i>Lactuca decipiens</i> (H. & T.) Clarke	-	-	+	Th	N	Dec	-	D	L	W	S
133.	<i>Lactuca sativa</i> L.	+	+	+	Th	Mac	Dec	-	D	L	C	S
134.	<i>Lactuca persica</i> Boiss.	+	+	-	Th	N	Dec	-	D	L	W	S
135.	<i>Lactuca serriola</i> L.	+	+	+	Th	Mes	Dec	-	D	L	W	S
136.	<i>Lactuca dolichophylla</i> Kitam.	-	-	+	Th	N	Dec	-	D	L	W	S
137.	<i>Matricaria aurea</i> L.	+	+	+	Th	N	Dec	-	D	L	W	Dis.
138.	<i>Matricaria disciformis</i> (C.A.M.) DC. Prodr.	+	+	+	Th	N	Dec	-	D	L	W	Dis.
139.	<i>Pentanema indicum</i> (L.) Y. Ling	-	+	-	Th	N	Dec	-	D	L	W	S
140.	<i>Phagnalon acuminatum</i> Boiss.	+	+	-	Th	L	Dec	-	D	L	W	S
141.	<i>Pulicaria salviaefolia</i> Bunge	+	-	+	H	N	Dec	-	D	L	W	S

142.	<i>Saussurea heteromalla</i> (D. Don.) Hann.	-	+	-	Th	Mic	Dec	-	D	L	W	S
143.	<i>Scorzonera virgata</i> DC	+	-	-	H	L	Dec	-	D	L	W	Dis.
144.	<i>Sonchus arvensis</i> Boiss.	+	+	+	Th	Mes	Dec	-	M	L	W	Dis.
145.	<i>Sonchus asper</i> (L.) Hill	+	+	+	Th	Mes	Dec	-	M	L	W	Dis.
146.	<i>Sonchus oleraceus</i> L.	+	+	+	Th	N	Dec	-	M	L	W	Dis.
147.	<i>Senecio dublitabilis</i> C. Jeffery & Y.L. Chen	+	-	-	Th	N	Dec	-	M	L	W	S
148.	<i>Tagetes erecta</i> L.	+	+	-	Th	N	Dec	-	D	L	C	Dis.
149.	<i>Taraxacum officinale</i> Weber	+	+	+	G	Mes	Dec	-	M	L	W	S
150.	<i>Tragopogon gracilis</i> D. Don.	-	+	-	H	N	Dec	-	D	L	W	S
151.	<i>Xanthium strumarium</i> L.	+	+	+	Th	Mes	Dec	+	D	L	W	S
34. Family Berberidaceae												
152.	<i>Berberis lycium</i> Royle	-	-	+	NP	N	Dec	+	D	L	W	S
35. Family Balsaminaceae												
153.	<i>Impatiens bicolor</i> Royle	-	+	+	Th	Mic	Dec	-	M	Sd	W	S
154.	<i>Impatiens edgeworthii</i> Hk. f. FBI	-	+	+	Th	Mic	Dec	-	M	Sd	W	S
36. Family Bignoniaceae												
155.	<i>Campsis grandiflora</i> L.	+	-	-	Ch (Cl)	Mes	E	-	D	L	C	S
37. Family Boraginaceae												
156.	<i>Arnebia decumbens</i> (Vent) Coss & Kral.	-	-	+	H	N	Dec	-	D	L	W	S
157.	<i>Asperugo procumbens</i> L.	+	-	-	Th	Mic	Dec	-	D	L	W	S
158.	<i>Cynoglossum glochidiatum</i> Wall. ex Benth.	+	+	-	H	N	Dec	-	D	L	W	S
159.	<i>Cynoglossum lanceolatum</i> Forssk.	+	+	-	H	N	Dec	-	D	L	W	S
160.	<i>Lithospermum arvense</i> L.	+	-	-	Th	N	Dec	-	D	L	W	S
161.	<i>Lappula microcarpa</i> (Ledeb.) Gurke	+	+	-	Th	L	Dec	-	D	L	W	S
162.	<i>Lepechiniella inconspicua</i> (Brand) Reidl.	+	-	-	H	Mes	Dec	-	D	L	W	S
163.	<i>Lindelofia longiflora</i> (Benth.) Baill.	-	+	+	N	N	Dec	-	D	L	W	S
164.	<i>Onosma dichroanthum</i> Boiss.	+	-	-	H	N	Dec	-	D	L	W	S
165.	<i>Onosma hispidum</i> Wall ex. G. Don.	+	-	-	H	N	Dec	-	D	L	W	S
166.	<i>Pseudomertensia chitralensis</i> (Riedl) Reidl in Rechinger	-	+	-	H	N	Dec	-	D	L	W	S
167.	<i>Solananthus circinnatus</i> Ledeb.	-	+	-	H	N	Dec	-	D	L	W	S
38. Family Brassicaceae												
168.	<i>Alliaria petiolata</i> (M. B.)	+	-	+	Th	N	Dec	-	D	L	W	S

	Cav. & Grande Boll.											
169.	<i>Alyssum desertorum</i> Stapf.	+	-	+	Th	N	Dec	-	D	L	W	S
170.	<i>Arabidopsis wallichii</i> (H. & T.) N. Busch.	+	-	+	H	N	Dec	-	D	L	W	S
171.	<i>Arabis auriculata</i> Lam.	+	+	+	Th	N	Dec	-	D	L	W	S
172.	<i>Brassica campestris</i> L.	+	+	+	Th	Mac	Dec	-	D	L	C	Dis.
173.	<i>Brassica napus</i> L.	+	+	+	Th	Mac	Dec	-	D	L	C	Dis.
174.	<i>Capsella bursa-pastoris</i> (L.) Medic.	+	+	+	Th	Mes	Dec	-	M	L	W	Dis.
175.	<i>Cardamine hirsuta</i> L.	+	-	+	Th	N	Dec	-	M	L	W	Com
176.	<i>Coronopus didymus</i> (L.) Sm.	+	+	+	Th	L	Dec	-	M	L	W	Dis.
177.	<i>Descurainea sophia</i> (L.) Webb. & Berth.	-	-	+	Th	N	Dec	-	M	L	W	Dis.
178.	<i>Draba lanceolata</i> Royle	+	+	-	H	N	Dec	-	D	L	W	S
179.	<i>Draba altaica</i> (C.A.M.) Bunge	-	+	-	Th	N	Dec	-	D	L	W	S
180.	<i>Draba olgae</i> var. <i>chitralensis</i> O.E. Schulz	-	+	-	Th	N	Dec	-	D	L	W	S
181.	<i>Draba trinervis</i> O.E.S.	-	+	-	Th	N	Dec	-	D	L	W	S
182.	<i>Eruca sativa</i> Miller	+	-	-	Th	Mic	Dec	-	D	L	W	S
183.	<i>Lepidium sativum</i> L.	+	+	+	Th	N	Dec	-	D	L	W	S
184.	<i>Malcolmia africana</i> (L.) R. Br.	+	+	-	Th	L	Dec	-	D	L	W	S
185.	<i>Malcolmia cabulica</i> (Boiss.) H. & T.	-	+	-	Th	N	Dec	-	D	L	W	S
186.	<i>Matthiola tenera</i> Rech.f.,	+	-	+	Ch	Mes	Dec	-	M	L	W	S
187.	<i>Nasturtium officinale</i> R. Br.	+	+	-	G	N	E	-	M	L	W	Dis.
188.	<i>Neslia apiculata</i> Fisch.	+	+	+	Th	L	Dec	-	M	L	W	S
189.	<i>Raphanus sativus</i> L.	+	+	+	Th	Mac	Dec	-	M	L	C	Dis.
190.	<i>Sisymbrium brassiciforme</i> C. A. Mey	+	-	-	Th	N	Dec	-	D	L	W	Dis.
191.	<i>Sisymbrium irio</i> L.	+	+	+	Th	Mic	Dec	-	M	L	W	Dis.
192.	<i>Thlaspi andersonii</i> (H. & T.) O.E.S.	-	+	-	Th	Mic	Dec	-	D	L	W	S
39. Family Campanulaceae												
193.	<i>Campanula staintonii</i> Rech.	-	-	+	Th	N	Dec	-	M	L	W	S
194.	<i>Codonopsis ovata</i> Bth.	+	+	-	H	Mes	Dec	-	M	L	W	S
40. Family Cannabinaceae												
195.	<i>Cannabis sativa</i> L.	+	+	+	Th	N	Dec	-	D	L	W	Com
41. Family Capparidaceae												
196.	<i>Capparis spinosa</i> L.	+	+	-	H	Mes	Dec	+	D	L	W	S
197.	<i>Cleome ariana</i> Hedge & Lamond	+	+	-	Th	N	Dec	-	D	L	W	S
42. Family Caprifoliaceae												
198.	<i>Viburnum cotinifolium</i> D. Don.	+	+	-	H	Mac	Dec	-	M	L	W	Com

43. Family Caryophyllaceae												
199.	<i>Arenaria griffithii</i> Boiss.	+	+	-	Ch	L	E	-	D	L	W	S
200.	<i>Arenaria serpyllifolia</i> L.	+	-	-	Th	N	Dec	-	D	L	W	S
201.	<i>Herniaria hirsuta</i> L.	+	-	+	Th	L	Dec	-	D	L	W	S
202.	<i>Lepyrodiclis holosteoides</i> (C. A. Mey) Fenzl.	+	+	-	Th	N	Dec	-	D	L	W	S
203.	<i>Silene conoidea</i> L.	+	+	+	Th	N	Dec	-	D	L	W	S
204.	<i>Silene pseudo-verticillata</i> Nasir	-	-	+	Th	Mic	Dec	-	D	L	W	S
205.	<i>Silene viscosa</i> (L.) Pers.	+	+	+	Th	N	Dec	-	D	L	W	S
206.	<i>Silene vulgaris</i> (Moench) Garcke.	-	+	-	H	N	Dec	-	D	L	W	S
207.	<i>Spergula arvensis</i> L.	-	+	-	Th	L	Dec	-	D	L	W	S
208.	<i>Stellaria media</i> (L.) Cyr.	+	+	+	Th	N	Dec	-	D	L	W	S
44. Family Chenopodiaceae												
209.	<i>Atriplex crassifolia</i> C. A. Mey	+	+	+	Th	N	E	-	D	L	W	S
210.	<i>Chenopodium album</i> L.	+	+	+	Th	N	Dec	-	D	L	W	S
211.	<i>Chenopodium ambrosioides</i> L.	+	-	-	Th	L	Dec	-	M	L	W	S
212.	<i>Chenopodium botrys</i> L.	-	-	+	Th	L	Dec	-	D	L	W	S
213.	<i>Chenopodium foliosum</i> (Merrich.) Aschers.	-	-	+	Th	N	Dec	-	D	L	W	S
214.	<i>Chenopodium murale</i> L.	+	+	+	Th	N	Dec	-	D	L	W	S
215.	<i>Chenopodium novopokrovskyanum</i> (Aellen) Uotila	-	+	-	Th	N	Dec	-	D	L	W	S
216.	<i>Kochia indica</i> Wight.	+	+	+	Th	L	Dec	-	D	L	W	S
45. Family Convolvulaceae												
217.	<i>Convolvulus arvensis</i> L.	+	+	+	Th (Cl)	Mes	Dec	-	D	L	W	S
46. Family Crassulaceae												
218.	<i>Sedum ewersii</i> Ledeb.	+	+	-	G	N	Dec	-	M	L	W	S
219.	<i>Sedum quadrifidum</i> Pall.	-	+	-	G	N	Dec	-	M	L	W	S
47. Family Cucurbitaceae												
220.	<i>Citrullus vulgaris</i> L.	+	+	+	Th	Mes	Dec	-	D	L	C	Com
221.	<i>Cucumis sativa</i> L.	+	+	+	Th	Mes	Dec	-	D	L	C	Com
222.	<i>Cucurbita maxima</i> Duch ex Lam	+	+	+	Th	Mac	Dec	-	D	L	C	Com
223.	<i>Cucurbita pepo</i> L.	+	+	+	Th	Mac	Dec	-	D	L	C	Com
48. Family Cuscutaceae												
224.	<i>Cuscuta brevistyla</i> A. Braun. ex A. Rich.	-	-	+	P	Ap	Ap	-	D	L	W	Ap
225.	<i>Cuscuta lehmanniana</i> Bunge	-	-	+	P	Ap	Ap	-	D	L	W	Ap
226.	<i>Cuscuta reflexa</i> Roxb.	+	+	+	P	Ap	Ap	-	D	L	W	Ap
49. Family Dipsacaceae												
227.	<i>Dipsacus inermis</i> var. <i>mitis</i> (D. Don) Y. Nasir	-	+	-	Th	L	Dec	-	D	L	W	S

50. Family Elaeagnaceae												
228.	<i>Elaeagnus angustifolia</i> L.	+	-	-	MacP	Mes	Dec	-	D	L	W	S
51. Family Euphorbiaceae												
229.	<i>Euphorbia granulata</i> L.	-	+	-	Th	N	Dec	-	D	L	W	S
230.	<i>Euphorbia falcata</i> L.	+	+	+	Th	N	Dec	-	D	L	W	S
231.	<i>Euphorbia helioscopia</i> L.	+	+	+	Th	N	Dec	-	D	L	W	S
232.	<i>Euphorbia peplus</i> L.	+	+	+	Th	L	Dec	-	D	L	W	S
233.	<i>Euphorbia prostrata</i> L.	-	-	+	Th	L	Dec	-	D	L	W	S
52. Family Fabaceae												
234.	<i>Astragalus grahamianus</i> Royle. ex Bth.	+	-	+	Ch	L	Dec	+	D	L	W	Com
235.	<i>Astragalus subumbellatus</i> Klotzsch.	+	+	-	H	N	Dec	-	D	L	W	Com
236.	<i>Astragalus nivales</i> Kar & Kir	+	+	-	H	L	Dec	-	D	L	W	Com
237.	<i>Indigofera heterantha</i> var. <i>heterantha</i> L.	-	+	-	Ch	Mic	Dec.	-	D	L	W	Com
238.	<i>Lathyrus aphaca</i> L.	+	+	+	Th	N	Dec	-	D	L	W	S
239.	<i>Lotus corniculatus</i> L.	+	+	+	H	N	Dec	-	D	L	W	S
240.	<i>Medicago lupulina</i> L.	+	-	-	Th	N	Dec	-	D	L	W	Com
241.	<i>Medicago polymorpha</i> L.	+	+	+	Th	N	Dec	-	D	L	W	Com
242.	<i>Melilotus indica</i> (L.) All.	+	-	+	Th	N	Dec	-	D	L	W	Com
243.	<i>Robinia psuedoacacia</i> L.	+	-	+	NP	N	E	+	D	L	C	Com
244.	<i>Sophora mollis</i> (Royle) Baker	+	-	+	NP	N	Dec	+	D	L	W	S
245.	<i>Trifolium pretense</i> L.	+	+	+	G	N	Dec	-	M	L	W	S
246.	<i>Trifolium repens</i> L.	+	+	+	G	N	Dec	-	M	L	W	S
247.	<i>Trigonella incisa</i> Bth.	+	+	+	Th	N	Dec	-	M	L	W	S
248.	<i>Vicia monantha</i> L.	+	+	+	Th (Cl)	N	Dec	-	M	L	W	S
249.	<i>Vicia sativa</i> L.	+	+	+	Th (Cl)	N	Dec	-	M	L	W	S
53. Family Fumariaceae												
250.	<i>Fumaria indica</i> (Hausskn.) H. N. Pugsley	+	+	+	Th	N	Dec	-	D	L	W	Dis.
54. Family Fagaceae												
251.	<i>Quercus baloot</i> Griffith	+	+	+	NP	Mic	E	+	D	L	W	Com
252.	<i>Quercus dilatata</i> Lindl.	+	+	+	MegP	Mic	E	-	D	L	W	Com
55. Family Geraniaceae												
253.	<i>Erodium cicutarium</i> (L.) L' Herit.	+	-	-	Th	Mic	Dec	-	D	L	W	Com
254.	<i>Geranium rotundifolium</i> L.	+	+	+	Th	N	Dec	-	M	L	W	Com
255.	<i>Geranium wallichianum</i> D. Don. Ex Sweet	+	-	-	Th	Mes	Dec	-	M	L	W	Com
56. Family Juglandaceae												
256.	<i>Juglans regia</i> L.	+	+	+	MegP	Mac	Dec	-	D	L	W	S
57. Family Lamiaceae												
257.	<i>Calamintha umbrosa</i> (M. Bieb.) Fisch. & Mey.	+	+	-	Th	N	Dec	-	D	L	W	S

290.	<i>Oxalis corniculata</i> L.	+	+	+	Th	Mes	Dec	-	M	L	W	S
63. Family Paeoniaceae												
291.	<i>Paeonia emodi</i> Wall ex G. Don	-	+	-	G	N	Dec	-	M	Sd	W	Com
64. Family Papaveraceae												
292.	<i>Papaver dubium</i> L.	-	-	+	Th	L	Dec	-	D	L	W	Dis
65. Family Plantaginaceae												
293.	<i>Plantago lanceolata</i> L.	+	+	+	Th	Mes	Dec	-	D	L	W	S
294.	<i>Plantago major</i> Aitch.	+	+	+	G	Mac	Dec	-	M	L	W	S
295.	<i>Plantago ovata</i> Forssk.	-	-	+	Th	Mic	Dec	-	M	L	W	S
66. Family Platanaceae												
296.	<i>Platanus orientalis</i> L.	+	+	+	MegP	Mac	Dec	-	D	L	C	Com
67. Family Plumbaginaceae												
297.	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	-	-	+	Ch	L	Dec	-	D	L	W	S
298.	<i>Limonium griffithii</i> (Aitch. & Hemsl.) O. Ktze.	-	+	+	H	Mic	Dec	-	D	L	W	S
68. Family Polygonaceae												
299.	<i>Bistorta affinis</i> (D. Don) Green	-	-	+	Ch	N	Dec	-	D	L	W	S
300.	<i>Bistorta vivipara</i> (L.) S.F. Gray	-	-	+	H	N	Dec	-	D	L	W	S
301.	<i>Oxyria digyna</i> (L.) Hill.	+	+	+	Th	N	Dec	-	M	L	W	S
302.	<i>Polygonum amplexicaule</i> D Don.	-	+	+	Th	L	Dec	-	D	L	W	S
303.	<i>Polygonum aviculare</i> L.	-	-	+	Th	L	Dec	-	D	L	W	S
304.	<i>Polygonum convolvulus</i> L.	-	+	+	Th	L	Dec	-	D	L	W	S
305.	<i>Polygonum paronychioides</i> C,A, Mey. ex Hohen.	-	+	+	H	L	Dec	-	D	L	W	S
306.	<i>Polygonum nepalense</i> Meissn.	+	+	+	G	N	Dec	-	D	L	W	S
307.	<i>Rheum webbianum</i> Royle	+	-	-	G	Mac	Dec	-	D	L	W	Com
308.	<i>Rumex hastatus</i> D. Don	+	+	+	Ch	Mes	Dec	-	D	L	W	S
309.	<i>Rumex longifolius</i> DC	+	+	+	Th	Mes	Dec	-	D	L	W	S
310.	<i>Rumex nepalensis</i> Spreng	+	+	+	H	Mes	Dec	-	D	L	W	S
69. Family Portulacaceae												
311.	<i>Portulaca oleracea</i> L	+	+	+	Th	N	Dec	-	D	L	W	S
70. Family Primulaceae												
312.	<i>Anagallis arvensis</i> L.	+	+	+	Th	L	Dec	-	D	L	W	S
313.	<i>Androsace harrissii</i> Du.	-	-	+	H	N	Dec	-	M	L	W	S
314.	<i>Primula denticulata</i> Sm.	-	-	+	H	N	Dec	-	M	L	W	S
315.	<i>Primula elliptica</i> Royle	-	+	+	H	N	Dec	-	M	L	W	S
71. Family Punicaceae												
316.	<i>Punica granatum</i> L.	+	+	+	NP	Mes	Dec	-	D	L	C	S
72. Family Ranunculaceae												
317.	<i>Adonis aestivalis</i> L.	-	-	+	Th	L	Dec	-	D	L	W	S
318.	<i>Ceratocephalus falcatus</i> (L.) Pers.	-	-	+	Th	Mic	Dec	-	D	L	W	S

319.	<i>Clematis orientalis</i> L.	+	-	+	NP (Cl)	N	Dec	-	D	L	W	Com
320.	<i>Delphinium denudatum</i> Wall. ex H. & T	+	+	-	Ch	Mic	Dec	-	D	L	W	Dis
321.	<i>Thalictrum elegans</i> Wall. ex Royle	+	-	-	Th	N	Dec	-	M	L	W	Dis.
322.	<i>Ranunculus aucheri</i> L.	+	+	+	Th	N	Dec	-	M	L	W	Dis.
323.	<i>Ranunculus lanata</i> L.	+	+	+	Th	N	Dec	-	M	L	W	Dis.
324.	<i>Ranunculus muricatus</i> L.	+	+	-	Th	N	Dec	-	M	L	W	Dis.
325.	<i>Ranunculus sceleratus</i> L.	-	+	-	Th	N	Dec	-	M	L	W	Dis.
73. Family Rosaceae												
326.	<i>Cotoneaster microphylla</i> Wall. ex Lindl.	+	+	-	NP	L	Dec	+	D	L	W	S
327.	<i>Cotoneaster nummularia</i> Fisch. & Mey	+	+	-	NP	N	Dec	+	D	L	W	S
328.	<i>Crataegus songarica</i> C. Koch.	+	-	-	MegP	Mes	Dec	-	D	L	C	Com
329.	<i>Cydonia oblonga</i> Mill.	+	-	-	NP	Mac	Dec	-	D	L	C	S
330.	<i>Filipendula vestita</i> (Wall. ex G. Don) Maxim.	-	+	+	NP	Mic	Dec	-	D	L	W	S
331.	<i>Potentilla pamirica</i> Wolf.	-	-	+	Th	N	Dec	-	D	L	W	S
332.	<i>Potentilla sericea</i> L.	+	+	-	Th	L	Dec	-	D	L	W	S
333.	<i>Prunus armeniaca</i> L.	+	+	+	MegP	Mes	Dec	-	D	L	C	S
334.	<i>Prunus domestica</i> L.	+	-	-	MegP	Mes	Dec	-	D	L	C	S
335.	<i>Prunus griffithii</i> (Boiss.) C. K. Sch.	-	-	+	NP	Mes	Dec	-	D	L	W	Dis.
336.	<i>Prunus kuramica</i> (Korsh.) Kitam.	+	+	-	MegP	Mic	Dec	-	D	L	W	S
337.	<i>Prunus persica</i> L.	+	+	+	MesP	Mes	Dec	-	D	L	C	S
338.	<i>Pyrus communis</i> L.	+	+	+	MegP	Mac	Dec	-	D	L	C	S
339.	<i>Pyrus pashia</i> Ham. ex D. Don	-	-	+	MesP	Mic	Dec	-	D	L	W	S
340.	<i>Pyrus malus</i> L.	+	+	+	MegP	Mac	Dec	-	D	L	C	S
341.	<i>Rosa alba</i> L.	+	+	+	NP	Mic	Dec	+	D	L	C	Com
342.	<i>Rosa ecae</i> Aitch.	+	-	-	NP	N	Dec	+	D	L	W	Com
343.	<i>Rosa webbiana</i> Wall. ex Royle	+	+	+	NP	N	Dec	+	D	L	W	Com
344.	<i>Rubus fruticosus</i> L.	+	-	+	NP	Mic	Dec	-	D	L	W	Com
345.	<i>Rubus irritans</i> Focke	+	-	+	NP	Mic	Dec	-	D	L	W	Com
346.	<i>Spiraea canescens</i> Lour.	+	+	-	NP	N	Dec	-	D	L	W	S
347.	<i>Sorbaria tomentosa</i> (Lindl.) Rehder	+	+	-	Ch	Mic	Dec	-	D	L	W	Com
74. Family Rubiaceae												
348.	<i>Gallium aparine</i> L.	+	+	+	Th (Cl)	N	Dec	-	D	L	W	S
349.	<i>Gallium tricornutum</i> L.	+	+	+	Th	N	Dec	-	D	L	W	S

					(Cl)							
350.	<i>Rubia cordifolia</i> L.	+	+	-	Th	N	Dec	-	D	L	W	S
75. Family Salicaceae												
351.	<i>Populus alba</i> L.	-	+	+	MacP	Mes	Dec	-	M	L	C	S
352.	<i>Populus nigra</i> L.	+	+	+	MacP	Mac	Dec	-	M	L	C	S
353.	<i>Salix acmophylla</i> Boiss.	+	+	+	MesP	Mes	Dec	-	D	L	C	S
354.	<i>Salix linearifolia</i> E. Wolf.	+	-	-	MesP	Mes	Dec	-	D	L	C	S
355.	<i>Salix tetrasperma</i> Roxb.	+	+	+	MegP	Mes	Dec	-	D	L	C	S
356.	<i>Salix denticulata</i> Anderson subsp. <i>Denticulata</i>	+	+	-	MesP	Mes	Dec	-	D	L	C	S
76. Family Saxifragaceae												
357.	<i>Bergenia ciliata</i> (Haw.) Sternb.	+	-	+	G	Mic	E	-	M	Sd	W	S
358.	<i>Bergenia himalaica</i> Boriss	+	-	+	G	Mic	E	-	M	Sd	W	S
77. Family Scrophulariaceae												
359.	<i>Euphrasia aristulata</i> Penn.	+	-	+	Th	L	Dec	-	D	L	W	S
360.	<i>Kickxia ramossissima</i> (Wall.) Janchen	-	-	+	Th	L	Dec	-	M	Sd	W	S
361.	<i>Linaria bamianica</i> Patzak	+	+	+	Th	L	Dec	-	D	L	W	S
362.	<i>Pedicularis chitralensis</i> Penn.	-	+	-	H (P)	L	Dec	-	D	L	W	S
363.	<i>Scrophularia robusta</i> Penn.	-	-	+	Th	Mic	Dec	-	D	L	W	S
364.	<i>Scrophularia scoparia</i> Penn.	-	-	+	Th	Mic	Dec	-	D	L	W	S
365.	<i>Verbascum thapsus</i> L.	+	+	+	G	Mes	Dec	-	D	L	W	S
366.	<i>Veronica anagallis</i> <i>aquatica</i> L.	+	+	+	G	Mes	Dec	-	M	L	W	Com
367.	<i>Veronica persica</i> L.	+	-	-	Th	L	Dec	-	M	L	W	S
368.	<i>Veronica verna</i> L.	+	-	-	Th	Mic	Dec	-	M	L	W	Com
78. Family Simaroubaceae												
369.	<i>Ailanthus altissima</i> (Mill.) Swingle	+	+	+	NP	Mic	Dec	-	M	L	W	Com
79. Family Solanaceae												
370.	<i>Datura stramonium</i> L.	+	+	+	Th	Mic	Dec	-	D	L	W	S
371.	<i>Lycopersicon esculentum</i> Miller.	+	+	+	Th	Mic	Dec	-	D	L	C	Com
372.	<i>Solanum melongena</i> L.	+	+	+	Th	Mac	Dec	-	D	L	C	S
373.	<i>Solanum nigrum</i> L.	+	+	+	Th	Mes	Dec	-	M	L	W	S
374.	<i>Solanum tuberosum</i> L.	+	+	+	G	Mes	Dec	-	D	L	C	Com
80. Family Tamaricaceae												
375.	<i>Myricaria squamosa</i> Desv.	+	-	-	NP	L	Dec	-	M	L	W	S
376.	<i>Tamarix dioica</i> Roxb. ex Roth	+	+	+	NP	L	Dec	-	M	L	W	S
81. Family Thymeleaceae												
377.	<i>Daphne oleoides</i> Schreb.	-	+	-	NP	L	E	-	M	L	W	S
378.	<i>Thymelaea passerina</i> (L.) Coss. & Germ.	+	-	-	Th	N	Dec	-	D	L	W	S
82. Family Ulmaceae												
379.	<i>Celtis australis</i> L.	+	-	-	MacP	Mes	Dec	-	D	L	W	Com

83. Family Urticaceae												
380.	<i>Parietaria debilis</i> Forst.	-	+	-	Th	N	Dec	-	D	L	W	Com
381.	<i>Parietaria judaica</i> Starand.	-	+	-	Th	N	Dec	-	D	L	W	Com
382.	<i>Urtica dioica</i> L.	+	+	+	Th	Mac	Dec	-	D	L	W	Com
84. Family Valerianaceae												
383.	<i>Valeriana ficariifolia</i> Boiss.	+	-	-	Th	N	Dec	-	D	L	W	S
85. Family Verbenaceae												
384.	<i>Duranta repens</i> L.	+	-	-	NP	Mes	Dec	-	D	L	C	Com
385.	<i>Verbena officinalis</i> L.	+	+	-	Th	Mes	Dec	-	D	L	W	S
86. Family Violaceae												
386.	<i>Viola canescens</i> Wall. ex Roxb.	+	+	+	G	Mic	Dec	-	M	L	W	S
87. Family Vitaceae												
387.	<i>Vitis vinifera</i> L.	+	+	+	NP	Mac	Dec	-	D	L	C	Com
88. Family Zygophyllaceae												
388.	<i>Peganum harmala</i> L.	-	-	+	H	N	Dec	-	D	L	W	S
389.	<i>Tribulus terrestris</i> L.	+	-	+	Th	N	Dec	-	D	L	W	S
Total		275	247	258								

Keys: **B** = Bumburet, **R** = Rombor, **BR** = Birir

(1) Life form: Th. Therophytes, G. Geophytes, H. Hemicryptophytes, Ch. Chamaephytes, NP. Nanophanerophytes, MacP. Macrophanerophytes, MesP. Mesophanerophytes, MegP. Megaphanerophytes, Cl. Climber, P. Parasite.

(2) Leaf Size: AP. Aphyllous, L. Leptophyll, N. Nanophyll, Mic. Microphyll, Mes. Mesophyll, Mac. Macrophyll, Meg. Megaphyll.

(3) Leaf Persistence: E. Evergreen, Dec. Deciduous

(4) Spinyness: + Spiny, – Non spiny

(5) Habitat: M. Moist, D. Dry

(6) Light requirement: L. light, Sd. Shade

(7) Habit: C. Cultivated, W. Wild

(8) Leaf appearance: S. Simple, Com. Compound, Disec. Dissected

Table 4. Sum of ecological characteristics of plants of Kalash Valley, District Chitral, Hindukush range, Pakistan

S#	Ecological characteristics	No. of species	Percentage
Floristic list			
i.	Total species	389	-
ii.	Genera	273	-
iii.	Families	88	-
Species wise distribution of plant groups			
i.	Dicotyledonae	307	78.92
ii.	Monocotyledanae	55	14.13
iii.	Gymnosperms	10	02.57
iv.	Pteridophytes	12	03.08
v.	Bryophytes	04	01.03
vi.	Fungi	01	00.26
Total		389	100%
Total genera of plant groups			
i.	Dicotyledonae	208	76.19
ii.	Monocotyledanae	44	16.11
iii.	Gymnosperms	06	02.19
iv.	Pteridophytes	10	03.66
v.	Bryophytes	04	01.47
vi.	Fungi	01	0.37
Total		273	100 %
Total families of plant groups			
i.	Dicotyledonae	62	70.45
ii.	Monocotyledanae	11	12.50
iii.	Gymnosperms	03	03.41
iv.	Pteridophytes	07	07.95
v.	Bryophytes	04	04.54
vi.	Fungi	01	01.13
Total		88	100 %
Life form spectra			
i.	Therophytes	205	52.70
ii.	Geophytes	56	14.40
iii.	Hemicryptophytes	46	11.82
iv.	Nanophanerophytes	29	07.45
v.	Chamaephytes	21	05.40
vi.	Megaphanerophytes	19	04.90
vii.	Mesophanerophytes	5	01.28
viii.	Macrophanerophytes	5	01.28
ix.	Parasites	3	00.77
Total		389	100 %
Leaf size classes			
i.	Nanophylls	178	45.76
ii.	Mesophylls	72	18.51

iii.	Leptophylls	53	13.62
iv.	Microphylls	44	11.31
v.	Macrophylls	29	07.45
vi.	Aphyllous	13	03.34
Total		389	100 %
Leaf persistence			
i.	Deciduous	328	84.32
ii.	Evergreen	48	12.34
iii.	Aphyllous	13	03.34
Total		389	100 %
Spinyness			
i.	Non-spiny	369	94.85
ii.	Spiny	20	05.15
Total		389	100 %
Habitat			
i.	Dry	291	74.81
ii.	Moist	98	25.19
Total		389	100 %
Light requirement			
i.	Heliophytes	363	93.31
ii.	Sciophytes	26	06.69
Total		389	100 %
Habit			
i.	Wild	340	87.40
ii.	Cultivated	49	12.60
Total		389	100%
Leaf appearance			
i.	Simple	266	68.38
ii.	Compound	66	16.97
iii.	Dissected	44	11.31
iv.	Leafless	13	03.34
Total		389	100%

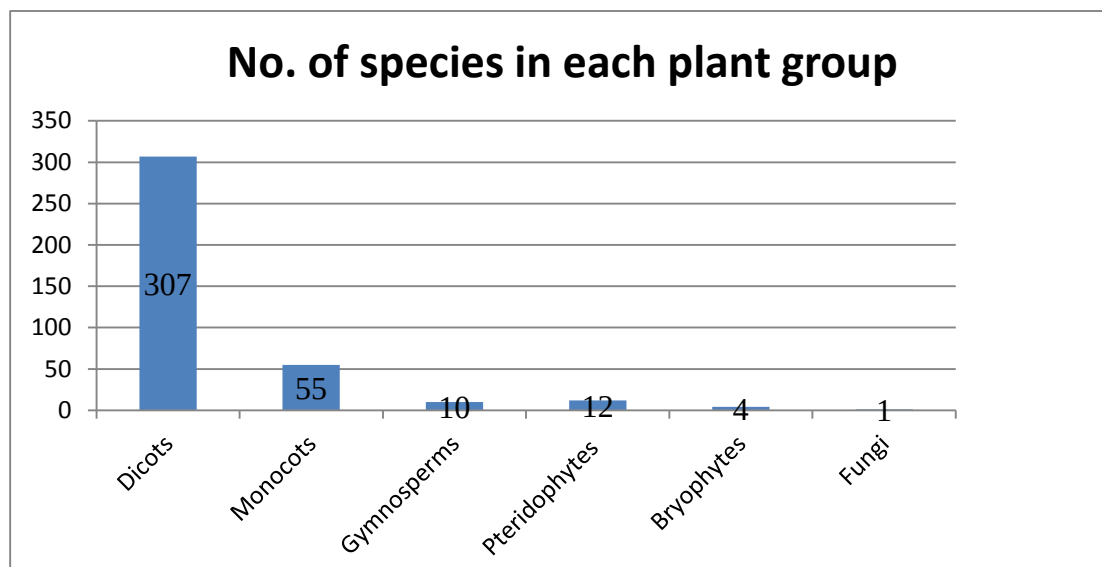


Figure 3. Graphical presentation of total species belong to specific plant group in Kalash Valley, district Chitral

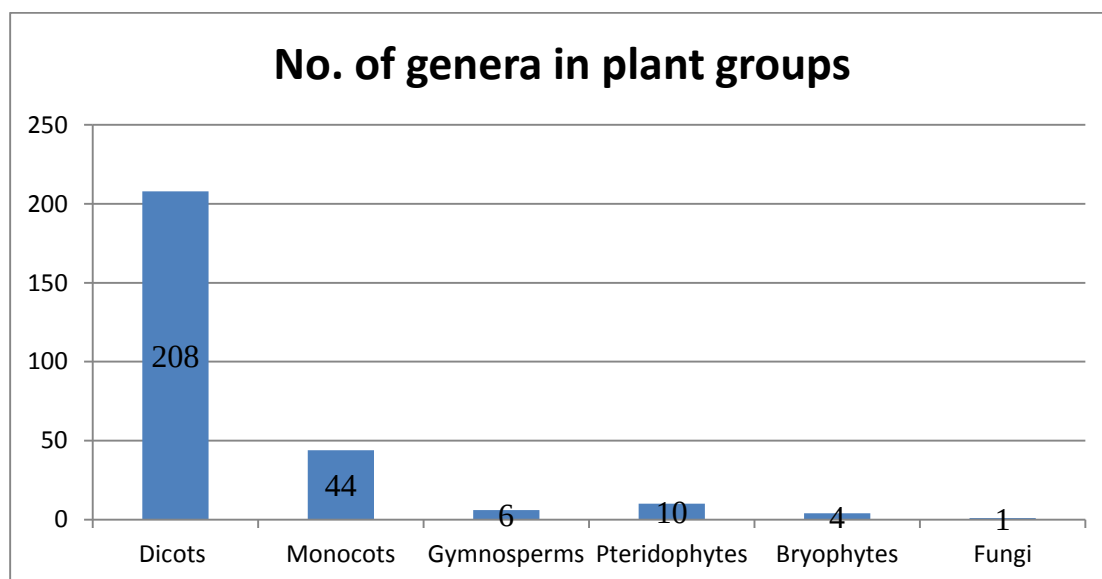


Figure 4. Graphical presentations of total genera belong to specific plant group in Kalash valley, district Chitral

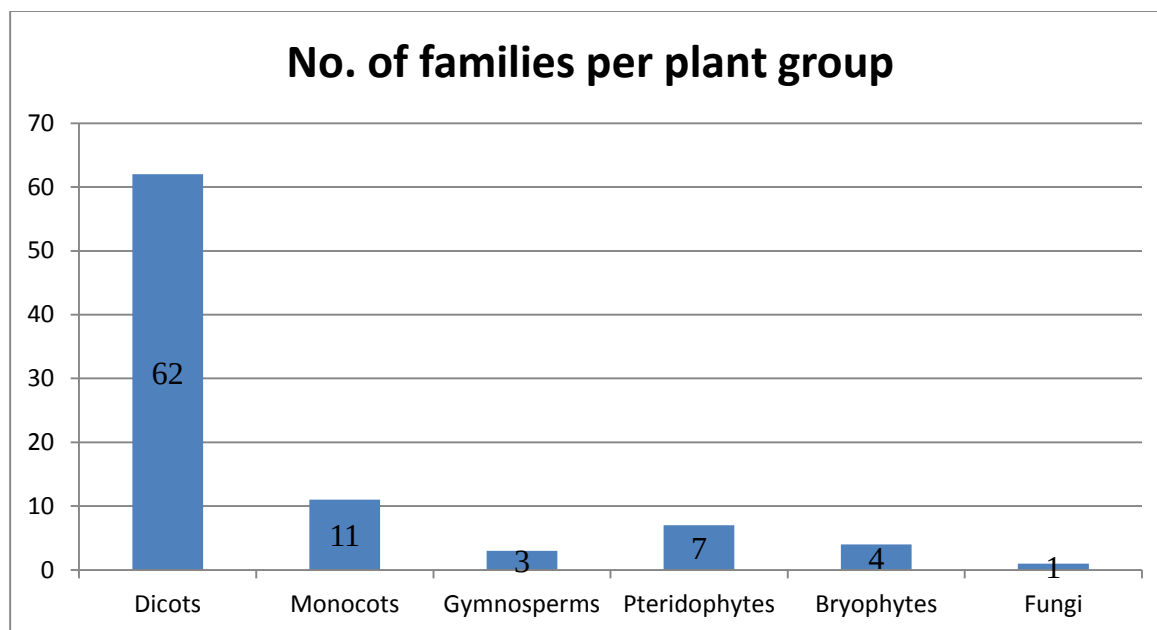


Figure 5. Graphical presentation of total no. of families belongs to specific plant group in Kalash valley, district Chitral

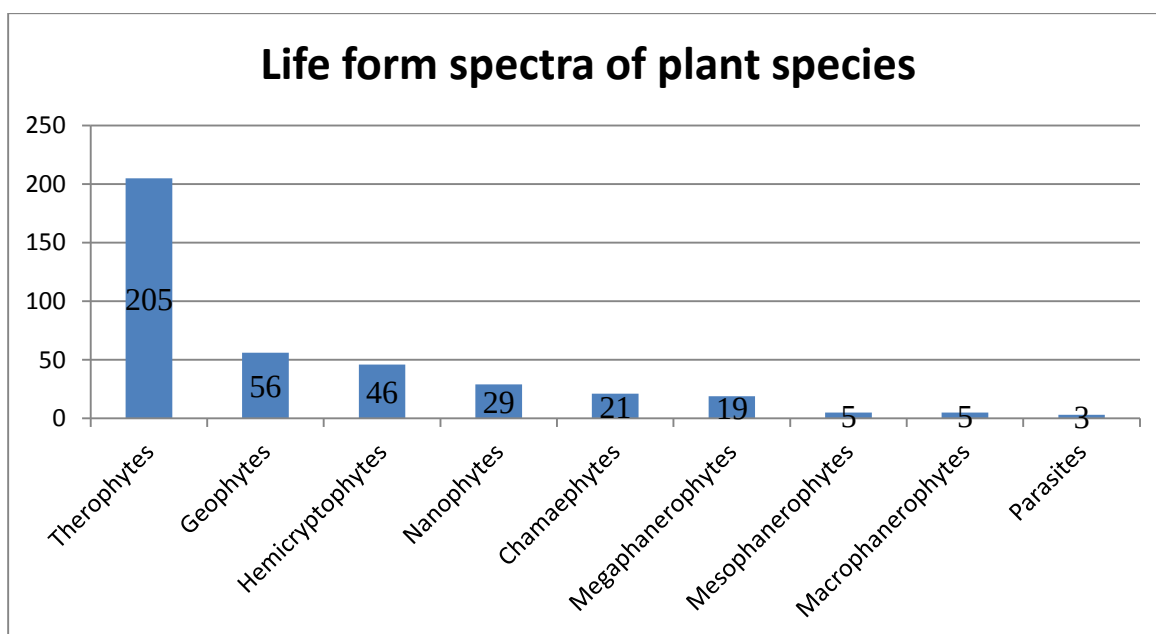


Figure 6. Graphical presentation of no. of species in different life form classes in Kalash valley, district Chitral

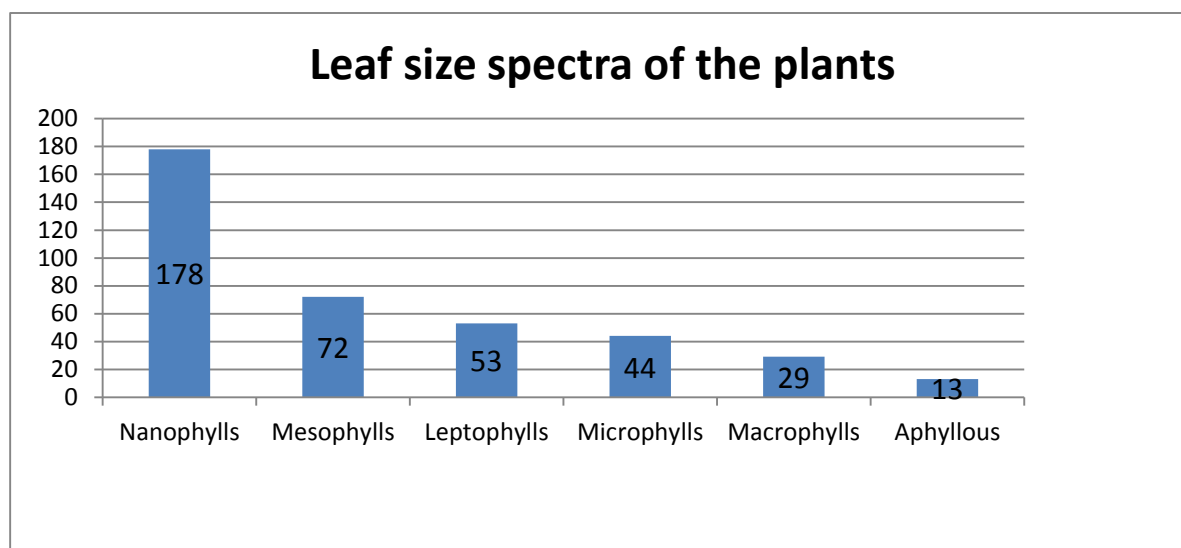


Figure 7. Graphical presentation of no. of species in different leaf size classes in Kalash valley, district Chitral

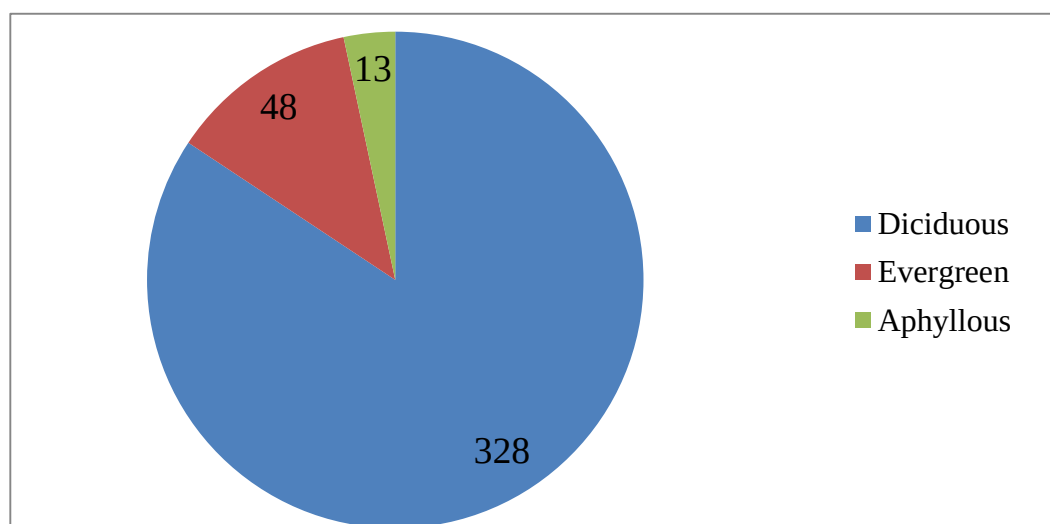


Figure 8. Graphical presentation of no. of species on the basis of leaf persistence in Kalash valley, district Chitral

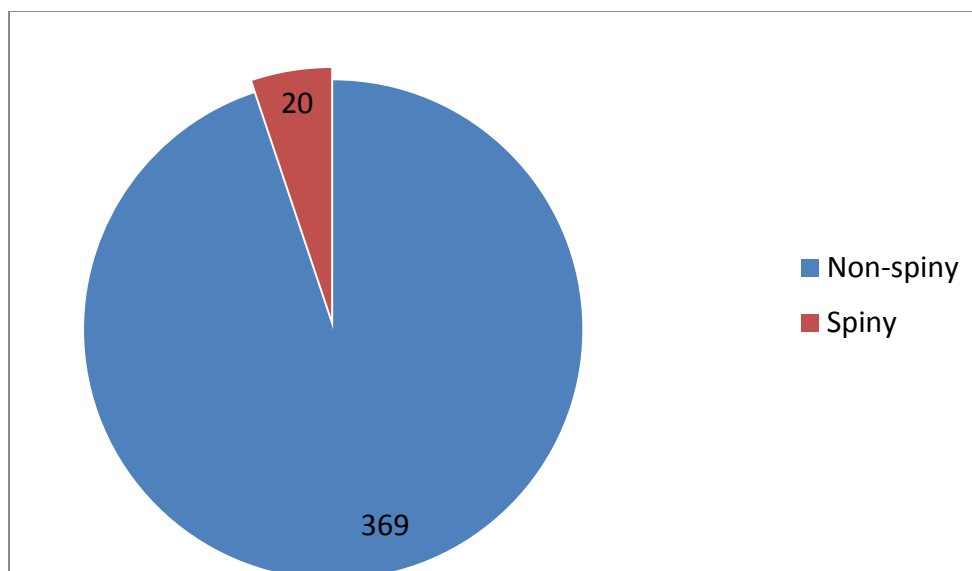


Figure 9. Graphical presentation of Spyness of plants in Kalash valley, district Chitral

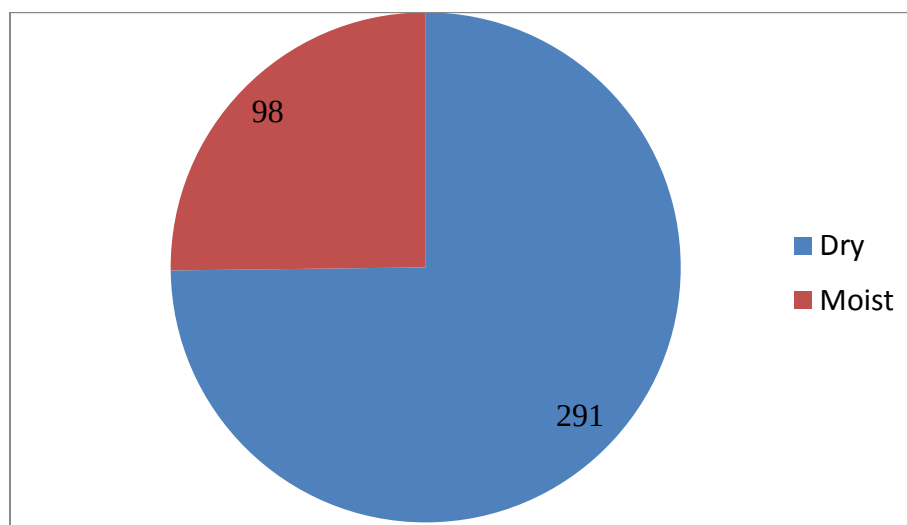


Figure 10. Graphical presentation of habitat of plants in Kalash valley, district Chitral

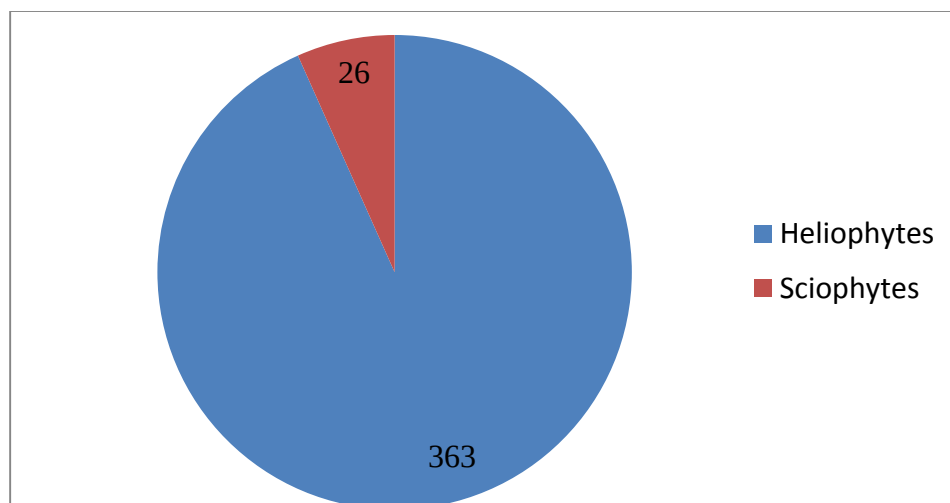


Figure 11. Graphical presentation of light requirement of plants in Kalash valley, district Chitral

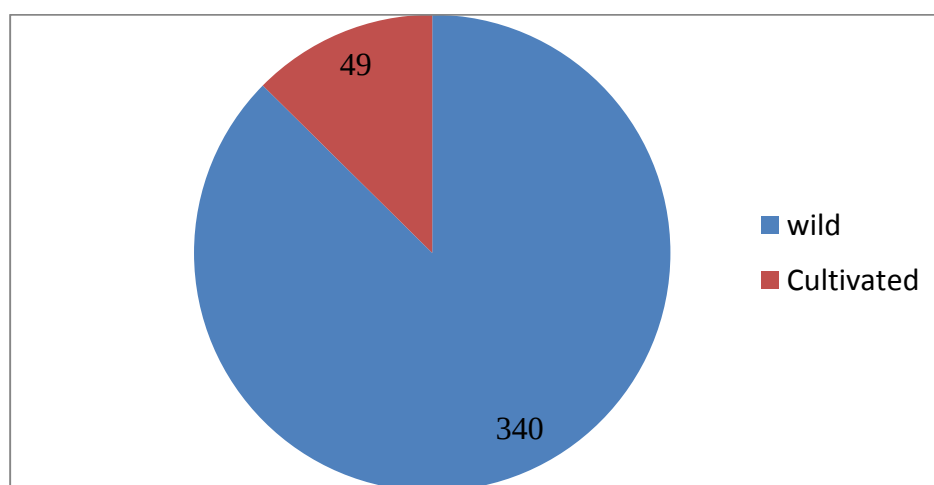


Figure 12. Graphical presentation of nature of growth of plants in Kalash valley, district Chitral

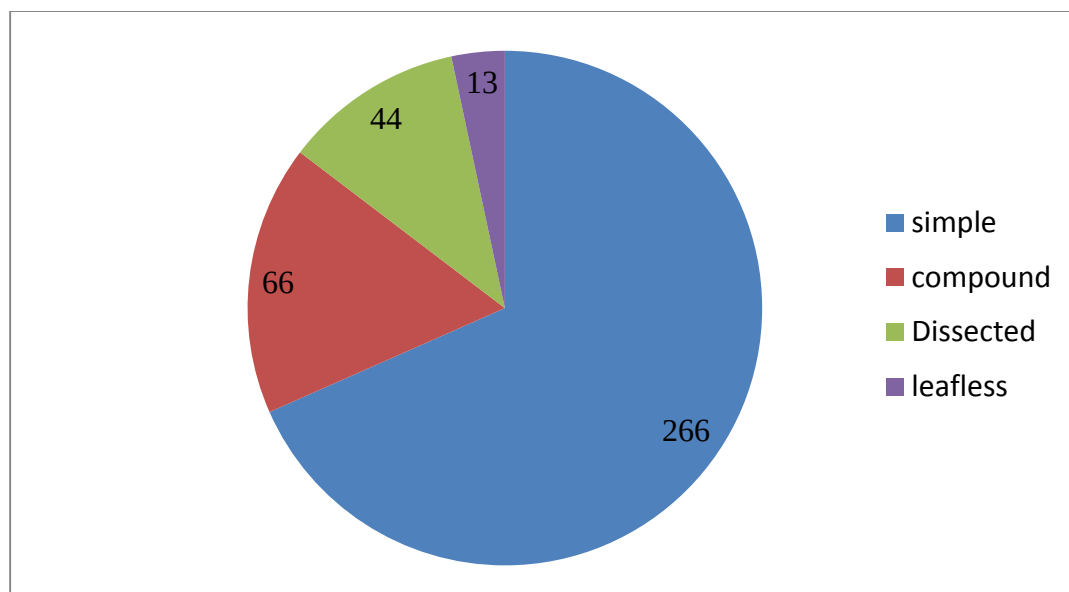


Figure 13. Graphical presentation of leaf shapes of plants in Kalash valley, district Chitral

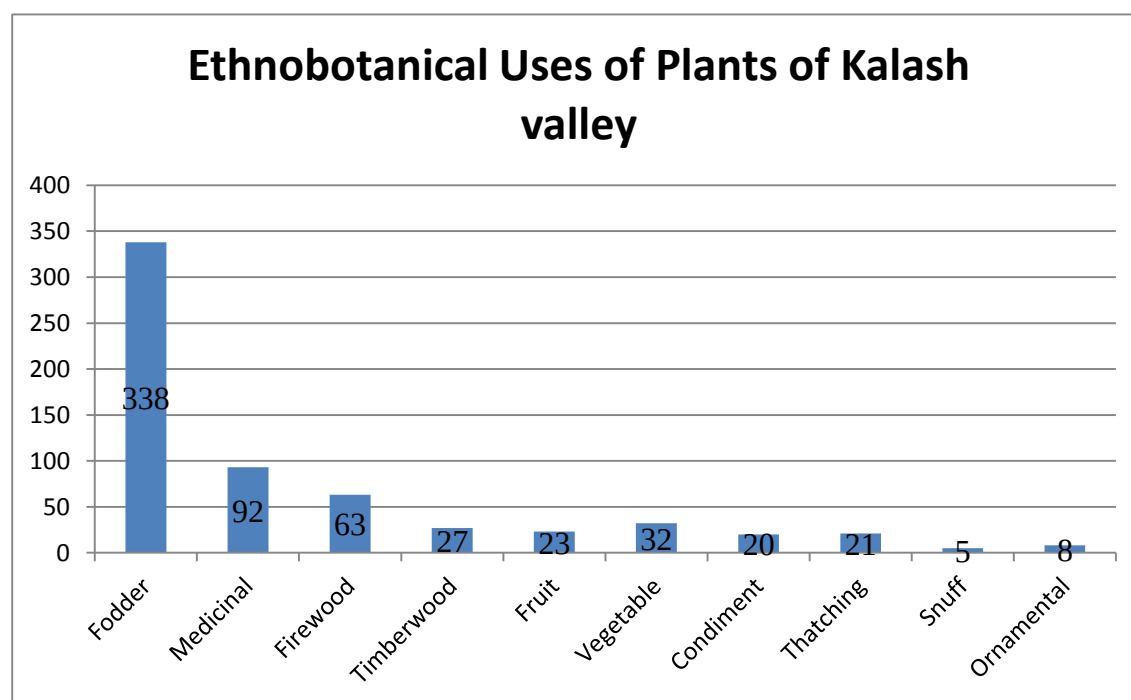


Figure 14. Graphical presentation of ethnobotanical uses of the plants in Kalash valley, district Chitral

67.	<i>Panicum antidotale</i> Retz.	+	-	-	-	-	-	-	-	-	-
68.	<i>Phleum pretense</i> L.	+	-	-	-	-	-	-	-	-	-
69.	<i>Phragmites karka</i> (Retz.) Trin. ex Steud	+	-	-	-	-	-	-	+	-	-
70.	<i>Piptatherum wendelboi</i> Bor	+	-	-	-	-	-	-	-	-	-
71.	<i>Poa annua</i> L.	+	-	-	-	-	-	-	-	-	-
72.	<i>Poa bulbosa</i> L.	+	-	-	-	-	-	-	-	-	-
73.	<i>Poa pratensis</i> L.	+	-	-	-	-	-	-	-	-	-
74.	<i>Poa supina</i> Schrad.	+	-	-	-	-	-	-	-	-	-
75.	<i>Polypogon fugax</i> Nees ex Steud	+	-	-	-	-	-	-	-	-	-
76.	<i>Saccharum spontaneum</i> L.	+	-	-	-	-	-	-	+	-	-
77.	<i>Setaria viridis</i> (L.) P. Beauv.	+	-	-	-	-	-	-	-	-	-
78.	<i>Triticum aestivum</i> L.	+	-	-	-	-	-	-	-	-	-
79.	<i>Vulpia myuros</i> (L.) Gmel.	-	-	-	-	-	-	-	-	-	-
80.	<i>Zea mays</i> L.	+	+	-	-	-	-	-	-	-	-
26. Family Typhaceae											
81.	<i>Typha angustata</i> Bory & Chaub	+	-	-	-	-	-	-	+	-	-
DICOTYLEDONAE											
27. Family Aceraceae											
82.	<i>Acer pentapomicum</i> J.L. Stewart	+	-	+	-	-	-	-	-	-	-
28. Family Amaranthaceae											
83.	<i>Amaranthus viridis</i> L.	+	-	-	-	-	+	-	-	-	-
29. Family Anacardiaceae											
84.	<i>Pistacia integerrima</i> (L.) Steward ex Brandis	+	-	+	-	-	-	-	-	-	-
85.	<i>Pistacia khinjuk</i> Stocks	+	+	+	-	-	-	-	-	-	-
86.	<i>Rhus punjabensis</i> Steward ex Brandis	-	-	+	-	-	-	-	+	-	-
30. Family Apiaceae											
87.	<i>Ammi visnaga</i> (L.) Lamk.	+	-	-	-	-	-	-	-	-	-
88.	<i>Bumium persicum</i> (Boiss.) B. Fedtsch.	+	+	-	-	-	-	+	-	-	-
89.	<i>Bupleurum exaltatum</i> Clarke	+	-	-	-	-	-	-	-	-	-
90.	<i>Bupleurum gilessii</i> Wolff	+	-	-	-	-	-	-	-	-	-
91.	<i>Coriandrum sativum</i> L.	-	+	-	-	-	-	+	-	-	-
92.	<i>Carum capitum</i> L.	+	+	-	-	-	-	+	-	-	-
93.	<i>Carum carvi</i> L.	+	+	-	-	-	-	-	-	-	-

	(L.) L' Herit.										
254.	<i>Geranium rotundifolium</i> L.	+	-	-	-	-	-	-	-	-	-
255.	<i>Geranium wallichianum</i> D. Don ex Sweet	+	+	-	-	-	-	-	-	-	-
56. Family Juglandaceae											
256.	<i>Juglans regia</i> L.	+	+	+	+	+	-	-	-	-	-
57. Family Lamiaceae											
257.	<i>Calamintha umbrosa</i> (M. Bieb.) Fisch. & Mey.	+	-	-	-	-	-	-	-	-	-
258.	<i>Calamintha vulgaris</i> (L.) Druce	+	-	-	-	-	-	-	-	-	-
259.	<i>Lagochilus cabulicus</i> Bth. in DC. Prodr.	+	-	-	-	-	-	-	-	-	-
260.	<i>Lallemantia royleana</i> (Bth.) Bth.	+	-	-	-	-	-	-	-	-	-
261.	<i>Lamium amplexicaule</i> L.	+	-	-	-	-	-	-	-	-	-
262.	<i>Marrubium vulgare</i> L.	+	+	-	-	-	-	-	-	-	-
263.	<i>Mentha longifolia</i> (L.) Huds	+	+	-	-	-	-	+	-	-	-
264.	<i>Mentha piperata</i> Benth.	+	+	-	-	-	-	+	-	-	-
265.	<i>Nepeta brachyantha</i> Rech.	+	-	-	-	-	-	-	-	-	-
266.	<i>Nepeta clerkei</i> Hk. f.	+	-	-	-	-	-	-	-	-	-
267.	<i>Nepeta raphanorhiza</i> Bth.	+	-	-	-	-	-	-	-	-	-
268.	<i>Nepeta sewerzowii</i> Regel	+	-	-	-	-	-	-	-	-	-
269.	<i>Ocimum basilicum</i> L.	+	+	-	-	-	-	+	-	-	-
270.	<i>Phlomis cashmeriana</i> Royle	+	-	-	-	-	-	-	-	-	-
271.	<i>Prunella vulgaris</i> L.	+	-	-	-	-	-	-	-	-	-
272.	<i>Salvia aegyptiaca</i> L.	+	-	-	-	-	-	-	-	-	-
273.	<i>Salvia moocroftiana</i> Wall. ex Bth.	+	-	-	-	-	-	-	-	-	-
274.	<i>Salvia nubicola</i> wall. ex Sweet	+	+	-	-	-	-	-	-	-	-
275.	<i>Salvia plebeia</i> R. Br.	+	-	-	-	-	-	-	-	-	-
276.	<i>Scutellaria nuristanica</i> Rech.	+	-	-	-	-	-	-	-	-	-
277.	<i>Thymus serpyllum</i> L.	+	+	-	-	-	-	+	-	-	-
278.	<i>Ziziphora tenuior</i> L.	+	-	-	-	-	-	-	-	-	-
58. Family Malvaceae											
279.	<i>Abelmoschus esculentus</i> (L.) Moench Meth.	-	-	-	-	-	+	-	-	-	-

86. Family Violaceae											
386.	<i>Viola canescens</i> Wall. ex Roxb.	+	+	-	-	-	-	-	-	-	-
87. Family Vitaceae											
387.	<i>Vitis vinifera</i> L.	+	+	+	-	+	-	-	+	-	-
88. Family Zygophyllaceae											
388.	<i>Peganum harmala</i> L.	+	+	-	-	-	-	-	-	-	-
389.	<i>Tribulus terrestris</i> L.	+	-	-	-	-	-	-	-	-	-
Total species		338	92	63	27	23	32	20	21	05	08
Percentage		86.89	23.65	16.19	6.94	5.91	8.22	5.14	5.40	1.28	2.06

Key:

F= Fodder, M= Medicinal, FW= Firewood, TW= Timber wood, Fr= Fruit, V= vegetable, Co= Condiment, Th= Thatching, Sn= Snuff, O= Ornamental

Table 6. Medicinal plants with their families, local names, parts used, disease treated and description of recipe in Kalash valley, district Chitral, Hindukush range, Pakistan

S#	Plant species	Local name	Parts used	Disease cured	Description
A. FUNGI					
1. Family Halveliaceae					
1	<i>Morchella esculenta</i> (L.) Pers ex. Fr	Qusi	Whole plant	Tonic and Protienitious	The whole plant is cooked as vegetable
B. PTERIDOPHYTES					
2. Family Adiantaceae					
2.	<i>Adiantum capillus-veneris</i> L.	Sumbal	Fronds	Demulcent, expectorant and in sore throat	1 gm of powdered fronds is taken with one glass of water once daily before breakfast.
3.	<i>Adiantum venustum</i> D. Don.	Sumbal	Fronds & spores	Diuretic, cardiac problems	The extract of fronds is used as cardiac tonic. The spores are poured on wounds for healing.
C. GYMNOSPERMS					
3. Family Cupressaceae					
4.	<i>Juniperus excelsa</i> M. Bieb.	Sorooz	Leaves	Anthelmintic	Extract of leaves used to remove worms.
4. Family Ephedraceae					
5.	<i>Ephedra gerardiana</i> Wall ex. Stapf.	Somani	Shoots	Asthma, cough	one spoon of extract is drunk daily
5. Family Pinaceae					
6.	<i>Cedrus deodara</i> (Roxb. Ex Lamb.) G. Don	Rogh	Stem	Antiseptic, diaphoretic	The oil called “rogh xholo” obtained from freshly cut stem is used to heal wounds and skin diseases.
7.	<i>Pinus gerardiana</i> Wall. E.,x Lamb.	Chilghoza	Seeds	Tonic	Seeds are commonly used in winters as dry fruits, which act as tonic and nutritive.
D. ANGIOSPERMS (MONOCOTYLEDONS)					
6. Family Aliaceae					
8.	<i>Allium cepa</i> L.	Threshhto	Whole plant	Skin diseases, cure wounds	The bulbs are warmed and applied on affected skin, also used to cure wounds. Leaves used as carminatives and stimulants.
9.	<i>Allium sativum</i> L.	Werezhno	Whole plant	Blood pressure, skin diseases, expectorant	The bulbs and leaves are used to reduce blood pressure. The bulbs are warmed and kept on wounds to discharge puss.
7. Family Iridaceae					
10.	<i>Iris germanica</i> L.	Sosun	Rhizome s	Fever and urinary problems	The rhizomes are kept over inflamed body to reduce swelling. The rhizome extract

					are used for fever and urinary infections.
8. Family Poaceae					
11.	<i>Hordeum vulgare</i> L.	Seri	Grains	Refrigent, tonic, fever	The grains are used to reduce heartburn and gastric problems
12.	<i>Zea mays</i> L.	Juwari	Fresh carpals	Removal of kidney stone and reduce pain	2-3 gm of fresh carpals are boiled and the extract obtained is drunk one spoon trice a day to relieve kidney pain and removal of stones
(DICOTYLEDONS)					
9. Family Apiaceae					
13.	<i>Bomium persicum</i> (Boiss.) B. Fedtsch.	Hojoj	Fruits	Gastric problems	One cup of herbal tea is used to reduce abdomen pain and gastric trouble.
14.	<i>Carum capticum</i> L.	Shounj mik	Fruits	Gastric problems, fever	Herbal tea of fruits is taken trice a day to reduce gastric pain and fever.
15.	<i>Carum carvi</i> L.	Hojoj	Fruits	Throat infection, condiment, gastric problem	Herbal tea is drunk to cure throat infection and relieve gastric pain
16.	<i>Coriandrum sativum</i> L.	Danu	Shoots with leaves	Carminative, digestive	Shoots are cooked with food or eaten as such as appetizer, carminative.
17.	<i>Foeniculum vulgare</i> Miller	Bodioung	Fruits, leaves	Abdominal pain, laxative, expectorant	One tea spoon fruits are eaten to relieve abdominal pain and as expectorant and laxative. Leaves are chewed for the same purpose.
10. Family Asteraceae					
18.	<i>Artemisia brevifolia</i> Wall. Ex DC.	Droon	Shoots	Stomachic	The herbal tea of shots is used as stomachic and treat gastric problems.
19.	<i>Artemisia maritima</i> L. ex Hook. F	Bespok	Shoots	Antiseptic, anti-inflammatory, cooling agent	The decoction of shoots is used as antiseptic and anti-inflammatory. Leaf extract is taken as cooling agent.
20.	<i>Artemisia parviflora</i> Roxb.	Kharkhalich	Seeds	Anthelmintic and stomachic	One tea spoon seeds boiled in one glass water are drunk to expel worms and for relief of abdominal pain.
21.	<i>Artemisia scoparia</i> Waldst. & Kit.	Droon	Shoots	Anthelmintic, diabetic and reduces blood pressure	The extract of shoots is drunk to reduce blood pressure, diabetes and repel worms.

22.	<i>Calendula arvensis</i> L.	Bodeki	Leaves, flowers	Relieve Joints pain	The leaves and flowers are crushed in cooking oil and applied to relieve joint pain.
23.	<i>Cichorium intybus</i> L.	Kasti	Roots	Relieve typhoid fever	Roots are eaten as such or boiled and the extract is taken to relieve typhoid and general fever.
24.	<i>Matricaria chamomilla</i> L.	Shirisht	Flowers	Gastric pain	Herbal tea is prepared from flowers to relieve abdominal pain.
11. Family Berberidaceae					
25.	<i>Berberis lycium</i> Royle	Chovench	Roots, fruits	Healing of internal & external wounds, preparation of local wine	The powdered roots are used to heal wounds and the fruits are used to make local wine.
12. Family Brassicaceae					
26.	<i>Brassica rapa</i> L.	Teepor	Leaves and roots	Tonic and stomachic	The roots and leaves are cooked as vegetables and considered as tonic and stomachic respectively
27.	<i>Lepidium sativum</i> L.	Troak kardachi	Leaves	Stomachic	Fresh or cooked leaves are used as stomachic
28.	<i>Nasturtium officinale</i> R. Br.	Shiako shakh	Leaves	Gastric trouble	Fresh or cooked leaves are eaten for stomach pain
29.	<i>Raphanus sativus</i> L.	Trop	Roots and leaves	Vomiting, stomachic and Refrigent	The roots are eaten to relief vomiting and as Refrigent of body. Leaves are cooked as stomachic
30.	<i>Sisymbrium irio</i> L.	Kheli kheli	Seeds	Stabbing pain, sunburn	Paste of Powdered seeds is applied externally for stabbing pain and also used to cure sunburn.
13. Family Boraginaceae					
31.	<i>Onosma hispida</i> wall & G. Don	Phosok	Roots	Anti-dandruff, wounds healing	The paste of roots is mixed with mustard oil and used to control dandruff and also applied to wounds.
14. Family Cannabinaceae					
32.	<i>Cannabis sativa</i> L.	Bong	Leaves and seeds	Narcotic and stimulant	Leaves are crush to prepare a narcotic drug “chars”. Leaves and seeds are eaten as stimulant
15. Family Capparidaceae					
33.	<i>Capparis spinosa</i> L.	Kaveer	Floral buds and Fruits	To reduce blood pressure and as Refrigent	The floral buds are cooked with meat and taken as Refrigent and for control of BP and fever.
16. Family Caryophyllaceae					

34.	<i>Silene conoidea</i> L.	Apopar	Leaves	Laxative, purgative	Cooked leaves are used as laxative and purgative
17. Family Chenopodiaceae					
35.	<i>Chenopodium murale</i> L.	Dar kunak	Leaves	Blood purifier, for jaundice, anthelmintic	Leaves are cooked as vegetable and used
18. Family Convolvulaceae					
36.	<i>Convolvulus arvensis</i> L.	Bakar bali/ Mishk	Leaves	Stomachic	Cooked leaves are used to relieve stomach pain
19. Family Cucurbitaceae					
37.	<i>Cucumis sativa</i> L.	Badrang	Fruit	Refrigent	The fruit is eaten as salad and considered as Refrigent and causing cooling effect in body
38.	<i>Cucurbita maxima</i> Duch ex Lam	Alok	Fruit and seeds	Laxative, Refrigent, cough	The fruit is cooked as vegetable and eaten as laxative & refrigent. The seeds are boiled and the extract is taken to relieve cough.
20. Family Ebenaceae					
39.	<i>Diospyrus lotus</i> L.	Koki bana	Fruits	Tonic	The fruits are considered as tonic.
21. Family Elaeagnaceae					
40.	<i>Elaeagnus angustifolia</i> L.	Shinjoor	Bark and fruits	Sure throat, jaundice and digestive problems	The fruits are eaten to relieve throat infection and cough. The fruit and bark are boiled and the extract is drunk for jaundice, as blood purifier and to improve digestion.
22. Family Fabaceae					
42.	<i>Astragalus grahamianus</i> Royle	Garmenzu	Roots	Tooth ache	Toothbrushes are made from root and used to relief toothache
23. Family Fumariaceae					
43.	<i>Fumaria indica</i> (Hauskn.) H. N. Pugsley	Shahtara	Shoots	Blood purifier, antipyretic, stomachic	The shoots are shade dried and herbal tea is prepared, used to relieve stomach pain, fever and as blood purifier.
24. Family Geraniaceae					
44.	<i>Geranium wallichianum</i> D.Don ex Sweet	Ratanjoth	Rhizome	Backache, reduce BP	Rhizome is mixed with sweet dish and use to cure backache especially after child birth. The powdered rhizome is boiled in water to lower BP.
25. Family Juglandaceae					
45.	<i>Juglans regia</i> L.	Birmough	Bark, leaves, seeds	Toothbrush, antimicrobial, tonic	The bark (dandasa) and leaves are used to clean teeth and as antimicrobial agent.

					The seeds are eaten as good tonic and energetic material
26. Family Lamiaceae					
46.	<i>Mentha arvensis</i> L.	Podina	Leaves	Refrigent, stimulant, stomachic, carminative	The leaves are used as Refrigent and stimulant. Powdered leaves are mix with yogurt to relief stomach pain.
47.	<i>Mentha longifolia</i> (L.) Huds	Bain	Leaves	Stomachic, anti-vomiting, gas trouble	The leaves are eaten to relieve stomach pain, vomiting and gastric trouble. Herbal tea of the plant is used to control fever.
48.	<i>Marrubium vulgare</i> L.	Istor zokho	Leaves	Cough, vomiting	The decoction of young leaves is used to relief cough and vomiting.
49.	<i>Ocimum basilicum</i> L.	Kashmalo	Shoots	Stomachic, carminative	The shoots are eaten to control stomach pain and help in digestion.
50.	<i>Salvia nubicola</i> wall. ex Sweet		Shoots	Stomachic, carminative, flavoring agent	The shoots are eaten as stomachic and carminative and also used as flavoring agent.
51.	<i>Thymus serpyllum</i> L.	Woor jusho	Shoots	Cough, Refrigent, antipyretic, stimulant	Herbal tea prepared from shoots is used to relieve cough and fever and cause cooling effect and as stimulant.
27. Family Malvaceae					
52.	<i>Malva neglecta</i> Wallr.	Sawachal	Shoots	Antispasmodic	The shoots are cooked and eaten to relieve constipation and as antispasmodic.
28. Family Moraceae					
53.	<i>Ficus carica</i> L.	Kuyet	Fruit	Carminative, laxative, tonic	The fruits are eaten as tonic, carminative and laxative. Removes stones from kidney and urinary bladder.
54.	<i>Morus alba</i> L.	Marach	Fruit	Purgative, laxative, tonic	The fruits are eaten as purgative and laxative. Fruits are good tonic and dry fruits are specially used in winters to keep body warm.
55.	<i>Morus nigra</i> L.	Sha marach	Fruits	Cough, sore throat, laxative	The fruits are eaten to relief cough and throat infection. Also used as laxative
29. Family Oleaceae					
56.	<i>Fraxinus xanthoxyloides</i> (Wall. ex G. Don) DC.	Toor	Bark	Help in deliveries	One tea spoon powdered bark is mixed in one cup of water and given to pregnant women to reduce labour pain.

30. Family Paeoniaceae					
57.	<i>Paeonia emodi</i> Wall ex G. Don	Mamekhi	Fruits	Backache	Powdered fruit is mixed with wheat flour, fried in cooking oil and used to relieve backache
31. Family Plantaginaceae					
58.	<i>Plantago lanceolata</i> L.	Brono Achar	Leaves	Laxative, mouth diseases	The leaves are cooked as vegetable, used for mouth ulcers.
59.	<i>Plantago major</i> L.	Ustanbash	Leaves, seeds	Diarrhea, heartburn, jaundice	Cooked leaves are used for heartburn and jaundice. One teaspoon seeds are soaked in one glass water and taken to treat diarrhea.
32. Family Polygonaceae					
60.	<i>Bistorta amplexicaule</i> (D.Don) Green		Shoots	Tonic, carminative, antiseptic	Shoots are boiled in water and taken as tonic and carminative. Paste of shoots is applied as antiseptic.
61.	<i>Polygonum nepalense</i> Meissn.	Basir joshu	Shoots	Rheumatism	The stem is peeled off and cut in pieces, which are wormed and placed on joints to treat rheumatism.
62.	<i>Rheum emodi</i> Wall. ex Meissn.	Ishpar/ Chutial	Floral scape	Cough	The flowers are eaten to treat cough
63.	<i>Rumex hastatus</i> L.	Sirkonzo	Leaves	Astringent, constipation, purgative	The leaves are cooked as vegetable and also used for treatment of constipation.
33. Family Portulacaceae					
64.	<i>Portulaca oleracea</i> L.	Pecheli	Shoots	Improve digestion, laxative	The shoots are cooked as vegetable to improve digestion and as laxative
34. Family Primulaceae					
65.	<i>Primula denticulata</i> Sm.	Mamera	Rhizomes	Anti leach	The powder rhizome is applied to kill leaches and for leucoderms.
35. Family Punicaceae					
66.	<i>Punica granatum</i> L.	Daloom	Fruit, fruit of rind	Refrigent, cardiac, cure wounded or swollen body parts	The fruit or its juice is used as Refrigent, cardio tonic. The paste of dried fruit rind is applied over wounded/ affected parts of body for healing.
36. Family Ranunculaceae					
67.	<i>Adonis aestivalis</i> L.		Leaves	Laxative, diuretic	The leaf decoction is used as laxative and diuretic
68.	<i>Clematis orientalis</i> L.	Chountoruk	Flowers, fruits	Diarrhea, dysentery	The flowers and fruits are fried, then mixed with flour and added to water to prepare soup, which is taken to treat

					diarrhea and dysentery.
37. Family Rosaceae					
69.	<i>Cotoneaster microphylla</i> Wall. ex Lindl.	Badur	Fruits	Stomachic	The extract from fresh fruits is drunk to improve digestion and relieve abdominal pain.
70.	<i>Cotoneaster nummularia</i> Fisch. & Mey	Mekeen	Fruits	Blood deficiency, tonic	The fruits are eaten to improve and increase blood cells.
71.	<i>Crataegus songarica</i> C. Koch.	Gooni	Fruits	Cardio tonic	The fruit is considered as cardio tonic
72.	<i>Cydonia oblonga</i> Mill.	Boop	Fruits	Diarrhea, blood purifier, cardio tonic	The fruit is eaten as blood purifier, cardio tonic and is used in diarrhea
73.	<i>Prunus armeniaca</i> L.	Zhooli	Fruits	Weakness, laxative	Fruit in both fresh and dry form is eaten as tonic and heavy intake act as laxative.
74.	<i>Prunus domestica</i> L.	Alocha	Fruits	Blood purifier, Laxative	The fruit is considered to be blood purifier and laxative
75.	<i>Prunus dulcis</i> (Mill.) D. A. Webb.	Kandu	Kernel, gum	Massaging Oil, anti-dandruff	The oil extracted from kernel is used for massaging of hairs and as anti-dandruff. The gum has also the same uses.
76.	<i>Prunus persica</i> L.	Girgalogh	Fruits	Kidney problems. Wound healing	Fruits are considered to remove kidney stone and also useful in wound healing
77.	<i>Pyrus communis</i> L.	Toong	Fruit	Tonic, blood purifier	The fruit is eaten as blood purifier and tonic
78.	<i>Pyrus pashia</i> Ham. ex D. Don	Toong	Fruits, leaves	Cooling agent, tonic	The fruits are eaten as tonic and leaves are used as cooling agent.
79.	<i>Pyrus malus</i> L.	Paloogh	Fruits	Enriches Blood, tonic	The fruits are famous for nutritious values and as tonic.
80.	<i>Rosa webbiana</i> Wall. ex Royle	Thorny	Petals	Abdominal pain	Herbal tea prepared from petals is used as stomachic and for abdominal problems
81.	<i>Rubus fruticosus</i> L.	Acho	Fruits	Enriches blood, tonic	The fruits are eaten as tonic and to enrich blood.
38. Family Saxifragaceae					
82.	<i>Bergenia himalaica</i> Boriss	Besabur	Rhizome	Sun rays screener, dermal diseases	Powdered rhizome is mixed in mustard oil to make paste and is applied as sun screener and for skin diseases.
39. Family Scrophulariaceae					
83.	<i>Verbascum thapsus</i> L.	Gordogh karo	Leaves	Wounds healing	Paste of fresh leaves is used to care wound or inflammation
40. Family Solanaceae					

84.	<i>Datura stramonium</i> L.	Porol	Shoots	To relieve joint pain and burns	The shoots are dried, peeled off and placed over effected parts for rheumatism.
85.	<i>Lycopersicon esculentum</i> Miller.	Patengail	Fruits	Energy source, enriches blood	The fruits are cooked or eaten as salad to enrich blood and as energy source
86.	<i>Solanum tuberosum</i> L.	Alu	Stem tuber	Energy source food	The stem tubers are cooked and eaten as good energy source
87.	<i>Solanum nigrum</i> L.	Pirmelic	Leaves, fruits	Eye diseases, fever, cough	Fruit juice is applied to cure sore eyes while leaves are cooked and eaten to relieve cough and fever.
41. Family Tamaricaceae					
88.	<i>Tamarix dioica</i> roxb ex Roth.	Hinju	Inflorescence	Healing	Paste of inflorescence is applied on wounds for healing.
42. Family Urticaceae					
89.	<i>Urtica dioica</i> L.	Drozono	Whole plant	Anthelmintic	The decoction of plant is used as anthelmintic.
43. Family Violaceae					
90.	<i>Viola canescens</i> Wall. ex Roxb.	Milkhon, Banafsha	Leaves	Cough, fever, headache	Powdered leaves are taken to relieve cough, fever and headache.
44. Family Vitaceae					
91.	<i>Vitis venifera</i> L.	Drooch	Fruits	Typhoid, wine	The juice of fruit is drunk to cure typhoid fever. Local wine is also made from fruit juice.
45. Family Zygophyllaceae					
92.	<i>Peganum harmala</i> L.	Ispandor	Seeds	Evils repellent	The smoke of dried seeds is considered as evils repellent.

Table 7. Number of species used to treat a particular disease in Kalash valley, district Chitral, Pakistan

S #	Disease treated	Species used for a particular disease	% of species used in a particular disease
1	Gastro intestinal diseases	34	36.96
2	Respiratory tract diseases	9	9.78
3	Fever	7	7.61
4	Pain killers	6	6.52
5	Tonic	6	6.52
6	Skin diseases	5	5.43
7	Antiseptic	4	4.35
8	Blood pressure	3	3.26
9	Refrigent	3	3.26
10	Mouth diseases	3	3.26
11	Wounds	3	3.26
12	Blood tonic	3	3.26
13	Toothache	3	3.26
14	Cardio tonic	2	2.17
15	Kidney stones removal	2	2.17
16	Kidney infections	2	2.17
17	Anti-inflammatory	2	2.17
18	Diabetic	2	2.17
19	Rheumatism/ joints pain	2	2.17
20	Sun burn	2	2.17
21	Anti-dandruff	2	2.17
22	Purgative	2	2.17
23	Blood purifier	2	2.17

24	Vomiting	2	2.17
25	Stimulant	2	2.17
26	Anthelmintic	2	2.17
27	Backache	2	2.17
28	Anti-spasmodic	2	2.17
29	Protienitious	1	1.09
30	Demulcent	1	1.09
31	Diuretic	1	1.09
32	Diaphoretic	1	1.09
33	Typhoid fever	1	1.09
34	Stabbing pain	1	1.09
35	Narcotic	1	1.09
36	Labour cases/Delivery	1	1.09
37	Evil eye repellent	1	1.09
38	Jaundice	1	1.09
39	Anti leach	1	1.09

Table 8. Plant parts used in treatment of a particle disease in the Kalash valley, district Chitral

S#	Plant part used	Species with particular part used	% use of a particular part
1	Fruits	31	33.70
2	Leaves	24	26.10
3	Shoots	13	14.13
4	Roots/Rhizome	10	10.87
5	Seed	9	9.78
6	Flowers	8	8.70
7	Bark	3	3.26
8	Whole plants	3	3.26
9	Bulb	2	2.17
10	Stem	2	2.17
11	Gum	1	1.09
12	Tuber	1	1.09

VEGETATION STRUCTURE/ PHYTOSOCIOLOGY

The Kalash valley comprises of three sub valleys i.e. Bumburet, Birir and Rumbor. During the quantitative analysis of vegetation, two portions were selected in each sub valley viz: low village/foothill and alpine /mountain vegetations. Three communities were established in foothill vegetations and four communities were considered in alpine/mountain vegetation in each sub valley. Thus a total of 21 plant communities were established in the entire Kalash valley.

A. VEGETATION ALONG THE PLAINS/FOOTHILLS

a. Vegetation structure of Bumburet valley

Three plant communities were made along the plains/foothills habitats of Bumburet valley (Appendices 1-3).

1. *Salix-Tamarix-Mentha* community

This community contains 30 species and occurred between an altitude of 1700m-1810m (Table 9; Appendix 1). *Salix acmophylla*, *Tamarix aphylla* and *Mentha longifolia* were dominant species with IV value of (32.15), (28.13) and (24.72) respectively. *Maricaria squamosa*, *Trifolium repens*, *Epilobium hirsutum* and *Plantago lanceolata* were co-dominant species of the community. The soil was sandy loam with organic matter (0.75%), Calcium carbonate (5.50%), Nitrogen (0.037 ppm), Phosphorus (2.80 ppm), Potassium (100 ppm), pH (7.0), electric conductivity (0.42), total soluble salts (0.134 %), clay (4.8%), Silt (36%) and sand (59.2%) (Table 10).

2. *Artemisia-Artemisia-Quercus* community

This community had 31 species and occurred between an altitude of 2110m-2200m (Table 9; Appendix 2). *Artemisia brevifolia*, *Artemisia scoparia* and *Quercus baloot* were dominant species with IV value of (21.80), (20.89) and (20.39) respectively. *Arum jacquemontii*, *Impatiens balsamina*, *Medicago sativa* and *Artemisia maritima* were co-dominant species in the community. The soil was sandy loam with organic matter (0.85%), Calcium carbonate (6.50%), Nitrogen (0.030 ppm), Phosphorus (3.5 ppm), Potassium (90 ppm), pH (7.1), electric

conductivity (0.36), total soluble salts (0.131 %), clay (5.3%), Silt (39%) and sand (55.7%) (Table 10).

3. *Quercus-Artemisia-Sophora* community

This community was represented by 29 species and occurred between an altitude of 2300m-2410m (Table 9; Appendix 3). *Quercus baloot*, *Artemisia scoparia* and *Sophora mollis* were dominant species with IV value of (30.62), (24.12) and (21.71) respectively. *Juglans regia*, *Salvia nubicola*, *Artemisia brevifolia* and *Verbascum thapsus* were co-dominant species in the community. The soil was sandy loam with organic matter (0.81%), Calcium carbonate (4.90%), Nitrogen (0.034 ppm), Phosphorus (2.6 ppm), Potassium (90 ppm), pH (7.3), electric conductivity (0.27), total soluble salts (0.141 %), clay (6.8%), Silt (35%) and sand (58.2%) (Table 10).

b. Vegetation structure of Rumbor valley

Three plant communities were made along the plains/foothills habitats of Bumburet valley (Appendices 8-10).

1. *Artemisia-Rosa-Quercus* community

This community was represented by 30 species and occurred between an altitude of 1100m-1230m (Table 9; Appendix 8). *Artemisia brevifolia*, *Rosa webbiana* and *Quercus baloot* were dominant species with IV value of (22.03), (21.58) and (18.59) respectively. *Chenopodium botrys*, *Mentha longifolia* and *Sophora mollis* were co-dominant species in the community. The soil was sandy loam with organic matter (0.72%), calcium carbonate (9.50%), Nitrogen (0.042 ppm), Phosphorus (4.7 ppm), Potassium (70 ppm), pH (7.2), electric conductivity (0.39), total soluble salts (0.133 %), clay (7.1%), Silt (40%) and sand (52.9%) (Table 10).

2. *Quercus-Arum-Artemisia* community

This community had 34 species and occurred between an altitude of 1320m-1420m (Table 9; Appendix 9). *Quercus baloot*, *Arum jacquemontii* and *Artemisia brevifolia* were dominant species with IV value of (18.03), (17.65) and (17.18) respectively. *Juglans regia*,

Medicago sativa and *Echinops echinatus* were co-dominant species in the community. The soil was sandy loam with organic matter (0.40%), Calcium carbonate (9%), Nitrogen (0.020 ppm), Phosphorus (1.7 ppm), Potassium (70 ppm), pH (7.2), electric conductivity (0.69), total soluble salts (0.220 %), clay (4.2%), Silt (32%) and sand (63.8%) (Table 10).

3. *Quercus-Rosa-Fraxinus* community

This community had 30 species and occurred between an altitude of 1570m-1650m (Table 9; Appendix 10). *Quercus baloot*, *Rosa webbia* and *Fraxinus xanthoxyloides* were dominant species with IV value of (22.96), (21.58) and (19.59) respectively. *Artemisia brevifolia*, *Sophora mollis* and *Paeonia emodi* were co-dominant species in the community. The soil was sandy loam with organic matter (0.89%), Calcium carbonate (10%), Nitrogen (0.044 ppm), Phosphorus (10 ppm), Potassium (60 ppm), pH (7.4), electric conductivity (0.28), total soluble salts (0.089 %), clay (2.8%), Silt (46%) and sand (51.2%) (Table 10).

c. Vegetation structure of Birir valley

Three plant communities were made along the plains/foothills habitats of Birir valley (Appendices 15-17).

4. *Salix-Salix-Ailanthus* community

This community was represented by 33 species and occurred between an altitude of 1200m-1350m (Table 9; Appendix 15). *Salix acmophylla*, *Salix tetrasperma* and *Ailanthus altissima* were dominating species with IV values of (17.49), (17.12) and (16.80) respectively. *Mentha longifolia*, *Elaeagnus angustifolia* and *Trifolium repens* were co-dominant species in the community. The soil was sandy loam with organic matter (0.48%), calcium carbonate (7.92%) Nitrogen (0.055 ppm), Phosphorus (6.7 ppm), Potassium (80 ppm), pH (7.4), electric conductivity (0.52), total soluble salts (0.133 %), clay (4.3%), Silt (51%) and sand (44.7%) (Table 10).

2. *Artemisia-Salix-Arum* community

This community was represented by 31 species and occurred between an altitude of 1550m-1700m (Table 9; Appendix 16). *Artemisia brevifolia*, *Salix acmophylla* and *Arum jacquemontii* were dominant species with IV values of (18.48), (17.54) and (17.21) respectively. *Quercus baloot*, *Rosa webbiana* and *Anagalis arvensis* were co-dominant species in the community. The soil was sandy loam with organic matter (0.52%), Calcium carbonate (7.85%), Nitrogen (0.039 ppm), Phosphorus (5.8 ppm), Potassium (70 ppm), pH (7.3), electric conductivity (0.44), total soluble salts (0.124 %), clay (5.8%), Silt (45%) and sand (49.2%) (Table 10).

3. *Arum-Quercus-Artemisia* community

This community was represented by 31 species and occurred between an altitude of 1910m-2050m (Table 9; Appendix 17). *Arum jacquemontii*, *Quercus baloot* and *Artemisia scoparia*, were dominant species with IV values of (17.23), (16.95) and (15.88) respectively. *Sophora mollis*, *Juglans regia* and *Sedum ewersii* were co-dominant species in the community. The soil was sandy loam with organic matter (0.58%), Calcium carbonate (8.75%), Nitrogen (0.029 ppm), Phosphorus (2.8 ppm), Potassium (80 ppm), pH (7.5), electric conductivity (0.39), total soluble salts (0.124 %), clay (2.2%), Silt (28%) and sand (69.8%) (Table 10).

Table 9. IV values of different plant species in the plains/foothills in Kalash valley, Hindukush range, district Chitral

S#	Plant Species	Bumburet valley			Rumbor valley			Birir Valley		
		STM	AAQ	QAS	ARQ	QAA	QRF	SSA	ASA	AQA
1	<i>Acer pentapomicum</i> J.L. Stewart	-	-	-	3.08	-	-	-	-	-
2	<i>Adiantum capillus-veneris</i> L.	-	8.50	-	-	-	-	-	-	-
3	<i>Adonis aestivalis</i> L.	-	-	-	-	-	-	-	-	3.88
4	<i>Ailanthus altissima</i> (Mill.) Swingle	-	-	-	-	-	-	16.80	-	-
5	<i>Alliaria petiolata</i> (M. B.) Cav. & Grande Boll.	-	-	-	-	-	-	-	-	7.45
6	<i>Amaranthus viridis</i> L.	-	-	4.00	-	-	-	-	6.89	4.18
7	<i>Anagalis arvensis</i> L.	-	2.39	-	-	6.27	-	-	15.35	-
8	<i>Aristida cynantha</i> Nees ex Steud	-	-	-	12.97	-	-	-	-	-
9	<i>Artemisia brevifolia</i> Wall. Ex DC.	-	21.80	19.39	22.03	17.18	19.24	10.98	18.48	13.94
10	<i>Artemisia maritima</i> L.	-	17.96	-	-	14.59	-	-	11.57	-
11	<i>Artemisia parviflora</i> Roxb.	-	-	-	-	-	-	11.67	-	-
12	<i>Artemisia scoparia</i> Waldst. & Kit.	-	20.89	24.12	10.61	-	-	-	15.02	15.88
13	<i>Arum jacquemontii</i> Blume	-	18.87	-	-	17.65	-	-	17.21	16.95
14	<i>Astragalus grahamianus</i> Royle	-	1.79	-	-	-	-	-	-	-
15	<i>Astragalus subumbellatus</i> Klotzsch.	-	-	-	-	4.74	-	-	-	-
16	<i>Bromus tectorum</i> L.	-	-	5.20	-	-	-	-	-	6.10
17	<i>Bupleurum thomsonii</i> C.B. Clarke	-	-	2.32	-	-	-	-	-	3.61
18	<i>Calamintha vulgaris</i> (L.) Druce	-	-	-	-	1.86	-	-	-	-
19	<i>Capparis spinosa</i> L.	-	-	15.20	-	-	-	-	-	-
20	<i>Capsella bursa-pastoris</i> (L.) Medic.	4.02	-	-	-	-	-	4.06	-	-
21	<i>Cardamine hirsuta</i> L.	-	-	-	-	-	-	-	-	5.80
22	<i>Cedrus deodara</i> (Roxb. ex Lamb.) G. Don.	-	-	10.49	-	-	8.32	-	-	-
23	<i>Chenopodium album</i> L.	-	11.50	-	-	5.56	-	8.55	-	-

24	<i>Chenopodium botrys</i> L.	4.94	13.71	17.83	3.91	9.35	-	7.86	10.02	-
25	<i>Chrysopogon echinulatus</i> (Nees ex Steud.) W. Wats	-	-	-	10.99	-	-	-	-	-
26	<i>Cichorium intybus</i> L.	-	-	2.32	-	-	3.29	6.82	-	3.31
27	<i>Conyza bonariensis</i> (L.) Cronquist	-	1.97	-	-	1.52	-	-	2.48	-
28	<i>Cotoneaster microphylla</i> Wall ex Lind.	-	5.58	15.20	3.08	4.83	-	-	9.39	-
29	<i>Cousinia mattenfeldii</i> Bornm.	-	-	13.45	-	-	9.76	-	-	9.07
30	<i>Crataegus songarica</i> C. Koch.	-	-	14.65	-	-	10.66	-	-	-
31	<i>Cynodon dactylon</i> (L.) Pers.	9.83	-	5.20	9.32	-	4.55	10.61	7.19	5.02
32	<i>Cynoglossum lanceolatum</i> Forssk.	-	-	-	-	13.52	-	-	-	-
33	<i>Dactylis glomerata</i> L.	-	-	-	-	-	-	-	6.26	-
34	<i>Dichanthium annulatum</i> (Forssk.) Stapf.	-	4.24	4.00	2.25	2.92	4.13	-	4.99	4.46
35	<i>Dipsacus inermis</i> var. <i>mitis</i> (D. Don) Y. Nasir	-	-	-	-	3.67	-	-	-	-
36	<i>Echinops echinatus</i> Roxb.	-	4.74	-	14.21	15.67	-	-	5.93	-
37	<i>Elaeagnus angustifolia</i> L.	-	6.26	-	-	-	-	15.07	7.82	-
38	<i>Ephedra gerardiana</i> L.	-	-	2.32	-	-	3.23	-	10.63	1.33
39	<i>Epilobium hirsutum</i> L.	16.69	-	-	10.23	-	-	13.04	-	-
40	<i>Equisetum ramosissimum</i> Desf.	-	7.40	-	-	14.96	-	-	12.20	-
41	<i>Eragrostis poaeoides</i> P. Beave.	2.85	-	-	-	-	-	2.01	-	-
42	<i>Euphorbia falcata</i> L.	-	-	-	-	4.01	-	-	-	-
43	<i>Euphorbia peplus</i> L.	-	-	14.00	-	-	10.18	-	-	9.36
44	<i>Filipendula vestita</i> (Wall. ex G. Don) Maxim.	-	-	-	-	-	1.91	-	-	-
45	<i>Fraxinus xanthoxyloides</i> (Wall. ex G. Don) DC.	-	-	-	-	-	19.59	-	-	-
46	<i>Fritillaria imperialis</i> var. <i>chitralensis</i> Hort.	-	-	-	-	-	-	-	1.85	-
47	<i>Impatiens balsamina</i> L.	3.82	18.80	-	-	-	-	-	-	-

48	<i>Impatiens edgeworthii</i> Hk. f. FBI	3.42	-	-	-	-	-	-	-	-
49	<i>Indigofera heterantha</i> var. <i>heterantha</i> L.	-	1.79	-	-	1.52	-	-	-	-
50	<i>Ixiolirion tataricum</i> (Pall.) Herb.	-	-	-	-	-	-	-	4.36	-
51	<i>Juglans regia</i> L.	-	14.62	19.94	-	16.83	16.29	-	13.45	14.81
52	<i>Juncus articulata</i> L.	13.84	-	-	-	-	-	14.43	-	-
53	<i>Kochia indica</i> Wight.	-	4.17	-	-	-	-	-	-	-
54	<i>Lactuca serriola</i> L.	7.50	2.39	-	5.58	-	-	7.18	-	-
55	<i>Lepidium sativum</i> L.	-	-	-	-	12.32	-	-	-	-
56	<i>Lolium rigidum</i> Gaud.	-	-	-	7.45	-	-	-	-	-
57	<i>Lotus corniculata</i> L.	6.14	2.39	-	4.75	-	-	-	-	-
58	<i>Malcolmia africana</i> (L.) R. Br.	-	-	-	-	12.32	-	-	-	-
59	<i>Maricaria squamosa</i> Desv.	21.27	-	-	-	-	-	-	-	-
60	<i>Marrubium vulgare</i> L.	-	-	2.32	-	-	1.91	-	7.52	2.75
61	<i>Matricaria aurea</i> L.	2.85	-	-	-	-	-	-	-	-
62	<i>Matricaria disciformis</i> (C.A.M.) DC. Prodr.		-	-	-	-	-	4.44	-	-
63	<i>Medicago sativa</i> L.	2.85	17.96	-	-	16.49	-	1.68	13.15	-
64	<i>Melilotus officinale</i> (L.) Desr.	2.85	-	-	2.25	-	-	-	-	-
65	<i>Mentha longifolia</i> (L.) Huds.	42.72	-	2.32	17.37	-	1.91	15.79	-	1.60
66	<i>Morus alba</i> L.	-	-	-	-	-	15.40	12.67	-	-
67	<i>Nasturtium officinale</i> R. Br.	4.02	-	-	-	-	-	4.76	-	-
68	<i>Nepeta raphanorhiza</i> Bth.	-	-	2.32	-	1.52	-	-	-	2.75
69	<i>Nepeta sewerzowii</i> Regel	-	-	-	-	1.52	1.91	-	-	-
70	<i>Neslia apiculata</i> Fisch.	-	-	-	-	10.07	-	-	-	-
71	<i>Paeonia emodi</i> Wall ex G. Don	-	-	-	-	-	17.31	-	-	-
72	<i>Papaver dubium</i> L.	-	-	-	-	-	-	-	3.11	-
73	<i>Periploca aphylla</i> Dcne.	-	-	2.32	-	-	11.68	-	-	2.45
74	<i>Peganum harmala</i> L.	-	-	-	2.25	-	-	3.74	-	-
75	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	13.77	-	-	-	-	-	-	-	-
76	<i>Pinus gerardiana</i> L.	-	-	-	-	-	13.49	-	-	-

[illegible]

Table 10. Physico-chemical analysis of soils of plains/foothill communities of Kalash valley,
District Chitral, Pakistan

S #	Plant community	Soil texture	Organic matter (%)	CaCo3 (%)	N (ppm)	P (ppm)	K (ppm)	pH	ECX 10 ³	TSS %	Clay %	Silt %	Sand %
1	STM	Sandy loam	0.75	5.50	0.037	2.8	100	7.0	0.42	0.134	4.8	36	59.2
2	AAQ	Sandy loam	0.85	6.05	0.030	3.5	90	7.1	0.36	0.131	5.3	39	55.7
3	QAS	Sandy loam	0.81	4.90	0.034	2.6	90	7.3	0.27	0.141	6.8	35	58.2
4	ARQ	Sandy loam	0.72	9.50	0.042	4.7	70	7.2	0.39	0.133	7.1	40	52.9
5	QAA	Sandy loam	0.40	9.00	0.020	1.7	70	7.2	0.69	0.220	4.2	32	63.8
6	QRF	Sandy loam	0.89	10.00	0.044	10.0	60	7.4	0.28	0.089	2.8	46	51.2
7	SSA	Sandy loam	0.48	7.92	0.055	6.7	80	7.4	0.52	0.133	4.3	51	44.7
8	ASA	Sandy loam	0.52	7.85	0.039	5.8	70	7.3	0.44	0.124	5.8	45	49.2
9	AQA	Sandy loam	0.58	8.75	0.029	2.8	80	7.5	0.39	0.124	2.2	28	69.8

B. VEGETATION OF UPHILL MOUNTAINS AND ALPINE COMMUNITIES

a. Bumburet valley

1. *Quercus-Sophora-Artemisia*

This community had 24 species and occurred between an altitude of 2550m-2640m (Table 11; Appendix 4). *Quercus baloot*, *Sophora mollis* and *Artemisia scoparia* were dominant species with IV value of (33.40), (26.77) and (24.26) respectively. *Echinops echinatus*, *Rosa webbiana*, *Cotoneaster nummularia* and *Pinus wallichiana* were co-dominant species in the community. The soil was sandy loam with organic matter (0.96%), Calcium carbonate (6.25%), Nitrogen (0.043 ppm), Phosphorus (6.5 ppm), Potassium (80 ppm), pH (7.3), electric conductivity (0.46), total soluble salts (0.147 %), clay (6.8%), Silt (40%) and sand (53.2%) (Table 12).

2. *Echinops-Quercus-Marrubium*

This community was represented by 18 species and occurred between an altitude of 2780m-2870m (Table 11; Appendix 5). *Echinops echinatus*, *Quercus baloot* and *Marrubium vulgare* were dominant species with IV value of (30.98), (28.57) and (26.40) respectively. *Cedrus deodara*, *Pinus wallichiana* and *Artemisia maritima* were co-dominant species in the community. The soil was sandy loam with organic matter (1.10%), Calcium carbonate (0.75%), Nitrogen (0.055 ppm), Phosphorus (5.7 ppm), Potassium (120 ppm), pH (7.2), electric conductivity (0.10), total soluble salts (0.032 %), clay (7.2%), Silt (42%) and sand (50.8%) (Table 12).

3. *Indigofera-Cynoglossum-Scrophularia*

This community had 20 species and occurred between an altitude of 3000m-3090m (Table 11; Appendix 6). *Indigofera heterantha* var. *heterantha*, *Cynoglossum lanceolatum* and *Scrophularia scoparia* were dominant species with IV value of (32.10), (29.35) and (28.37) respectively. *Prunus kuramica*, *Potentilla supina* and *Ephedra gerardiana* were co-dominant species in the community. The soil was sandy loam with organic matter (0.40%), Nitrogen

(0.020 ppm), Phosphorus (20 ppm), Potassium (180 ppm), pH (6.5), electric conductivity (0.30), total soluble salts (0.096 %), clay (5.7%), Silt (44%) and sand (50.8%) (Table 12).

4. *Acantholimon-Juniperus-Epilobium*

This community was represented by 20 species and occurred between an altitude of 3200m-3310m (Table 11; Appendix 7). *Acantholimon lycopodioides*, *Juniperus excelsa* and *Epilobium royleanum* were dominant species with IV value of (31.74), (29.41) and (28.80) respectively. *Oxyria digyna*, *Juniperus communis* and *Pinus wallichiana* were co-dominant species in the community. The soil was sandy loam with organic matter (0.84%), Calcium carbonate (1.22%), Nitrogen (0.018 ppm), Phosphorus (11.02 ppm), Potassium (170 ppm), pH (6.7), electric conductivity (0.33), total soluble salts (0.044 %), clay (6.1%), Silt (49%) and sand (44.9%) (Table 12).

b. Rumbor valley

1. *Quercus-Sophora-Indigofera*

This community was represented by 26 species and occurred between an altitude of 1790m-1900m (Table 11; Appendix 11). *Quercus baloot*, *Sophora mollis* and *Indigofera heterantha* var. *heterantha* were dominating species with IV values of (24.31), (22.64) and (19.97) respectively. *Artemisia scoparia*, *Juglans regia* and *Tulipa stellata* were co-dominant species in the community. The soil was silt loam with organic matter (0.44%), Calcium carbonate (9.50%), Nitrogen (0.022 ppm), Phosphorus (10.8 ppm), Potassium (50 ppm), pH (7.2), electric conductivity (0.23), total soluble salts (0.073 %), clay (8.2%), Silt (72%) and sand (19.8%) (Table 12).

2. *Echinops-Verbascum-Pinus*

This community was represented by 21 species and occurred between an altitude of 2130m-2250m (Table 11; Appendix 12). *Echinops echinatus*, *Verbascum thapsus* and *Pinus wallichiana* were dominating species with IV values of (27.43), (26.20) and (24.54) respectively. *Arum jacquemontii*, *Cedrus deodara* and *Codonopsis ovata* were co-dominant species in the

community. The soil was sandy loam with organic matter (1.20%), Calcium carbonate (1.25%), Nitrogen (0.060 ppm), Phosphorus (15.7 ppm), Potassium (100 ppm), pH (7.8), electric conductivity (0.05), total soluble salts (0.016 %), clay (5.2%), Silt (40%) and sand (54.8%) (Table 12).

3. *Artemisia-Cedrus-Pinus*

This community was represented by 24 species and occurred between an altitude of 2550m-2700m (Table 11; Appendix 13). *Artemisia scoparia*, *Cedrus deodara* and *Pinus gerardiana* were dominating species with IV values of (23.75), (23.72) and (22.03) respectively. *Thymus linearis*, *Scrophularia scoparia* and *Artemisia sacrorum* were co-dominant species in the community. The soil was sandy loam with organic matter (0.40%), Nitrogen (0.020 ppm), Phosphorus (2.8 ppm), Potassium (90 ppm), pH (7.7), electric conductivity (0.04), total soluble salts (0.013 %), clay (7.2%), Silt (44%) and sand (48.8%) (Table 12).

4. *Ephedra-Juniperus-Cuscuta*

This community was represented by 19 species and occurred between an altitude of 2980m-3110m (Table 1; Appendix 14). *Ephedra intermedia*, *Juniperus communis* and *Cuscuta lehmanniana* were dominant species with IV values of (30.21), (28.57) and (27.49) respectively. *Oxyria digyna*, *Inula rhizocephala*, and *Rumex longifolius* were co-dominant species in the community. The soil was sandy loam with organic matter (0.82%), Calcium carbonate (2.04%), Nitrogen (0.032 ppm), Phosphorus (12.33 ppm), Potassium (110 ppm), pH (7.2), electric conductivity (0.22), total soluble salts (0.021 %), clay (6.2%), Silt (51%) and sand (42.8%) (Table 12).

c. Birir valley

1. *Quercus-Pinus-Rosa*

This community was represented by 26 species and occurred between an altitude of 2220m-2350m (Table 11; Appendix 18). *Quercus baloot*, *Pinus wallichiana* and *Rosa webbiana* were dominant species with IV values of (25.52), (23.91) and (20.97) respectively. *Sophora mollis*, *Artemisia scoparia* and *Cotoneaster nummularia* were co-dominant species in the

community. The soil was silt loam with organic matter (0.89%), Calcium carbonate (8.50%), Nitrogen (0.044 ppm), Phosphorus (20 ppm), Potassium (100 ppm), pH (7.6), electric conductivity (0.41), total soluble salts (0.131 %), clay (6.2%), Silt (56%) and sand (37.8%) (Table 12).

2. *Echinops–Marrubium–Rumex*

This community was represented by 23 species and occurred between an altitude of 2480m-2570m (Table 11; Appendix 19). *Echinops echinatus*, *Marrubium vulgare* and *Rumex hastatus* were dominant species with IV values of (24.01), (23.55) and (22.04) respectively. *Quercus baloot*, *Cedrus deodara* and *Pinus wallichiana* were co-dominant species in the community. The soil was Loamy sand with organic matter (0.34%), Calcium carbonate (0.75%), Nitrogen (0.017 ppm), Phosphorus (17.1 ppm), Potassium (80 ppm), pH (7.8), electric conductivity (0.06), total soluble salts (0.019 %), clay (5.2%), Silt (16%) and sand (78.8%) (Table 12).

3. *Potentilla–Astragalus–Chenopodium*

This community was represented by 15 species and occurred between an altitude of 2710m-2820m (Table 11; Appendix 20). *Potentilla pamirica*, *Astragalus grahamianus* and *Chenopodium foliosum* were dominant species with IV values of (36.78), (32.97) and (30.32) respectively. *Pinus gerardiana*, *Scrophularia* and *Ephedra gerardiana* were co-dominant species in the community. The soil was Loamy sand with organic matter (1.38%), Calcium carbonate (6.25%), Nitrogen (0.069 ppm), Phosphorus (40 ppm), Potassium (150 ppm), pH (6.7), electric conductivity (0.10), total soluble salts (0.032 %), clay (5.2%), Silt (30%) and sand (64.8%) (Table 12).

4. *Juniperus–Thymus–Anaphalis*

This community 18 species and occurred between an altitude of 2950m-3070m (Table 11; Appendix 20). *Juniperus excelsa*, *Thymus linearis* and *Anaphalis contorta* L. were dominant species with IV values of (32.58), (30.30) and (26.33) respectively. *Potentilla sericea*, *Astragalus nivalis* and *Anaphalis nepalensis* were co-dominant species in the community. The soil was sandy loam with organic matter (0.92%), Calcium carbonate (5.43%), Nitrogen (0.082

ppm), Phosphorus (38.9 ppm), Potassium (100 ppm), pH (7.1), electric conductivity (0.36), total soluble salts (0.043 %), clay (6.1%), Silt (45%) and sand (48.9%) (Table 12).

21	<i>Capsella bursa-pastoris</i> (L.) Medic.	-	-	-	-	-	-	8.26	-	-	-	-	-
22	<i>Carduus edelbergii</i> Rech.	-	-	-	-	-	-	-	-	-	14.16	-	-
23	<i>Cedrus deodara</i> (Roxb. Ex Lamb.) G.Don	-	24.67	9.16	-	-	21.99	23.72	-	-	19.59	-	-
24	<i>Centaurea iberica</i> Trev. ex Spreng.	-	-	-	-	5.29	-	-	-	-	-	-	-
25	<i>Ceratocephalus falcatus</i> (L.) Pers.	-	-	-	-	-	-	-	-	7.98	--	-	-
26	<i>Chenopodium album</i> L.	-	-	-	-	10.05	11.81	-	-	-	-	-	-
27	<i>Chenopodium botrys</i> L.	16.95	-	-	-	12.25	-	-	-	16.43	-	-	-
28	<i>Chenopodium foliosum</i> (Merrich.) Aschers.	-	-	-	-	-	-	-	-	-	-	30.32	-
29	<i>Codonopsis ovata</i> Bth.	-	-	5.51	-	-	19.49	-	--	-	-	-	-
30	<i>Conyza bonariensis</i> (L.) Cronquist	-	-	-	-	3.71	-	-	-	-	-	-	-
31	<i>Cotoneaster nummularia</i> Fisch. & Mey	20.31	-	-	-	13.96	-	-	-	18.88	-	-	-
32	<i>Cuscuta lehmanniana</i> Bunge	-	-	-	-	-	-	-	27.49	-	-	-	-
33	<i>Cuscuta reflexa</i> Roxb.	-	-	-	8.04	-	-	-	-	-	-	-	16.12
34	<i>Cynodon dactylon</i> L.	-	-	-	-	-	-	5.35	-	-	--	-	-
35	<i>Cynoglossum lanceolatum</i> Forssk.	-	-	29.35	-	-	-	-	-	--	-	6.67	-
36	<i>Dicanthium annulatum</i> Forssk. Stapf.	14.34	-	-	-	11.76	-	-	-	14.33	-	-	-
37	<i>Draba altaica</i> (C.A.M.) Bunge	-	-	-	-	-	-	6.17	-	-	-	-	-
38	<i>Echinops echinatus</i> Roxb.	20.31	30.98	3.64	-	15.63	27.43	2.47	-	17.49	24.01	-	-
39	<i>Ephedra gerardiana</i> L.	-	-	22.05	-	-	-	13.27	-	1.86	-	25.07	-
40	<i>Ephedra intermedia</i> Schrenk & Meyer	-	-	-	-	-	-	-	30.21	-	-	-	-
41	<i>Epilobium hirsutum</i> L.	-	-	8.25	-	-	-	4.95	-	-	-	-	-
42	<i>Epilobium royleanum</i> Hausskn.	-	-	-	28.80	-	-	-	-	-	-	-	-
43	<i>Eragrostis poaeoides</i> P. Beave.	-	-	-	14.20	-	-	-	13.69	-	--	-	-

44	<i>Euphorbia peplus</i> L.	-	-	3.64	-	-	-	-	-	-	-	-	-
45	<i>Euphorbia prostrata</i> L.	-	-	-	-	-	-	-	-	-	4.34	-	-
46	<i>Ficus carica</i> L.	-	-	-	-	-	-	-	-	2.35	-	-	-
47	<i>Fraxinus xanthoxyloides</i> (Wall. ex G. Don) DC.	-	-	12.89	-	-	-	7.43	-	-	-	-	-
48	<i>Galinsoga parviflora</i> Cav.	-	11.99	-	-	-	13.73	-	-	-	-	-	-
49	<i>Gallium tricornutum</i> L.	-	-	-	-	-	-	-	-	-	-	11.70	-
50	<i>Geranium rotundifolium</i> L.	-	5.25	-	-	-	10.64	-	-	-	-	-	-
51	<i>Geranium wallichianum</i> D. Don. Ex Sweet	-	-	-	4.17	-	-	-	-	-	-	-	4.65
52	<i>Impatiens bicolor</i> Royle	-	-	-	-	-	-	9.53	-	-	17.13	-	-
53	<i>Indigofera heterantha</i> var. <i>heterantha</i> L.	-	-	32.10	19.42	19.97	-	-	19.12	-	-	-	-
54	<i>Inula rhizocephala</i> Schrenk Enum.	-	-	-	-	-	-	-	21.55	-	-	-	-
55	<i>Juglans regia</i> L.	-	-	-	-	18.33	-	-	-	-	-	-	-
56	<i>Juniperus communis</i> L.	-	-	-	22.99	-	-	2.90	28.57	-	-	-	-
57	<i>Juniperus excelsa</i> M. Bieb.	-	-	4.53	29.74	-	-	-	16.69	-	-	4.52	32.58
58	<i>Juniperus squamata</i> Buch.	-	-	-	-	-	-	-	-	-	-	5.24	--
59	<i>Lactuca decipiens</i> (H. & T.) Clarke	-	11.99	-	-	-	-	-	-	-	7.82	-	-
60	<i>Lactuca persica</i> Boiss.	-	-	-	-	2.68	--	-	-	-	-	-	-
61	<i>Lactuca serriola</i> L.	10.99	-	-	-	9.01	-	-	-	9.29	10.27	-	-
62	<i>Lamium amplexicaule</i> L.	-	4.51	10.04	-	-	7.44	-	-	-	-	-	13.63
63	<i>Lolium rigidum</i> Gaud.	3.26	-	-	-	-	-	-	-	-	-	-	-
64	<i>Malcolmia africana</i> (L.) R. Br.	-	5.93	-	-	-	4.93	-	-	-	-	-	-
65	<i>Marrubium vulgare</i> L.	7.03	26.40	-	-	11.76	2.49	-	-	5.28	23.55	-	-
66	<i>Matricaria disciformis</i> (C.A.M.) DC. Prodr.	13.09	10.27	-	9.34	9.51	-	-	10.19	-	6.83	-	16.80
67	<i>Nepeta brachyantha</i> Rech.	5.78	-	17.42	-	-	-	11.18	-	-	-	20.54	-
68	<i>Nepeta raphanorhiza</i> Bth.	-	-	-	-	-	3.66	-	-	3.40	-	-	-
69	<i>Nepeta sewerzowii</i> Regel	-	-	-	-	-	-	-	6.17	-	-	13.37	-

70	<i>Oxalis corniculata</i> L.	-	-	-	-	-	-	-	-	-	-	15.05	-
71	<i>Oxyria digyna</i> (L.) Hill.	-	-	-	25.88	-	-	-	24.54	-	-	-	-
72	<i>Pimpinella diversifolia</i> DC.	-	-	-	11.32	-	-	-	-	-	-	-	19.29
73	<i>Pinus gerardiana</i> Wall. ex Lamb.	-	-	-	-	-	18.15	22.03	-	-	-	27.22	-
74	<i>Pinus wallichiana</i> A. B. Jackson	18.38	24.29	-	22.37	13.96	24.54	-	7.25	23.91	18.12	-	-
75	<i>Pistacia integerrima</i> (L.) Steward ex Brandis	-	-	-	-	2.19	-	-	-	-	-	-	-
76	<i>Polygonum amplexicaule</i> D Don.	-	-	-	-	-	-	-	-	-	14.68	-	-
77	<i>Polypogon fugax</i> Nees ex Steud	-	-	-	-	-	-	-	-	-	2.90	-	-
78	<i>Potentilla pamirica</i> Wolf.	-	-	-	-	-	-	-	-	-	-	36.78	-
79	<i>Potentilla sericea</i> L.	-	-	-	-	-	-	-	-	-	-	-	23.95
80	<i>Potentilla supina</i> L.	-	-	24.72	14.21	-	-	15.37	11.26	-	-	-	-
81	<i>Prunus kuramica</i> (Korsh.) Kitam.	-	-	25.71	-	-	-	-	-	-	-	-	-
82	<i>Quercus baloot</i> Griffith.	33.40	28.57	-	-	24.31	-	16.63	-	25.52	20.11	-	-
83	<i>Quercus dilatata</i> Lindl.	-	-	-	-	-	-	-	-	-	-	-	-
84	<i>Rheum emodi</i> Wall ex Meissn.	8.46	-	-	-	7.96	-	-	-	-	-	-	-
85	<i>Rosa webbiana</i> Wall ex Royle	20.31	-	-	-	14.45	3.07	-	-	20.97	-	-	-
86	<i>Rubia cordifolia</i> L.	-	-	-	-	-	-	-	-	-	-	-	3.85
87	<i>Rumex hastatus</i> D.Don	-	-	-	-	-	-	-	-	-	22.04	-	-
88	<i>Rumex longifolius</i> DC.	-	-	-	-	-	-	-	19.68	-	-	-	-
89	<i>Rumex nepalensis</i> Spreng	-	-	-	-	-	-	-	-	-	-	23.40	-
90	<i>Salix acmophylla</i> Boiss.	-	20.01	-	-	-	18.84	-	-	-	13.19	-	-
91	<i>Salvia moorcroftiana</i> Wall. ex Bth.	-	-	14.75	-	-	-	10.35	-	-	-	-	-
92	<i>Salvia nubicola</i> wall. ex Sweet	-	-	13.77	8.65	-	6.16	7.86	7.76	-	-	-	-
93	<i>Scrophularia scoparia</i> Penn.	-	-	28.37	17.40	-	-	19.97	15.61	-	-	25.79	-
94	<i>Scrophularia stewartii</i> Penn.	2.67	-	-	-	-	-	-	-	-	-	-	-
95	<i>Sedum ewersii</i> Ledeb.	-	15.14	-	-	-	15.01	-	-	-	10.72	-	-

96	<i>Silene viscosa</i> (L.) Pers.	-	-	-	-	-	16.28	-	-	-	-	-	-
97	<i>Solanum nigrum</i> L.	8.46	-	-	-	-	-	-	-	6.59	-	-	-
98	<i>Sonchus asper</i> L.	-	-	-	-	-	-	-	-	-	3.88	-	-
99	<i>Sonchus oleraceus</i> L.	-	8.84	-	-	2.19	8.71	-	-	-	5.85	-	-
100	<i>Sophora mollis</i> (Royle) Baker	26.77	18.28	-	-	22.64	18.15	-	-	19.92	11.72	-	-
101	<i>Spiraea canescens</i> Lour.	-	-	6.39	-	-	-	-	-	-	-	-	-
102	<i>Taraxacum officinale</i> Weber	-	-	-	7.43	-	-	14.54	5.09	-	-	-	11.47
103	<i>Thymus linearis</i> L.	-	-	-	-	-	-	20.79	-	-	-	-	30.30
104	<i>Tragopogon gracilis</i> D. Don.	-	-	-	-	-	-	17.87	-	-	-	-	-
105	<i>Trifolium repens</i> L.	-	-	-	-	-	-	-	-	13.85	-	-	-
106	<i>Tulipa stellata</i> Hk. f.	3.93	-	-	-	16.66	-	-	-	-	-	-	-
107	<i>Verbascum thapsus</i> L.	7.03	20.70	-	-	5.29	26.20	-	-	6.11	16.61	-	-
108	<i>Veronica verna</i> L.	-	-	-	-	-	-	-	-	12.79	-	-	-
109	<i>Viola canescens</i> Wall. ex Roxb.	-	-	20.09	-	-	-	12.44	-	-	-	-	-
110	<i>Vitis venifera</i> L.	-	-	-	-	16.17	-	-	-	-	-	-	-

Table 12. Physico-chemical analysis of soils of uphill mountains and alpine communities of Kalash valley, District Chitral, Pakistan

S #	Plant community	Soil texture	Organic matter (%)	CaCo3 (%)	N (ppm)	P (ppm)	K (ppm)	pH	ECX 10 ³	TSS %	Clay %	Silt %	Sand %
1	QSA	Sandy loam	0.96	6.25	0.043	6.5	80	7.3	0.46	0.147	6.8	40	53.2
2	EQM	Sandy loam	1.10	0.75	0.055	5.7	120	7.2	0.10	0.032	7.2	42	50.8
3	ICS	Sandy loam	0.40	-	0.020	20.0	180	6.5	0.30	0.096	5.2	44	50.8
4	AJE	Sandy loam	0.84	1.22	0.018	11.02	170	6.7	0.33	0.044	6.1	49	44.9
5	QSI	Silt loam	0.44	9.50	0.022	10.8	50	7.2	0.23	0.073	8.2	72	19.8
6	EVP	Sandy loam	1.20	1.25	0.060	15.7	100	7.8	0.05	0.016	5.2	40	54.8
7	ACP	Sandy loam	0.40	-	0.020	2.8	90	7.7	0.04	0.013	7.2	44	48.8
8	EJC	Sandy loam	0.82	2.04	0.032	12.33	110	7.2	0.22	0.021	6.2	51	42.8
9	QPR	Silt loam	0.89	8.50	0.044	20.0	100	7.6	0.41	0.131	6.2	56	37.8
10	EMR	Loamy sand	0.34	0.75	0.017	17.1	80	7.8	0.06	0.019	5.2	16	78.8
11	PAC	Loamy sand	1.38	6.25	0.069	40.0	150	6.7	0.10	0.032	5.2	30	64.8
12	JTA	Sandy loam	0.92	5.43	0.082	38.9	100	7.1	0.36	0.043	6.1	45	48.9

Similarity Index (SI)

Similarity index shows the presence or absence of a species. It allows the combination of two plant communities in an association or vegetation types. The large number of plant communities can be reduced into few similar vegetation types through Similarity Index. Communities having less than 65% similarity are considered as dissimilar (Chao *et al.* 2006 and 2008). In the present study all the communities have more than 65 % similarity index and hence no dissimilar community was found. The largest similarity (97.0%) ASA and AQA of Birir valley followed by communities QAA and SSA (96.6%) and SSA and ASA (96.3%) of Birir. The lowest similarity index (80.0%) was noted between communities QAS and QSA followed by communities STM and QAS and STM and QSA (81.3%) (Table 13).

The higher similarities between the communities might be due to similarity in soil nutrients, proximity of stands with similar habitat conditions in terms of pH, phosphorus and soil from clay loam to sandy loam (Badshah, 2011). Our results are supported by this statement as throughout the valley has almost similar soil profile.

Table 13. Similarity Index of different plant communities of Kalash valley, District Chitral, Hindukush range, Pakistan

STM	X																					
AAQ	87.6	X																				
QAS	80.7	86.4	X																			
QSA	81.3	86.8	80.0	X																		
EQM	85.3	91.5	84.1	84.6	X																	
ICS	87.2	93.6	86.2	86.5	90.5	X																
AJE	88.1	94.7	87.1	87.4	91.4	93.2	X															
ARQ	83.3	90.3	81.9	82.5	87.2	89.3	90.4	X														
QAA	87.3	95.8	86.0	86.4	91.5	93.7	94.9	90.2	X													
QRF	84.5	92.1	83.1	83.7	88.3	90.4	91.5	86.6	91.6	X												
QSI	83.3	90.0	81.9	82.5	87.0	89.1	90.2	85.1	89.9	86.4	X											
EVP	86.4	93.2	85.3	85.7	90.0	91.9	92.9	88.7	85.8	89.9	88.5	X										
ACP	86.7	94.0	85.5	86.0	90.5	92.5	93.5	89.1	94.3	90.4	88.9	92.1	X									
EJC	87.7	94.3	86.6	87.0	91.0	92.9	93.8	90.0	94.5	91.1	89.7	92.5	93.2	X								
SSA	87.5	96.2	86.2	86.6	91.7	94.0	95.2	90.4	96.6	91.9	90.1	93.6	94.6	95.4	X							
ASA	87.0	96.1	85.7	86.2	91.2	93.5	94.7	89.9	95.9	91.3	89.6	93.1	93.9	94.6	96.3	X						
AQA	85.9	94.3	84.5	85.0	90.2	92.5	93.7	88.6	96.0	90.1	88.3	92.0	92.8	93.6	95.0	97.0	X					
QPR	83.2	89.7	81.9	82.5	86.9	88.9	90.0	85.0	89.6	86.3	84.9	88.3	88.7	89.8	89.4	91.3	88.1	X				
EMR	86.7	94.0	85.5	88.0	90.4	92.4	93.5	89.1	94.2	90.4	88.9	92.0	92.7	93.4	94.5	96.2	92.7	88.6	X			
PAC	84.6	90.1	83.5	84.0	87.7	95.1	90.3	86.2	90.1	87.3	86.1	88.9	89.3	90.0	90.3	91.6	88.9	86.0	89.2	X		
JTA	82.9	88.5	81.6	82.2	86.1	87.9	88.8	84.3	88.2	85.4	84.3	87.2	87.6	88.7	88.4	89.8	86.9	84.2	87.5	85.4	X	

Key:

(**STM**) *Salix-Tamarix-Mentha*, (**AAQ**) *Artemisia-Artemisia-Quercus*, (**QAS**) *Quercus-Artemisia-Sophora*, (**QSA**) *Quercus-Sophora-Artemisia*, (**EQM**) *Echinops-Quercus-Marrubium*, (**ICS**) *Indigofera-Cynoglossum-Scrophularia*, (**AJE**) *Acantholimon-Juniperus-Epilobium*, (**ARQ**) *Artemisia-Rosa-Quercus*, (**QAA**) *Quercus-Arum-Artemisia*, (**QRF**) *Quercus-Rosa-Fraxinus*, (**QSI**) *Quercus-Sophora-Indigofera*, (**EVP**) *Echinops-Verbascum-Pinus*, (**ACP**) *Artemisia-Cedrus-Pinus*, (**EJC**) *Ephedra-Juniperus-Cuscuta*, (**SSA**) *Salix-Salix-Ailanthus*, (**ASA**) *Artemisia-Salix-Arum*, (**AQA**) *Arum-Quercus-Artemisia*, (**QPR**) *Quercus-Pinus-Rosa*, (**EMR**) *Echinops-Marrubium-Rumex*, (**PAC**) *Potentilla-Astragalus-Chenopodium*, (**JTA**) *Juniperus-Thymus-Anaphalis*

Cluster Analysis

Three plant associations were recognized from entire Kalash valley, district Chitral based on cluster dendrogram analysis (Fig. 15). The associations are described below and have characteristic species and confined to a specific habitat.

1. Association I

This association consists of 9 communities and dominated by herbs and trees. It included stands/ communities 2, 3, 6, 8, 10, 11, 12, 13 and 14. The association consists of *Indigofera heterantha* var. *heterantha* with IV (32.10), *Quercus baloot* (IV= 30.62), *Ephedra intermedia* (IV= 30.21) and *Cynoglossum lanceolatum* (IV= 29.35). Some other important plants of the association were *Scrophularia scoparia*, *Echinops echinatus*, *Verbascum thapsus*, *Juniperus communis*, *Cuscuta lehmanniana*, *Pinus wallichiana*, *Pinus gerardiana*, *Cedrus deodara* and *Artemisia scoparia*. The vegetation of the association represents the dry temperate conditions of the area.

2. Association II

This association was consisting of 7 communities and spread throughout the mountains and alpine habitats and dominated by trees and predominated by herbs and high altitude annual plants. It included stands 8, 9, 10, 11, 13, 20 and 21. *Potentilla pamirica* (IV= 36.78), *Astragalus grahamianus* (IV= 32.97) and *Juniperus excelsa* (IV= 32.58) were dominating species. Other important species of the association were *Chenopodium foliosum*, *Thymus linearis*, *Anaphalis contorta*, *Echinops echinatus*, *Verbascum thapsus*, *Pinus gerardiana*, *Cedrus deodara*, *Artemisia scoparia*, *Artemisia brevifolia*, *Ephedra gerardiana* and *Quercus baloot*.

3. Association-III

This association was purely spread over high altitude mountains and alpine of the valley and consists of 4 stands/ communities viz: 18, 19, 20 and 21. It contains mostly annuals and some tree species. The dominant species were *Potentilla pamirica* (IV= 36.78), *Astragalus grahamianus* (IV= 32.97) and *Juniperus excelsa* (IV= 32.58). *Quercus baloot*, *Pinus wallichiana*, *Cedrus deodara*, *Quercus baloot*, *Rumex hastatus*, *Marrubium vulgare*, *Echinops echinatus*, *Sophora mollis* and *Rosa webbiana* were some important plants of the association.

The findings of many workers support our results i.e. Ahmad *et al.* (2004) used cluster analysis by TWINSpan (Two Way Indicator Species Analysis) technique and grouped many communities into few associations of Islamabad. Xianping *et al.* (2006) divided forest communities of Pangquangou National Nature Reserve into seven associations by using DCA. Jafari *et al.* (2007) clustered 90 plant communities into seven groups. Shah (2014) divided 33 plant communities of Mastuj valley, Chitral into 4 associations.

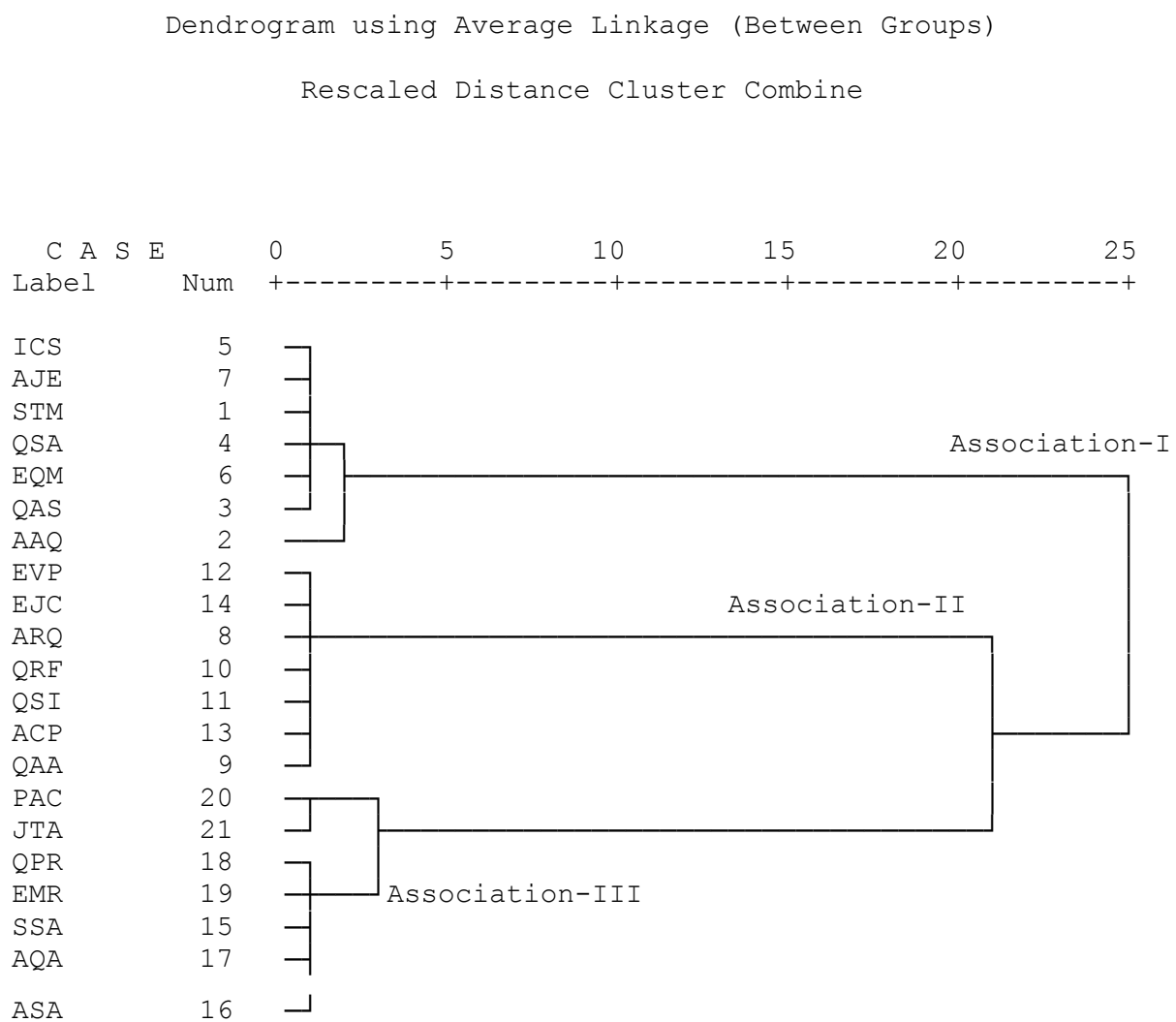


Figure 15. Cluster Dendrogram Analysis showing three associations of 21 communities of vegetation of Kalash valley, District Chitral

DEGREE OF PALATABILITY AND PRODUCTIVITY

1. Degree of Palatability

Palatability is the acceptance of plant species by the grazing animals. It depends on the chemical nature, growth stages, external plant forms and kinds of plant species which affect the acceptability and may stimulate selective responses by animals or may prevent from grazing (Heady, 1964).

The grazing pattern of cattle was observed in the research area from April to December. The results showed that Cow grazed on 47 plant species (Table 14). Of these, 20 (42.55 %) species were highly palatable, 18 (38.30 %) were mostly palatable and 9 (19.15 %) were less palatable. Specific part of the plant species used showed that whole plant of 25 (53.19 %) species, leaves of 19 (40.42 %) species, shoots of 2 (4.25 %) species and flowers of one (2.13 %) species were used as forage. Out of 47 species, 28 (59.57%) were herbs, 14 (29.78%) were trees and 5 (10.63%) were shrubs. Goats grazed on 65 species (Table 15). Of these 20 (30.77 %) species each were highly palatable and less palatable, 21 (32.31 %) mostly palatable and 4 (6.15 %) species were rarely palatable. Part used showed that whole plant of 26 (40 %) species, leaves of 24 (36.92 %) species, shoots of 14 (21.54 %) species and fruit of 1 (1.54 %) species were used by goats for grazing. Out of 65 species, 33 (50.77 %) were herbs, 19 (29.23 %) were shrubs and 13 (20 %) were trees. Sheep of the area graze on 42 species (Table 16). Of these, 18 (42.86 %) species were mostly palatable, 13 (30.95 %) were highly palatable, 10 (23.81 %) were less palatable and 1 (2.38%) species was rarely palatable. The whole plants of 17 (40.48 %) species, leaves of 13 (30.95 %) species, shoots of 10 (23.81 %) species and fruit of 1 (2.38 %) species was preferred by sheep for grazing. Out of 42 species, 26 (61.90 %) were herbs, 10 (23.81 %) were shrubs and 6 (14.28%) were trees.

It was noted in the present findings that the forage availability and variety reduced in the winter and dormant stage. Similar results were reported by Chocarro *et al.* (2005), Hirata *et al.* (2005), Neal & Miller (2007), Akram *et al.* (2009), Glindemann *et al.* (2009), Hussain & Durrani (2009) and Sher *et al.* (2010). Grazing is one of the factors of reduction of rangeland vegetation, species occurrence and decline in distribution of medicinal plants in the study area. Our findings are correlated with that of Peters, 2007; Hussain & Durrani, 2009; Sher *et al.* 2010 and Rahim *et*

al. 2011) as they found similar reductions in species distribution and occurrence in their research areas.

Cattle rearing are main and traditional source of income generation for the Kalash people. Most of them carry special places within their houses or in higher pastures for livestock to fulfill their food and dairy requirements. A good number of Kalash people have large quantity of livestock and they have engaged labour for their care. This practice not only provides jobs to the poor people but is also providing good quality dairy products that are sold throughout the district for income generation. Grazing is usually starts in lower lands and pastures from May till October and for the rest of the period the livestock is feed on stored materials.

Table 14. Palatability of forage plants by cow in Kalash valley, District Chitral, Pakistan

S #	Plant name	Palatability	Part used	Availability	Habit
1	<i>Bromus tectorum</i>	HP	WP	June	H
2	<i>Capsella bursa-pastoris</i>	MP	WP	June	H
3	<i>Carex orbicularis</i>	LP	WP	June	H
4	<i>Chenopodium album</i>	HP	WP	June	H
5	<i>Chenopodium botrys</i>	HP	WP	June	H
6	<i>Cichorium intybus</i>	MP	WP	June	H
7	<i>Convolvulus arvensis</i>	HP	WP	June	H
8	<i>Crataegus songarica</i> C. Koch.	LP	Leaves	July	T
9	<i>Cynodon dactylon</i>	HP	WP	June	H
10	<i>Elaeagnus angustifolia</i>	MP	Leaves	July	T
11	<i>Equisetum ramosissimum</i>	HP	WP	August	H
12	<i>Gallium aparine</i>	HP	WP	June	H
13	<i>Inula rhizocephala</i>	HP	WP	August	H
14	<i>Iris germanica</i>	MP	Leaves	September	H
15	<i>Juglans regia</i> L.	MP	Leaves	October	T
16	<i>Kickxia ramosissima</i> (Wall.) Janchen	LP	WP	September	H
17	<i>Lotus corniculatus</i>	MP	WP	July	H
18	<i>Malva neglecta</i> Wallr.	MP	WP	June	H
19	<i>Matricaria aurea</i>	LP	WP	September	H
20	<i>Matricaria disciformis</i>	LP	WP	September	H
21	<i>Medicago lupulina</i>	HP	WP	August	H
22	<i>Morus alba</i> L.	HP	Leaves	September	T
23	<i>Morus nigra</i> L.	HP	Leaves	September	T

24	<i>Myricaria squamosa</i> Desv.	MP	Shoots	July	S
25	<i>Onosma dichroanthum</i>	LP	WP	June	H
26	<i>Plantago lanceolata</i> L.	HP	WP	June	H
27	<i>Plantago major</i> L.	MP	WP	July	H
28	<i>Platanus orientalis</i> L.	MP	Leaves	June	T
29	<i>Populus nigra</i> L.	MP	Leaves	June	T
30	<i>Prunus armeniaca</i> L.	HP	Leaves	June	T
31	<i>Prunus persica</i> L.	HP	Leaves	June	T
32	<i>Pyrus communis</i> L.	HP	Leaves	July	T
33	<i>Pyrus pashia</i> Ham. ex D. Don	HP	Leaves	June	T
34	<i>Pyrus malus</i> L.	HP	Leaves	June	T
35	<i>Robinia psuedoacacia</i>	HP	Leaves	June	T
36	<i>Salix acmophylla</i> Boiss.	MP	Leaves	June	T
37	<i>Salix linearifolia</i> E. Wolf.	LP	Leaves	June	S
38	<i>Salix tetrasperma</i> Roxb.	MP	Leaves	June	S
39	<i>Salix denticulata</i> subsp. <i>denticulata</i> Anderson	MP	Leaves	July	S
40	<i>Taraxacum officinale</i>	MP	WP	June	H
41	<i>Trifolium pretense</i> L.	MP	WP	Jun	H
42	<i>Trifolium repens</i> L.	HP	WP	June	H
43	<i>Tulipa stellata</i>	LP	Flowers	August	H
44	<i>Verbena officinalis</i> L.	LP	WP	July	H
45	<i>Viola canescens</i> Wall. ex Roxb.	MP	WP	August	H
46	<i>Vitis venifera</i>	MP	Leaves	August	S
47	<i>Zea mays</i>	HP	Shoots	July	H

Table 15. Palatability of forage plants by goats in Kalash valley, District Chitral, Pakistan

S #	Plant name	Palatability	Part used	Availability	Habit
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	MP	Shoots	Aug	S
2	<i>Ailanthus altissima</i> (Mill.) Swingle	HP	Lvs	June	T
3	<i>Artemisia brevifolia</i>	MP	Shoots	June	S
4	<i>Artemisia scoparia</i>	MP	Shoots	September	S
5	<i>Astragalus grahammianus</i>	LP	WP	August	S
6	<i>Astragalus nivalis</i>	LP	WP	August	S
7	<i>Bromus tectorum</i>	LP	WP	June	H
8	<i>Bumium persicum</i>	MP	Shoots	July	H
9	<i>Ceratocephalus falcatus</i> (L.) Pers	LP	WP	August	S
10	<i>Chenopodium album</i>	MP	WP	July	H
11	<i>Chenopodium botrys</i>	HP	WP	June	H
12	<i>Chenopodium foliosum</i>	RP	WP	August	H
13	<i>Clematis orientalis</i> L.	HP	Shoots	August	H
14	<i>Cotoneaster microphylla</i> Wall. ex Lindl.	LP	Lvs	August	S
15	<i>Cotoneaster nummularia</i> Fisch. & Mey	LP	Lvs	August	S
16	<i>Crataegus songarica</i> C. Koch.	LP	Lvs	July	T
17	<i>Convolvulus arvensis</i>	LP	WP	June	H
18	<i>Cynodon dactylon</i>	HP	WP	June	H
19	<i>Datura stramonium</i> L.	HP	WP	August	S
20	<i>Echinops cornigerus</i>	HP	WP	July	H
21	<i>Elaeagnus angustifolia</i>	HP	Lvs	October	T

22	<i>Ephedra gerardiana</i>	RP	Shoots	September	S
23	<i>Euphorbia peplus</i>	LP	WP	July	H
24	<i>Gallium aparine</i>	LP	WP	June	H
25	<i>Indigofera heterantha</i> var. <i>heterantha</i>	MP	Lvs	August	S
26	<i>Iris germinia</i>	RP	Lvs	August	H
27	<i>Juniperus squamata</i>	LP	Lvs	August	S
28	<i>Lamium amplexicaule</i> L.	HP	Shoots	August	H
29	<i>Marrubium vulgare</i> L.	HP	Shoots	August	H
30	<i>Matricaria aurea</i>	HP	WP	October	H
31	<i>Matricaria disciformis</i>	HP	WP	October	H
32	<i>Mentha longifolia</i> (L.) Huds	LP	WP	August	H
33	<i>Morus alba</i> L.	HP	Lvs	August	T
34	<i>Morus nigra</i> L.	HP	Lvs	August	T
35	<i>Myricaria squamosa</i> Desv.	MP	Shoots	November	H
36	<i>Nepeta raphanorhiza</i>	LP	Shoots	August	H
37	<i>Onosma dichroanthum</i>	LP	WP	June	H
38	<i>Plantago lanceolata</i> L.	HP	WP	June	H
39	<i>Plantago major</i> L.	MP	WP	July	H
40	<i>Platanus orientalis</i> L.	MP	Lvs	June	T
41	<i>Populus alba</i> L.	MP	Lvs	June	T
42	<i>Populus nigra</i> L.	MP	Lvs	June	T
43	<i>Pulicaria salviaefolia</i>	HP	WP	November	H
44	<i>Pyrus malus</i> L.	HP	Lvs	June	T
45	<i>Quercus baloot</i> Griffith	LP	Lvs	June	T
46	<i>Quercus dilatata</i> Lindl.	MP	Lvs	June	T
47	<i>Robinia psuedoacacia</i>	HP	Lvs	June	T

48	<i>Rosa webbiana</i>	MP	Shoots	July	S
49	<i>Rumex hastatus</i> D Don	LP	Lvs	July	H
50	<i>Salix acmophylla</i> Boiss.	MP	Lvs	June	T
51	<i>Salix denticulata</i> subsp. <i>denticulata</i> Anderson	MP	Lvs	July	S
52	<i>Salix linearifolia</i> E. Wolf.	LP	Lvs	June	S
53	<i>Salix tetrasperma</i> Roxb.	MP	Lvs	June	S
54	<i>Salvia nubicola</i>	LP	Shoots	July	H
55	<i>Scrophularia robusta</i> Penn.	MP	WP	August	H
56	<i>Sophora mollis</i>	HP	Fruit	September	S
57	<i>Tamarix dioica</i> Roxb. ex Roth	RP	Shoots	November	S
58	<i>Taraxacum officinale</i>	LP	WP	June	H
59	<i>Thymus serpyllum</i>	MP	Shoots	August	H
60	<i>Trifolium pretense</i> L.	MP	WP	June	H
61	<i>Trifolium repens</i> L.	HP	WP	May	H
62	<i>Verbena officinalis</i> L.	LP	WP	July	H
63	<i>Viola canescens</i> Wall. ex Roxb.	MP	WP	August	H
64	<i>Vitis venifera</i>	MP	Lvs	September	S
65	<i>Zea mays</i>	HP	Lvs	July	H

Table 16. Palatability of forage plants by sheep in Kalash valley, District Chitral, Pakistan

S #	Plant name	Palatability	Part used	Availability	Habit
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	MP	Shoots	August	S
2	<i>Ailanthus altissima</i> (Mill.) Swingle	MP	Lvs	June	T
3	<i>Artemisia brevifolia</i>	MP	Shoots	June	S
4	<i>Artemisia scoparia</i>	MP	Shoots	September	S
5	<i>Astragalus nivalis</i>	LP	WP	August	H
6	<i>Bromus tectorum</i>	HP	WP	June	H
7	<i>Bumium persicum</i>	MP	Shoots	July	H
8	<i>Ceratocephalus falcatus</i> (L.) Pers	LP	WP	August	S
9	<i>Chenopodium album</i>	HP	WP	August	H
10	<i>Chenopodium botrys</i>	HP	WP	September	H
11	<i>Chenopodium foliosum</i>	RP	WP	August	H
12	<i>Clematis orientalis</i> L.	HP	Shoots	November	H
13	<i>Cotoneaster microphylla</i> Wall. ex Lindl.	LP	Lvs	August	S
14	<i>Cotoneaster nummularia</i> Fisch. & Mey	LP	Lvs	August	S
15	<i>Cynodon dactylon</i>	HP	WP	June	H
16	<i>Elaeagnus angustifolia</i>	MP	Lvs	October	T
17	<i>Iris germinia</i>	MP	Lvs	September	H
18	<i>Indigofera heterantha</i> var. <i>heterantha</i>	MP	Lvs	August	S
19	<i>Lamium amplexicaule</i> L.	HP	shoots	August	H
20	<i>Lotus corniculatus</i>	MP	WP	July	H
21	<i>Marrubium vulgare</i> L.	HP	shoots	August	H

22	<i>Mentha longifolia</i> (L.) Huds	LP	WP	August	H
23	<i>Medicago lupulina</i>	HP	WP	August	H
24	<i>Onosma dichroanthum</i>	LP	WP	June	H
25	<i>Peganum harmala</i> L.	LP	Shoots	July	H
26	<i>Populus nigra</i> L.	MP	Lvs	June	T
27	<i>Plantago lanceolata</i> L.	HP	WP	June	H
28	<i>Plantago major</i> L.	MP	WP	July	H
29	<i>Platanus orientalis</i> L.	MP	Lvs	June	T
30	<i>Quercus baloot</i> Griffith	LP	Lvs	June	T
31	<i>Quercus dilatata</i> Lindl.	MP	Lvs	June	T
32	<i>Rosa webbiana</i>	MP	shoots	July	S
33	<i>Rumex hastatus</i> D Don	LP	Lvs	July	H
34	<i>Salvia nubicola</i>	LP	shoots	July	H
35	<i>Scrophularia robusta</i> Penn.	MP	WP	August	H
36	<i>Sophora mollis</i>	HP	Fruit	September	S
37	<i>Taraxacum officinale</i>	HP	WP	May	H
38	<i>Trifolium pretense</i> L.	MP	WP	June	H
39	<i>Trifolium repens</i> L.	HP	WP	June	H
40	<i>Thymus serpyllum</i>	MP	Shoots	August	H
41	<i>Vitis venifera</i>	MP	Lvs	September	S
42	<i>Zea mays</i>	HP	Lvs	September	H

Key: HP = Highly Palatable; MP= Mostly Palatable; LP = Less Palatable; RP = Rare Palatable;
 WP = Whole Plant; Lvs = Leaves; H = Herb; S = Shrub; T = Tree

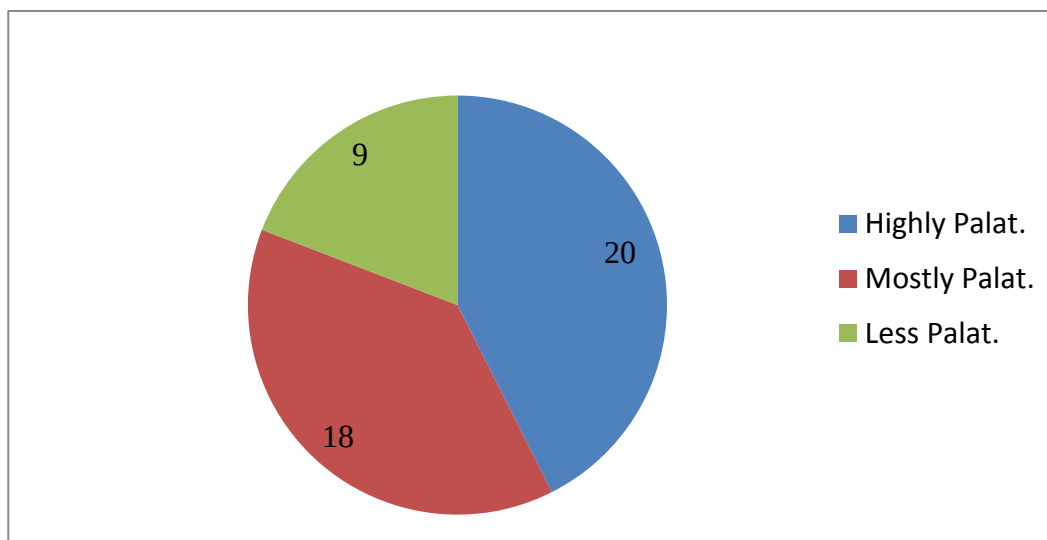


Figure 16. Graphical presentation of cow palatability of plants in Kalash valley, district Chitral

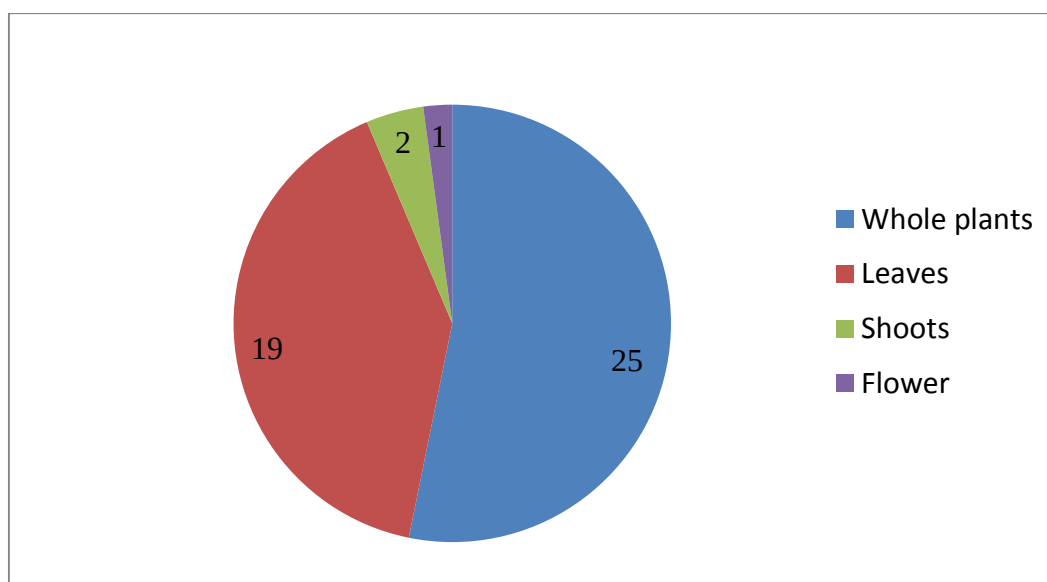


Figure 17. Graphical presentation of parts of plants preferred by cow as forage in Kalash valley, district Chitral

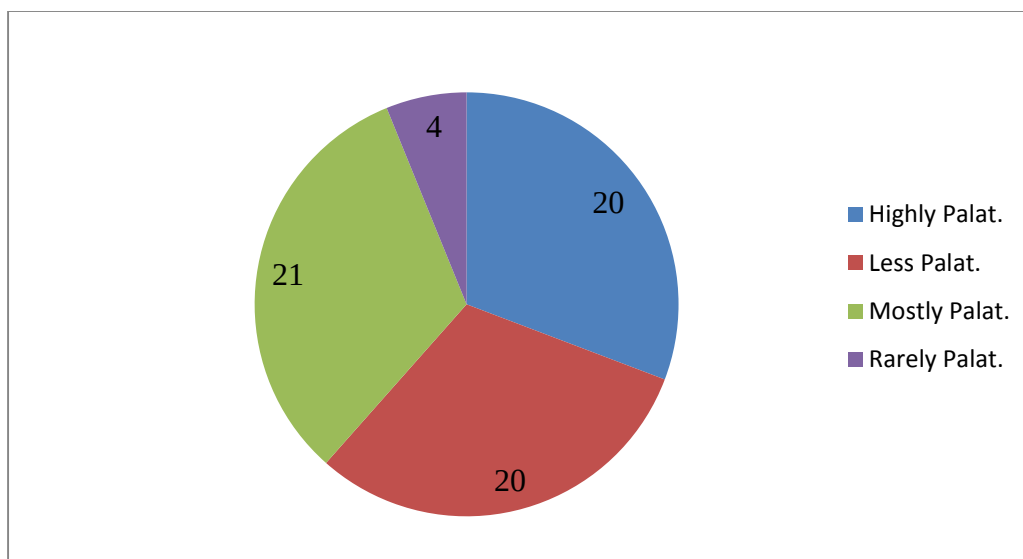


Figure 18. Graphical presentation of goat palatability of plants in Kalash valley, district Chitral

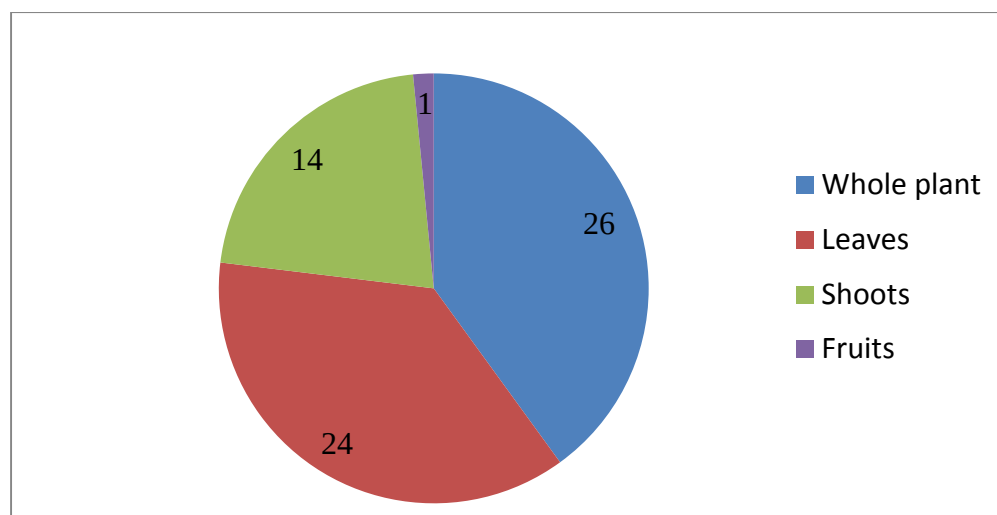


Figure 19. Graphical presentation of plant parts preferred by goat in Kalash valley, district Chitral

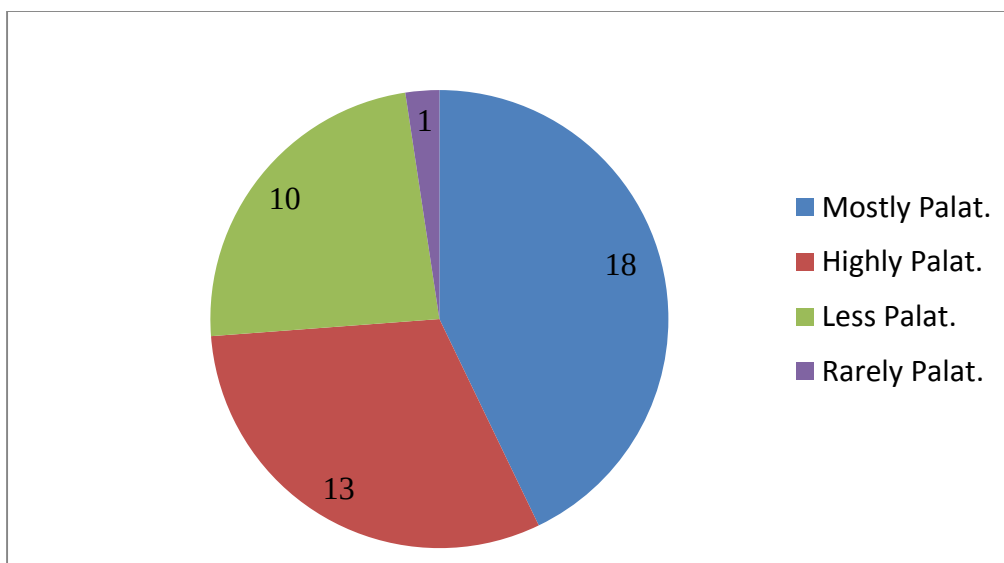


Figure 20. Graphical presentation of sheep palatability of plants in Kalash valley, district Chitral

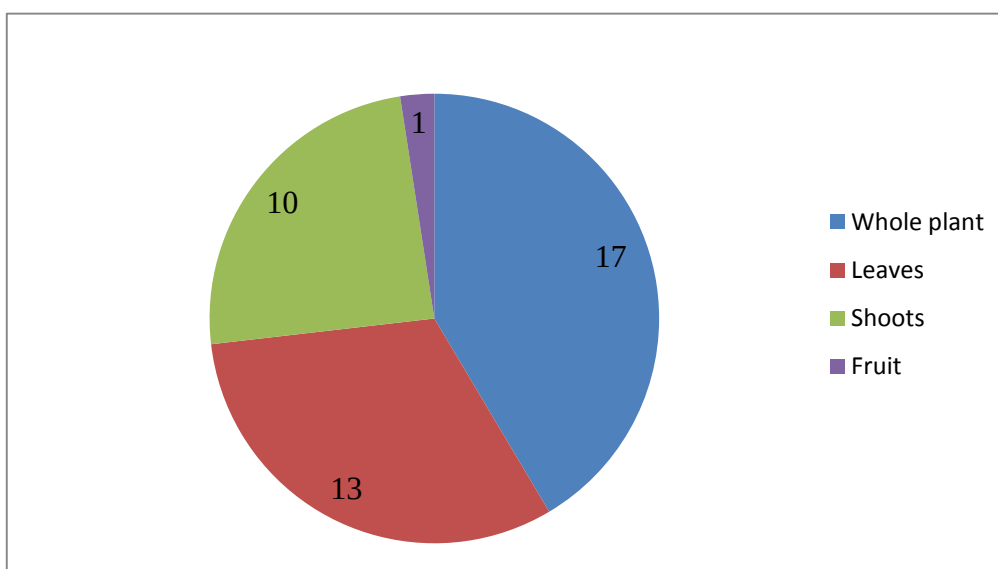


Figure 21. Graphical presentation of sheep preference of plant parts as forage in Kalash valley, district Chitral

FORAGE PRODUCTIVITY

Biomass is a measure of plant natural resources of a community that depend on different species (Bonham, 1989). The Kalash valley has arid sub-alpine ranges in the three sub valleys and the productivity of herbs, shrubs, trees and grasses were measured for three consecutive years i.e. 2013-2015. The results indicated that the grasses contributed 1240 kg/ha, herbs had 46595 kg/ha and shrubs/trees contributed to 79649 kg/ha of forage production. The total productivity of the entire Kalash valley was 127484 kg/ha. Highest productivity (9445 kg/ha) was recorded for the community *Salix-Salix-Ailanthus* in Oroly area of Birir followed by *Salix-Tamarix-Mentha* community of Anesht area of Bumborat (9065 kg/ha) and *Artemisia-Rosa-Quercus* community of Gombac area of Rumbor (8775 kg/ha). The lowest forage productivity (815 kg/ha) was recorded for Chenarsin area of Rumbor followed by Achar Kandor area (996 kg/ha) of Birir (Table 17). The productivity was higher in the plains/foothills or communities that were close to water flow and the productivity decreased in the uphill mountains. The total grasses production in the foothills was 402 kg/ha in Birir, 350 kg/ha in Bumboret and 330 kg/ha in Rumbor. But in uphills and alpine communities the grass forage productivity decreased to 91 kg/ha, 35 kg/ha and 32 kg/ha in Rumbor, Bumboret and Birir respectively. The total herbs productivity in the foothill/plains was maximum (9553 kg/ha) in Birir followed by Bumboret (9335 kg/ha) and Rumbor (8860 kg/ha). In the uphills/alpine communities the production decreased to 7640kg/ha in Bomburet, 6207 kg/ha in Rumbor and 5000 kg/ha in Birir.

The total productivity of shrubs/trees plains/foothills in entire Kalash valley was maximum in Bumboret (16485 kg/ha) followed by Rumbor with 15350 kg/ha and Birir 14760 kg/ha. The forage production of shrubs/trees in uphills/alpine decreased to 11470 kg/ha in Bomburet, 10836 kg/ha in Rumbor and 10748 in Birir valley. It is concluded from present findings that the forage productivity reduced in uphills/alpine regions because the climatic conditions becoming harsh with elevation and also the grazing and browsing increases in non cultivated rangelands. It was also observed that the productivity of shrubs and trees were higher than that of herbaceous flora and grasses, it is because the the herbs and grasses are mostly annual or seasonal and provide low forage composition to cattle as compare to shrubs and trees have more canopy cover and production.

The productivity of forage of any range depends on number of factors such as Edaphology, rainfall, grazing pattern and saesaonal availability of forage (Durrani *et al.* 2005).

As in the present study it was observed that the increase in the elevation and high rate of grazing in higher altitudes has caused reduction in the biomass of forage production. In Pakistan the forage productivity is always high during spring in the dry temperate regions (Omer *et al.* 2006). The fluctuation of climatic conditions has great effect on the availability and the optimum use of rangeland resources depends on seasonal mass production (Hussain & Durrani, 2007). Kumar *et al.* (2011) found that biomass of vegetation generally increased with the age of plants in Rajasthan India. Similarly Rosenschein *et al.* (1999), Ali & Shah (2004), Durrani *et al.* (2005), Hussain & Durrani (2007), Badshah (2011) and Shah (2014) reported that grazing and browsing has totally altered and reduced the biomass of the vegetation which are in accordance with the our present findings. The overgrazing, exploration of plants for medicines, firewood and timberwood, rapid urbanization due to high rate of population increase, floods, soil erosion and land sliding has badly effected the kalash valley and its vegetation. So, the proper range management must be tried with the help and consultation of local community for the sustainability and improvement of the rangelands and vegetation of the valley.

Table 17. Forage/Biomass production (kg/ha) in different plant communities of Kalash valley, Hindukush range, Pakistan

Habitat	Kalash valley	Plant communities/ stands	Altitude / Localities	Grasses	Herbs	Shrubs/ Trees	Total
Plains and foothills	Bumburet	STM	1700-1810m / Anesht	205	3270	5590	9065
		AAQ	2110-2200m / krakal	110	3335	5145	8590
		QAS	2300-2410m / Shekhanan deh	35	2730	5750	8515
	Rumbor	ARQ	1100-1230m / Gombac	310	3185	5280	8775
		QAA	1320-1420m / Parkalak	-	2900	4425	7325
		QRF	1570-1650m / Kalashan deh	20	2775	5645	8440
	Birir	SSA	1200-1350m / Oroly	285	4205	4955	9445
		ASA	1550-1700m / Garambeth	105	3190	4750	8045
		QAA	1910-2050m / Gasgoro	12	2158	5055	7225
Uphill mountains / alpine	Bumboret	QSA	2550-2640m / Piosh	25	2925	5765	8715
		EQM	2780-2870m / Otakawo	10	2865	3535	6410
		ICS	3000-3090m / Bronzik Gol	-	955	1235	2190
		AJE	3200-3310m / Peenlusht	-	895	935	1830
	Rumbor	QSI	1790-1900m / Piakaar	33	2847	4673	7553
		EVP	2130-2250m / Shekhanan deh	43	2164	4565	6772
		ACP	2550-2700m / Gangal Wat	15	964	1015	1994
		EJC	2980-3110m / Chenarsin	-	232	583	815
	Birir	QPR	2220-2350m / Chesbetagan	24	2200	4945	7169
		EMR	2480-2570m / Kotial	8	1842	4545	6395
		PAC	2710-2820m / Chondovech	-	535	685	1220
		JTA	2950-3070m / Achar Kandor	-	423	573	996
Total				1240	46595	79649	127484

CHEMICAL EVALUATION OF SOME SELECTED FORAGE PLANTS

A. Elemental/ mineral composition

Minerals have a key role in proper functioning of animal body and also affect the growth and reproduction of animals. In Pakistan about 30 million herds of livestock are supported by rangeland productivity which contributes to the annual export income of the country (Anonymous, 2006).

In the present study the mineral contents of thirteen species were analyzed in three phenological stages having 2 trees, 7 shrubs and 4 herbs/forbs species (Table 18). The results for each element were presented below.

a. Macronutrients

1. Calcium (Ca)

Calcium is an important and basic component plant cell wall and gives strength, support and rigidity to plant cell wall and other membranes. For animals Ca play key role in strengthening of bones. In the present study the data regarding Ca contents of the species at three phenological stages is presented in Table 19. The mean value among herbs varied in between 0.64 ppm (*Marrubium vulgare*) to 1.36 ppm (*Peganum harmala*). Among the woody plants, Ca concentration varied from 0.62 ppm (*Astragalus grahammianus*) to 1.58 ppm (*Sophora mollis*). The maximum amount of Ca was found in herbs and was recorded in *Peganum harmala* (2 ppm) at pre-reproductive stage followed by shrubs that is (1.95 ppm) in *Daphne oleoides* at pre-reproductive stage and (1.91 ppm) in *Sophora mollis* post reproductive stage. The average Ca contents in herbs were i.e. *Artemisia parviflora* (0.91 ppm), *Echinops cornigerus* (0.87 ppm), *Marrubium vulgare* (0.64 ppm), *Peganum harmala* (1.36 ppm), *Salvia nubicola* (1.23 ppm) and *Thymus serpyllum* (0.91 ppm). In shrubs *Sophora mollis* showed maximum (1.58 ppm) Ca contents followed by *Daphne oleoides* (1.41 ppm), *Rosa webbiana* (1.29 ppm), *Acantholimon lycopodioides* (0.98 ppm) and *Astragalus grahammianus* (0.62 ppm). In trees *Joniperus communis* showed maximum (1.02 ppm) Ca contents followed by *Ephedra gerardiana* (0.99 ppm). The overall trend of Ca concentration was increasing with maturity of plants. Our findings are similar to those of Seiler & Campbell (2004), Ashraf *et al.* (2005) and Khan *et al.* (2005), who also reported increase in the concentration of Ca in plants with maturity.

2. Potassium (K)

Potassium is an essential nutrient that activates many enzyme systems. Its deficiency adversely affects the plant growth and metabolism (Rahim *et al.*, 2008). Physiological functions of livestock require at least 0.5 ppm potassium (Anonymous, 1985).

The potassium contents of the plant species at three phenological stages are presented in Table 20. Among the herbs the mean values of K varied in between 0.52 ppm (*Artemisia parviflora*) to 1.22 ppm (*Thymus serpyllum*). Similarly, K content of woody plants varied from 0.29 ppm in *Daphne oleoides*) to 0.96 ppm in *Sophora mollis*. Overall maximum amount of K was found in herbs and was recorded in *Marrubium vulgare* (1.54 ppm) at redroductive stage followed by *Thymus serpyllum* (1.34 ppm) at post-reproductive stage and 1.21 ppm each in *Salvia nubicola* at post-reproductive and in *Thymus serpyllum* at reproductive stage respectively. The average K contents in herbs were i.e. *Artemisia parviflora* (0.52 ppm), *Echinops cornigerus* (0.96 ppm), *Marrubium vulgare* (1.16 ppm), *Peganum harmala* (0.77 ppm), *Salvia nubicola* (1.18 ppm) and *Thymus serpyllum* (1.22 ppm). In woody plants *Astragalus grahammianus* showed maximum (0.90 ppm) Ca contents followed by *Sophora mollis* (0.73 ppm), *Daphne oleoides* (0.29 ppm), *Rosa webbiana* (0.42 ppm), *Acantholimon lycopodioides* (0.37 ppm), *Joniperus communis* (0.22 ppm) and *Ephedra gerardiana* (0.61 ppm). The overall trend of K concentration was increasing up to reproductive stage and then reduced with the maturity of plants. Our findings are similar to those of Ashraf *et al.* (2005) and Ahmad *et al.* (2008c) who stated that different plants parts and phenological stages varied in K concentration.

Table 18. Plant species analysed for chemical and proximate composition showing different palatability at different phenological stages

S #	Plant Species	Phenological stage		
		Pre-reproductive stage	Reproductive stage	Post-reproductive stage
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	RP	LP	MP
2	<i>Artemisia parviflora</i> Roxb.	RP	NP	LP
3	<i>Astragalus grahammianus</i> Royle	LP	HP	MP
4	<i>Daphne oleoides</i> Schreb.	LP	MP	MP
5	<i>Echinops cornigerus</i> DC.	HP	LP	LP
6	<i>Ephedra gerardiana</i> L.	LP	MP	HP
7	<i>Juniperus excelsa</i> M. Bieb.	NP	LP	LP
8	<i>Marrubium vulgare</i> L.	RP	LP	MP
9	<i>Peganum harmala</i> L.	LP	MP	HP
10	<i>Rosa webbiana</i> Wall. ex Royle.	LP	HP	MP
11	<i>Salvia nubicola</i> Wall ex Sweet.	NP	LP	MP
12	<i>Sophora mollis</i> (Royle) Baker.	NP	MP	HP
13	<i>Thymus serpyllum</i> L.	LP	HP	MP

Table 19. Ca (ppm) contents of different plant species at three phenological stages in Kalash valley, District Chitral, Hindukush range, Pakistan

S #	Plant species	Habit	Phenological stages			Average
			Pre-Reproductive stage	Reproductive stage	Post reproductive stage	
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Shrub	0.82	1.04	1.09	0.98
2	<i>Artemisia parviflora</i> Roxb.	Herb	0.94	0.89	0.91	0.91
3	<i>Astragalus grahammianus</i> Royle	Shrub	0.32	0.68	0.87	0.62
4	<i>Daphne oleoides</i> Schreb.	Shrub	1.95	1.04	1.23	1.41
5	<i>Echinops cornigerus</i> DC.	Herb	0.89	1.02	0.72	0.87
6	<i>Ephedra gerardiana</i> L.	Shrub	0.72	0.92	1.33	0.99
7	<i>Juniperus excelsa</i> M. Bieb.	Tree	0.86	1.43	0.79	1.02
8	<i>Marrubium vulgare</i> L.	Herb	0.37	0.45	1.10	0.64
9	<i>Peganum harmala</i> L.	Herb	2.00	1.24	0.88	1.36
10	<i>Rosa webbiana</i> Wall. ex Royle.	Shrub	1.79	1.12	0.98	1.29
11	<i>Salvia nubicola</i> Wall ex Sweet.	Herb	1.33	1.42	0.94	1.23
12	<i>Sophora mollis</i> (Royle) Baker.	Shrub	1.10	1.73	1.91	1.58
13	<i>Thymus serpyllum</i> L.	Herb	0.78	1.02	0.92	0.91

Table 20. K (ppm) contents of different plant species at three phenological stages in Kalash valley, District Chitral, Hindukush range, Pakistan

S #	Plant species	Habit	Phenological stages			Average
			Pre-Reproductive stage	Reproductive stage	Post reproductive stage	
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Shrub	0.40	0.41	0.32	0.37
2	<i>Artemisia parviflora</i> Roxb.	Herb	0.49	0.56	0.53	0.52
3	<i>Astragalus grahammianus</i> Royle	Shrub	0.98	0.91	0.82	0.90
4	<i>Daphne oleoides</i> Schreb.	Shrub	0.32	0.26	0.29	0.29
5	<i>Echinops cornigerus</i> DC.	Herb	0.95	1.11	0.82	0.96
6	<i>Ephedra gerardiana</i> L.	Shrub	0.61	0.59	0.63	0.61
7	<i>Juniperus excelsa</i> M. Bieb.	Tree	0.20	0.22	0.25	0.22
8	<i>Marrubium vulgare</i> L.	Herb	1.02	1.54	0.94	1.16
9	<i>Peganum harmala</i> L.	Herb	0.73	0.81	0.78	0.77
10	<i>Rosa webbiana</i> Wall. ex Royle.	Shrub	0.44	0.39	0.43	0.42
11	<i>Salvia nubicola</i> Wall ex Sweet.	Herb	1.18	1.15	1.21	1.18
12	<i>Sophora mollis</i> (Royle) Baker.	Shrub	0.67	0.71	0.81	0.73
13	<i>Thymus serpyllum</i> L.	Herb	1.11	1.21	1.34	1.22

3. Sodium (Na)

Sodium help in the regulation of regulation of blood, heart activity, blood pressure and regulate the acid/base balance in the body. The data regarding Na contents of the plant species at three phenological stages is presented in Table 21. The mean value among herbs varied in between 0.09 ppm (*Marrubium vulgare*) to 0.38 ppm (*Artemisia parviflora*). Among the woody plants, Na contents varied from 0.11 ppm (*Juniperus excelsa*) to 0.33 ppm (*Astragalus grahammianus*). The maximum amount of Na was recorded in herbaceous plant *Artemisia parviflora* (0.72 ppm) at post-redroductive stage followed by *Acantholimon lycopodioides* (0.32 ppm) at pre-reproductive stage and *Artemisia parviflora* (1.91 ppm) at pre-reproductive stage. The average Na contents in herbs were i.e. *Artemisia parviflora* (0.72 ppm), *Echinops cornigerus* (0.14 ppm), *Marrubium vulgare* (0.09 ppm), *Peganum harmala* (0.18 ppm), *Salvia nubicola* (0.17 ppm) and *Thymus serphyllum* (0.15 ppm). In woody plants *Sophora mollis* had (1.58 ppm) of Na contents, *Daphne oleoides* (0.16 ppm), *Rosa webbiana* (0.23 ppm), *Acantholimon lycopodioides* (0.23 ppm) and *Astragalus grahammianus* (0.33 ppm), *Juniperus communis* (0.11 ppm) and *Ephedra gerardiana* (0.15 ppm). The overall trend of Ca concentration was increasing with maturity of plants. Khan *et al.* (2006b, 2007a) and Tiffany *et al.* (2000) reported low concentration of sodium in different forage plants from different regions. They support our findings as this study also reports low Na contents in most of the cases.

4. Magnesium (Mg)

Magnesium is one of the important components of cell and it catalyses different enzyme reaction as enzyme activator. About 0.05 % of the body mass consists of magnesium. The data presented in Table 22 shows Mg contents of plant species at three phenological stages. The mean values for herbs varied in between 0.11 ppm (*Echinops cornigerus*) to 0.42 ppm (*Artemisia parviflora*). The woody plants showed high concentration of Mg as compare to herbs and the contents in woody plants varied from 0.09 ppm (*Astragalus grahammianus*) to 0.46 ppm (*Ephedra gerardiana*). The concentratation of Mg was higher in woody plants then herbs and was recorded maximun (0.61 ppm) in *Rosa webbiana* at pre-reproductive stage followed by *Artemisia parviflora* (0.52 ppm) also at pre-reproductive stage and *Sophora mollis* (0.47 ppm) at redroductive stage. The average Mg contents in herbs were i.e. *Artemisia parviflora* (0.42 ppm), *Echinops cornigerus* (0.11 ppm), *Marrubium vulgare* (0.27 ppm), *Peganum harmala* (0.27 ppm),

Salvia nubicola (0.35 ppm) and *Thymus serpyllum* (0.40 ppm). In woody plants *Sophora mollis* showed 0.37 ppm of Mg contents, *Daphne oleoides* (0.24 ppm), *Rosa webbiana* (0.40 ppm), *Acantholimon lycopodioides* (0.33 ppm) and *Astragalus grahammianus* (0.09 ppm), *Juniperus communis* (0.17 ppm) and *Ephedra gerardiana* had 0.46 ppm contents of Mg. In overall the concentration of Mg was decreasing with maturity of plants but the ratio of Mg remained above the minimum range in all plants at all phenological stages.

Table 21. Na (ppm) contents of different plant species at three phenological stages in Kalash valley, District Chitral, Hindukush range, Pakistan

S #	Plant species	Habit	Phenological stages			Average
			Pre-Reproductive stage	Reproductive stage	Post reproductive stage	
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Shrub	0.32	0.17	0.21	0.23
2	<i>Artemisia parviflora</i> Roxb.	Herb	0.26	0.17	0.72	0.38
3	<i>Astragalus grahammianus</i> Royle	Shrub	0.08	0.12	0.13	0.33
4	<i>Daphne oleoides</i> Schreb.	Shrub	0.18	0.15	0.16	0.16
5	<i>Echinops cornigerus</i> DC.	Herb	0.11	0.14	0.17	0.14
6	<i>Ephedra gerardiana</i> L.	Shrub	0.13	0.17	0.15	0.15
7	<i>Juniperus excelsa</i> M. Bieb.	Tree	0.11	0.12	0.09	0.11
8	<i>Marrubium vulgare</i> L.	Herb	0.06	0.09	0.12	0.09
9	<i>Peganum harmala</i> L.	Herb	0.18	0.20	0.17	0.18
10	<i>Rosa webbiana</i> Wall. ex Royle.	Shrub	0.23	0.27	0.19	0.23
11	<i>Salvia nubicola</i> Wall ex Sweet.	Herb	0.15	0.22	0.14	0.17
12	<i>Sophora mollis</i> (Royle) Baker.	Shrub	0.21	0.13	0.16	0.16
13	<i>Thymus serpyllum</i> L.	Herb	0.15	0.19	0.13	0.15

Table 22. Mg (ppm) contents of different plant species at three phenological stages in Kalash valley, District Chitral, Hindukush range, Pakistan

S #	Plant species	Habit	Phenological stages			Average
			Pre-Reproductive stage	Reproductive stage	Post reproductive stage	
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Shrub	0.32	0.35	0.34	0.33
2	<i>Artemisia parviflora</i> Roxb.	Herb	0.52	0.44	0.31	0.42
3	<i>Astragalus grahammianus</i> Royle	Shrub	0.09	0.07	0.11	0.09
4	<i>Daphne oleoides</i> Schreb.	Shrub	0.24	0.27	0.21	0.24
5	<i>Echinops cornigerus</i> DC.	Herb	0.13	0.08	0.14	0.11
6	<i>Ephedra gerardiana</i> L.	Shrub	0.46	0.42	0.51	0.46
7	<i>Juniperus excelsa</i> M. Bieb.	Tree	0.17	0.14	0.21	0.17
8	<i>Marrubium vulgare</i> L.	Herb	0.26	0.21	0.36	0.27
9	<i>Peganum harmala</i> L.	Herb	0.30	0.24	0.27	0.27
10	<i>Rosa webbiana</i> Wall. ex Royle.	Shrub	0.61	0.32	0.29	0.40
11	<i>Salvia nubicola</i> Wall ex Sweet.	Herb	0.36	0.32	0.38	0.35
12	<i>Sophora mollis</i> (Royle) Baker.	Shrub	0.25	0.47	0.39	0.37
13	<i>Thymus serpyllum</i> L.	Herb	0.33	0.46	0.41	0.40

5. Phosphorus (P)

Phosphorous is an essential component of cell as a part of DNA and RNA. It strengthens the skeleton and teeth of animals and is also helpful in assimilation of carbohydrates and fats and protein synthesis and necessary for enzyme activation. Phosphorous usually present in low concentration in range plants as it loss by soil erosion (Hussain & Durrani, 2008).

Table 23 shows that the mean values for herbs varied between 0.16 ppm (*Echinops cornigerus*) to 0.52 ppm (*Artemisia parviflora*). Among the woody plants P contents are between 0.09 ppm (*Astragalus grahammianus*) to 0.39 ppm (*Ephedra gerardiana*). The maximum concentration of P was recorded in *Artemisia parviflora* (0.55 ppm) at pre-reproductive and followed by *Ephedra gerardiana* (0.54 ppm) at post-reproductive stage and *Artemisia parviflora* (0.53 ppm) at reproductive stages. The percentage of P contents in herbaceous plants was recorded as *Artemisia parviflora* (0.52 ppm), *Echinops cornigerus* (0.16 ppm), *Marrubium vulgare* (0.25 ppm), *Peganum harmala* (0.38 ppm), *Salvia nubicola* (0.35 ppm) and *Thymus serpyllum* (0.36 ppm). The woody plants showed the P contents as *Sophora mollis* (0.30 ppm), *Daphne oleoides* (0.27 ppm), *Rosa webbiana* (0.34 ppm), *Acantholimon lycopodioides* (0.35 ppm) and *Astragalus grahammianus* (0.09 ppm), *Juniperus communis* (0.13 ppm) and *Ephedra gerardiana* (0.50 ppm). It is noted that the P contents of the plant species were declined as with the maturity of plants and in herbaceous species it was observed more than in woody plants. Our findings are similar to those of Akhtar *et al.* (2007), Hussain & Durrani (2008), Badshah (2011) and Shah (2014), who also reported decrease in P contents with the maturity of woody plants particularly.

6. Carbon (C)

Carbon contents of the species at three phenological stages are presented in Table 24. The mean value among herbs varied in between 73.82 ppm (*Sophora mollis*) to 41.64 ppm (*Rosa webbiana*). The maximum C content was found in woody plants i.e. *Sophora mollis* (89.87 ppm) at post-reproductive stage followed by *Ephedra gerardiana* (76.43 ppm) at post-reproductive stage and (76.40 ppm) in *Peganum harmala* at post reproductive stage. The average C contents in herbs like *Artemisia parviflora* (55.23 ppm), *Echinops cornigerus* (52.75 ppm), *Marrubium vulgare* (51.75 ppm), *Peganum harmala* (63.05 ppm), *Salvia nubicola* (59.55 ppm) and *Thymus serpyllum* (58.55 ppm). The woody species i.e. *Sophora mollis* showed maximum (73.82 ppm) C content, *Daphne oleoides* (47.37 ppm), *Rosa webbiana* (41.64 ppm), *Acantholimon*

lycopodioides (49.05 ppm), *Astragalus grahammianus* (52.28 ppm), *Joniperus communis* (68.44 ppm) and *Ephedra gerardiana* (66.07 ppm). The overall trend of C contents were increasing with maturity of plants.

Table 23. P (mg/L) contents of different plant species at three phenological stages in Kalash valley, District Chitral, Hindukush range, Pakistan

S #	Plant species	Habit	Phenological stages			Average
			Pre-Reproductive stage	Reproductive stage	Post reproductive stage	
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Shrub	0.29	0.35	0.33	0.32
2	<i>Artemisia parviflora</i> Roxb.	Herb	0.55	0.52	0.49	0.52
3	<i>Astragalus grahammianus</i> Royle	Shrub	0.09	0.07	0.11	0.09
4	<i>Daphne oleoides</i> Schreb.	Shrub	0.24	0.31	0.28	0.27
5	<i>Echinops cornigerus</i> DC.	Herb	0.13	0.15	0.20	0.16
6	<i>Ephedra gerardiana</i> L.	Shrub	0.46	0.51	0.54	0.39
7	<i>Juniperus excelsa</i> M. Bieb.	Tree	0.17	0.11	0.13	0.13
8	<i>Marrubium vulgare</i> L.	Herb	0.26	0.28	0.23	0.25
9	<i>Peganum harmala</i> L.	Herb	0.30	0.41	0.44	0.38
10	<i>Rosa webbiana</i> Wall. ex Royle.	Shrub	0.41	0.34	0.29	0.34
11	<i>Salvia nubicola</i> Wall ex Sweet.	Herb	0.36	0.41	0.29	0.35
12	<i>Sophora mollis</i> (Royle) Baker.	Shrub	0.25	0.36	0.30	0.30
13	<i>Thymus serpyllum</i> L.	Herb	0.29	0.46	0.34	0.36

Table 24. C (mg/L) contents of different plant species at three phenological stages in Kalash valley, District Chitral, Hindukush range, Pakistan

S #	Plant species	Habit	Phenological stages			Average
			Pre-Reproductive stage	Reproductive stage	Post reproductive stage	
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Shrub	45.44	50.69	51.04	49.05
2	<i>Artemisia parviflora</i> Roxb.	Herb	58.43	49.62	57.65	55.23
3	<i>Astragalus grahammianus</i> Royle	Shrub	51.99	48.84	56.03	52.28
4	<i>Daphne oleoides</i> Schreb.	Shrub	44.51	47.09	50.52	47.37
5	<i>Echinops cornigerus</i> DC.	Herb	51.43	56.93	49.91	52.75
6	<i>Ephedra gerardiana</i> L.	Shrub	53.11	68.67	76.40	66.07
7	<i>Juniperus excelsa</i> M. Bieb.	Tree	63.58	69.54	72.21	68.44
8	<i>Marrubium vulgare</i> L.	Herb	53.62	49.42	52.22	51.75
9	<i>Peganum harmala</i> L.	Herb	52.27	60.54	76.43	63.08
10	<i>Rosa webbiana</i> Wall. ex Royle.	Shrub	36.45	38.87	49.61	41.64
11	<i>Salvia nubicola</i> Wall ex Sweet.	Herb	51.59	56.43	70.65	59.55
12	<i>Sophora mollis</i> (Royle) Baker.	Shrub	55.28	76.32	89.87	73.82
13	<i>Thymus serpyllum</i> L.	Herb	53.23	52.41	70.4	58.68

7. Oxygen (O)

The Oxygen contents presented in Table 25 shows that the mean value among herbs varied in between 43.42 ppm (*Salvia nubicola*) to 49.41 ppm (*Echinops cornigerus*). Woody plants showed that O contents varied from 38.46 ppm (*Rosa webbiana*) to 51.84 ppm (*Astragalus grahammianus*). The maximum contents of O was found in woody plants i.e (58.98 ppm) at post-reproductive stage in *Ephedra gerardiana* followed by *Astragalus grahammianus* (58.54 ppm) at post-reproductive stage and (53.75 ppm) in *Artemisia parviflora* at post reproductive stage. The average O contents in herbs were i.e. *Artemisia parviflora* (44.99 ppm), *Echinops cornigerus* (49.40 ppm), *Marrubium vulgare* (45.83 ppm), *Peganum harmala* (48.48 ppm), *Salvia nubicola* (43.42 ppm) and *Thymus serpyllum* (42.15 ppm). The woody plants like *Sophora mollis* showed (41.23 ppm) O contents, *Daphne oleoides* (44.86 ppm), *Rosa webbiana* (38.46 ppm), *Acantholimon lycopodioides* (42.50 ppm) and *Astragalus grahammianus* (51.84 ppm), *Juniperus communis* (39.45 ppm) and *Ephedra gerardiana* (47.45 ppm). In overall the O contents increased with maturity of plants in the area.

8. Nitrogen (N)

Nitrogen is an important component of the cell and is a part of many amino acids and enzymes. Table 26 shows that mean value among herbs varied in between 0.99 ppm (*Salvia nubicola*) to 3.63 ppm in *Marrubium vulgare*. The woody plants showed the variation of N contents from 0.71 ppm in *Sophora mollis* to 2.08 in *Ephedra gerardiana*. The maximum N contents were found in herbs i.e *Marrubium vulgare* (3.63 ppm) followed by *Echinops cornigerus* (3.21 ppm) and *Peganum harmala* (2.29 ppm). The average N contents in herbs were *Artemisia parviflora* (1.15 ppm), *Echinops cornigerus* (3.21 ppm), *Marrubium vulgare* (3.63 ppm), *Peganum harmala* (2.29 ppm), *Salvia nubicola* (0.99 ppm) and *Thymus serpyllum* (3.07 ppm). The woody plants like *Daphne oleoides* had (1.72 ppm), *Rosa webbiana* (1.33 ppm), *Acantholimon lycopodioides* (1.39 ppm), *Astragalus grahammianus* (1.01 ppm), *Juniperus communis* (1.73 ppm) and *Ephedra gerardiana* (2.08 ppm). Overall N content was Maximum in herbs than woody plants and decreased with maturity in both. Our findings are similar to those of Bignami *et al.* (2005) and Coskun *et al.* (2004), which reported the presence of N in all stages and reduction in its contents with maturity of plants.

Table 25. O (mg/L) contents of different plant species at three phenological stages in Kalash valley, District Chitral, Hindukush range, Pakistan

S #	Plant species	Habit	Phenological stages			Average
			Pre-Reproductive stage	Reproductive stage	Post reproductive stage	
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Shrub	39.33	42.87	45.32	42.50
2	<i>Artemisia parviflora</i> Roxb.	Herb	41.29	48.55	53.55	47.79
3	<i>Astragalus grahammianus</i> Royle	Shrub	45.12	51.87	58.54	51.84
4	<i>Daphne oleoides</i> Schreb.	Shrub	39.82	45.32	49.44	44.86
5	<i>Echinops cornigerus</i> DC.	Herb	43.86	50.62	53.75	49.41
6	<i>Ephedra gerardiana</i> L.	Shrub	37.60	45.77	58.98	47.45
7	<i>Juniperus excelsa</i> M. Bieb.	Tree	33.40	40.09	44.86	39.45
8	<i>Marrubium vulgare</i> L.	Herb	41.85	46.11	49.55	45.83
9	<i>Peganum harmala</i> L.	Herb	43.91	50.21	51.33	48.48
10	<i>Rosa webbiana</i> Wall. ex Royle.	Shrub	35.06	38.77	41.57	38.46
11	<i>Salvia nubicola</i> Wall ex Sweet.	Herb	40.64	44.64	44.98	43.42
12	<i>Sophora mollis</i> (Royle) Baker.	Shrub	36.72	39.08	47.91	41.23
13	<i>Thymus serpyllum</i> L.	Herb	38.98	41.26	46.22	42.15

Table 26. N (mg/L) contents of different plant species at three phenological stages in Kalash valley, District Chitral, Hindukush range, Pakistan

S #	Plant species	Habit	Phenological stages			Average
			Pre-Reproductive stage	Reproductive stage	Post reproductive stage	
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Shrub	0.88	1.87	1.42	1.39
2	<i>Artemisia parviflora</i> Roxb.	Herb	0.94	1.21	1.30	1.15
3	<i>Astragalus grahammianus</i> Royle	Shrub	1.22	0.78	1.04	1.01
4	<i>Daphne oleoides</i> Schreb.	Shrub	1.32	1.77	2.07	1.72
5	<i>Echinops cornigerus</i> DC.	Herb	0.94	1.23	1.04	1.07
6	<i>Ephedra gerardiana</i> L.	Shrub	2.05	1.78	2.41	2.08
7	<i>Juniperus excelsa</i> M. Bieb.	Tree	1.39	1.87	1.93	1.73
8	<i>Marrubium vulgare</i> L.	Herb	3.24	4.02	3.65	3.63
9	<i>Peganum harmala</i> L.	Herb	2.33	2.13	2.43	2.29
10	<i>Rosa webbiana</i> Wall. ex Royle.	Shrub	1.11	1.32	0.97	1.13
11	<i>Salvia nubicola</i> Wall ex Sweet.	Herb	0.83	0.93	1.21	0.99
12	<i>Sophora mollis</i> (Royle) Baker.	Shrub	0.74	0.52	0.89	0.71
13	<i>Thymus serpyllum</i> L.	Herb	2.89	3.21	3.12	3.07

b. Micronutrients

Micronutrients are usually required in very small quantity, but yet their presence is necessary for proper growth and development of plants and animals. The main source is soil and water which provide these nutrients to forage plants and the deficiency of these minerals ultimately decrease the livestock production (Provenza, 1996; McDowell, 2003). However, the excess of these minerals has toxic effects for the plants. The following micronutrients were analysed in the selected plant species.

1. Aluminum (Al)

The Al contents of the selected plants have been mentioned in Table 27. The results revealed that the mean values among the herbs varied in between 0.23 ppm (*Peganum harmala*) to 1.31 ppm (*Salvia nubicola*). While the woody plants showed Al contents between 0.53 ppm (*Daphne oleoides*) to 1.24 ppm (*Ephedra gerardiana*). The maximum contents of Al were found in woody plants i.e (1.91 ppm) at post-reproductive stage in *Acantholimon lycopodioides* followed by *Ephedra gerardiana* (1.89 ppm) at post-reproductive stage each and (1.78 ppm) in *Astragalus grahammianus* at post reproductive stage. The average Al contents in herbs were i.e. *Artemisia parviflora* (0.45 ppm), *Echinops cornigerus* (0.54 ppm), *Marrubium vulgare* (0.59 ppm), *Peganum harmala* (0.23 ppm), *Salvia nubicola* (1.31 ppm) and *Thymus serpyllum* (0.76 ppm). The woody plants like *Sophora mollis* showed (0.87 ppm) of Al contents, *Daphne oleoides* (0.53 ppm), *Rosa webbiana* (0.58 ppm), *Acantholimon lycopodioides* (1.04 ppm), *Astragalus grahammianus* (0.87 ppm), *Juniperus communis* (0.80 ppm) and *Ephedra gerardiana* (1.24 ppm). The Al contents in general increased with maturity of the plants of the area.

2. Iron (Fe)

The results in Table 28 indicate the Iron contents of the selected plant species that shows mean values among the herbs varied in between 0.22 ppm (*Artemisia parviflora*) to 0.76 ppm (*Salvia nubicola*). Woody plants showed Fe contents between 0.47 ppm (*Sophora mollis*) to 1.04 ppm (*Astragalus grahammianus*). The woody plants showed maximum Fe contents i.e (0.97 ppm) at post-reproductive stage in *Astragalus grahammianus* followed by *Ephedra gerardiana* (0.94 ppm) at post-reproductive stage. The average Fe contents in herbs were i.e. *Artemisia parviflora* (0.22 ppm), *Echinops cornigerus* (0.55 ppm), *Marrubium vulgare* (0.33 ppm),

Peganum harmala (0.28 ppm), *Salvia nubicola* (0.76 ppm) and *Thymus serpyllum* (0.68 ppm). The woody plants *Sophora mollis* showed (0.47 ppm), *Daphne oleoides* (0.62 ppm), *Rosa webbiana* (0.52 ppm), *Acantholimon lycopodioides* (1.01 ppm), *Astragalus grahammianus* (1.04 ppm), *Juniperus excelsa* (0.31 ppm) and *Ephedra gerardiana* (0.57 ppm). The Fe contents in general increased with maturity of the plants from vegetative to reproductive stages.

3. Silicon (Si)

The Si contents of the selected plants have been mentioned in Table 29 that indicates the mean values of herbs between 0.51 ppm (*Artemisia parviflora*) to 2.56 ppm in *Salvia nubicola*. The woody plants showed Si contents between 0.77 ppm (*Rosa webbiana*) to 4.15 ppm in *Astragalus grahammianus*. The maximum contents of Si were found in woody plants i.e (4.91 ppm) at post-reproductive stage in *Astragalus grahammianus*. The average Si contents in herbeaceous plants showed that *Artemisia parviflora* had 0.51 ppm, *Echinops cornigerus* (1.67 ppm), *Marrubium vulgare* (1.44 ppm), *Peganum harmala* (0.55 ppm), *Salvia nubicola* (2.56 ppm) and *Thymus serpyllum* (1.46 ppm). The woody plants *Sophora mollis* had 0.93 ppm of Si contents, *Daphne oleoides* (0.82 ppm), *Rosa webbiana* (0.77 ppm), *Acantholimon lycopodioides* (1.85 ppm), *Astragalus grahammianus* (4.15 ppm), *Juniperus excelsa* (1.58 ppm) and *Ephedra gerardiana* (1.20 ppm). The results indicate that the Si contents are gradually increasing with maturity of the plants species.

4. Sulphur (S)

The S contents of the selected plant species have been mentioned in Table 30. The results revealed that the mean values among the herbs varied in between 0.10 ppm (*Artemisia parviflora*) to 0.23 ppm (*Peganum harmala*). The woody plants showed S contents between 0.06 ppm (*Sophora mollis*) to 0.19 ppm (*Astragalus grahammianus*). The maximum contents of S were found in herbaceous plants i.e (0.32 ppm) at reproductive stage in *Peganum harmala* followed by *Astragalus grahammianus* (0.24 ppm) at post-reproductive stage. The average S contents in herbs were i.e. *Artemisia parviflora* (0.10 ppm), *Echinops cornigerus* (0.19 ppm), *Marrubium vulgare* (0.12 ppm), *Peganum harmala* (0.23 ppm), *Salvia nubicola* (0.13 ppm) and *Thymus serpyllum* (0.20 ppm). The woody plants *Sophora mollis* showed 0.87 ppm of S contents, *Daphne oleoides* (0.10 ppm), *Rosa webbiana* (0.14 ppm), *Acantholimon lycopodioides*

(0.11 ppm), *Astragalus grahammianus* (0.19 ppm), *Juniperus exelsa* (0.13 ppm) and *Ephedra gerardiana* (0.08 ppm). The S content was maximum in herbs and the contents general increased with maturity of the plants.

Table 27. Al (ppm) contents of different plant species at three phenological stages in Kalash valley, District Chitral, Hindukush range, Pakistan

S #	Plant species	Habit	Phenological stages			Average
			Pre-Reproductive stage	Reproductive stage	Post reproductive stage	
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Shrub	0.43	0.77	1.92	1.04
2	<i>Artemisia parviflora</i> Roxb.	Herb	0.29	0.32	0.76	0.45
3	<i>Astragalus grahammianus</i> Royle	Shrub	1.46	1.23	1.78	0.87
4	<i>Daphne oleoides</i> Schreb.	Shrub	0.46	0.54	0.61	0.53
5	<i>Echinops cornigerus</i> DC.	Herb	0.48	0.52	0.64	0.54
6	<i>Ephedra gerardiana</i> L.	Shrub	1.02	0.82	1.89	1.24
7	<i>Juniperus excelsa</i> M. Bieb.	Tree	0.49	0.91	1.02	0.80
8	<i>Marrubium vulgare</i> L.	Herb	0.47	0.34	0.97	0.59
9	<i>Peganum harmala</i> L.	Herb	0.16	0.23	0.31	0.23
10	<i>Rosa webbiana</i> Wall. ex Royle.	Shrub	0.34	1.21	0.21	0.58
11	<i>Salvia nubicola</i> Wall ex Sweet.	Herb	0.85	1.23	1.86	1.31
12	<i>Sophora mollis</i> (Royle) Baker.	Shrub	0.71	0.91	1.01	0.87
13	<i>Thymus serpyllum</i> L.	Herb	0.69	0.73	0.86	0.76

Table 28. Fe (ppm) contents of different plant species at three phenological stages in Kalash valley, District Chitral, Hindukush range, Pakistan

S #	Plant species	Habit	Phenological stages			Average
			Pre-Reproductive stage	Reproductive stage	Post reproductive stage	
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Shrub	0.91	1.22	0.92	1.01
2	<i>Artemisia parviflora</i> Roxb.	Herb	0.25	0.24	0.19	0.22
3	<i>Astragalus grahammianus</i> Royle	Shrub	1.05	1.10	0.97	1.04
4	<i>Daphne oleoides</i> Schreb.	Shrub	0.51	0.62	0.73	0.62
5	<i>Echinops cornigerus</i> DC.	Herb	0.48	0.53	0.65	0.55
6	<i>Ephedra gerardiana</i> L.	Shrub	0.32	0.45	0.94	0.57
7	<i>Juniperus excelsa</i> M. Bieb.	Tree	0.21	0.42	0.32	0.31
8	<i>Marrubium vulgare</i> L.	Herb	0.30	0.42	0.28	0.33
9	<i>Peganum harmala</i> L.	Herb	0.23	0.35	0.27	0.28
10	<i>Rosa webbiana</i> Wall. ex Royle.	Shrub	0.41	0.82	0.34	0.52
11	<i>Salvia nubicola</i> Wall ex Sweet.	Herb	0.55	0.81	0.92	0.76
12	<i>Sophora mollis</i> (Royle) Baker.	Shrub	0.23	0.44	0.75	0.47
13	<i>Thymus serpyllum</i> L.	Herb	0.58	0.67	0.81	0.68

Table 29. Si (ppm) contents of different plant species at three phenological stages in Kalash valley, District Chitral, Hindukush range, Pakistan

S #	Plant species	Habit	Phenological stages			Average
			Pre-Reproductive stage	Reproductive stage	Post reproductive stage	
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Shrub	1.34	2.25	1.98	1.85
2	<i>Artemisia parviflora</i> Roxb.	Herb	0.62	0.52	0.41	0.51
3	<i>Astragalus grahammianus</i> Royle	Shrub	4.31	4.91	3.23	4.15
4	<i>Daphne oleoides</i> Schreb.	Shrub	0.83	0.92	0.73	0.82
5	<i>Echinops cornigerus</i> DC.	Herb	1.50	1.72	1.81	1.67
6	<i>Ephedra gerardiana</i> L.	Shrub	1.07	1.12	1.43	1.20
7	<i>Juniperus excelsa</i> M. Bieb.	Tree	1.08	1.63	2.03	1.58
8	<i>Marrubium vulgare</i> L.	Herb	1.17	1.54	1.62	1.44
9	<i>Peganum harmala</i> L.	Herb	0.43	0.53	0.71	0.55
10	<i>Rosa webbiana</i> Wall. ex Royle.	Shrub	0.57	0.71	1.03	0.77
11	<i>Salvia nubicola</i> Wall ex Sweet.	Herb	2.37	2.41	2.92	2.56
12	<i>Sophora mollis</i> (Royle) Baker.	Shrub	0.78	0.91	1.11	0.93
13	<i>Thymus serpyllum</i> L.	Herb	1.63	1.93	0.82	1.46

5. Cadmium (Cd)

Table 31 shows the mean values of Cd contents among the herbs which varied between 0.011 ppm (*Peganum harmala*) to 0.075 ppm (*Marrubium vulgare*). The woody plants showed Cd contents between 0.014 ppm (*Daphne oleoides*) to 0.057 ppm (*Rosa webbiana*). The maximum contents of Cd were found in herbaceous plants i.e (0.075 ppm) at post-reproductive stage in *Marrubium vulgare* followed by *Salvia nubicola* (0.074 ppm) at post-reproductive stage. The average Cd contents in herbs were i.e. *Artemisia parviflora* (0.030 ppm), *Echinops cornigerus* (0.012 ppm), *Marrubium vulgare* (0.075 ppm), *Peganum harmala* (0.011 ppm), *Salvia nubicola* (0.072 ppm) and *Thymus serpyllum* (0.044 ppm). The woody plants like *Sophora mollis* showed 0.87 ppm of Cd contents, *Daphne oleoides* (0.014 ppm), *Rosa webbiana* (0.057 ppm) and *Acantholimon lycopodioides* (0.026 ppm). The Cd contents in most of the species general increased with maturity.

6. Zinc (Zn)

The Zn contents of the selected plants have been mentioned in Table 32. The results revealed that the mean values among the herbs varied in between 0.016 ppm (*Peganum harmala*) to 0.115 ppm (*Marrubium vulgare*). The woody plants showed Zn contents between 0.017 ppm (*Acantholimon lycopodioides*) to 0.079 ppm (*Sophora mollis*). The maximum contents of Zn were found in herbaceous plants i.e (0.153 ppm) at post-reproductive stage in *Salvia nubicola*. The average Zn contents in herbs were i.e. *Artemisia parviflora* (0.067 ppm), *Echinops cornigerus* (0.063 ppm), *Marrubium vulgare* (0.115 ppm), *Peganum harmala* (0.016 ppm), *Salvia nubicola* (0.139 ppm) and *Thymus serpyllum* (0.027 ppm). The woody plants *Sophora mollis* had 079 ppm of Zn contents, *Daphne oleoides* (0.041 ppm), *Rosa webbiana* (0.056 ppm), *Acantholimon lycopodioides* (0.017 ppm), *Astragalus grahamianus* (0.031 ppm), *Juniperus exelsa* (0.073 ppm) and *Ephedra gerardiana* (0.078 ppm). The Zn contents generally increased with maturity of the plants of the area.

Table 30. S (ppm) contents of different plant species at three phenological stages in Kalash valley, District Chitral, Hindukush range, Pakistan

S #	Plant species	Habit	Phenological stages			Average
			Pre-Reproductive stage	Reproductive stage	Post reproductive stage	
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Shrub	0.04	0.12	0.19	0.11
2	<i>Artemisia parviflora</i> Roxb.	Herb	0.10	0.12	0.08	0.10
3	<i>Astragalus grahammianus</i> Royle	Shrub	0.14	0.19	0.23	0.18
4	<i>Daphne oleoides</i> Schreb.	Shrub	0.06	0.10	0.14	0.10
5	<i>Echinops cornigerus</i> DC.	Herb	0.15	0.19	0.23	0.19
6	<i>Ephedra gerardiana</i> L.	Shrub	0.05	0.13	0.06	0.08
7	<i>Juniperus excelsa</i> M. Bieb.	Tree	0.09	0.12	0.19	0.13
8	<i>Marrubium vulgare</i> L.	Herb	0.08	0.12	0.17	0.12
9	<i>Peganum harmala</i> L.	Herb	0.21	0.32	0.18	0.23
10	<i>Rosa webbiana</i> Wall. ex Royle.	Shrub	0.05	0.08	0.13	0.14
11	<i>Salvia nubicola</i> Wall ex Sweet.	Herb	0.06	0.13	0.21	0.13
12	<i>Sophora mollis</i> (Royle) Baker.	Shrub	0.02	0.06	0.11	0.06
13	<i>Thymus serpyllum</i> L.	Herb	0.20	0.31	0.11	0.20

Table 31. Cd (ppm) contents of different plant species at three phenological stages in Kalash valley, District Chitral, Hindukush range, Pakistan

S #	Plant species	Habit	Phenological stages			Average
			Pre-Reproductive stage	Reproductive stage	Post reproductive stage	
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Shrub	0.023	0.024	0.031	0.026
2	<i>Artemisia parviflora</i> Roxb.	Herb	0.033	0.028	0.031	0.030
3	<i>Astragalus grahammianus</i> Royle	Shrub	-	-	-	-
4	<i>Daphne oleoides</i> Schreb.	Shrub	0.012	0.013	0.018	0.014
5	<i>Echinops cornigerus</i> DC.	Herb	0.011	0.012	0.014	0.012
6	<i>Ephedra gerardiana</i> L.	Shrub	-	-	-	-
7	<i>Juniperus excelsa</i> M. Bieb.	Tree	-	-	-	-
8	<i>Marrubium vulgare</i> L.	Herb	0.072	0.073	0.075	0.075
9	<i>Peganum harmala</i> L.	Herb	0.015	0.010	0.009	0.011
10	<i>Rosa webbiana</i> Wall. ex Royle.	Shrub	0.052	0.060	0.061	0.057
11	<i>Salvia nubicola</i> Wall ex Sweet.	Herb	0.072	0.071	0.074	0.072
12	<i>Sophora mollis</i> (Royle) Baker.	Shrub	0.025	0.029	0.028	0.027
13	<i>Thymus serpyllum</i> L.	Herb	0.042	0.047	0.045	0.044

Table 32. Zn (ppm) contents of different plant species at three phenological stages in Kalash valley, District Chitral, Hindukush range, Pakistan

S #	Plant species	Habit	Phenological stages			Average
			Pre-Reproductive stage	Reproductive stage	Post reproductive stage	
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Shrub	0.012	0.024	0.015	0.017
2	<i>Artemisia parviflora</i> Roxb.	Herb	0.089	0.054	0.060	0.067
3	<i>Astragalus grahammianus</i> Royle	Shrub	0.041	0.032	0.022	0.031
4	<i>Daphne oleoides</i> Schreb.	Shrub	0.037	0.048	0.040	0.041
5	<i>Echinops cornigerus</i> DC.	Herb	0.076	0.052	0.061	0.063
6	<i>Ephedra gerardiana</i> L.	Shrub	0.112	0.064	0.062	0.079
7	<i>Juniperus excelsa</i> M. Bieb.	Tree	0.063	0.080	0.077	0.073
8	<i>Marrubium vulgare</i> L.	Herb	0.132	0.102	0.112	0.115
9	<i>Peganum harmala</i> L.	Herb	0.012	0.023	0.014	0.016
10	<i>Rosa webbiana</i> Wall. ex Royle.	Shrub	0.071	0.054	0.045	0.056
11	<i>Salvia nubicola</i> Wall ex Sweet.	Herb	0.153	0.129	0.137	0.139
12	<i>Sophora mollis</i> (Royle) Baker.	Shrub	0.077	0.098	0.062	0.079
13	<i>Thymus serpyllum</i> L.	Herb	0.033	0.022	0.027	0.027

7. Copper (Cu)

The Cu contents of the selected plants have been mentioned in Table 33. The results revealed that the mean values among the herbs varied in between 0.020 ppm (*Marrubium vulgare*) to 0.119 ppm (*Salvia nubicola*). The woody plants showed Cu contents between 0.014 ppm (*Astragalus grahammianus*) to 0.116 ppm (*Rosa webbiana*). The maximum contents of Cu were found in herbaceous plants i.e (0.133 ppm) at reproductive stage in *Salvia nubicola* followed by *Rosa webbiana* (0.128 ppm) at reproductive stage. The average Cu contents in herbs were i.e. *Artemisia parviflora* (0.067 ppm), *Echinops cornigerus* (0.042 ppm), *Marrubium vulgare* (0.020 ppm), *Peganum harmala* (0.041 ppm), *Salvia nubicola* (0.119 ppm) and *Thymus serpyllum* (0.091 ppm). The woody plants like *Sophora mollis* showed 0.074 ppm of Cu contents, *Daphne oleoides* (0.033 ppm), *Rosa webbiana* (0.116 ppm), *Acantholimon lycopodioides* (0.049 ppm), *Astragalus grahammianus* (0.014 ppm), *Juniperus excelsa* (0.060 ppm) and *Ephedra gerardiana* (0.041 ppm). The results indicated that the Cu contents in generally increased with maturity of the tested plant species.

Table 33. Cu (ppm) contents of different plant species at three phenological stages in Kalash valley, District Chitral, Hindukush range, Pakistan

S #	Plant species	Habit	Phenological stages			Average
			Pre-Reproductive stage	Reproductive stage	Post reproductive stage	
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Shrub	0.052	0.049	0.048	0.049
2	<i>Artemisia parviflora</i> Roxb.	Herb	0.087	0.065	0.049	0.067
3	<i>Astragalus grahammianus</i> Royle	Shrub	0.023	0.019	-	0.014
4	<i>Daphne oleoides</i> Schreb.	Shrub	0.040	0.032	0.027	0.033
5	<i>Echinops cornigerus</i> DC.	Herb	0.055	0.042	0.029	0.042
6	<i>Ephedra gerardiana</i> L.	Shrub	0.073	0.021	0.031	0.041
7	<i>Juniperus excelsa</i> M. Bieb.	Tree	0.051	0.062	0.068	0.060
8	<i>Marrubium vulgare</i> L.	Herb	0.009	0.023	0.029	0.020
9	<i>Peganum harmala</i> L.	Herb	0.044	0.049	0.031	0.041
10	<i>Rosa webbiana</i> Wall. ex Royle.	Shrub	0.109	0.128	0.113	0.116
11	<i>Salvia nubicola</i> Wall ex Sweet.	Herb	0.121	0.133	0.104	0.119
12	<i>Sophora mollis</i> (Royle) Baker.	Shrub	0.074	0.065	0.083	0.074
13	<i>Thymus serpyllum</i> L.	Herb	0.091	0.102	0.082	0.091

Table 34. Statistical analysis of the elements present in the selected plants of Kalash valley, district Chitral

Pre-Rep		Reproductive		Post-Rep	
Herbs	Woody	Herbs	Woody	Herbs	Woody
Carbon (C)					
Herbs	Woody plants	Herbs	Woody plants	Herbs	Woody plants
58.43	45.44	49.62	50.69	57.65	51.04
51.43	51.99	56.93	48.84	49.91	56.03
53.62	44.51	49.42	47.09	52.22	50.52
52.27	53.11	60.54	68.67	76.43	76.40
51.59	63.58	56.43	69.54	70.65	72.21
53.23	36.45	52.41	38.87	70.40	49.61
	55.28		76.32		89.87
NS=0.374		NS= 0949		NS= 0.349	
Nitrogen (N)					
0.94	0.88	1.21	1.87	1.30	1.42
0.94	1.22	1.23	0.78	1.04	1.04
3.24	1.32	4.02	1.77	3.65	2.07
2.33	2.05	2.13	1.78	2.43	2.41
0.83	1.39	0.93	1.87	1.21	1.93
2.89	1.11	3.21	1.32	3.12	0.97
	0.74		0.52		0.89
NS= 0.273		NS= 0.341		NS= 0.336	
Oxygen (O)					

41.29	39.33	48.55	42.87	53.55	45.32
43.86	45.12	50.62	51.87	53.75	58.54
41.85	39.82	46.11	45.32	49.55	49.44
43.91	37.60	50.21	45.77	51.33	58.98
40.64	33.40	44.64	40.09	44.98	44.86
38.98	35.06	41.26	38.77	46.22	41.57
	36.72		39.08		47.91
NS= 0.047		NS= 0.049		NS= 0.964	
Sodium (Na)					
0.26	0.32	0.17	0.17	0.72	0.21
0.11	0.08	0.14	0.12	0.17	0.13
0.06	0.18	0.09	0.15	0.09	0.16
0.18	0.13	0.20	0.17	0.20	0.15
0.15	0.11	0.22	0.12	0.22	0.09
0.15	0.23	0.19	0.27	0.19	0.19
	0.21		0.13		0.16
NS= 0.465		NS= 0.953		NS= 0.249	
Magnesium (Mg)					
0.52	0.32	0.44	0.35	0.31	0.34
0.13	0.09	0.08	0.07	0.14	0.11
0.26	0.24	0.21	0.27	0.36	0.21
0.30	0.46	0.24	0.42	0.27	0.51
0.36	0.17	0.32	0.14	0.38	0.21
0.33	0.61	0.46	0.32	0.41	0.29

	0.25		0.47		0.39
NS= 0.984		NS=0.609		NS= 0.619	
Silicon (Si)					
0.62	1.34	0.52	2.25	0.41	1.98
1.50	4.31	1.72	4.91	1.81	3.23
1.17	0.83	1.54	0.92	1.62	0.73
0.43	1.07	0.73	1.12	0.71	1.43
2.37	1.08	2.41	1.63	2.92	2.03
1.63	0.57	1.93	0.71	0.82	1.03
	0.78		0.91		1.11
NS= 0.705		NS= 0.549		NS= 0.0.456	
Aluminum (Al)					
0.29	0.43	0.32	0.77	0.76	1.92
0.48	1.46	0.52	1.23	0.64	1.78
0.47	0.46	0.34	0.54	0.97	0.61
0.16	1.02	0.23	0.82	0.31	1.89
0.85	0.49	1.23	0.51	1.86	1.02
0.69	0.34	0.73	1.21	0.86	0.21
	0.71		0.91		1.01
NS= 0.419		NS= 0.238		NS= 0.473	
Phosphorus (P)					
0.55	0.29	0.52	0.35	0.49	0.32
0.13	0.09	0.15	0.07	0.20	0.11
0.26	0.24	0.28	0.31	0.23	0.28

0.30	0.46	0.41	0.51	0.44	0.54
0.36	0.17	0.41	0.11	0.29	0.13
0.29	0.41	0.46	0.34	0.34	0.29
	0.25		0.36		0.30
NS= 0.675		NS=0.183		NS= 0.288	
Sulphur (S)					
0.10	0.04	0.12	0.12	0.08	0.19
0.15	0.14	0.19	0.19	0.23	0.23
0.08	0.06	0.12	0.10	0.17	0.14
0.21	0.05	0.32	0.13	0.18	0.06
0.06	0.09	0.13	0.12	0.21	0.19
0.20	0.05	0.31	0.08	0.11	0.13
	0.02		0.06		0.11
NS= 0.110		NS= 0.142		NS=0.836	
Zinc (Zn)					
0.089	0.012	0.054	0.024	0.060	0.015
0.076	0.041	0.052	0.032	0.061	0.022
0.132	0.037	0.102	0.048	0.112	0.040
0.012	0.112	0.023	0.064	0.014	0.062
0.153	0.063	0.129	0.080	0.137	0.077
0.033	0.071	0.022	0.054	0.027	0.045
	0.077		0.098		0.062
NS=0.451		NS= 0.411		NS= 0.252	

Potassium (K)					
0.49	0.40	0.56	0.41	0.53	0.37
0.95	0.98	1.11	0.91	0.82	0.90
1.02	0.32	1.54	0.26	0.94	0.29
0.73	0.61	0.81	0.59	0.78	0.61
1.18	0.20	1.15	0.22	1.21	0.22
1.11	0.44	1.21	0.39	1.34	0.42
	0.67		0.71		0.73
NS= 0.055		NS= 0.027		NS= 0.050	
Calcium (Ca)					
0.94	0.82	0.89	1.04	0.91	0.98
0.89	0.32	1.02	0.68	0.87	0.62
0.37	1.95	0.45	1.04	0.64	1.41
2.00	0.72	1.24	0.92	1.36	0.99
1.33	0.86	1.42	1.43	1.23	1.02
0.78	1.79	1.02	1.12	0.91	1.29
	1.10		1.73		1.58
NS= 0.957		NS= 0.908		NS= 0.371	
Copper (Cu)					
0.087	0.052	0.065	0.049	0.049	0.048
0.055	0.023	0.042	0.019	0.029	
0.009	0.040	0.023	0.032	0.029	0.027
0.044	0.073	0.049	0.021	0.031	0.031
0.121	0.051	0.133	0.062	0.104	0.068

0.091	0.109	0.102	0.128	0.082	0.113
	0.074		0.065		0.083
NS= 0.589		NS= 0.264		NS= 0.546	
Cadmium (Cd)					
0.033	0.023	0.028	0.024	0.031	0.031
0.011		0.012		0.014	
0.072	0.012	0.073	0.013	0.075	0.018
0.015		0.010		0.009	
0.074		0.071		0.075	
0.042	0.052	0.047	0.060	0.045	0.061
	0.025		0.047		0.028
NS= 0.102		NS= 0,140		NS= 0.168	
Iron (Fe)					
0.25	0.91	0.24	1.22	0.19	0.92
0.48	1.05	0.53	1.10	0.65	0.97
0.30	0.51	0.42	0.62	0.27	0.73
0.23	0.32	0.35	0.45	0.28	0.94
0.55	0.21	0.81	0.42	0.92	0.32
0.58	0.41	0.67	0.82	0.81	0.34
	0.23		0.44		0.75
NS= 0.341		NS= 0.216		NS= 0.471	

b. Proximate composition

The same thirteen species were analysed for proximate composition and the result found are described below (Table 33).

1. Dry matter (DM)

The solid part of the plant or animal obtained after the removal of its entire constituent water is called dry matter. It includes arbohydrates, fats, proteins, vitamins, minerals, and antioxidants (thiocyanate, anthocyanin, and quercetin). Carbohydrates, fats and proteins provide energy in foods and make up to 90% of the dry weight of a diet.

The present study suggests that herbaceous plants usually have more dry matter than woody plants (Table 35). The dry matter of herbs varied from 83.94 % (*Thymus serpyllum*) to 91.26 % (*salvia nubicola*). Among the woody species the average DM varied in between 80.35 % (*Juniperus excelsa*) to 89.48 % (*Astragalus grahammianus*). The dry matter increased with age and was remained maximum during the flowering. However, with further maturity the DM decreased. The maximum DM was observed in *Marrubium vulgare* (95.87%) and *Salvia nubicola* (95.32 %) in reproductive stages of both species. The minimum DM was recorded in *Ephedra gerardiana* (68.97 %) and in *Juniperus excelsa* at post-reproductive stage of both of the species. The herbaceous plants showed average of dry matter as *Artemisia parviflora* (87.21 %), *Echinops cornigerus* (89.42 %), *Marrubium vulgare* (90.68 %), *Peganum harmala* (86.21 %), *Salvia nubicola* (91.26 %) and *Thymus serpyllum* (83.94 %). The woody plants i.e. *Acantholimon lycopodioides* (86.14 %), *Astragalus grahammianus* (89.48 %), *Daphne oleoides* (88.26 %), *Ephedra gerardiana* (84.76 %), *Juniperus excelsa* (80.35 %), *Rosa webbiana* (80.52 %) and *Sophora mollis* (86.06 %). Statistical analysis showed non-significant difference at phenological stages and among the plant species. Storecheier *et al.* (2002); Kramberger & Klemmencic (2003) and Badshah (2011) found the same results as the DM increased with maturity in plants of their area.

2. Moisture content (%)

It is the percentage ratio of water mass to solid mass of plant or animal material. The plants obtain moisture from the soil in the form of soil water. Table 35 shows the moisture content of plant species and suggests that woody plants usually have more moisture content than

herbaceous plants. The moisture content of herbs varied in between 4.98 % (*Artemisia parvifolia*) to 31.54 % (*Salvia nubicola*). Among the woody species the average moisture content varied in between 7.64 % (*Juniperus excelsa*) to 27.73 % (*Ephedra gerardiana*). The moisture content of the species increased with age and maturity. The maximum moisture content was observed in *Salvia nubicola* (32.21 %) and (31.43 %) in post-reproductive and reproductive stages respectively. The minimum moisture content was recorded in *Artemisia parvifolia* (4.86 %) and (4.98 %) at pre-reproductive and reproductive stages respectively. The herbaceous plants showed average of moisture content as *Artemisia parviflora* (4.98 %), *Echinops cornigerus* (7.79 %), *Marrubium vulgare* (11.80 %), *Peganum harmala* (11.22 %), *Salvia nubicola* (31.54 %) and *Thymus serpyllum* (6.47 %). The woody plants i.e. *Acantholimon lycopodioides* (15.57 %), *Astragalus grahammianus* (25.56 %), *Daphne oleoides* (13.86 %), *Ephedra gerardiana* (27.73 %), *Juniperus excelsa* (7.54 %), *Rosa webbiana* (12.13 %) and *Sophora mollis* (11.10 %). Statistical analysis showed non-significant difference at phenological stages and among the plant species. Our findings are agreements of those of Storecheier *et al.* (2002); Tahira *et al.* (2012) and Shah (2014) that the moisture content of plants increased with maturity.

3. Ash content (AC)

The incinerated organic matter at higher temperature (500-600 °C) gives residues called ash containing salts and their oxides. Table 35 shows the ash content of plant species and suggests that woody plants usually have more ash content than herbaceous plants. The ash content of herbaceous plants was recorded in between 5.47 % (*Artemisia parvifolia*) to 30.99 % (*Salvia nubicola*). The woody species showed average ash content in between 7.45 % (*Juniperus excelsa*) to 24.01 % (*Astragalus grahammianus*). The ash content of the species increased with age and maturity. The maximum ash content was observed in *Salvia nubicola* (32.43 %) and (31.43 %) in reproductive and pre-reproductive stages respectively. The minimum ash content was recorded in *Artemisia parvifolia* (4.86 %) and (5.43 %) at pre-reproductive and post-reproductive stages respectively. The herbaceous plants showed average of ash content as *Artemisia parviflora* (5.47 %), *Echinops cornigerus* (11.33 %), *Marrubium vulgare* (13.04 %), *Peganum harmala* (10.67 %), *Salvia nubicola* (30.99 %) and *Thymus serpyllum* (7.11 %). The woody plants i.e. *Acantholimon lycopodioides* (16.46 %), *Astragalus grahammianus* (24.01 %), *Daphne oleoides* (13.40 %), *Ephedra gerardiana* (22.55 %), *Juniperus excelsa* (7.45 %), *Rosa*

webbiana (11.69 %) and *Sophora mollis* (11.75 %). Statistical analysis showed non-significant difference at phenological stages and among the plant species. Our findings are in agreement of those of Storecheier *et al.* (2002); Tahira *et al.* (2012) and Shah (2014) that the ash content of plants increased with maturity.

4. Crude proteins (CP)

Proteins are basic constituents and components of all living organisms including enzymes and hormones. The woody plants usually have low contents of proteins than herbaceous plants (Table 35). The protein concentration for herbs varied between 13.13 % (*Salvia nubicola*) to 17.79 % (*Marrubium vulgare*). The protein contents of woody species varied in between 14.80 % (*Ephedra gerardiana*) to 17.08 % (*Daphne oleoides*). The protein contents usually decreased with age and maturity of the species. The maximum proteins were noted for *Peganum harmala* (19.85 %) followed by *Salvia nubicola* (19.53) both at pre-reproductive stages. The minimum proteins content were recorded for *Salvia nubicola* (9.44%) and *Echinops cornigerus* (10.21 %) at post-reproductive stages of both species. The herbaceous plants showed average of crude fibres as *Artemisia parviflora* (15.72 %), *Echinops cornigerus* (30.50 %), *Marrubium vulgare* (17.79 %), *Peganum harmala* (17.57 %), *Salvia nubicola* (13.13 %) and *Thymus serpyllum* (16.12 %). The woody plants i.e. *Acantholimon lycopodioides* (15.72 %), *Astragalus grahamianus* (16.00 %), *Daphne oleoides* (17.08 %), *Ephedra gerardiana* (14.80 %), *Juniperus excelsa* (15.17 %), *Rosa webbiana* (15.62 %) and *Sophora mollis* (15.77 %). Statistical analysis showed non-significant difference at phenological stages and among the plant species. Our findings are supported by Bukhsh *et al.* (2007); Dairo & Adanlawo (2007); Badshah (2011); Shah (2014) and Monica *et al.* (2015) as they also observed high concentration of proteins during early growth than at later stages.

5. Crude fibers (%)

It is the organic residue remaining after digestion of plant powder material with 0.255 N H₂SO₄ and 0.313 N NaOH. It usually contains structural carbohydrates, lipids, lignin, protein, starch and sugar. The herbaceous plants usually have high contents of crude fibres than woody plants (Table 35). The herbs showed crude fibres in between 17.28 % (*Salvia nubicola*) to 57.09 % (*Artemisia parviflora*). The woody species had crude fibres in between 15.83 % (*Sophora mollis*) to 31.35 % (*Acantholimon lycopodioides*). The results showed that the crude fibres

increased with age and maturity of the species. The maximum proteins were noted for *Artemisia parviflora* (62.33 %) at reproductive stage followed by *Echinops cornigerus* (45.43 %) at post-reproductive stage. The minimum crude fibres were observed in *Sophora mollis* (14.67%) and in *Salvia nubicola* (15.33 %) at pre-reproductive stages of both species. The herbaceous plants showed average of crude fibres as *Artemisia parviflora* (57.09 %), *Echinops cornigerus* (42.78 %), *Marrubium vulgare* (19.69 %), *Peganum harmala* (23.69 %), *Salvia nubicola* (17.28 %) and *Thymus serpyllum* (40.27 %). The woody plants i.e. *Acantholimon lycopodioides* (31.35 %), *Astragalus grahammianus* (27.42 %), *Daphne oleoides* (19.59 %), *Ephedra gerardiana* (21.48 %), *Juniperus excelsa* (26.53 %), *Rosa webbiana* (20.51 %) and *Sophora mollis* (15.83 %). Statistical analysis showed non-significant difference at phenological stages and among the plant species. Gutierrez *et al.* (2008); Hussain & Durrani *et al.* (2009) and Sultan *et al.* (2009) found that crude fibres declined with maturity, which are disagreement of our findings.

6. Ether extract (Fats)

It is a part of complex organic material that is soluble in ether and consists chiefly of fats and fatty acids. It is a measure of the fat or oil (lipid) contents of the feed available for cattle. The herbaceous plants usually have low contents of fats than woody plants (Table 35). The herbs showed fats content in between 0.87 % (*Artemisia parviflora*) to 6.26 % (*Thymus serpyllum*). The woody species contained fats varied between 3.73 % (*Daphne oleoides*) to 9.72 % (*Astragalus grahammianus*). The results showed that the fats increased up to reproductive stages and then declined during further aging and maturity. The maximum fats were noted for *Ephedra gerardiana* (11.76 %) followed by *Astragalus grahammianus* (10.43 %) at reproductive stages in both of the species. The minimum fats were observed in *Artemisia parviflora* (0.51%) at pre-reproductive stage followed by 0.98 % observed in the same species at *Artemisia parviflora* post-reproductive stage. The herbaceous plants showed average fats as *Artemisia parviflora* (0.87 %), *Echinops cornigerus* (1.7 %), *Marrubium vulgare* (2.78 %), *Peganum harmala* (4.23 %), *Salvia nubicola* (5.92 %) and *Thymus serpyllum* (6.26 %). The woody plants i.e. *Acantholimon lycopodioides* (4.30 %), *Astragalus grahammianus* (9.72 %), *Daphne oleoides* (3.73 %), *Ephedra gerardiana* (9.64 %), *Juniperus excelsa* (7.18 %), *Rosa webbiana* (6.81 %) and *Sophora mollis* (5.52 %). Statistical analysis showed non-significant difference at phenological stages and among the plant species. Our findings are in line with those of Cherney & Chenrey

(2005); Ghani *et al.* (2014) and Monica *et al.* (2015) that reported increase in fats upto some extent during maturity of plants.

7. Organic matter (%)

The organic matter of the plants is mentioned in Table 35. The range of organic matter in herbs varied in between 69.00 % (*Salvia nubicola*) to 6.26 % (*Thymus serpyllum*). The woody species contained matter varied between 75.98 % (*Daphne oleoides*) to 94.54 % (*Juniperus excelsa*). The results showed that the organic matter declined with aging and maturity. The maximum organic matter were noted for *Artemisia parviflora* (95.14 %) and (94.57%) at pre-reproductive and reproductive stages respectively. The minimum organic matter was observed in *Astragalus grahammianus* (74.79 %) and (77.37 %) at reproductive and pre-reproductive stages respectively. The herbaceous plants showed average organic matter as *Artemisia parviflora* (94.52 %), *Echinops cornigerus* (89.68 %), *Marrubium vulgare* (87.29 %), *Peganum harmala* (89.31 %), *Salvia nubicola* (69.00 %) and *Thymus serpyllum* (92.88 %). The woody plants i.e. *Acantholimon lycopodioides* (83.53 %), *Astragalus grahammianus* (75.98 %), *Daphne oleoides* (86.60 %), *Ephedra gerardiana* (77.45 %), *Juniperus excelsa* (92.54 %), *Rosa webbiana* (88.30 %) and *Sophora mollis* (88.24 %). Statistical analysis showed non-significant difference at phenological stages and among the plant species. Our findings are in line with those of Chiesa *et al.* (2008) and Ghani *et al.* (2014) that organic matter decreased with maturity of plants. However, Sultan *et al.* (2009) and Badshah (2011) reported opposite to our findings.

8. Carbohydrates

Carbohydrates are organic compounds including celluloses, gums, starches all forms of sugars. They are produced through the process of photosynthesis by green parts of the plants. The present studies suggest that carbohydrates were in high concentration in herbs than in woody plants (Table 35). It was observed that the carbohydrate contents of herbaceous flora varied in between 18.40 % (*Salvia nubicola*) to 72.94 % (*Artemisia parviflora*). The woody species showed carbohydrates ranging between 24.68 % (*Astragalus grahammianus*) to 62.54 % (*Juniperus excelsa*). The carbohydrates content increased with growth of plants to flowering, but after it the carbohydrates content decreased with aging and maturity. The maximum carbohydrates were noted for *Artemisia parviflora* (74.60 %) and (74.13%) at pre-reproductive

and post-reproductive stages respectively. The minimum carbohydrates were observed in *Salvia nubicola* (12.84 %) and (19.50 %) at pre-reproductive and reproductive stages respectively. The average carbohydrate contents were *Artemisia parviflora* (72.94 %), *Echinops cornigerus* (65.60%), *Marrubium vulgare* (54.57%), *Peganum harmala* (56.29 %), *Salvia nubicola* (18.40 %) and *Thymus serpyllum* (64.02 %). The woody plants i.e. *Acantholimon lycopodioides* (48.82%), *Astragalus grahammianus* (24.68 %), *Daphne oleoides* (51.92 %), *Ephedra gerardiana* (25.26 %), *Juniperus excelsa* (62.54 %), *Rosa webbiana* (53.74 %) and *Sophora mollis* (64.02 %). Statistical analysis showed non-significant difference at phenological stages and among the plant species. Our findings are in line with those of Fulkerson *et al.* (2001); Hopkins *et al.* (2002); Chatterton *et al.* (2006); Sultan *et al.* (2009) and Badshah (2011) that the carbohydrate contents were maximum in reproductive stage and were in high percentage in herbs than in woody plants.

Table 34: Proximate analysis of selected plant species of Kalash valley, District Chitral, Pakistan

Plant	Phenological stages	Dry matter (%)	Moisture (%)	Ash content (%)	Crude Proteins (%)	Crude fibers (%)	Ether extract (Fat %)	Organic matter (%)	Total Carbohydrates
<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Pre-reproductive	76.74	14.45	15.22	13.34	28.43	3.21	84.78	53.78
	Reproductive	92.32	15.32	17.21	15.22	33.54	4.88	82.79	47.37
	Post-reproductive	89.37	16.96	16.96	15.95	32.09	4.81	83.04	45.32
	Mean	86.14	15.57	16.46	14.83	31.35	4.30	83.53	48.82
<i>Artemisia parviflora</i> Roxb.	Pre-reproductive	90.99	4.86	4.86	15.17	53.41	0.51	95.14	74.60
	Reproductive	92.43	4.98	6.13	17.67	62.33	1.13	93.87	70.09
	Post-reproductive	78.23	5.12	5.43	14.34	55.54	0.98	94.57	74.13
	Mean	87.21	4.98	5.47	15.72	57.09	0.87	94.52	72.94
<i>Astragalus grahammianus</i> Royle	Pre-reproductive	92.44	24.63	24.63	16.15	24.86	9.86	75.37	24.73
	Reproductive	94.89	25.05	25.21	17.43	27.65	10.43	74.79	21.88
	Post-reproductive	81.12	27.02	22.21	14.43	29.76	8.89	77.79	27.45
	Mean	89.48	25.56	24.01	16.00	27.42	9.72	75.98	24.68
<i>Daphne oleoides</i> Schreb.	Pre-reproductive	90.48	12.21	12.21	19.58	19.77	3.34	87.79	52.66
	Reproductive	91.87	14.03	14.56	15.44	21.23	4.21	85.44	51.76
	Post-reproductive	82.43	15.34	13.43	16.22	17.77	3.66	86.57	51.35
	Mean	88.26	13.86	13.40	17.08	19.59	3.73	86.60	51.92

<i>Echinops cornigerus</i> DC.	Pre-reproductive	91.54	7.08	10.14	15.97	42.38	1.35	92.92	65.46
	Reproductive	93.76	7.78	12.76	14.33	40.54	2.03	87.24	63.10
	Post-reproductive	82.98	8.52	11.11	10.21	45.43	1.92	88.89	68.24
	Mean	89.42	7.79	11.33	13.50	42.78	1.76	89.68	65.60
<i>Ephedra gerardiana</i> L.	Pre-reproductive	90.45	27.56	22.66	15.88	20.76	7.52	77.34	26.38
	Reproductive	94.87	28.43	21.78	17.33	23.92	11.76	78.22	20.70
	Post-reproductive	68.97	27.22	23.21	11.21	19.76	9.65	76.79	28.71
	Mean	84.76	27.73	22.55	14.80	21.48	9.64	77.45	25.26
<i>Juniperus excelsa</i> M. Bieb.	Pre-reproductive	79.82	6.98	6.32	14.32	23.43	6.87	93.68	65.51
	Reproductive	89.91	7.75	7.75	18.22	26.84	7.35	92.25	58.93
	Post-reproductive	71.32	8.21	8.29	12.98	29.32	7.33	91.71	63.19
	Mean	80.35	7.64	7.45	15.17	26.53	7.18	92.54	62.54
<i>Marrubium vulgare</i> L.	Pre-reproductive	91.63	11.17	11.71	19.39	20.00	2.22	88.29	55.51
	Reproductive	95.87	11.92	15.21	16.66	21.54	3.21	84.79	53.00
	Post-reproductive	84.54	12.33	12.21	17.33	17.54	2.91	88.79	55.22
	Mean	90.68	11.80	13.04	17.79	19.69	2.78	87.29	54.57
<i>Peganum harmala</i> L.	Pre-reproductive	89.87	10.53	10.53	19.85	22.30	4.82	89.47	54.27
	Reproductive	79.87	11.21	11.98	18.55	26.51	3.32	88.02	54.94
	Post-reproductive	88.89	11.92	9.54	14.32	22.28	4.55	90.46	59.67
	Mean	86.21	11.22	10.68	17.57	23.69	4.23	89.31	56.29

<i>Rosa webbiana</i> Wall. ex Royle.	Pre-reproductive	88.87	11.44	11.44	18.09	18.77	6.63	88.56	52.40
	Reproductive	73.65	12.19	13.32	16.22	19.43	6.71	86.68	51.56
	Post-reproductive	79.05	12.76	10.32	12.55	23.33	7.11	89.68	57.26
	Mean	80.52	12.13	11.69	15.62	20.51	6.81	88.30	53.74
<i>Salvia nubicola</i> Wall ex Sweet.	Pre-reproductive	92.03	30.99	30.99	19.53	15.33	5.65	69.01	12.84
	Reproductive	95.32	31.43	32.43	10.44	17.76	6.20	67.57	19.50
	Post-reproductive	86.43	32.21	29.56	9.44	18.76	5.93	70.44	22.86
	Mean	91.26	31.54	30.99	13.13	17.28	5.92	69.00	18.40
<i>Sophora mollis</i> (Royle) Baker.	Pre-reproductive	91.55	10.22	10.22	17.77	14.67	5.56	89.78	56.23
	Reproductive	81.87	11.21	13.21	14.23	17.43	6.12	86.79	55.23
	Post-reproductive	84.76	11.87	11.83	15.32	15.39	4.88	88.17	56.10
	Mean	86.06	11.10	11.75	15.77	15.83	5.52	88.24	55.85
<i>Thymus serpyllum</i> L.	Pre-reproductive	82.77	5.92	7.21	16.31	37.55	7.22	92.79	63.34
	Reproductive	90.06	6.64	6.64	18.95	41.07	6.25	93.36	61.52
	Post-reproductive	78.99	6.87	7.50	13.11	42.21	5.32	92.50	67.20
	Mean	83.94	6.47	7.11	16.12	40.27	6.26	92.88	64.02

CONSERVATION STATUS OF PLANTS

Plants being living organisms have to face different natural and anthropogenic hazards, which greatly affect their growth, development, occurrence and distribution. Plant conservation studies usually deal with the causes of decline of plant species and the techniques and measures taken to protect these species. The conservation status of plants of Kalash valley indicated that there were 323 wild growing species belonging to 167 families. Out of these species 8 (2.47%) were rare, 60 (18.57%) were endangered and 255 (78.94%) species were vulnerable (Table 36). Many plants of the valley are used for medicinal purposes, as timber, as fire wood, heavily grazed by animals and the harsh environmental conditions have slow down their natural regeneration, so these plants have become endangered with passage of time. These include *Juniperus communis*, *Juniperus excelsa*, *Juniperus squamata*, *Ephedra intermedia*, *Cedrus deodara*, *Picea smithiana*, *Pinus gerardiana*, *Pinus wallichiana*, *Colchicum luteum*, *Pistachia integerrima*, *Pistachia khinjik*, *Arabidopsis wallichii*, *Arabis auriculata* and *Dipsacus inermis* var. *mitis* etc. *Arum jacquemontii*, *Iris lacteal*, *Juncus articulata*, *Matricaria aurea*, *Coronopus didymus*, *Cannabis sativa* and *Lathyrus aphaca* were the rare species in the valley.

The present study indicates that major part of the vegetation of the area is endangered or near to become endangered due tremendous anthropogenic pressure. So, atleast the *ex-situ* conservation of medicinal plants should be encouraged in the valley. Heywood & Iriondo (2003) also recommends the *ex-situ* conservation of medicinal plant and other important plants.

Malik *et al.* (2011) reported 80 medicinal plants from northern region of Kashmir Himalaya, of which 28 species were rare, 24 vulnerable, 14 endangered and 9 species were critically endangered. Hadi *et al.* (2014) elaborated flora of Dag Behsud graveyard, district Nowshera, Pakistan and reported 41 medicinal plants belonging to 24 families and concluded that the graveyards were generally protected from anthropogenic activities and hence have conserved flora. They found that Dag Behsud graveyard has conserved *Aerva javanica*, *Matricaria camomilla*, *Calendula arvensis*, *Eruca sativa*, *Malcolmia cabulica*, and *Cymbopogon jwarancusa* species which were almost absent from surrounding areas.

Ullah & Rashid (2014) studied the conservation status of medicinal plants of Mankial valley, Swat-Kohistan and reported that 13 species were vulnerable, 21 endangered and 11 were critically endangered species. Alam & Ali (2015) studied the distribution of *Astragalus*

clarkeanus in Pakistan and reported that it is a critically endangered species and endemic to Gilgit-Baltistan. The main threats are limited population size, habitat loss and over grazing. However, proper conservation studies are almost negligible in Pakistan (Alam & Ali, 2009, 2010).

The major and common threats to plants of Kalash valley are overgrazing, deforestation, habitat loss and different human activities. So, proper conservation strategies must be adopted to protect the plant resources of the valley.

S#	Plant name	Criteria					Conservation status
		Availability	Collection	Part used	Growth	Total Score	
FUNGI							
89. Family Halveliaceae							
1.	<i>Morchella esculenta</i> (L.) Pers ex. Fr	0	0	0	3	3	Endangered
BRYOPHYTES							
90. Family Funariaceae							
2.	<i>Funaria hygrometrica</i> Hedw.	0	0	0	3	3	Endangered
91. Family Marchantiaceae							
3.	<i>Marchantia polymorpha</i> L.	0	0	0	3	3	Endangered
92. Family Aytoniaceae							
4.	<i>Reboulia hemisphaerica</i> (L.) Raddi	0	0	0	3	3	Endangered
93. Family Polytrichaceae							
5.	<i>Polytrichum</i> sp.	0	0	0	3	3	Endangered
PTERIDOPHYTES							
94. Family Adiantaceae							
6.	<i>Adiantum capillus-veneris</i> L.	0	3	0	3	6	Vulnerable
7.	<i>Adiantum venustum</i> D. Don.	0	3	0	3	6	Vulnerable
8.	<i>Cheilanthes pteridioides</i> (Reichb.) C. Chr	0	0	0	3	3	Endangered
95. Family Aspleniaceae							
9.	<i>Asplenium trichomanes</i> L.	0	0	0	3	3	Endangered
96. Family Cystopteridaceae							
10.	<i>Cystopteris fragilis</i> (L.) Bernh.	0	0	0	3	3	Endangered
97. Family Dryopteridaceae							
11.	<i>Dryopteris ramosa</i> (Hope) C. Chr.	0	0	0	3	3	Endangered
98. Family Equisetaceae							
12.	<i>Equisetum arvense</i> L.	2	3	0	3	8	Vulnerable
13.	<i>Equisetum ramosissimum</i> Desf.	1	3	0	3	7	Vulnerable
99. Family Pteridaceae							
14.	<i>Cystopteris fragilis</i> (L.) Bernh.	0	0	0	3	3	Endangered
15.	<i>Polystichum acanthophyllum</i> (Franch) Christ	0	0	0	3	3	Endangered
16.	<i>Pteris cretica</i> L.	0	0	0	3	3	Endangered
100. Family Selaginellaceae							

17.	<i>Selaginella indica</i> (Milde) Alston.	0	0	0	3	3	Endangered
GYMNOSPERMS							
101. Family Cupressaceae							
18.	<i>Juniperus communis</i> L.	1	1	0	0	2	Endangered
19.	<i>Juniperus excelsa</i> M. Bieb.	1	1	0	0	2	Endangered
20.	<i>Juniperus squamata</i> Buch.	1	0	0	0	1	Endangered
102. Family Ephedraceae							
21.	<i>Ephedra gerardiana</i> Wall ex. Stapf.	3	1	0	2	6	Vulnerable
22.	<i>Ephedra intermedia</i> Schrenk & Meyer	1	1	0	2	4	Endangered
103. Family Pinaceae							
23.	<i>Cedrus deodara</i> (Roxb. Ex Lamb.) G. Don	1	1	0	0	2	Endangered
24.	<i>Picea smithiana</i> (Wall.) Boiss.	1	1	0	0	2	Endangered
25.	<i>Pinus gerardiana</i> Wall. ex Lamb.	1	1	2	0	4	Endangered
26.	<i>Pinus wallichiana</i> A. B. Jackson	1	1	0	0	2	Endangered
MONOCOTYLEDANAE							
104. Family Aceraceae							
27.	<i>Acer pentapomicum</i> J.L. Stewart	2	3	3	0	8	Vulnerable
105. Family Alliaceae							
28.	<i>Allium carolinianum</i> DC.	0	2	0	3	5	Vulnerable
29.	<i>Allium chitralicum</i> Wang & Tang	0	3	0	3	6	Vulnerable
106. Family Amaryllidaceae							
30.	<i>Ixiolirion tataricum</i> (Pall.) Herb.	0	3	0	3	6	Vulnerable
107. Family Araceae							
31.	<i>Arum jacquemontii</i> Blume	2	3	3	3	11	Rare
108. Family Colchicaceae							
32.	<i>Colchicum luteum</i> Baker	0	0	0	3	3	Endangered
109. Family Cyperaceae							
33.	<i>Carex orbicularis</i> Boott.	1	2	0	3	6	Vulnerable
34.	<i>Cyperus diluta</i> M. Bieb.	1	2	0	3	6	Vulnerable
35.	<i>Scirpus setaceus</i> L.	1	1	0	3	5	Vulnerable
110. Family Iridaceae							
36.	<i>Iris lactea</i> Pallas	1	3	3	4	11	Rare
111. Family Juncaceae							
37.	<i>Juncus articulata</i> L.	2	2	3	3	10	Rare
112. Family Liliaceae							
38.	<i>Fritillaria imperialis</i> var. <i>chitralensis</i> Hort.	0	2	3	3	8	Vulnerable
39.	<i>Tulipa stellata</i> Hk. f.	0	2	3	3	8	Vulnerable

113. Family Orchidaceae							
40.	<i>Epipactis wallichii</i> Schlech.	0	3	0	3	6	Vulnerable
41.	<i>Spiranthes lancea</i> (Thunb.) Backer	1	3	0	3	7	Vulnerable
114. Family Poaceae							
42.	<i>Agropyron semicostatum</i> Nees ex Steud	1	2	0	3	6	Vulnerable
43.	<i>Agrostis viridis</i> Gouan.	1	2	0	3	6	Vulnerable
44.	<i>Aristida cynantha</i> Nees ex Steud	2	1	0	4	7	Vulnerable
45.	<i>Arundo donax</i> L.	1	2	0	3	6	Vulnerable
46.	<i>Avena fatua</i> L	2	1	0	3	6	Vulnerable
47.	<i>Avena sativa</i> L.	2	1	0	3	6	Vulnerable
48.	<i>Bromus danthoniae</i> Trin.	2	1	0	3	6	Vulnerable
49.	<i>Bromus tectorum</i> L.	2	1	0	3	6	Vulnerable
50.	<i>Calamagrostis emodensis</i> Griseb.	2	3	0	3	8	Vulnerable
51.	<i>Chrysopogon echinulatus</i> (Nees ex Steud.) W. Wats	2	1	0	3	6	Vulnerable
52.	<i>Cynodon dactylon</i> (L.) Pers.	3	1	0	4	8	Vulnerable
53.	<i>Dactylis glomerata</i> L.	2	2	0	3	7	Vulnerable
54.	<i>Dichanthium annulatum</i> (Forssk.) Stapf.	2	2	0	4	8	Vulnerable
55.	<i>Echinochloa crusgalli</i> (L.) P. Beauv.	2	3	0	3	8	Vulnerable
56.	<i>Eragrostis poaeoides</i> P. Beave.	2	3	0	3	8	Vulnerable
57.	<i>Hordeum murinum</i> L.	1	2	0	3	6	Vulnerable
58.	<i>Koeleria gracilis</i> Pers.	1	2	0	3	6	Vulnerable
59.	<i>Lolium rigidum</i> Gaud.	1	3	0	3	7	Vulnerable
60.	<i>Lolium temulentum</i> L.	2	3	0	3	8	Vulnerable
61.	<i>Melica inaequiglumis</i> (Boiss.) Bor.	2	3	0	2	7	Vulnerable
62.	<i>Panicum antidotale</i> Retz.	1	1	0	3	5	Vulnerable
63.	<i>Phleum pretense</i> L.	1	1	0	3	5	Vulnerable
64.	<i>Phragmites karka</i> (Retz.) Trin. ex Steud	3	0	0	3	6	Vulnerable
65.	<i>Piptatherum wendelboi</i> Bor	1	1	0	3	5	Vulnerable
66.	<i>Poa annua</i> L.	1	3	0	3	7	Vulnerable
67.	<i>Poa bulbosa</i> L.	1	3	0	3	7	Vulnerable
68.	<i>Poa pratensis</i> L.	1	2	0	3	6	Vulnerable
69.	<i>Poa supina</i> Schrad.	1	2	0	3	6	Vulnerable
70.	<i>Polypogon fugax</i> Nees ex Steud	1	3	0	3	7	Vulnerable
71.	<i>Saccharum spontaneum</i> L.	3	0	0	3	6	Vulnerable
72.	<i>Setaria viridis</i> (L.) P.	1	3	0	3	7	Vulnerable

	Beauv.						
73.	<i>Vulpia myuros</i> (L.) Gmel.	1	1	0	3	5	Vulnerable
115. Family Typhaceae							
74.	<i>Typha angustata</i> Bory & Chaub	3	0	0	2	5	Vulnerable
DICOTYLEDONAE							
116. Family Amaranthaceae							
75.	<i>Amaranthus viridis</i> L.	2	2	0	3	7	Vulnerable
117. Family Anacardiaceae							
76.	<i>Pistacia integerrima</i> (L.) Steward ex Brandis	1	1	0	0	2	Endangered
77.	<i>Pistacia khinjak</i> Stocks	1	1	0	0	2	Endangered
78.	<i>Rhus punjabensis</i> Steward ex Brandis	1	2	0	3	6	Vulnerable
118. Family Apiaceae							
79.	<i>Ammi visnaga</i> (L.) Lamk.	1	1	2	3	7	Vulnerable
80.	<i>Bumium persicum</i> (Boiss.) B. Fedtsch.	1	1	2	3	7	Vulnerable
81.	<i>Bupleurum gilesii</i> Wolff	1	2	0	3	6	Vulnerable
82.	<i>Bupleurum thomsoni</i> C.B. Clarke	1	2	0	3	6	Vulnerable
83.	<i>Carum capticum</i> L.	1	1	2	3	7	Vulnerable
84.	<i>Carum carvi</i> L.	1	1	2	3	7	Vulnerable
85.	<i>Pimpinella stewartii</i> (Dunn) Wolff.	0	3	0	3	6	Vulnerable
86.	<i>Pimpinella diversifolia</i> DC.	0	3	0	3	6	Vulnerable
87.	<i>Prangos pabularia</i> Lindl.	0	3	0	2	5	Vulnerable
88.	<i>Trachyspermum ammi</i> (L.) Sprague	1	2	2	3	8	Vulnerable
119. Family Asclepiadaceae							
89.	<i>Cynanchum acutum</i> L.	1	1	0	2	4	Endangered
90.	<i>Periploca aphylla</i> Dcne.	1	1	0	3	4	Vulnerable
120. Family Asteraceae							
91.	<i>Anaphalis nepalensis</i> (Spreng.) Hand.	2	2	0	3	7	Vulnerable
92.	<i>Artemisia brevifolia</i> Wall. Ex DC.	3	0	0	3	6	Vulnerable
93.	<i>Artemisia maritima</i> L.	3	0	0	2	5	Vulnerable
94.	<i>Artemisia parviflora</i> Roxb.	3	1	0	3	7	Vulnerable
95.	<i>Artemisia sacrorum</i> Ledeb.	3	1	0	2	6	Vulnerable
96.	<i>Artemisia scoparia</i> Waldst. & Kit.	3	0	0	2	5	Vulnerable
97.	<i>Carduus edelbergii</i> Rech.	1	2	0	3	6	Vulnerable
98.	<i>Centaurea iberica</i> Trev. ex Spreng.	1	3	0	3	7	Vulnerable
99.	<i>Cichorium intybus</i> L.	2	0	0	3	5	Vulnerable

131.	<i>Berberis lycium</i> Royle	0	0	0	1	1	Endangered
122. Family Balsaminaceae							
132.	<i>Impatiens bicolor</i> Royle	1	3	0	3	7	Vulnerable
133.	<i>Impatiens edgeworthii</i> Hk. f. FBI	1	3	0	3	7	Vulnerable
123. Family Boraginaceae							
134.	<i>Arnebia decumbens</i> (Vent) Coss & Kral.	1	2	0	3	6	Vulnerable
135.	<i>Asperugo procumbens</i> L.	1	2	0	3	6	Vulnerable
136.	<i>Cynoglossum glochidiatum</i> Wall. ex Benth.	1	3	0	3	7	Vulnerable
137.	<i>Cynoglossum lanceolatum</i> Forssk.	1	3	0	3	7	Vulnerable
138.	<i>Heliotropium europium</i> var. <i>lasiocarpum</i> (Fish. & Mey.) Kazmi	0	2	0	3	5	Vulnerable
139.	<i>Lappula microcarpa</i> (Ledeb.) Gurke	1	2	0	3	6	Vulnerable
140.	<i>Lepechiniella inconspicua</i> (Brand) Reidl.	0	1	0	3	4	Endangered
141.	<i>Lindelofia longiflora</i> (Benth.) Baill.	0	1	0	3	4	Endangered
142.	<i>Onosma dichroanthum</i> Boiss.	0	2	0	3	5	Vulnerable
143.	<i>Onosma hispida</i> Wall ex. G. Don.	0	2	0	3	5	Vulnerable
144.	<i>Pseudomertensia chitralensis</i> (Riedl) Reidl in Rechinger	0	1	0	3	4	Endangered
145.	<i>Solananthus circinnatus</i> Ledeb.	1	1	0	3	5	Vulnerable
124. Family Brassicaceae							
146.	<i>Alliaria petiolata</i> (M. B.) Cav. & Grande Boll.	2	2	0	3	7	Vulnerable
147.	<i>Arabidopsis wallichii</i> (H. & T.) N. Busch.	0	1	0	3	4	Endangered
148.	<i>Arabis auriculata</i> Lam.	0	1	0	3	4	Endangered
149.	<i>Capsella bursa-pastoris</i> (L.) Medic.	3	1	0	3	7	Vulnerable
150.	<i>Cardamine hirsuta</i> L.	1	2	0	3	6	Vulnerable
151.	<i>Coronopus didymus</i> (L.) Sm.	3	3	0	3	9	Rare
152.	<i>Descurainia sophia</i> (L.) Webb. & Berth.	1	1	0	3	5	Vulnerable
153.	<i>Draba lanceolata</i> Royle	0	1	0	3	4	Endangered
154.	<i>Draba olgae</i> Regel & Schrenk	0	1	0	3	4	Endangered
155.	<i>Draba trinervis</i> O.E.S.	0	1	0	3	4	Endangered
156.	<i>Eruca sativa</i> Miller	2	2	0	3	7	Vulnerable

157.	<i>Lepidium sativum</i> L.	3	2	0	3	8	Vulnerable
158.	<i>Malcolmia africana</i> (L.) R. Br.	3	1	0	3	7	Vulnerable
159.	<i>Malcolmia cabulica</i> (Boiss.) H. & T.	3	1	0	3	7	Vulnerable
160.	<i>Matthiola tenera</i> Rech.f.,	1	2	0	3	6	Vulnerable
161.	<i>Nasturtium officinale</i> R. Br.	2	2	0	3	7	Vulnerable
162.	<i>Neslia apiculata</i> Fisch.	3	2	0	3	8	Vulnerable
163.	<i>Sisymbrium brassiciforme</i> C. A. Mey	0	2	0	3	5	Vulnerable
164.	<i>Sisymbrium irio</i> L.	2	2	0	3	7	Vulnerable
165.	<i>Thlaspi andersonii</i> (H. & T.) O.E.S.	1	1	0	3	5	Vulnerable
125. Family Campanulaceae							
166.	<i>Campanula staintonii</i> Rech.	1	1	0	3	5	Vulnerable
167.	<i>Codonopsis rotundifolia</i> Bth.	1	2	0	3	6	Vulnerable
126. Family Cannabinaceae							
168.	<i>Cannabis sativa</i> L.	3	2	2	3	10	Rare
127. Family Capparidaceae							
169.	<i>Capparis spinosa</i> L.	0	1	2	3	6	Vulnerable
170.	<i>Cleome ariana</i> Hedge & Lamond	2	3	0	3	8	Vulnerable
128. Family Caprifoliaceae							
171.	<i>Viburnum cotinifolium</i> D. Don.	1	2	0	2	5	Vulnerable
129. Family Caryophyllaceae							
172.	<i>Arenaria griffithii</i> Boiss.	1	1	0	3	5	Vulnerable
173.	<i>Arenaria serpyllifolia</i> L.	1	2	0	3	6	Vulnerable
174.	<i>Herniaria hirsuta</i> L.	0	2	0	3	5	Vulnerable
175.	<i>Lepyrodiclis holosteoides</i> (C. A. Mey) Fenzl.	1	1	0	3	5	Vulnerable
176.	<i>Silene conoidea</i> L.	3	2	0	3	8	Vulnerable
177.	<i>Silene viscosa</i> (L.) Pers.	1	3	0	3	7	Vulnerable
178.	<i>Silene vulgaris</i> (Moench) Garcke.	2	1	0	3	6	Vulnerable
179.	<i>Spergula arvensis</i> L.	2	1	0	3	6	Vulnerable
180.	<i>Stellaria media</i> (L.) Cyr.	3	2	0	3	8	Vulnerable
130. Family Chenopodiaceae							
181.	<i>Atriplex crassifolia</i> C. A. Mey	1	1	0	3	5	Vulnerable
182.	<i>Chenopodium album</i> L.	2	0	0	3	5	Vulnerable
183.	<i>Chenopodium ambrosioides</i> L.	2	3	0	3	8	Vulnerable
184.	<i>Chenopodium botrys</i> L.	2	2	0	3	7	Vulnerable
185.	<i>Chenopodium foliosum</i> (Merrich.) Aschers.	0	1	0	3	4	Endangered

186.	<i>Chenopodium murale</i> L.	3	2	0	3	8	Vulnerable
187.	<i>Kochia prostrata</i> (L.) Schard.	1	1	0	3	5	Vulnerable
131. Family Convolvulaceae							
188.	<i>Convolvulus arvensis</i> L.	3	2	0	3	8	Vulnerable
132. Family Crassulaceae							
189.	<i>Sedum ewersii</i> Ledeb.	1	1	0	3	5	Vulnerable
190.	<i>Sedum quadrifidum</i> Pall.	1	1	0	3	5	Vulnerable
133. Family Cuscutaceae							
191.	<i>Cuscuta brevistyla</i> A. Braun. ex A. Rich.	0	2	0	3	5	Vulnerable
192.	<i>Cuscuta lehmanniana</i> Bunge	0	3	0	3	6	Vulnerable
193.	<i>Cuscuta reflexa</i> Roxb.	0	2	0	3	5	Vulnerable
134. Family Dipsacaceae							
194.	<i>Dipsacus inermis</i> var. <i>mitis</i> (D. Don) Y. Nasir	0	1	0	3	4	Endangered
135. Family Euphorbiaceae							
195.	<i>Euphorbia boissieriana</i> (Woron.) Prokh.	1	1	0	3	5	Vulnerable
196.	<i>Euphorbia falcata</i> L.	2	1	0	3	6	Vulnerable
197.	<i>Euphorbia helioscopia</i> L.	2	1	0	3	6	Vulnerable
198.	<i>Euphorbia peplus</i> L.	1	1	0	3	5	Vulnerable
199.	<i>Euphorbia wallichii</i> Hk.f.	0	1	0	3	4	Endangered
136. Family Fabaceae							
200.	<i>Astragalus grahammianus</i> Royle. ex Bth.	0	1	0	3	4	Endangered
201.	<i>Astragalus subumbellatus</i> Klotzsch.	0	1	0	3	4	Endangered
202.	<i>Astragalus nivalis</i> Kar & Kir	1	1	0	3	5	Vulnerable
203.	<i>Indigofera heterantha</i> var. <i>heterantha</i> L.	2	1	0	3	6	Vulnerable
204.	<i>Lathyrus aphaca</i> L.	3	3	0	3	9	Rare
205.	<i>Lotus corniculatus</i> L.	3	2	0	3	8	Vulnerable
206.	<i>Medicago lupulina</i> L.	2	1	0	3	6	Vulnerable
207.	<i>Medicago polymorpha</i> L.	2	1	0	3	6	Vulnerable
208.	<i>Melilotus indica</i> (L.) All.	1	3	0	3	7	Vulnerable
209.	<i>Trifolium pretense</i> L.	2	2	0	3	7	Vulnerable
210.	<i>Trifolium repens</i> L.	2	2	0	3	7	Vulnerable
211.	<i>Trigonella incisa</i> Bth.	1	1	0	3	5	Vulnerable
212.	<i>Vicia monantha</i> L.	2	1	0	3	6	Vulnerable
213.	<i>Vicia sativa</i> L.	2	1	0	3	6	Vulnerable
137. Family Fumariaceae							
214.	<i>Fumaria indica</i> (Hauskn.) H. N. Pugsley	2	3	0	3	8	Vulnerable
138. Family Fagaceae							
215.	<i>Quercus baloot</i> Griffith	3	1	0	0	4	Endangered
216.	<i>Quercus dilatata</i> Lindl.	1	1	0	0	2	Endangered

139. Family Geraniaceae							
217.	<i>Erodium cicutarium</i> (L.) L' Herit.	1	3	0	3	7	Vulnerable
218.	<i>Geranium rotundifolium</i> L.	1	3	0	3	7	Vulnerable
219.	<i>Geranium wallichianum</i> D. Don. Ex Sweet	1	3	0	3	7	Vulnerable
140. Family Juglandaceae							
220.	<i>Juglans regia</i> L.	2	0	2	0	4	Endangered
141. Family Lamiaceae							
221.	<i>Calamintha umbrosa</i> (M. Bieb.) Fisch. & Mey.	1	2	0	3	6	Vulnerable
222.	<i>Calamintha vulgaris</i> (L.) Druce	1	2	0	3	6	Vulnerable
223.	<i>Lagochilus cabulicus</i> Bth. in DC. Prodr.	0	2	0	3	5	Vulnerable
224.	<i>Lallemantia royleana</i> (Bth.) Bth.	0	1	0	3	5	Vulnerable
225.	<i>Lamium amplexicaule</i> L.	0	1	0	3	4	Endangered
226.	<i>Marrubium vulgare</i> L.	1	1	0	3	5	Vulnerable
227.	<i>Mentha longifolia</i> (L.) Huds	3	2	0	3	8	Vulnerable
228.	<i>Mentha royleana</i> Benth.	2	0	0	3	5	Vulnerable
229.	<i>Nepeta brachyantha</i> Rech.	1	3	0	3	7	Vulnerable
230.	<i>Nepeta clerkei</i> Hk. f.	1	3	0	3	7	Vulnerable
231.	<i>Nepeta raphanorhiza</i> Bth.	2	2	0	3	7	Vulnerable
232.	<i>Nepeta sewerzowii</i> Regel	1	3	0	3	7	Vulnerable
233.	<i>Phlomis cashmeriana</i> Royle	3	2	0	3	8	Endangered
234.	<i>Prunella vulgaris</i> L.	1	3	0	3	7	Vulnerable
235.	<i>Salvia aegyptiaca</i> L.	1	3	0	3	7	Vulnerable
236.	<i>Salvia moorcroftiana</i> Wall. ex Bth.	1	2	0	3	6	Vulnerable
237.	<i>Salvia nubicola</i> wall. ex Sweet	1	3	0	3	7	Vulnerable
238.	<i>Salvia plebeia</i> R. Br.	1	3	0	3	7	Vulnerable
239.	<i>Scutellaria nuristanica</i> Rech.	1	3	0	3	7	Vulnerable
240.	<i>Thymus serpyllum</i> L.	1	3	0	3	7	Vulnerable
241.	<i>Ziziphora tenuior</i> L.	1	2	0	3	6	Vulnerable
142. Family Malvaceae							
242.	<i>Althaea rosea</i> (L.) Cav. Diss.	2	3	0	3	8	Vulnerable
243.	<i>Malva neglecta</i> Wallr.	1	3	0	3	7	Vulnerable
244.	<i>Malva perviflora</i> L.	1	3	0	3	7	Vulnerable
143. Family Moraceae							
245.	<i>Ficus carica</i> L.	2	3	0	3	7	Vulnerable
144. Family Onagraceae							
246.	<i>Epilobium hirsutum</i> L.	1	3	0	3	7	Vulnerable

247.	<i>Epilobium latifolium</i> L.	1	3	0	3	7	Vulnerable
248.	<i>Epilobium royleanum</i> Hausskn.	1	3	0	3	7	Vulnerable
145. Family Oxalidaceae							
249.	<i>Oxalis corniculata</i> L.	1	3	0	3	7	Vulnerable
146. Family Paeoniaceae							
250.	<i>Paeonia emodi</i> Wall ex G. Don	0	1	0	0	1	Endangered
147. Family Papaveraceae							
251.	<i>Papaver dubium</i> L.	1	3	0	3	7	Vulnerable
148. Family Plantaginaceae							
252.	<i>Plantago lanceolata</i> L.	1	3	0	3	7	Vulnerable
253.	<i>Plantago major</i> Aitch.	1	3	0	3	7	Vulnerable
149. Family Plumbaginaceae							
254.	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	2	0	0	0	2	Endangered
255.	<i>Limonium griffithii</i> (Aitch. & Hemsl.) O. Ktze.	2	0	0	0	2	Endangered
150. Family Polygonaceae							
256.	<i>Bistorta affinis</i> (D. Don) Green	0	3	0	3	6	Vulnerable
257.	<i>Bistorta vivipara</i> (L.) S.F. Gray	0	3	0	3	6	Vulnerable
258.	<i>Oxyria digyna</i> (L.) Hill.	2	3	0	3	8	Vulnerable
259.	<i>Polygonum amplexicaule</i> D Don.	0	3	0	3	6	Vulnerable
260.	<i>Polygonum aviculare</i> L.	0	3	0	3	6	Vulnerable
261.	<i>Polygonum paronychioides</i> C,A, Mey. ex Hohen.	1	3	0	3	7	Vulnerable
262.	<i>Polygonum nepalense</i> Meissn.	1	3	0	3	7	Vulnerable
263.	<i>Rheum webbianum</i> Royle	2	0	0	0	2	Endangered
264.	<i>Rumex hastatus</i> D. Don	2	3	0	3	8	Vulnerable
265.	<i>Rumex longifolius</i> DC	0	3	0	3	6	Vulnerable
266.	<i>Rumex nepalensis</i> Spreng	3	2	0	3	8	Vulnerable
151. Family Portulacaceae							
267.	<i>Portulaca oleracea</i> L	2	3	0	3	7	Vulnerable
152. Family Primulaceae							
268.	<i>Anagallis arvensis</i> L.	3	3	0	3	9	Rare
269.	<i>Androsace harrissii</i> Du.	2	1	0	3	6	Vulnerable
270.	<i>Primula denticulata</i> Sm.	1	3	0	3	7	Vulnerable
271.	<i>Primula elliptica</i> Royle	1	3	0	3	7	Vulnerable
153. Family Ranunculaceae							
272.	<i>Adonis aestivalis</i> L.	1	3	0	3	7	Vulnerable
273.	<i>Ceratocephalus falcatus</i> (L.) Pers.	0	2	0	3	5	Vulnerable
274.	<i>Clematis orientalis</i> L.	1	2	0	2	5	Vulnerable

275.	<i>Delphinium denudatum</i> Wall. ex H. & T	1	3	0	3	7	Vulnerable
276.	<i>Thalictrum elegans</i> Wall. ex Royle	0	2	0	3	5	Vulnerable
277.	<i>Ranunculus arvensis</i> L.	3	3	0	3	9	Rare
278.	<i>Ranunculus aucheri</i> Boiss.	0	1	0	3	4	Endangered
279.	<i>Ranunculus muricatus</i> L.	1	3	0	3	7	Vulnerable
280.	<i>Ranunculus sceleratus</i> L.	1	3	0	3	7	Vulnerable
154. Family Rosaceae							
281.	<i>Cotoneaster microphylla</i> Wall. ex Lindl.	2	0	1	0	3	Endangered
282.	<i>Cotoneaster nummularia</i> Fisch. & Mey	2	0	1	0	3	Endangered
283.	<i>Filipendula vestita</i> (Wall. ex G. Don) Maxim.	1	2	0	3	6	Vulnerable
284.	<i>Potentilla pamirica</i> Wolf.	0	1	0	3	4	Endangered
285.	<i>Potentilla sericea</i> L.	0	1	0	3	4	Endangered
286.	<i>Prunus kuramica</i> (Korsh.) Kitam.	1	1	1	1	4	Endangered
287.	<i>Pyrus pashia</i> Ham. ex D. Don	2	3	2	0	7	Vulnerable
288.	<i>Rosa ecae</i> Aitch.	0	3	1	0	4	Endangered
289.	<i>Rosa webbiana</i> Wall. ex Royle	2	0	0	2	4	Endangered
290.	<i>Rubus fruticosus</i> L.	2	1	0	2	5	Vulnerable
291.	<i>Rubus irritans</i> Focke	2	1	0	2	5	Vulnerable
292.	<i>Sorbaria tomentosa</i> (Lindl.) Rehder	1	1	0	3	5	Vulnerable
155. Family Rubiaceae							
293.	<i>Gallium aparine</i> L.	3	2	0	3	8	Vulnerable
294.	<i>Gallium tricornutum</i> L.	3	2	0	3	8	Vulnerable
295.	<i>Rubia cordifolia</i> L.	1	1	0	3	5	Vulnerable
156. Family Salicaceae							
296.	<i>Salix acmophylla</i> Boiss.	2	0	0	1	3	Endangered
297.	<i>Salix denticulata</i> Anderson subsp. <i>Denticulata</i>	2	0	0	1	3	Endangered
157. Family Saxifragaceae							
298.	<i>Bergenia ciliata</i> (Haw.) Sternb.	1	3	0	3	7	Vulnerable
299.	<i>Bergenia himalaica</i> Boriss	1	3	0	3	7	Vulnerable
158. Family Scrophulariaceae							
300.	<i>Euphrasia aristulata</i> Penn.	0	3	0	3	6	Vulnerable
301.	<i>Kickxia ramosissima</i> (Wall.) Janchen	0	3	0	3	6	Vulnerable
302.	<i>Linaria bamianica</i> Patzak	0	2	0	3	5	Vulnerable
303.	<i>Pedicularis chitralensis</i>	0	3	0	3	6	Vulnerable

	Penn.						
304.	<i>Scrophularia robusta</i> Penn.	0	3	0	3	6	Vulnerable
305.	<i>Scrophularia scoparia</i> Penn.	0	3	0	3	6	Vulnerable
306.	<i>Verbascum thapsus</i> L.	2	2	0	3	7	Vulnerable
307.	<i>Veronica anagallis aquatica</i> L.	2	3	0	3	8	Vulnerable
308.	<i>Veronica biloba</i> L.	2	3	0	3	8	Vulnerable
309.	<i>Veronica verna</i> L.	2	3	0	3	8	Vulnerable
159. Family Simaroubaceae							
310.	<i>Ailanthus altissima</i> (Mill.) Swingle	2	0	2	3	7	Vulnerable
160. Family Solanaceae							
311.	<i>Datura stramonium</i> L.	1	3	0	3	7	Vulnerable
312.	<i>Solanum nigrum</i> L.	1	2	0	3	6	Vulnerable
161. Family Tamaricaceae							
313.	<i>Myricaria squamosa</i> Desv.	2	0	0	3	5	Vulnerable
314.	<i>Tamarix dioica</i> Roxb. ex Roth	1	3	0	3	7	Vulnerable
162. Family Thymeleaceae							
315.	<i>Daphne oleoides</i> Schreb.	1	2	0	3	6	Vulnerable
316.	<i>Thymelaea passerina</i> (L.) Coss. & Germ.	1	2	0	3	6	Vulnerable
163. Family Ulmaceae							
317.	<i>Celtis australis</i> L.	1	3	0	0	4	Endangered
164. Family Urticaceae							
318.	<i>Parietaria judaica</i> Starand.	0	2	0	3	6	Vulnerable
319.	<i>Urtica dioica</i> L.	1	1	0	3	5	Vulnerable
165. Family Verbenaceae							
320.	<i>Verbena officinalis</i> L.	1	1	0	3	5	Vulnerable
166. Family Violaceae							
321.	<i>Viola canescens</i> Wall. ex Roxb.	2	1	0	3	6	Vulnerable
167. Family Zygophyllaceae							
322.	<i>Peganum harmala</i> L.	2	1	0	3	6	Vulnerable
323.	<i>Tribulus terrestris</i> L.	1	1	0	3	5	Vulnerable

Keys:

1. Availability: 0- Uncommon or very rare, 1- Less common or rare, 2- Occasional 3- Abundant

2. Collection: 0- More than 1000 kg/year, 1- Consumed from 500-1000 kg/year, 2- Consumed from 200-500 kg/year, 3- Consumed from 100-200 kg/year.

3. Part used: 0- Root or whole plant, 1- Bark, 2- Seeds, fruits, 3- Flowers, 4- Gum, latex.

4. Growth: 0- Re-growth in more than three years, 1- Re-growth in three years, 2- Re-growth in two years, 3- Re-growth in one year, 4- Re-growth in a season.

5. Total Score: 0-4 = Endangered, 5-8 = Vulnerable, 9-12 = Rare, 12-14= infrequent, 15-16 = Dominant.

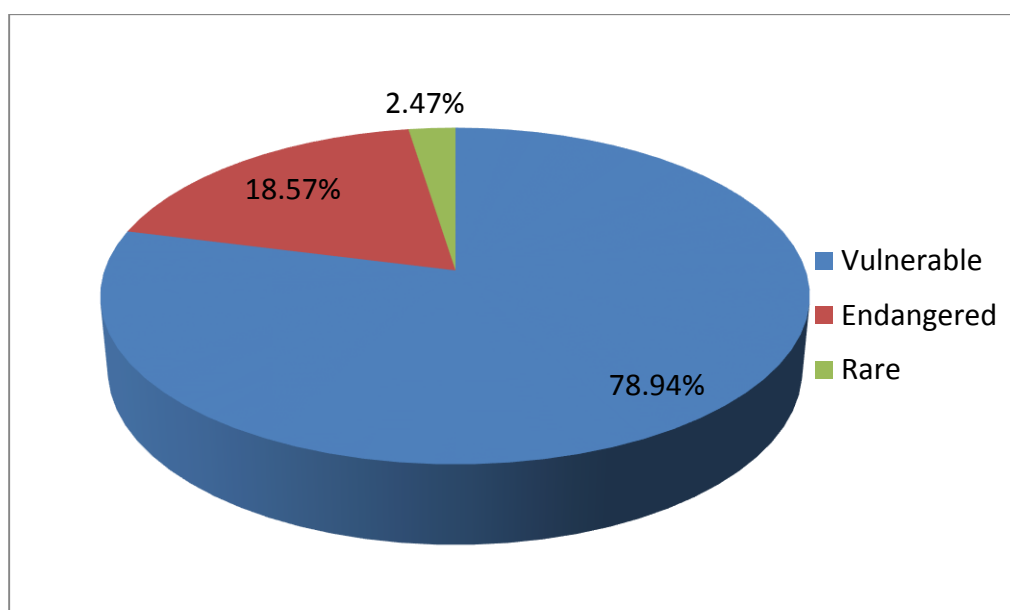


Figure 22. Graphical presentation of conservation status of plants of Kalash valley, district Chitral

CONCLUSION AND RECOMMENDATIONS

1. The present research work was initiated to illuminate the basic data on the floristic, vegetation structure, medicinal plants, chemical composition, forage productivity and rangeland resources of historical Kalash valley, district Chitral. The present findings might be helpful for plant scientists to improve their future research activities in this remote area.
2. The study indicated that the plant diversity of the area was composed of 389 species belonging to 88 families. Out of these species 307 were dicots, 55 were monocots, 12 were pteridophytes, 10 were gymnosperms, 4 were bryophytes and one was fungus species.
3. The flora was dominated by annuals (therophytes and hemicryptophytes) which indicate the harsh climatic conditions of the area.
4. 21 plant communities were established in the entire valley, seven each in Bumboret, Rumbor and Birir. The foothill/plain communities usually have more vegetation as compare to uphill mountains and alpine communities.
5. The valley is rich with the indigenous knowledge of plant uses and 92 species were documented to be used in various ailments.
6. The area is rich in plant natural resources, which are under severe threats due to heavy grazing, deforestation, collection of medicinal plants, floods and land sliding. Moderate and rotational grazing and afforestation with sustainability must be introduced and encouraged in the valley.
7. The area is very remote and has insufficient health care facilities therefore most of the locals still depends on the medicinal plants for treatment of diseases. The local people should be properly trained for scientific methods of collection and processing of medicinal plants.
8. Cattle rearing are the basic income source for the Kalash people and they are totally dependant on the natural rangeland resources for forage and fodder. This resulted severe decline in the natural vegetation of the valley and some plants are near to extinction. Therefore, some alternative sources of fodder plants must be introduced in the valley and also the sustainable use of natural vegetation should be practiced.

9. Different research activity should be initiated on emergency basis in the valley to explore seed germination, development and growth behaviour of fuel wood, fodder, timber wood and medicinal plants for successful propagation and reintroduction.
10. The physico-chemical analysis showed that soil of the valley has weak texture and compostion. This is the case with the plants and as well as with livestock. Therefore, natural and synthetic fertilizers should be used to improve the soil quality.
11. The valley is internationally famous for its inhabitants having indigenous culture, language and life style. Therefore, strong linkages between international, regional and national research and developmental organisations are required to appliance integrated management plans so that ecological and socioeconomic conditions could be addressed appropriately and the life standard of the locals could be improved.
12. The valley has border with Nooristan province of Afghanistan, so some international joint projects could be helpful to study plant interactions between the two countries and also will contribute in discovery of new species in this particular uexplored rich mountainous range.
13. The rangelands can be used as game reserve and will help in income generation.
14. Tourism is well developed industry in the valley and thousands of visitors come here to enjoy the natural beauty and to know about the unique cultured Kalash people. But, the hotels and tourists are adding huge quantity of wastes to this beautiful valley which ultimately causing damages to ecosystem and its services. Therefore, proper check and balance system should be initiated for the conservation of plants and ecosystem.
15. Rehabilitation of degraded habitats by introduction of some fast growing fodder plants, afforestation, sustainable use of medicinal plants and introduction of improved breeds of livestock with high yield are some long term plans which can be helpful to improve and ensure the overall sustainable biological productivity of the area.



Figure 23. Forest of *Cedrus deodara* in Kalash valley



Figure 24. *Tragopogon gracilis* (Asteraceae)

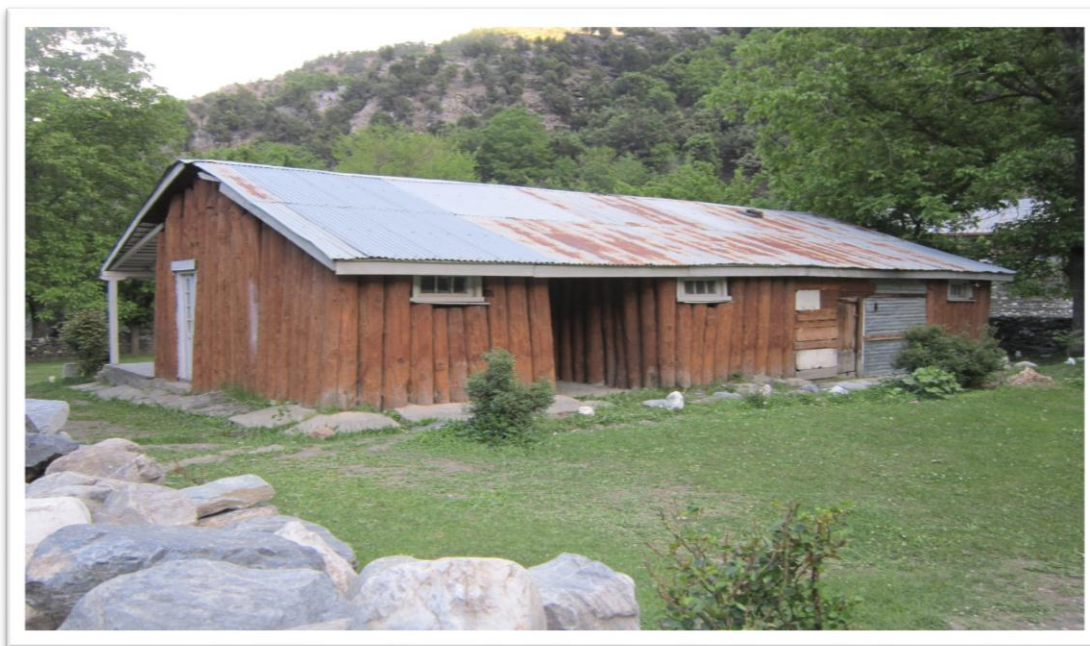


Figure 25. House made of *Cedrus deodara* wood in Birir valley



Figure 26. Identification of plant in field



Figure 27. Collection of ethnobotanical information from local elder



Figure 28. *Arum jacquomontii*



Figure 29. *Asplenium trichomanes*



Figure 30. Hedge made of *Quercus baloot*



Figure 31. The personal things of the death body are kept with the body in graveyard: One of the basic traditions of Kalash people



Figure 32. Death bodies were not buried but kept open in graveyard inside *Cedrus deodara* coffin (This tradition has been changed now)



Figure 33. The pouch used by an old lady for collection of food items from field is now lying on her grave as traditional believe (The death bodies are now buried)



Figure 34. A lady wearing typical Kalash dress



Figure 35. Inside of Kalash house



Figure 36. An old lady busy in weeding in wheat field

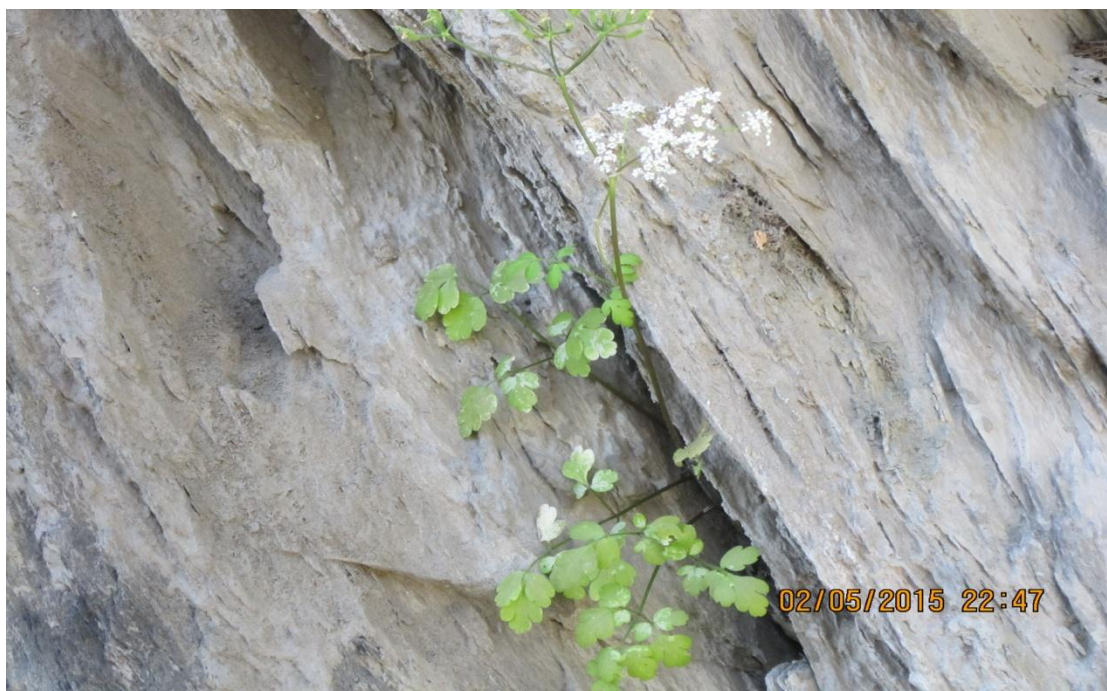


Figure 37. Plant of *Carum copticum*



Figure 38. *Artemisia* sp.



Figure 39. Plant of *Kickxia ramossissima* (Scrophulariaceae)



Figure 40. Plant of *Rheum emodi* (Polygonaceae)



Figure 41. Plant of *Descurainaea sophia* (Brassicaceae)



Figure 42. Higher altitude plant *Bellis perennis* (Asteraceae)



Figure 43. Plant of *Urtica dioica* (Urticaceae)



Figure 44. Deforestation (Logs of *Cedrus deodara*)



Figure 45. Deforestation (*Cedrus deodara*) showing cut stump



Figure 46. Plant collection



Figure 47. Group photo with local Nomads



Figure 48. High pasture grassland of Kalash valley

REFERENCES

- Abbas, F., T. Akhtar and A. Mian. 2009. Phytosociological analysis within the range of Grey goral in Pakistan and Azad Kashmir. *Pak. J. Bot.*, 41(2): 667-682.
- Abbas, H., M. Qaiser and J. Alam. 2010. Conservation status of *Cadaba heterotricha* Stocks (Capparaceae): an endangered species in Pakistan. *Pak. J. Bot.*, 42 (1): 35-46.
- Abbasi, M.K. and M.N. Khan. 2004. Introduction of white clover for herbage production and nitrogen fixation in the hilly areas of Azad Jammu and Kashmir. *Mountain Res. Devel. J.*, 24(2): 134-140.
- Adam, F. B and G. E. Crow. 2010. The Flora and vegetation of timber Island, Lake Winnepesaukee, New Hampshire, U.S.A. *Rhodora*, 112 (950): 156-190.
- Addo-Fordjour, P., A.K. Anning, E.J.D. Belford and D. Akonnor. 2008. Diversity and conservation of medicinal plants in the Bomaa community of the Brong Ahafo region, Ghana. *J. Med. Pl. Res.* 2(9): 266-273.
- Adhikari, B.S., M.M. Babu, P.L. Saklani and G.S. Rawat. 2007. Distribution, use pattern and prospects for conservation of medicinal shrubs in Uttaranchal state, India. *J. Mountain Sci.*, 4(2): 155-180.
- Afzal, S., N. Afzal, M. R. Awan, T. S. Khan, A. Gilani, R. Khanum and S. Tariq. 2009. Ethno-Botanical studies from Northern Pakistan. *J. Ayub. Med. Coll. Abbottabad*. 21(1): 52-57.
- Agili, A. F. 2014. Chemical Composition, Antioxidant and Antitumor Activity of *Thymus vulgaris* L. Essential Oil. *Middle-East Journal of Scientific Research* 21 (10): 1670-1676.
- Ahmad, H. and M. Waseem. 2004. Conservation status of some medicinal plants of the salt range. *Zonas Aridas.*, 8: 1-8.
- Ahmad, S. S., T. Ahmad and K. F. Akbar. 2004. Baseline study of roadside vegetation of Lahore- Islamabad Motorway (M-2) and its fertility status. *J. of Appl. Sci.* 4: 266-270.
- Ahmad, S., M. K. Leghari and M. Idris. 2005. Some aquatic vascular plants of Islamabad, Pakistan. *Pak. J. Pl. Sci.*, 11 (1): 39-43.
- Ahmad, S., A. Ali, H. Beg, A. A. Dasti and Z. K. Shinwari. 2006. Ethnobotanical studies on some medicinal plants of Booni valley, district Chitral Pakistan. *Pak. J. Weed Sci. Res.* 12 (3):183-190.
- Ahmad, K., M. Ashraf, Z. I. Khan and E. E. Valeem. 2008c. Evaluation of macro-mineral

- concentrations of forages in relation to ruminants' requirements: a case study in Soone Valley, Punjab, Pakistan. *Pak. J. Bot.*, 40 (1): 295-299.
- Ahmad, S. S., S. Fazal, E. E. Valeem, Z. I. Khan, G. Sarwar and Z. Iqbal. 2009b. Evaluation of ecological aspects of roadside vegetation around Havelian city using multivariate techniques. *Pak. J. Bot.*, 41 (1): 53-60.
- Ahmad, S., N. Khan, M. Wahab and K. Nazim. 2010c. Vegetation studies of selected graveyards of upper Swat. *J. Biol. Biotech.*, 7 (3): 221-217.
- Ahmad, I., M. Ibrar, B. Ullah, and N. Ali. 2011. Ethnobotanical Study of Tehsil Kabal, Swat District, KPK, Pakistan. *Journal of Botany*. 10: 1-9.
- Ahmad, M., S. Sultana, S.F. Hadi, T.B. Hadda, S. Rashid, M. Zafar, M.A. Khan, M.P. Khan and G. Yaseen. 2014. An Ethnobotanical study of Medicinal Plants in high mountainous region of Chail valley (District Swat- Pakistan). *J. Ethnobiol. Ethnomed.* 10 (36): 225-233.
- Ahmad, K., Z. I. Khan, S. Yasmin, M. Ashraf and A. Ishfaq. 2014. Accumulation of metals and metalloids in turnip (*brassica rapa* L.) irrigated with domestic wastewater in the peri-urban Areas of Khushab City, Pakistan. *Pak. J. Bot.*, 46(2): 511-514.
- Ahmad, K., Z. I. Khan, A. Ashfaq, M. Ashraf and S. Yasmin. 2014. Assessment of heavy metal and metalloid levels in spinach (*spinacia oleracea* L.) grown in wastewater irrigated Agricultural soil of Sargodha, Pakistan. *Pak. J. Bot.*, 46(5): 1805-1810.
- Ahmad, B., S.J. Abbas, F. Hussain, S. Bashir and D. Ahmad. 2014. Study on *Caralluma tuberculata* nutritional composition and its importance as medicinal plant. *Pak. J. Bot.*, 46 (5): 1677-1684.
- Ajaib, M, Z. U Khan, N. Khan and M. Wahab. 2010. Ethnobotanical studies on useful shrubs of District Kotli, Azad Jammu & Kashmir, Pakistan. *Pak. J. Bot.*, 42 (3):1407-1415.
- Ajaib, M., S. K. Haider, A. Zikrea and M. F. Siddiqui. 2014. Ethnobotanical studies of herbs of Agra valley, Parachinar, Upper Kurram Agency, Pakistan. *Int. J. Biol. Biotech.*, 11 (1): 71-83.
- Akbar, G., S. Khatoon, M. Imran, N. Rizwan, M. Z. Khan and S. Islam. 2010. Floristic and phytosociological assessment of vegetation of Keenjhar Lake and surrounding area (Thatta, Sindh) Pakistan. *Int. J. Biol. Biotech.*, 7 (3): 147-158.
- Akhtar, M. Z., A. Khan, M. Sarwar and A. Javaid. 2007. Influence of soil and forage minerals on

- Buffalo (*Bubalus bubalis*) haemoglobinaria. *Asian-Australian J. Ani. Sci.*, 20: 393-399.
- Akhtar, N., A. Rashid, W. Murad and E. Bergmeier. 2013. Diversity and use of ethno-medicinal plants in the region of Swat, North Pakistan. *J. Ethnobiol. Ethnomedicine*. 9:25. 1-13.
- Akram, M., M. A. Kahlowan and Z. A. Soomro. 2009. Desertification control for sustainable land use in the Cholistan Desert, Pakistan. *Earth & Env. Science*. 6:483-492.
- Alam, J. and S. I. Ali. 2009. Conservation Status of *Astragalus gilgitensis* Ali (Fabaceae): A critically endangered species in the Gilgit District, Pakistan. *Phyton*. 48 (2): 211-225.
- Alam, J. and S. I. Ali. 2010. Conservation status of *Androsace russellii* Y. Nasir: a critically endangered species in Gilgit district, Pakistan *Pak. J. Bot.*, 42 (3): 1381-1393.
- Alam, N., Z.K. Shinwari, M. Ilyas and Z. Ullah. 2011. Indigenous knowledge of medicinal plants of Chagharzai Valley, district Buner, Pakistan. *Pak. J. Bot.*, 43 (2): 773-780.
- Alam, J., and S. I. Ali. 2015. *Astragalus clarkeanus* Ali: a threatened and narrow endemic species in Gilgit-Baltistan, Pakistan. *Pak. J. Bot.*, 47 (SI): 43-49.
- Alelign, A., D. Teketay, Y. Yemshaw and S. Edwards. 2007. Diversity and status of regeneration of woody plants on the peninsula of Zegie, northwestern Ethiopia. *Tropical Ecology*. 48 (1): 37-49.
- Ali, S.I. and Y.J. Nasir, 1989-1991. Flora of Pakistan. Department of Botany, University of Karachi.
- Ali, S.I. and M. Qasir, 1993-2015. Flora of Pakistan. Department of Botany, University of Karachi.
- Ali, A. and H. Shah. 2004. Local communities access to forest resources of Hillkot Watershed, Mansehra, Pakistan. *Pak. J. Forestry*. 54 (2): 137-145.
- Ali, H. and M. Qaiser. 2009. The ethnobotany of Chitral valley, Pakistan with Particular reference to medicinal plants. *Pak. J. Bot.*, 41(4): 2009-2041.
- Ali, S., A. Perveen and M. Qaiser. 2015. Vegetation structure, Edaphology and ethnobotany of Mahaban and Malka (District Buner) KPK, Pakistan. *Pak. J. Bot.*, 47 (SI): 15-22.
- Ali, K., M. Shuaib, Z. Hussain, W. Sajjad, F. Ali and M. Fazil. 2016. Ethnobotanical assessment of the medicinal flora of Khyber agency, Pakistan. *Pak. J. Weed Sci. Res.* 22(4): 607-616.
- Almeida Jr, E.B., F.S.S. Filho, E.L. Araujo and C.S. Zickel. 2011. Structural characteristics of the woody plants in resting of Brazil. *J. Ecol. Nat. Environ.*, 3(3): 95-103.
- Altay, V., I.I. Ozygit, C. Yarci. 2012. Plant communities in urban habitats of Istanbul, Turkey.

- Pak. J. Bot.*, 44 (1): 177-186.
- Al-Yemeni, M. and H. Sher. 2010. Biological spectrum with some other ecological attributes of the flora and vegetation of the Asir Mountain of Southwest Saudi Arabia. *African J. Biotech.*, 9 (34): 5550-5559.
- Amjad, M. S., M. Arshad and I. A. Qamar. 2013. Phytosociology of *Pinus-Quercus* Forest Vegetation of Nikyal Hills, district Kotli, Azad Kashmir, Pakistan. *Inter. J. Agric. Crop Sci.* 5 (24): 2952-2960.
- Amjad, M. S., M. Arshad, S. Fatima and N. Mumtaz. 2014. Palatability and Animal Preferences of Plants in Tehsil Nikyal, District Kotli, Azad Jammu and Kashmir Pakistan. *Annual Research & Review in Biology*. 4(6): 1-9.
- Andueza, D., P. Cruz, A. Farruggia, R. Baumont, F. Picard and B.M. Doreau. 2010. Nutritive value of two meadows and relationships with some vegetation traits. *Grass & Forage Sci.*, 65 (3): 325-334.
- Angassa, A. 2005. The ecological impact of bush encroachment on the yield of grasses in Borana rangeland ecosystem. *African J. Ecol.*, 43 (1): 14-20.
- Anonymous. 1985. Nutrient requirements of domestic animals. Nutrient requirements of sheep. *Nat. Acad. Sci., Nat. Res. Council*, Washington, DC.
- Anonymous. 2006. Economic Survey. Government of Pakistan, Finance Division, Islamabad, Pakistan.
- AOAC. 1984. Official Methods of Analysis. 11th ed. Association of Official Analytical Chemists, Washington, DC.
- AOAC.1990. Official Methods of Analysis (15th Ed.). Association of Official Analytical Chemists, Washington, DC, USA. 5: 3-10.
- Arenas, P. and G. F. Scarpa. 2007. Edible wild plants of the Chorote Indians, Gran Chaco, Argentina. *Botanical J. Linn. Society*, 153 (1): 73-85.
- Armstrong, D. P., K. A. Tarrant, C. K. M. Ho, L. R. Malcolm and W. J. Wales. 2010. Evaluating development options for a rain-fed dairy farm in Gippsland. *Animal Production Science*, 50 (5-6): 363-370.
- Arshad, M., A. U. Hussan, M. Y. Ashraf, S. Noureen and M. Moazzam. 2008. Edaphic factors and distribution of vegetation in the Cholistan desert, Pakistan. *Pak. J. Bot.*, 40 (5): 1923-1931.

- Aryapak, S. and P. Ziarati. 2014. Nutritive Value of Persian Walnut (*Juglans regia* L.) Orchards. *American-Eurasian J. Agric. & Environ. Sci.*, 14 (11): 1228-1235.
- Ashraf, A., R.A. Sarfraz, F. Anwar, S. A. Shahid and K.M. Alkharfy. 2015. Chemical composition and biological activities of leaves of *Ziziphus mauritiana* L. Native to Pakistan. *Pak. J. Bot.*, 47 (1): 367-376.
- Badshah, L. 2011. Ecological evaluation of plant resources and Vegetation structure of district Tank, Pakistan. *Ph.D. Thesis*. Department of Botany. University of Peshawar.
- Badshah, L., F. Hussain, Z. Sher and T. Burni. 2014. Harvesting and consumption of fuel and timber wood in Rural area of district Tank, Pakistan. *Pak. J. Bot.*, 46(5): 1719-1724.
- Baily, D.W. and J. R. Brown. 2011. Rotational grazing systems and livestock grazing behaviour in shrub dominated semi-arid and arid rangelands. *Rangeland Ecol. & Manage.* 64(1): 1-9.
- Bakhsh, A., S. M. Iqbal and I. K. Haq. 2007. Evolution of chickpea germplasm for wilt resistance, *Pak. J. Bot.*, 39 (2): 583-593.
- Bano, Z., A. Begum and K. Bano. 2013. Ethnobotanical studies of some selected plants in Mastuj, Chitral valley, Khyber Pakhtunkhwa. *Can. J. App. Sci.* 1(3): 413- 426.
- Bano, A., M. Ayub, S. Rashid, S. Sultana and H. Sadia. 2013. Ethnobotany and conservation status of floral diversity of Himalayan range of Azad Jammu and Kashmir – Pakistan. *Pak. J. Bot.*, 45 (SI): 243-251.
- Basnet, D.B. and D.R. Chhetri. 2004. Ethnobotany of some fiber yielding plants of Himalayan environment of Darjeeling, India. In A. Kumar. 2004. *Biodiversity and Environment*. 571-586.
- Bignami, C., C. Cammilli, G. Moretti and L. Sallusti. 2005. Growth analysis and nitrogen dynamics in hazelnut Tonda Gentile Romana. *Acta Hort.*, 686: 193-200.
- Bebber, D.P., S.A. Hartris, K.J. Gaston and R.W. Scotland. 2007. Ethnobotany and the first records of British flowering plants. *Glob. Ecol. Biogeo.*, 16 (1): 103-108.
- Bebika, Ch. and B.M. Sharma. 2004. Variations in the net primary production of the macrophytes in the Sanapati Lake, Manipur, India. In A. Kumar. 2004. *Biodiversity and Conservation*. 519-530.
- Bhellum, B. L. 2012. Taxonomic status of *Bupleurum* (*Apiaceae*) in outer hills of Kashmir Himalayas, India. *J. Biol. Earth Sci.* 2(2): .63-69.
- Bonham, C.D. 1989. Measurement for terrestrial vegetation. John Wiley and Sons. New York.

- Brady, N. C. 1990. The Nature and Properties of Soils. 10th ed. Macmillan Publishing Co. New York, NY. 621 p.
- Bremner, J. M., and C. S. Mulvaney. 1982. Nitrogen - Total. In: Methods of Soil Analysis (A. L. Page et al., ed.). Agronomy Monograph 9, Part 2, 2nd ed. American Society of Agronomy, Madison, WI. pp. 595-624.
- Bouyoucos, G. J. 1936. Directions for making mechanical analysis of soils by the hydrometer method. *Soil Sci.*, 42: 225-228.
- Bulut, Z. and H. Yilmaz. 2010. The current situation of threatened endemic flora in Turkey: Kemaliye (Erzincan) Case. *Pak. J. Bot.*, 42 (2): 711-719.
- Cain, S. A. and G. M. Castro. 1959. Manual of Vegetation analysis. Harper, NY pp. 325.
- Carvalho, D. and I. M. M. Saraiva. 2005. Effects of water stress on the proximate composition and mineral contents of seeds of two lupins (*Lupinus albus* and *Lupinus mutabilis*). *J. Food Quality*. 28 (4): 325-332.
- Chao, A., R.L. Chazdon, R.K Colwell and T.J. Shen. 2006. Abundance-based similarity indices and their estimation when there are unseen species in samples. *Biometrics*. 62 (2):361-71.
- Chao, A., L. Jost, S. C. Chiang, Y. H. Jiang and R. L. Chazdon. 2008. A two-stage probabilistic approach to multiple-community similarity indices. *Biometrics*. 64 (4): 1178-1186.
- Chatterton, N. J., K. A. Watts, K. B. Jensen, P. A. Harrison and W. H. Horton. 2006. Nonstructural carbohydrates in oat forage. *J. Nut.*, 136: 2111S-2113S.
- Chaudhry, A.A., M.S. Haider, J. Ahsan and S. Afzal. 2010. Determining the carrying capacity of treated and untreated areas of Mari reserve forest after reseeded with *Cenchrus ciliaris*. *J. An. & Pl. Sci.*, 20(2): 103-106.
- Cherney, J. H. and D. J. R. Cherney. 2005. Agronomic response of cool-Season grasses to low-intensity harvest management and low potassium fertility. *Agron J.*, 97:1216-1221.
- Chiesa, A. P. R., G. V. Kozloski, L. M. B. Sanchez, L. D. Lima, L. Oliveira, C. J. Harter, G. Fiorentini and R. L. Cadorin. 2008. Age of regrowth as a factor affecting the nutritive value of hay of kikuyu grass (*Pennisetum clandestinum*) offered to lambs. *Grass & Forage Science*, 63 (2): 193-201.
- Chocarro, C., J. Lloveras and R. Fanlo. 2005. Effects of winter grazing on spring production of lucerne under Mediterranean conditions. *Grass & Forage Science*, 60 (2): 146-150.
- Coskun, B., N. Gulsen and H. D. Umucalilar. 2004. The nutritive value of *Prangos ferulacea*.

- Grass & Forage Science*, 59 (1): 15-19.
- Costa, R. C., F. S. Araujo and L. W. Lima-Verde. 2007. Flora and life-form spectrum in an area of deciduous thorn woodland (Caatinga) in Northeastern, Brazil. *J. Arid Environments*. 68 (2): 237-247.
- Dad, J.M. and Z. A. Reshi. 2015. Floristic composition and diversity patterns of vascular plants in mountain meadow of Gurez valley, Kashmir, India. *Taiwania* 60(1): 8–17.
- Dairo, F. A. S and I. G. Adanlawo. 2007. Nutritional Quality of *Crassocephalum crepidioides* and *Senecio bialfrae*. *Pak. J. Nut.*, 6 (1): 35-39.
- Dalle, G., B. L. Maass and J. Isselstein. 2006. Encroachment of woody plants and its impact on pastoral livestock production in the Borana lowlands, Southern Oromia, Ethiopia. *African J. Ecology*, 44 (2): 237-24.
- Dastagir, G., F. Hussain and K. F. Khattak. 2014. Nutritional evaluation of plants of family Zygophyllaceae and Euphorbiaceae. *Pak. J. Bot.*, 46(5): 1703-1707.
- Davidar, P., D. Mohandass and S.L. Vijayan. 2007. Floristic inventory of woody plants in a tropical montane (shola) forests in the Palni hills of the western Ghats, India. *Tropical Ecology*. 48(1): 15-25.
- Devineau, J. L. and A. Fournier. 2007. Integrating environmental and sociological approaches to assess the ecology and diversity of herbaceous species in a Sudan type savanna (Bondoukuy, Western Burkina Faso). *Flora, Morphology, Distribution, Functional Ecology of Plants* 202 (5): 350-370.
- DeWalt, S. J. and J. Chave . 2004. Structure and biomass of four lowland Neotropical Forests. *Biotropica*, 36 (1): 7-19.
- Dishi, K. and K. Daniel. 2010. Forage productivity of Gongoshi grazing reserve, Adamawa state, Nigeria. *GJMBR*. 10 (8): 49-51.
- District Census Report (DCR) Chitral.1998. Government of Pakistan, Islamabad.
- Djuikouo, M.N.K., J.L. Doucet, C.K. Nguembou, S.L. Lewis and B. Sonke. 2010. Diversity and above ground biomass in three tropical forest type in the Dja Biosphere Reserve, Cameroon. *African J. Ecol.*, 48(4): 1053-1063.
- Dharani, N., J. I. Kinyamario and J. M. Onyari. 2006. Structure and composition of *Acacia xanthophloea* woodland in Lake Nakuru National Park, Kenya. *African J. Ecology*, 44 (4): 523-530.

- Domínguez-Gómez, T.G., R. G. Ramírez-Lozano, H. González-Rodríguez, I. Cantú-Silva, M. Gómez-Meza and M.D.S. Alvarado. 2015. Mineral content in four browse species from northeastern Mexico. *Pak. J. Bot.*, 46 (4): 1421-1429.
- Dondeyne, S., A. Wijffels, L. B. Emmanuel, J. Deckers and M. Hermy. 2004. Soils and vegetation of Angai forest: ecological insights from a participatory survey in South Eastern Tanzania. *African J. Ecology*. 42 (3): 198-207.
- Durrani, M.J., F. Hussain and S. Rehman. 2005. Ecological characteristics of plants of Harboi rangelands, Kalat, Pakistan. *J. Trop. & Subtrop. Bot.*, 13(2): 130-138.
- Durrani, M. J., A. Razaq, S. G. Muhammad and F. Hussain. 2010. Floristic diversity, ecological, characteristics and ethnobotanical profile of plants of Aghberg rangelands, Balochistan, Pakistan. *Pak. J. Pl. Sci.*, 16 (1): 29-36.
- Eilu, G., L. N. H. David and J. M. Kasenene. 2004. Tree species distribution in forests of the Albertine Rift, Western Uganda. *African J. Ecology*, 42 (2): 100-110.
- Eilu, G., J. Oriekot and H. Tushabe. 2007. Conservation of indigenous plants outside protected areas in Tororo district, eastern Uganda. *African J. Ecol.*, 45(3): 73-78.
- Estrella, M.D.L., F.J. Cabezas, C. Aedo and M. Velayes. 2006. Checklist of the Ceasalpinoideae (Leguminosae) of Equatorial Guinea (Annobon, Bioko and Rio Muni). *Bot. J. Linn. Soc.*, 151(4): 541-562.
- Evan, S.G., A.J. Pelster, W.C. Leninger and M.J. Trlica. 2004. Seasonal diet selection of cattle grazing a montane riparian community. *J. Range. Manage.*, 57:539-545.
- Farooq, M. U. 2003. Some suitable and sustainable strategies for improving rangeland productivity in Pakistan. *Pak. J. Forestry*, 53 (2): 193-199.
- Farooq, S., A. Z. Khan, M. Yousaf and H. Fazal. 2010. Phytosociological study of Push Ziarat area (Shawal) in the South Waziristan, Pakistan. *Pak. J. Weed Sci. Res.* 16 (1): 47-55.
- Fatna, B., B. Noury, B. Souhila and B. Djamel. 2014. Research of the eco-floristic data Into the contribution of groups to Halophyte, hammam boughrara area West Algeria. *European Scientific Journal*. 10 (29): 296-307.
- Fawad, M., B. Gul, H. Khan and Z. Khan. 2013. Study and collection of hydrophytes of the district Swabi, Pakistan. *Pak. J. Weed sci. Res.*, 19 (4): 513-522.
- Fazal, H., N. Ahmad, A. Rashid and S. Farooq. 2010. A Checklist of phanerogamic flora of Haripur Hazara, Khyber Pakhtunkhwa, Pakistan. *Pak. J. Bot.*, 42 (3): 1511-1522.

- Fleischmann, K., P. J. Edwards, D. Ramseier and J. Kollmann. 2006. Stand structure, species diversity and regeneration of an endemic palm forest on the Seychelles. *African J. Ecology*. 43 (4): 291-301.
- Francisco, J. C., M. D. L. Estrella, C. Aedo and M. Velayos. 2007. Checklist of Commelinaceae of Equatorial Guinea (Annobón, Bioko and Río Muni). *Botanical J. Linn. Society*. 159 (1): 106-122.
- Fulkerson, W. J. and D. J. Donaghy. 2001. Plant-soluble carbohydrate reserves and senescence-key criteria for developing an effective grazing management system for ryegrass-based pasture: A review. *Austral. J. Exper. Agric.*, 41: 261-275.
- Galyean, M. 1985. Techniques and Procedures in Animal Nutrition Research. New Mexico State University, Deptt. Animal & Range Conditions.
- Garg, A. N., A. Kumar, A. G. C. Nair and A. V. R. Reddy. 2007. Analysis of some Indian medicinal herbs by INAA. *J. Radianalytical & Nuclear Chemistry*. 271 (3): 611-619.
- Ghani, A., Z. Ali, T. Islam, S. Sanaullah and S. Saeed. 2014. Nutrient evaluation and elemental analysis of four selected medicinal plants of soon valley Khushab, Punjab, Pakistan. *Pak. J. Pharm. Sci.*, 27(3): 597-600.
- Gjorgieva, D., T.K. Panovska, K. Baeva and T. Stafilov. 2011. Metallic trace elements in medicinal plants from Macedonia. *Middle-East J. Sci. Res.*, 7 (1): 109-114.
- Glindemann, T.A. C.A. Wang, B.M.A. Tans, A.A. Schilbora and A.A. Susebbeth. 2009. Impact of grazing intensity on herbage intake, composition and digestibility and on live weight gain of sheep on the inner Mongolian steppe. *Livestock Science*. 124(1): 142-147.
- Golluscio, R. A., M. Oesterheld and M. R. Aguiar. 2005. Relationship between phenology and life form: a test with 25 Patagonian species. *Ecography*, 28(3): 273-282.
- Gruber, G. 1977. Gletscher und Schneegrenze in Chitral. *Frankf. Wirtsch.-Sozialgeogr. Schr.*, 26: 99-139.
- Guo, Q. S., X. F. Wang, G. Bar, Y. Kang, M. Hong, S. X. Pei and F. J. Zhang. 2009. Life form spectra, leaf character, and hierarchical-synusia structure of vascular plants in *Thuja sutchuehensis* community. *Pub Med.*, 20 (9): 2057-2062.
- Gutierrez, D., S. Mendoza, V. Serrano, M. Bah, R. Pelz, P. Balderas and F. Leon. 2008. Proximate composition, mineral content, and antioxidant properties of 14 Mexican weeds used as fodder. *Weed Biology & Management*. 8 (4): 291-296.

- Gwali, S., P. Okullo, D. Hafashimana and D. M. Bayabashaija. 2010. Diversity and composition of trees and shrubs in Kasagala forest: a semiarid savannah woodland in central Uganda. *African J. Ecol.*, 48(1): 111-118.
- Hadi, F., P. Akhtar, S. M. Shah and F. Hussain. 2009. Graveyard of Palosi, District Peshawar, as an example of conservation of local plants. *PUTAJ Sci.*, 16: 21-28.
- Hadi, F., A. Razzaq, A. Rahman and A. Rashid. 2013. Ethnobotanical notes on woody plants of Rech Valley, Torkhow, District Chitral, Hindu-Kush range, Pakistan. *Scholarly Journal of Agricultural Science*. 3(11): 468-472.
- Hadi, F. and M. Ibrar. 2013. Ethnobotany and conservation status of non-flowering plants of Kalash valley, district Chitral, Hindukush range, Pakistan. *J. Sc. & Tech. Univ. Peshawar*. 37 (2): 1-6.
- Hadi, F. and M. Ibrar. 2014. Ethnobotanical Profile of Gymnospermic Flora of Kalash Valley, District Chitral, Hindu-Kush Range, Pakistan. *American-Eurasian J. Agric. & Environ. Sci.*, 14 (12): 1405-1408.
- Hadi, F., M. Ibrar and N. Zaidi. 2014. Role of Dag Behsud graveyard in conservation of indigenous medicinal flora of district Nowshera, Pakistan. *Scholarly Journal of Agricultural Science*. 4(2): 87-89.
- Hadi, F., A. Rahman, M. Ibrar, G. Dastagir, M. Arif, K. Naveed and M. Adnan. 2014. Weed diversity with special reference to their ethnomedicinal uses in wheat and maize at Rech valley, Hindukush range, Chitral, Pakistan. *Pak. J. Weed Sci. Res.*, 20 (3): 335-346.
- Hadi, F. and M. Ibrar. 2015. Weeds as a source of medicines for the descendants of Alexander the Great in Kalash valley, district Chitral, Hindukush range, Pakistan. *Pak. J. Weed Sci. Res.*, 21(4): 565-574.
- Han, X., Z. Hu, G. Xin, X. Shi, D. Huang and G. Zhang. 2014. Studies on the characteristics of vegetation and soil on mount Sejila, Tibet. *Pak. J. Bot.*, 46(2): 457-464.
- Haq, F. 2012. The Ethno Botanical Uses of Medicinal Plants of Allai Valley, Western Himalaya Pakistan. *International Journal of Plant Research*. 2 (1): 21-34.
- Haserodt, K. 1996. The geographical features and problems of Chitral: A short introduction. In: *Proceedings of the Second International Hindukush Conference*, (Ed.), E. Bashir & Israruddin. Oxford University Press.
- Heady, H. G. 1964. Palatability of herbage and animal preferences. *J. Range management*, 17:

76-82.

- Heywood, V. H. and J. M. Iriondo. 2003. Plant conservation: old problems, new perspectives. *Biological Conservation*, 113 (3): 321-335.
- Hickman, K. R., D. C. Hartnett, R. C. Cochran and C. E. Owensby. 2004. Grazing management effects on plant species diversity in tall grass prairie. *Rangeland Ecol. & Management*. 57 (1): 58-65.
- Hirata, M., N. Koga, H. Shinjo, H. Fujita, G. Gintzburger, J. Ishida and A. Miyazaki. 2005. Measurement of above-ground plant biomass, forage availability and grazing impact by combining satellite image processing and field survey in a dry area of north-eastern Syria. *Grass & Forage Science*. 60 (1): 25-33.
- Hopkins, C., J. P. Marais and D. C. V. Goodenough. 2002. A comparison, under controlled environmental conditions, of a *Lolium multiflorum* selection bred for high dry matter content and nonstructural carbohydrate concentration with a commercial cultivar. *Grass & Forage Science*, 57: 367-372.
- Hurka, A. H. 2004. Species richness and composition during sylvigenesis in a tropical dry forest in northwestern, Costa Rica. *Tropical Ecology*, 45 (1): 43-57.
- Hussain, F. 1989. Field and laboratory manual of Plant Ecology. UGC, Islamabad.
- Hussain, F., L. Badshah, P. Sanaullah and M. J. Durrani. 2004. Ethnobotany of timber wood species of South Waziristan, Pakistan. *Pak. J. Pl. Sci.*, 10 (1): 9-16.
- Hussain, F., I. Iqbal and P. Akhtar. 2005. Floristic and vegetation studies of Ghalegay Hills, District Swat, Pakistan. *Inter. J. Biol. & Biotechnology*. 2 (4):847-852.
- Hussain, F. and M. J. Durrani. 2007. Forage productivity of arid temperate Harboi rangeland, Kalat, Pakistan. *Pak. J. Bot.*, 39 (5): 1455-1470.
- Hussain, F., S. M. Shah and H. Sher. 2007. Traditional resource evaluation of some plants of Mastuj, district Chitral, Pakistan. *Pak. J. Bot.*, 39(2): 339-354.
- Hussain, F. and M. J. Durrani. 2008. Mineral composition of some range grasses and shrubs from Harboi rangeland Kalat, Pakistan. *Pak. J. Bot.*, 40 (6): 2513-2523.
- Hussain, F. and M. J. Durrani. 2009. Seasonal availability, palatability and animal preferences of forage plants in Harboi arid range land, Kalat, Pakistan. *Pak. J. Bot.*, 41(2): 539-554.
- Hussain, M. I. and A. Perveen. 2009. Plant biodiversity and phytosociological attributives of Tiko Baran (Kirthar Range). *Pak. J. Bot.*, 41 (2): 581-586.

- Hussain, A., S. N. Mirza, I. A. Khan and M. A. Naeem. 2009. Determination of relative species composition and seasonal plant communities of nurpur reserved forest in scrub rangelands of District Chakwal. *Pak. J. Agri. Sci.*, 46 (1): 55-59.
- Hussain, A., M. A. Farooq, M. Ahmad, M. Akbar and M. U. Zafar. 2010. Phytosociology and Structure of Central Karakoram National Park (CKNP) of Northern Areas of Pakistan. *World Applied Sciences Journal*. 9 (12): 1443-1449.
- Hussain, S. S., M. Ahmad, M. F. Siddiqui and M. Wahab. 2010b. Threatened and endangered native plants of Karachi. *J. Biol. Biotech.*, 7 (3): 259-266.
- Hussain, M.I. and A. Perveen. 2015. Phytosociological attributes of the plant biodiversity of the Fort Ranikot and adjoining area (Kirthar range). *Pak. J. Bot.*, 47(3): 927-935.
- Hussain, F., S. M. Shah, L. Badshah and M.J. Durrani. 2015. Diversity and ecological characteristics of Flora of Mastuj Valley, district Chitral, Hindukush Range, Pakistan. *Pak. J. Bot.*, 47(2): 495-510.
- Ibrar, M., F. Hussain and A. Sultan. 2007. Ethnobotanical studies on plant resources of Ranyal hills, district Shangla, Pakistan. *Pak. J. Bot.*, 39(2): 329-337.
- Ighbareyeh, M. H. J., A. Cano-Ortiz, A. A. Suliemih, M. M. H. Ighbareyeh and E. Cano. 2014. Phytosociology with other Characteristic Biologically and Ecologically of Plant in Palestine. *American Journal of Plant Sciences*. 5 (20): 4236-4249.
- Ikram, A., N.B. Zahra, Z. K. Shinwari and M. Qaiser. 2015. Ethnomedicinal review of folklore medicinal plants belonging to family Apiaceae of Pakistan. *Pak. J. Bot.*, 47(3): 1007-1014.
- Ilyas, M., R. Qureshi, M. Arshad and S. N. Mirza. 2013. A preliminary checklist of the vascular flora of Kabal Valley, Swat, Pakistan. *Pak. J. Bot.*, 45(2): 605-615.
- Ishtiaq, M., W. Hanif, M. A. Khan, A. Ashraf and A. M. Butt. 2007. An ethnomedicinal survey and documentation of important medicinal folklore food phytonims of flora of Samahni valley, (Azad Kashmir) Pakistan. *Pak. J. Biol. Sci.*, 10 (13): 2241-2256.
- Ishtiaq, M., P. Iqbal and T. Hussian. 2013. Ethnobotanical uses of Gymnosperms of Neelam valley and Muzaffarabad of Kashmir. *Indian J. Traditional knowledge*. 12 (3): 404-410.
- IUCN. 2001. IUCN Red List Categories and Criteria: Version 3.1. IUCN Species Survival Commission. IUCN. Gland. Switzerland and Cambridge, UK. 2: 30.
- Jabbar, A., M. A. Raza, Z. Iqbal and M. N. Khan. 2006. An inventory of the ethnobotanicals

- used as anthelmintics in the southern Punjab (Pakistan). *J Ethnopharmacol.*, 108 (1): 152-154.
- Jafari, R., M. M. Lewis and B. Ostendorf. 2007. Evaluation of vegetation indices for assessing vegetation cover in southern arid lands in South Australia. *The Rangeland J.*, 29: 9-49.
- Jamshed, S., A. Ullah and A. Rashid. 2014. Tree species and their associated conservation issues at Hayatabad Township, Khyber Pakhtunkhwa Peshawar, Pakistan. *Int. J. Biol. Biotech.*, 11 (2-3): 309-317.
- Jan, G., M. A. Khan and F. Jan. 2009. Traditional Medicinal and Economic Uses of Gymnosperms of Dir Kohistan Valleys, NWFP, Pakistan. *Ethnobotanical Leaflets* 13: 1509-21.
- Kakudidi, E.K. 2004. Cultural and social uses of plants from and around Kibale National Park. Western Uganda. *African J. Ecol.* 42(1): 114-118.
- Kamal, M., S. M. Wazir, M. Hassan, M. Subhan, S. U. Khan, A. Muhammad and S. Taj. 2009. Ethnobotanically important plants of District Bannu, Pakistan *Pak. J. Pl. Sci.*, 15 (2): 87-93.
- Kar, P. K., A. K. Biswal and K. L. Barik. 2010. Floristic composition and biological spectrum of a grassland community of Rangamatia in the district of Mayurbhanj, Odisha. *J. Curr. Sci.*, 15 (2): 465-469.
- Karsten, W., S. Miehe and G. Miehe. 2005. Plant communities of the Gobi Gurvan Sayhan National Park (Aymak South Gobi, Mongolia). *Candollea*, 60 (1): 149-205.
- Katende, A.B. 2004. The diversity of macrophytes in some Kyoga basin lakes and their importance as fish habitats. *African J. Ecology*, 42 (1): 42-45.
- Khalik, K. A., M. El-Sheikh and A. El-Aidarous. 2013. Floristic diversity and vegetation analysis of Wadi al-Noman, Mecca, Saudi Arabia. *Turk. J. Bot.* 37: 894-907.
- Khan, Z. I., A. Hussain, M. Ashraf, E. E. Valeem and I. Javed. 2005. Evaluation of variation in soil and forage micro-mineral concentrations in a semiarid region of Pakistan. *Pak. J. Bot.*, 37 (4): 921-931.
- Khan, I., R.A. Islam and M. Saeed. 2005. Ethnobotanical studies on some medicinal and aromatic plants in districts Buner, Swat and Chitral. ICE 2006. Chiang Rai, Thailand.
- Khan, Z. I., A. Hussain, M. Ashraf and L. R. McDowell. 2006a. Mineral status of soils and

- forages in southwestern Punjab-Pakistan: Micro-minerals. *Asian-australasian J. Animal Sciences*, 19 (8): 1139-1147.
- Khan, Z. I., M. Ashraf and E. E. Valeem. 2006b. Forage mineral status evaluation: The influence of pastures. *Pak. J. Bot.*, 38 (4): 1043-1054.
- Khan, S. W. and S. Khatoon. 2007. Ethnobotanical studies on useful trees and shrubs of Haramosh and Bugrote Valleys in Gilgit northern areas of Pakistan. *Pak. J. Bot.* 39 (3): 699-710.
- Khan, Z. I., M. Ashraf, E. E. Valeem, K. Ahmad and M. Danish. 2007a. Pasture concentration of minerals in relation to the nutrient requirements of farm livestock. *Pak. J. Bot.*, 39 (6): 2183-2191.
- Khan, Z.D. and A.A. Sardar. 2008. A checklist of vascular plants of Tehsil Shakargarh district Narowal, Pakistan. *Pak. J. Pl. Sci.*, 14(1): 15-19.
- Khan, S. U., S. M. Wazir, M. Subhan, M. Zahoor, M. Kamal and S. Taj. 2009. Some of the ethnobotanically important plants of F.R. Bannu, NWFP, Pakistan. *Pak. J. Pl. Sci.*, 15 (1): 81-85.
- Khan, N., M. Ahmed, M. Wahab and M. Ajaib. 2010. Phytosociology, structure and physiochemical analysis of soil in *Quercus baloot* Griff, district Chitral Pakistan. *Pak. J. Bot.*, 42(4): 2429-2441.
- Khan, N., M. Ahmed, A. Ahmed, S.S. Shaukat, M. Wahab, M. Ajaib, M. F. Siddiqui and M. Nasir. 2011. Important medicinal plants of Chitral Gol National Park (CGNP) Pakistan. *Pak. J. Bot.*, 43(2): 797-809.
- Khan, M. and F. Hussain. 2012. Palatability and animal preferences of plants in Tehsil Takht-e-Nasrati, District Karak, Pakistan. *Afr. J. Agric. Res.* 7 (44): 5858-5872.
- Khan, M. A., M. A. Khan, G. Mujtaba and M. Hussain. 2012. Ethnobotanical study about medicinal plants of poonch valley Azad kashmir. *The journal of animal & plant sciences*, 22(2): 493-500.
- Khan, N. A. and M. Shah. 2013. Eco-taxonomic study of family Brassicaceae of District Mardan, Khyber Pukhtoon- Khwa, Pakistan. *PJLS.* 1(1): 28-35.
- Khan, M. A., A. Ullah, A. Rashid, S. M. Shah and S. Fida. 2014. Floristic leaf-size and life form spectra of Asshab Baba Graveyard Chaghar Matti, district Peshawar, Khyber Pakhtunkhwa, Pakistan. *Int. J. Biol. Biotech.*, 11 (1): 167-171.

- Khan, M., F. Nouroz, M.F. Khan and S. Rizwan. 2015. Nutritional values of selected date palm varieties in Pakistan. *American-Eurasian J. Agric. & Environ. Sci.*, 15 (5): 764-768.
- Khan, R.U., S. Mehmood, A. Muhammad, S. Mussarat, S. U. Khan and Amina. 2015. Medicinal plants from flora of Bannu used traditionally by North West Pakistan's women to cure gynecological disorders. *American-Eurasian j. Agric. & environ. Sci.*, 15 (4): 553-559.
- Khan, Z.A., K. Ahmad, M. Ashraf, R. Parveen, I. Mustafa, A. Khan, Z. Bibi and N.A. Akram. 2015. Bioaccumulation of heavy metals and metalloids in *Luffa (Luffa cylindrica L.)* irrigated with domestic wastewater in Jhang, Pakistan: A prospect for human nutrition.
- Khan, M. T., S. Hashim, S. Ayub, A. Jan and K.B. Marwat. 2015. A case study of ethnobotany and biodiversity conservation from Tehsil Barawal, Upper Dir, Khyber Pakhtunkhwa, Pakistan. *Pak. J. Bot.*, 47(SI): 7-13.
- Khan, M.A, A. Ullah and A. Rashid. 2015. Ethnoveterinary medicinal plants practices in district Peshawar, Khyber Pakhtunkhwa Pakistan. *Pak. J. Bot.*, 47(SI): 105-114.
- Khan, W.M., S.Z. Shah and M.S. Khan. 2016. Ethnobotanical relevance of the weed flora of Tall Dardyal, tehsil Kabal, district Swat, Pakistan. *Pak. J. Weed Sci. Res.* 22(1): 125-145.
- Khattak, M.I. and M.I. Khattak. 2012. Study of heavy metals in some medicinal herbal plants of Pakistan. *Pak. J. Bot.* 43(4): 2003-2009.
- Kiyani, S. A., A. Masood, A. K. Khan and S. Ambreen. 2007. Distribution of secondary metabolites in plants of Quetta-Balochistan. *Pak. J. Bot.*, 39 (4): 1173-1179.
- Kiyani, A. K. 2008. Farm size and productivity in Pakistan. *European J. Social Sci.*, 7 (2): 42-52.
- Knoop, M. C. and N. O. Smith. 2006. Foraging ecology of roan antelope: key resources during critical periods. *African J. Ecology*, 44 (2): 228-236.
- Koca, I., I. Hasbay, S. Bostanci, V.A. Yilmaz and A.F. Koca. 2015. Some Wild Edible Plants and Their Dietary Fiber Contents. *Pakistan Journal of Nutrition*. 14 (4): 188-194.
- Pak. J. Bot.*, 47(1): 217-224.
- Korkmaz, M., Z. Alpaslan, N. Turgut and V. Ilhan. 2014. Ethnobotanical aspects of some geophytes from Ergani Mountain, Turkey. *Bangladesh J. Bot.* 43(3): 315-321.
- Korkmaz, M. and S. Karakuş. 2015. Traditional uses of medicinal plants of Üzümlü district, Erzincan, Turkey. *Pak. J. Bot.*, 47(1): 125-134.
- Kotresha, K., S.V. Kambhar and N.S. Harihar. 2011. Floristic composition of woody species in Karnataka College Dharwad (KCD), Karnataka, India. *Life Sci. Leaflets*. 18: 656-669.

- Kramberger, B. and S. Klemencic. 2003. Effect of harvest date on the chemical composition and nutrient value of *Ceratium holosteoides*. *Grass & Forage Sci.*, 58: 12-16.
- Kumar, M.S., N. Ayyapan, N. Parthasarathy, D. Mudappa, T.R.S. Raman, M.A. Selwyn and L.A. Pragasan. 2006. Plant community structure in tropical rain forest fragment of the western Ghats, India. *Biotropica*. 38(2): 143-160.
- Kumar, J. I. N., P. R. Sajish, R. N. Kumar and K. Patel. 2011. Biomass and Net Primary Productivity in Three Different Aged *Butea* Forest Ecosystems in Western India, Rajasthan. *Iranica J. Energy & Environment*, 2 (1): 01-07.
- Kumar, M., R.W. Bussmann, J. Mukesh and P. Kumar. 2011. Ethnomedicinal uses of plants close to rural habitation in Garhwal Himalaya, India. *J. Med. Pl. Res.*, 5(11): 2252-2260.
- Laidlaw, M., R. Kitching., K. Goodall., A. Small and N. Stork. 2007. Temporal and spatial variation in an Australian tropical rainforest. *Austral. Ecology*, 32 (1): 10-20.
- Liddell, M. J., N. Nieullet, O. C. Campoe and A. Freiberg. 2007. Assessing the aboveground biomass of a complex tropical rainforest using a canopy crane. *Aust. Ecol.*, 32 (1): 43-58.
- Loeser, M. R. R., T. D. Sisk and T. E. Crews. 2007. Impact of grazing intensity during drought in Arizona Grassland. *Conservation Biology*, 21 (1): 87-97.
- Lovett, J. C., A. R. Marshall and J. Carr. 2006. Changes in tropical forest vegetation along an altitudinal gradient in the Udzungwa Mountains National Park, Tanzania. *African J. Ecology*, 44 (4): 478-490.
- Lucas, R. W., T. T. Baker, M. K. Wood, C. D. Allison and D. M. Vanleeuwen. 2004. Riparian vegetation response to different intensities and seasons of grazing. *J. Range Management*, 57 (5): 466-474.
- Lutfullah, G., H. Tila, A. Hussain and A. A. Khan. 2014. Evaluation of Plants Extracts for Proximate Chemical Composition, Antimicrobial and Antifungal Activities. *American-Eurasian J. Agric. & Environ. Sci.*, 14 (10): 964-970.
- Macia, M. J. 2004. Multiplicity in palm uses by the Huaorani of Amazonian Ecuador. *Botanical J. Linn. Society*. 144 (2): 149-159.
- Maestre, F. T., M. A. Bradford and J. F. Reynolds. 2006. Soil heterogeneity and community composition jointly influence grassland biomass. *J. Vegetation Science*, 17 (3): 261-270.
- Mahmood, A., A. Mahmood and A. Tabassum. 2011. Ethnomedicinal survey of plants from district Sialkot, Pakistan. *J. App .Pharm.*, 2 (3):212-220.

- Malik, N. Z. and Z. H. Malik. 2004. Present status of subtropical chirpine vegetation of Kotli Hills, Azad Jammu and Kashmir. *J. Res. Sci.*, 15 (1): 85-90.
- Malik, Z. H., F. Hussain and N. Z. Malik. 2007. Life form and Leaf Size Spectra of Plant Communities Harboursing Ganga Chotti and Bedori Hills during 1999-2000. *International J. Agriculture & Biology*. 9 (6): 833-838.
- Malik, A.R., M.A.A. Siddique, P.A. Safi and J.S. Butola. 2011. Ethnomedicinal practices and conservation status of medicinal plants of North Kashmir Himalayas. *Res. J. Med. Pl.*, 5(5): 515-530.
- Manan, Z., Sirajuddin, A. Razzaq, M. Islam and Ikramullah. 2007. Diversity of medicinal plants in Wari subdivision District Dir Upper, Pakistan. *Pak. J. Pl. Sci.*, 13(1): 19-26.
- Manhas, R. K., L. Singh, H. B. Vasistha and M. Negi. 2010. Floristic diversity of protected ecosystems of Kandi Region of Punjab, India. *New York Science Journal*, 3 (4): 96-103.
- Maoe, A. A., T. M. Hynniewta and M. Sanjappa. 2009. Plant wealth of Northeast India with reference to ethnobotany. *IJTK*, 8 (1): 96-103.
- Mapinduzi, A. L., G. Oba, R. B. Weladji and J. E. Colman. 2004. Use of indigenous ecological knowledge of the Maasai pastoralists for assessing rangeland biodiversity in Tanzania. *African J. Ecology*. 41 (4): 329-336.
- Maria, G. A., R. M. Harley, D. Q. L. Paganucci, M. D. G. L. Wanderley and V. D. B. Cassio. 2005. Biodiversity and conservation of plants in Brazil. *Conservation Biology*, 19 (3): 632-639.
- Marwat, S. K., F. Rehman, K. Usman, A.A Khakwani, S. Ghulam, N. Anwar, M. Sadiq and S.J. Khan. 2011. Medico-ethnobotanical studies of edible wild fruit plants species from the flora of North Western Pakistan (D. I. Khan district). *Journal of Medicinal Plants Research*. 5(16): 3679-3686.
- McDowell, L. R. 2003. Minerals in animals and human nutrition. 2nd ed. 144 p. Elsevier Science BV Amsterdam, Netherlands.
- Mendez, E. 2005. The vegetation of Laguna de Llanqueto provincial reserve (Mendoza, Argentina). *Candollea*. 60 (1): 123-148.
- Miah, M. D., H. A. Rashid and M. Y. Shin. 2009. Wood fuel use in the traditional cooking stoves in the rural floodplain areas of Bangladesh: A socio-environmental perspective. *Biomass & Bioenergy*, 33 (1): 70-78.

- Milewski, A. V. and D. Madden. 2006. Interactions between large African browsers and thorny *Acacia* on a wildlife ranch in Kenya. *African J. Ecology*, 44 (4): 515-522.
- Miller, S. M. and R. P. Thompson. 2005. Seasonal patterns of diet composition, herbage intake and digestibility identify limitations to performance of weaker sheep grazing native pasture in the Falkland Islands. *Grass & Forage Science*. 60 (4):356-366.
- Mirza, S.N., M. Athar and M. Qayyum. 2009. Effect of drought on rangeland productivity and animal performance in dryland regions of Baluchistan, Pakistan. *Agriculture Conspectus Scientificus*. 74(2): 105-109.
- Mónica A. V. Solana, V. Y. M. García, A. T. Valencia, G. G. Arenas, J. S. Pacheco, J. J. A. Romero and E. S. Campos. 2015. Nutritional Content and Elemental and Phytochemical Analyses of *Moringa oleifera* Grown in Mexico. *Journal of Chemistry*. Article ID 860381, 9 pages. <http://dx.doi.org/10.1155/2015/860381>.
- Muoghalu, J. I. and O. O. Okeesan. 2005. Climber species composition, abundance and relationship with trees in a Nigerian secondary forest. *African J. Ecology*. 43(3): 258-266.
- Murad, W., A. Ahmad, G. Ishaq, M. S. Khan, A. M. Khan, I. Ullah, Azizullah and I. Khan. 2012. Ethnobotanical studies on plant resources of Hazar Nao Forest, district Malakand, Pakistan. *Pak. J. Weed Sci. Res.*, 18(4): 509-527.
- Murad, W., A. Azizullah, M. Adnan, A. Tariq, K. U. Khan, S. Waheed and A. Ahmad. 2013. Ethnobotanical assessment of plant resources of Banda Daud Shah, District Karak, Pakistan. *J. Ethnobiol. Ethnomedi*. 9:77. 1-10.
- Murtaza, M.G. 1962. *Nai Tarikh e Chitral*. Public Art press, Peshawar, Pakistan.
- Musila, W. M., J. I. Kinyamario and P. D. Jungerius. 2003. Vegetation dynamics of coastal sand dunes near Malindi, Kenya. *African J. Ecology*, 39 (2): 170-177.
- Mustafa, A., M. Hameed, R. Jabeen and A. Hamzazai. 2015. Ethno Botanical Study of Plants Used by People of Quetta as Cosmetics and Phytochemical Test of Some Selected Plants. *American-Eurasian J. Agric. & Environ. Sci.*, 15 (4): 523-528.
- Muthuramkumar, S., N. Ayyappan, N. Parthasarathy, M. Divya, S. T. R Raman, S. M. Arthur and P. L. Arul. 2006. Plant community structure in tropical rain forest fragments of the Western Ghats, India. *Biotropica*. 38 (2): 143-160.
- Nasrullah, M. Nisar, Suliman and Z. Ali. 2012. Ethnobotanical Wealth of Jandool Valley, Dir Lower, Khyber Pakhtunkhwa (Kpk), Pakistan. *Intern. J. Phytomedicine*. 4: 351-354.

- Nasir, Y.J. and S.I. Ali, 1970-1989. Flora of Pakistan. Karachi and Islamabad.
- Nasir, Z. A. and S. Sultan. 2002. Floristic, biological and leaf size spectra of weeds in gram, lentil, mustard and wheat fields of district Chakwal, Pakistan. *Pakistan J. Biological Sciences*, 5 (7): 758-762.
- Nazir, A and Z. H. Malik. 2006. Life form and index of similarity of plant communities recorded at Sarsawa Hill District Kotri. *J. Res. Sci.*, 17 (1): 27-33.
- Nazir, A., R. N. Malik and M. Ajaib. 2012. Phytosociological Studies of the vegetation of Sarsawa Hills District Kotli, Azad Jammu & Kashmir. *BIOLOGIA (PAKISTAN)*. 58: (1&2), 123-133.
- Neal, J. E. and B. P. Miller. 2007. Livestock grazing impacts on desert vegetation, Khirthar National Park, Pakistan. *Rangeland Ecology & Management*. 60 (6): 680-684.
- Nickel, A. 2002. Rare, threatened and legally protected plants of Nowy Sacz (Polish western Carpathians). *Fragm. Flor. Geobot. Polonica*. 9: 135-140.
- Nisar M. F., F. Jaleel, S. M. Haider, Y. Toor, S. Ismail, M. Arfan and M. Azeem. 2014. Exploration of Ethno-Medicinal Plants and Their Ritual Uses in Bahawalnagar, Pakistan. *Middle-East Journal of Scientific Research*. 21 (9): 1466-1471.
- Noman, A., I. Hussain, Q. Ali, M. A. Ashraf and M. Z. Haider. 2013. Ethnobotanical studies of potential wild medicinal plants of Ormara, Gawadar, Pakistan. *Emir. J. Food Agric*. 25 (10): 751-759.
- Noor, M.J. and U. Kalsoom. 2011. Ethnobotanical studies on selected plants of Ratwal valley, district Attock. Pakistan. *Pak. J. Bot.*, 43 (2):781-786.
- Noor, M. J., M. Ahmad, M. Zafar, M. Sarfraz, I. Yusoff, Y. Alias and M. A. Ashraf. 2014. Floristic and ethnoecological diversity in various habitats of a semi-arid area in the Chakwal district (Pakistan), with special emphasis on medicinal plants. *Plant Ecology*. 215 (8): 1-17.
- Osman, A. K., F. Al-Ghamdi and A. Bawadekji. 2014. Floristic diversity and vegetation analysis of Wadi Arar: A typical desert Wadi of the Northern Border region of Saudi Arabia. *Saudi Journal of Biological Sciences*. 21 (6): 554–565.
- Olsen, S. R. and L. E. Sommers. 1982. Phosphorus. In: Methods of Soil Analysis, Part 2 (2nd ed.), Madison, WI, USA, pp. 406-407.
- Omer, R. M., A.J. Hester, I.J. Gordon, M.D. Swaine and S.M. Rafique. 2006. Seasonal changes

- in pasture biomass production and off take under transhumance system in northern Pakistan. *J. Arid. Environ.* 67: 641-660.
- Parswan, K., J. P. Mehta and Sobodh. 2010. Floristic composition and biological spectrum of vegetation of alpine meadows of Kedarnath: Garhwal Himalaya. *Nature and Sci.*, 8(7): 109-115.
- Parvaiz, M., K. H. Bhatti, K. Nawaz, Z. Hussain, R. M. W. Khan and A. Hussain. 2013. Ethno-Botanical Studies of Medicinal Plants of Dinga, District Gujrat, Punjab, Pakistan. *World Applied Science Journal*. 26 (6): 826-833.
- Perveen, A., G. R. Sarwar and I. Hussain. 2008. Plant biodiversity and phytosociological attributes of Dureji (Khirthar Range). *Pak. J. Bot.*, 40 (1): 17-24.
- Peters, H. A. 2007. The significance of small herbivores in structuring annual grassland. *J. Vegetation Science*. 18 (2): 175-182.
- Phillips, W. A., P. J. Starks, S. Glasgow and S. W. Coleman. 2007. Different methods of estimating crude protein concentration of Bermuda grass pastures for stocker calf production. *Professional Animal Scientist*. 23: 696 -701.
- Pirzada, A.J., W. Shaikh, T.G. Kazi, P. Iqbal, K.U. Ghazi and H. Abro. 2005. Analysis of essential elements and anti fungal activity of medicinal plants *Fagonia critica* L. against dermatophytes. *Sindh Uni. Res. J.*, 37(2):9-16.
- Poonam, K. and G.S. Sing. 2009. Ethnobotanical study of medicinal plants used by the Taungya community in Terai Arc Landscape, India. *J. Ethnopharmacology*. 123(1): 167-176.
- Pradhan, S.D., N.C. Palei, P. Bhakta, K. Rath and K.K. Swain. 2015. Assessment of Floristic Diversity of Mangrove Vegetation in Bagagahan Heronry of the Bhitarkanika National Park, Odisha, India. *American-Eurasian J. Agric. & Environ. Sci.*, 15 (2): 237-242.
- Prakash, K. C. 2005. Indigenous uses, population density and conservation of threatened medicinal plants in protected areas of the Indian Himalayas. *Conservation Biology*, 19 (2): 368-378.
- Provenza, F. D. 1996. Post ingestive feedback as an elemental determinant of food reference and intake in ruminants. *J. Range Management*. 48: 2-17.
- Qaisar, M., S. Farooq, S. N. Gilani, M. A. Wasim, M. Kakar, S. W. A. Shah and A. Rauf. 2013. Ethnobotanical Survey of Medicinal Plants Used in Wazir and Daur Tribes of North Waziristan, Pakistan. *Global Veterinaria*. 11 (3): 285-292.

- Qamar, Z. Q., M. Anwar, N. I. Dar and U. Ali. 2010. Ethno-Botanical Study of Wild Medicinal Plants of Neelum valley, Azad Jammu & Kashmir, Pakistan. *Pak. J. Wildl.*, 1(1): 25-30.
- Qasem, J. R. 2015. Prospects of wild medicinal and industrial plants of saline habitats in the Jordan valley. *Pak. J. Bot.*, 47(2): 551-570.
- Qasim, M., S. Gulzar, Z. K. Shinwari, I. Aziz and M. A. Khan. 2010. Traditional ethnobotanical uses of halophytes from Hub, Baluchistan. *Pak. J. Bot.*, 42 (3): 1543-1551.
- Qureshi, R. and G. R. Bhatti. 2005. Nara Desert, Pakistan: Part II: Human Life. *Rangelands (USA)*. 27 (5): 32-35.
- Qureshi, R. A., S. A. Gilani and M. A. Ghufuran. 2007. Ethnobotanical studies of plants of Mianwali district Punjab, Pakistan. *Pak. J. Bot.*, 39 (7): 2285-2290.
- Qureshi, R. 2008. Vegetation assessment of Sawan Wari of Nara desert, Pakistan. *Pak. J. Bot.*, 40 (5): 1885-1895.
- Qureshi, R. and G. R. Bhatti. 2008b. Taxonomy of Scrophulariaceae from Nara Desert, Pakistan. *Pak. J. Bot.*, 40 (3): 973-978.
- Qureshi, R., H. Shaheen, M. Ilyas, W. Ahmed and M. Munir. 2014. Phytodiversity and plant life of Khanpur Dam, Khyber Pakhtunkhwa, Pakistan. *Pak. J. Bot.*, 46(3): 841-849.
- Rafay, M., R. A. Khan, S. Yaqoob and M. Ahmad. 2013. Floristic composition of grass species in the degrading rangelands of Cholistan desert. *Pak. J. Agri. Sci.*, 50(4): 599-603.
- Rafique, S.M. 2005. The current use of forage resources of the northern mountainous region of N.W.F.P., Pakistan and its implication for sustainable development. *Pak. J. Forestry*. 55(1): 1-12.
- Rahim, I. U., J. I. Sultan, M. Yaqoob, H. Nawaz, I. Javed and M. Hameed. 2008. Mineral profile, palatability and digestibility of marginal land grasses of trans-himalayan grasslands of Pakistan. *Pak. J. Bot.*, 40 (1): 237-248.
- Rahim, S. M. A., S. Hasnain, R. A. Shamsi and F. Jabeen. 2011. The phytosociological analysis of saline area of Tehsil Ferozewala, district Sheikhupura (Punjab), Pakistan. *African J. Environmental Science and Technology*. 5(4): 316-326.
- Rakotoarimanana, V. and M. Grouzis. 2006. Influence of fire and grazing on richness and floristic diversity of a savanna dominated by *Heteropogon contortus* in the southwest of Madagascar (region of Sakaraha). *Condollea*. 61(1): 167-188.
- Randal, D. J. and B. A. Diaz. 2006. Spring-fed wetland and riparian plant communities respond

- differently to alter grazing intensity. *J. Appl. Ecology*, 43 (3): 485-498.
- Rao, P. S., B. Sujatha, K. Lakshminarayana and S. V. Ratnam. 2013. A study on Phytosociology, soil conservation and socio-economic aspects in red sand dunes near Bhimili of Visakhapatnam. *Archives of Applied Science Research*. 5 (1):45-56.
- Rashid, A., M. F. Swati, H. Sher and M. N. Al-Yemeni. 2011. Phytoecological evaluation with detail floristic appraisal of the vegetation around Malam Jabba, Swat, Pakistan. *Asian Pac. J. Trop. Biomed*. 1(6): 461–467.
- Rathod, M.M. and G.S. Chaughary. 2004. Biodiversity of ethnomedicinal wild plants from Patnadevi forest of Maharashtra, India. In A. Kumar. 2004. *Biodiversity and Environment*. 443-449.
- Raunkiaer, C. 1934. The life forms of plants and Statistical Plant Geography. Clrendon Press, Oxford.
- Rawat, L., R. K. Manhas, D. Kholiya and S. K. Kamboj. 2013. Floristic Diversity of Kandi Region of Hoshiarpur, Punjab, India. *Applied Ecology and Environmental Sciences*. 1(4): 49-54.
- Ray, J.G. and J. George. 2009. Phytosociology of roadside communities to identify ecological potential of tolerant species. *JENE*. 1(8): 184-190.
- Rayan, J. N., R. W. Harvey, D. W. Metge and J. E. Larson. 1997. Transport of bacteriophage PRD1 and silica colloids in a sewage-contaminated aquifer. *Eos*, Transactions of the American Geophysical Union 86, F231. Presented at the Fall Meeting of the American Geophysical Union.
- Raza, H. and A. Ullah. 2014. Diversity and economic importance of tree species in the Peshawar cantonment, Khyber Pakhtunkhwa, Pakistan. *J. Sc. & Tech. Univ. Peshawar*. 38 (1): 1-7.
- Razzaq, A., A. Rashid, M. Islam, A. Iqbal and H. Khan. 2013. Ethnomedicinal profile and conservation status of Plant Biodiversity in Alexander the Great Valley, District Shangla, Pakistan. *Journal of Medicinal Plants Research*. 7(20): 1379-1386.
- Rhoades, J. D. 1982. Soluble salts. In: *Methods of Soil Analysis, Part 2* (2nd. ed.), Madison, WI, USA, pp. 169–173.
- Richard, L. A. 1954. Diagnoses and improvement of saline and alkali soils. *Agriculture Hand Book*, 60: USDA, USA.
- Rosenschein, A., T. Tietema and D. O. Hall. 1999. Biomass measurement and monitoring of

- trees and shrubs in a semi-arid region of central Kenya. *J. Arid Environment*, 42: 97-116.
- Ross, S. M., J. R. King, J. T. O. Donovan and D. M Spaner. 2005. The productivity of oats and berseem clover intercrops. II. Effects of cutting date and density of oats on annual forage yield. *Grass & Forage Science*. 60 (1): 87-98.
- Rothschild, M., G. Bergstrom and S.A. Wangerg. 2005. *Cannabis sativa*: volatile compounds from pollen and entire male and female plants of two variants, Northern Light and Hawaiian Indica. *Bot. J. Linn. Soc.*, 147(4): 387-397.
- Ruiz, J., M.C. Fandino and R.L. Chazdon. 2005. Vegetation structure, composition and species richness across a 56-year chronosequence of dry tropical forest on Providencia Island, Columbia. *Biotropica*. 37 (4): 520-530.
- Ruizhi, W., H. Yaning, R.Y. Yuan and R. Yukui. 2015. Metal contents in *Glycine max* (L.) Merr. from seven provinces of China. *Bangladesh J. Bot.* 44 (1): 151-154.
- Saeed, M., Z.U.D. Khan and M. Ajaib. 2012. Some phytosociological studies of chasmophytes and epiphytes of Lahore city. *Pak. J. Bot.*, 44: 165-169.
- Sağlam, C. 2013. A phytosociological study of the forest, shrub, and steppe vegetation of Kızıldağ and environs (Isparta, Turkey). *Turk J Bot.* 37: 316-335.
- Sahito, S., T. Kazi, G.H. Kazai, M.A. Jakharani, A.J. Pirzada, A.N. Memon, M.A. Memon and H.R. Sheikh. 2004. Analysis of total and available elements in medicinal plant *Moringa oleifera* using atomic absorption spectrophotometer. *Hamdard Medicus*. XLVII (4):14-18.
- Saima, S., A. A. Dasti, Q. Abbas and F. Hussain. 2010. Floristic diversity during monsoon in Ayubia National Park District Abbottabad Pakistan. *Pak. J. Pl. Sci.*, 16 (1): 43-50.
- Sardar A. A and Z. U. Khan. 2009. Ethnomedicinal studies on plant resources of Tehsil Shakargarh, District Narowal, Pakistan. *Pak. J. Bot.*, 41 (1): 11-18.
- Saranya, A., T. S. Ramanathan, K. S. Kesavanarayanan and A. Adam. 2015. Traditional Medicinal Uses, Chemical Constituents and Biological Activities of a Mangrove Plant, *Acanthus ilicifolius* Linn. : A Brief Review. *American-Eurasian J. Agric. & Environ. Sci.*, 15 (2): 243-250.
- Schlaepfer, M.A., D.F. Sax and D.J. Olden. 2011. The potential conservation value of non-native species. *Cons. Biol.* 25(3): 428-437.
- Segawa, P. and D. N. Nkuutu. 2006 .Diversity of vascular plants on Ssesse islands in Lake Victoria, Central Uganda. *African J. Ecology*. 44 (1): 22-29.

- Seiler, G. J. and L. G. Campbell. 2004. Genetic variability for mineral element concentrations of wild Jerusalem artichoke forage. *Crop Sci.*, 44: 289-292.
- Shah, S.M., F. Hussain and M. Ibrar, 2006. Floristic composition, life form and leaf size spectra of summer plants of Mastuj, District Chitral. *PUTAJ Science*, 13: 167-179.
- Shah, S.M. and F. Hussain. 2007. Ecology of waterlogged habitats around Chamkani, district Peshawar. *PUTAJ*. 14: 55-64.
- Shah, S. M. and F. Hussain. 2008. Ecology of wetlands of Akbarpura, District Nowshera. *Pak. J. Pl. Sci.*, 14 (1): 47-57.
- Shah, M. and F. Hussain. 2008. Ethnobotanical study of some medicinal plants of Mount Elum, district Buner, Pakistan. *Pak. J. Pl. Sci.*, 14(2): 91-95.
- Shah, M. and F. Hussain. 2009. Phytosociological study of the vegetation of Hayat Abad Peshawar, Pakistan. *Pak. J. Pl. Sci.*, 15 (2): 123-128.
- Shah, S. M. and F. Hussain. 2012. Ethnomedicinal plant wealth of Mastuj valley, Hindukush range, District Chitral, Pakistan. *Journal of Medicinal Plants Research*. 6(26): 4328-4337.
- Shah, M. and F. Hussain. 2012. Conservation assessment of Plant resources of Chakesar valley, district Shangla, KPK, Pakistan. *Pak. J. Bot.*, 44 (special issue): 179-186.530.
- Shah, S.M. 2014. Ecological evaluation of rangeland resources in Mastuj valley, Hindukush Range, Pakistan. *Ph.D. Thesis*. Department of Botany. University of Peshawar.
- Shah, M. and Rozina. 2013. Phytosociological attributes and phytodiversity of Dheri baba hill and Peer Taab Graveyard, District Swabi, Khyber Pakhtunkhwa, Pakistan. *PJLS*. 1(1): 1-16.
- Shah, S.M. and F. Hussain. 2014. Evaluation of Micro-Minerals and Nutritional Status of Some Forage Grasses in Mastuj Valley, Hindukush Range, Pakistan. *Pakistan Journal of Nutrition*. 13 (11): 622-625.
- Shah, A.H., S. M. Khan, A. H. Shah, A. Mehmood, I. Rahman and H. Ahmad. 2015. Cultural uses of plants among Basikhel tribe of district Tor Ghar, Khyber pakhtunkhwa, pakistan. *Pak. J. Bot.*, 47(SI): 23-41.
- Shaheen, H., Z.K. Shinwari, R.A. Qureshi and Z. Ullah. 2012. Indigenous plant resources and their utilization practices in village population of Kashmir Himalayas. *Pak. J. Bot.*, 44 (2):739-745.

- Shaheen, H., R. Qureshi, I. Zahra, M. Munir and M. Ilyas. 2014. Floristic diversity of Santh Saroola, Kotli Sattian, Rawalpindi, Pakistan. *Pak. J. Bot.*, 46(6): 1945-1954.
- Shaheen, H., R. Qureshi, A. Akram, M. Gulfraz and D. Potter. 2014. A preliminary floristic checklist of Thal Desert Punjab, Pakistan. *Pak. J. Bot.*, 46(1): 13-18.
- Shaheen, H., N.M. Malik and M.E.I. Dar. 2015. Species composition and community structure of subtropical Forest stands in western Himalayan foothills of Kashmir. *Pak. J. Bot.*, 47(6): 2151-2160.
- Sharma, K. K. and A. K. Pandey. 2010. Phytosociological study of vegetation of some selected arid region of the Thar desert of Rajasthan, India. *Curr. World Environ.* 5 (1):51-58.
- Sharma, P., J. C. Rana, U. Devi, S. S. Randhawa and R. Kumar. 2014. Floristic Diversity and Distribution Pattern of Plant Communities along Altitudinal Gradient in Sangla Valley, Northwest Himalaya. *The Scientific World Journal*.10:1155-1164.
- Shaukat, S.S., M. A. Khan, M. Mett and M.F. Siddiqui. 2014. Structure, composition and diversity of the vegetation of Hub Dam catchment area, Pakistan. *Pak. J. Bot.*, 46(1): 65-80.
- Sheikh, I., A. Naz, Hazirullah, Q. Khan, W. Khan and N. Khan. 2014. An Ethnographic Analysis of Death and Burial Customs in Kalash Community of Chitral District of Khyber Pakhtunkhwa Pakistan. *Middle-East Journal of Scientific Research* 21 (10): 1937-1946.
- Shimwell, D. W. 1971. The Description and Classification of Vegetation Sedgwick and Jackson, p: 322. London.
- Sher, Z. and Z. Khan. 2007. Floristic composition, life form and leaf size spectra of the vegetation of Chagharzai valley, district Buner. *Pak. J. Pl. Sci.*, 13(1): 55-64.
- Sher, H., A. Ahmad, m. Eleyemeni and S.F. Hadi. 2010. Impact of nomadic grazing on the medicinal plants diversity in Miandam, Swat-Pakistan (Preliminary results). *Int. J. Biod. Cons.*, 2(6): 146-154.
- Sher, Z., Z. D. Khan and F. Hussain. 2011. Ethnobotanical studies of some plants of Chagharzai Valley, district Buner, Pakistan. *Pak. J. Bot.*, 43(3): 1445-1452.
- Sher, Z., F. Hussain and M. Saleem. 2014. Macro-minerals status at three phonological stages of some forage shrubs of Gadoon Hills, district Swabi, Khyber Pakhtunkhwa, Pakistan. *Pak. J. Bot.* 44(2): 711-716.
- Shimwell, D. W. 1971. The Description and Classification of Vegetation Sedgwick and

- Jackson. 322. London.
- Shinwari, Z. K., S. Malik, A. M. Karim, R. Faisal and M. Qaiser. 2015. Biological activities of commonly used medicinal plants from Ghazi Brotha, Attock District. *Pak. J. Bot.*, 47(1): 113-120.
- Shuaib, M., I. Khan, Sharifullah, R. Khan, Hashmatullah, S. Mubarik and R. Naz. 2014. Ethnobotanical studies of spring flora of Dir Lower, Khyber Pakhtunkhwa, Pakistan. *Pak. J. Weed Sci. Res.*, 20(1): 37-49.
- Siddiqui, M. F., M. Ahmad, N. Khan and I. A. Khan. 2010. Quantitative description of moist temperate conifer forests of Himalayan region of Pakistan and Azad Kashmir. *Int. J. Biol. Biotech.*, 7 (3): 175-85.
- Smith, T., V. Mlambo, J. L. N. Sikosana, V. Maphosa, I. Mueller-Harvey and E. Owen. 2005. *Dichrostachys cinerea* and *Acacia nilotica* fruits as dry season feed supplements for goats in a semi-arid environment: Summary of a DFID funded project in Zimbabwe. *Animal Feed Science & Technology*. 122 (1-2): 149-157.
- Smit, C., J. D. Ouden and H. Muller-Scharer. 2006. Unpalatable plants facilitate tree sapling survival in wooded pastures. *J. Appl. Ecology*. 43 (2): 305-312.
- Srivastava, R.K., V.P. Khanduri, C.M. Sharma and P. Kumar. 2005. Structure, diversity and regeneration potential of Oak dominant conifers mixed forest along an altitudinal gradient in Garhwal Himalaya. *Indian forester*. 131(12): 1537-1553.
- Staaland., H., I. Brattbakk, K. Ekern and K. Kildemo. 2006. Chemical composition of reindeer forage plants in Svalbard and Norway. *Ecography*. 6 (2): 109-122.
- Starks, P. J., D. Zhao, W. A. Phillips and S. W. Coleman. 2006. Development of canopy reflectance algorithms for real-Time prediction of Bermuda grass pastures biomass and nutritive values. *Crop Sci.*, 46: 927-934.
- Storeheier, P., V, S. D. Mathiesen, J. C. Tyler, N, I. Schjelderup and M. A. Olsen. 2002. Utilization of nitrogen- and mineral-rich vascular forage plants by reindeer in winter. *J. Agricultural Science*, 139 (2): 151-160.
- Sultan, J. I., I. U. Rahim, M. Yaqoob, M. I. Mustafa, H. Nawaz and P. Akhtar. 2009. Nutritional evaluation of herbs as fodder source for ruminants. *Pak. J. Bot.*, 41(6): 2765-2776.
- Tahira, M., A. Bahadur, Z. Shah, M. Danish, S. Khalid. 2012. Elemental and Nutritional analysis

- and Ethnomedicinal Study of Selected Wild Plants Species of District Swabi, Khyber Pakhtunkhwa, Pakistan. *Journal of Pharmacy Research*. 5(9): 4910-4913.
- Tardío, J., M. P. D. Santayana and R. Morales. 2006. Ethnobotanical review of wild edible plants in Spain. *Botanical J. Linn. Society*, 152 (1): 27-71.
- Tandon, P. Kumaria, S. Nongrum and Laibadaiahun. 2009. Conservation and management of plant genetic resources of Northeast India. *IJTK*, 8 (1): 29 - 34.
- Tareen, R. B. and S. A. Qadir. 1993. Life form and Leaf size spectra of the plant communities of diverse areas ranging from Harnai, Sinjawī to Duki regions of Pakistan. *Pak. J. Bot.*, 25 (1): 83-92.
- Tiffany, M. E., L. R. McDowell, G. A. O'Connor, H. Nguyen, F. G. Martin, N. S. Wilkinson and E. C. Cardoso. 2000. Effects of pasture applied biosolids on forage and soil concentrations over a grazing season in north Florida. I. Macrominerals. Crude Protein and *In Vitro* Digestibility. *Commun. Soil Sci. Plant Anal.*, 31: 201-203.
- Timothy, D., M. Porath, C. T. Parsons and J. A. Morrison. 2005. Management strategies for sustainable beef cattle grazing on forested rangelands in the Pacific Northwest. *Rangeland Ecology & Management*, 58 (2): 119-127.
- Tripathi, S. and R. P. Shukla. 2007. Effect of clipping and grazing on various vegetational parameters of grassland communities of Gorakhpur, U.P. *Trop. Ecology*, 48 (1): 61-70.
- Tripathi, K.P. and B. Sing. 2009. Species diversity and vegetation structure across various strata in natural and plantation forests in Keterniaght wildlife sanctuary, north India. *Tropical Ecology*. 50(1): 191-200.
- Torell, L.A., K.C. McDaniel and V. Koren. 2011. Estimating grass yield on Blue Gana Range from seasonal rainfall and moisture measurements. *Rangeland Ecol. & Manage.*, 64(1):56-66.
- Ture, C. and H. Bocuk. 2007. An investigation on the diversity, distribution and conservation of *Poaceae* species growing naturally in Eskişehir Province (Central Anatolia–Turkey). *Pak. J. Bot.*, 39 (4): 1055-1070.
- Uddin, S., M. Ali, S. Ali, S. Shah, S. Ullah and Z. Hussain. 2016. Ethnobotanical studies of weeds at district Mardan, Pakistan. *Pak. J. Weed Sci. Res.* 22(3): 481-490.
- Ullah, A. and A. Rashid. 2014. Conservation status of threatened medicinal plants of Mankial

- Valley Hindukush Range, Pakistan. *Int. J. Biodiv. Conserv.* 61(1): 59-70.
- Ullah, S., A. Ullah and A. Rashid. 2014. Utilization of plant natural resources by the local communities in Landi Kotal valley Khyber Agency, Pakistan. *Int. J. Biol. Biotech.*, 11 (4): 617-621.
- Ullah, Z., M. Ahmad and S.M. Khan. 2015. Phytogeographic analysis and Diversity of grasses and Sedges (*Poales*) of Northern Pakistan. *Pak. J. Bot.*, 47(SI): 93-104.
- Ullah, A. and A.U. Rahman. 2016. Conservation issues of medicinal plants of Zewar Valley Upper Chitral, Hindukush Range Pakistan. *Pak. J. Weed Sci. Res.* 22(1): 147-156.
- Uysal, I., S. Gucel, T. Tutenocakli and M. Ozturk. 2012. Studies on the medicinal plants of Ayvacik-Canakkale in Turkey. *Pak. J. Bot.*, 44(1): 239-244.
- Volesky, J.D., W.H. Schacht and D.M. Richardson. 2004. Stocking rate and grazing frequency effects on Nebraska sand hills meadows. *J. Range. Manage.*, 57: 553-560.
- Wahab, M., M. Ahmad, N. Khan, and A. M. Sarangzai. 2010. A phytosociological study of Pine forest from District Dir, Pakistan. *J. Biol. Biotech.*, 7 (3): 219-226.
- Walpole, M. J., N. Moriaso and M. Charles. 2004. Status of the Mara woodlands in Kenya. *African J. Ecology*, 42 (3): 180-188.
- Wang, R. Z. 2004. Responses of *Leymus chinensis* (*Poaceae*) to long-term grazing disturbance in the Songnen grasslands of north-eastern China. *Grass & Forage Science*, 59 (2): 191-195.
- Wariss, H. M., M. Mukhtar, S. Anjum, G. R. Bhatti, S. A. Pirzada and K. Alam. 2013. Floristic Composition of the Plants of the Cholistan Desert, Pakistan. *American Journal of Plant Sciences*. 4 (12): 1009-1015.
- Wariss, H.M., S. A. Pirzada, K. Alam, S. Anjum and R. Qureshi. 2014. Flora of Lal Suhanra National Park, Bahawalpur, Punjab, Pakistan. *Pak. j. bot.*, 46(4): 1331-1341.
- Wazir, S. M., A. A. Dasti and J. Shah. 2004. Common medicinal plants of Chapursan Valley, Gojalli, Gilgit Pakistan. *J. Res. Sci.*, 15 (1): 41-43.
- Wu, W., J. Hu, W. Duan, Y. Shen, Z. Cao and Q. Shu. 2015. Study on the chemical components of shoots and leaves of *Camellia oleifera* from different elevations. *Pak. J. Bot.*, 47(3): 1111-1114.
- Xianping, Z., M. Wang, B. She and Y. Xiao. 2006. Quantitative classification and ordination of

- forest communities in Pangquangou National Nature Reserve. *Acta Ecologica Scsinica*, 26 (3): 754-761.
- Yadav, A. S. and S. K. Gupta. 2007. Effect of micro-environment and human disturbance on the diversity of herbaceous species in Sariska Tiger Project. *Tropical Ecology*, 48 (1): 125-128.
- Yuming, Y., W. Kanglin, P. Shengji and H. Jiming . 2004. Bamboo diversity and traditional uses in Yunnan. China. *Mountain Research & Development*, 24 (2):157-165.
- Zabiullah, Q., N. Akhter and A. Rashid. 2007. A checklist of plants in Manzaray Baba valley, Malakand Agency, Pakistan. *Pak. J. Pl. Sci.*, 13(1): 111-117.
- Zahoor, M., S. M. Wazir, A. Muhammad and S. F. Muhammad. 2009. Ethnobotany of some plants from Darra-e Pezo, District Lakki Marwat, Pakistan. *Pak. J. Pl. Sci.*, 15 (1): 75-80.
- Zaidi, M.A., S. Khan, N. Jahan, A. Yousafzai and A. Mansoor. 2012. Micropropagation and conservation of three *Juniperus* species (Cupressaceae). *Pak. J. Bot.*, 44(1): 301-304.
- Zereen, A. and Z. Khan. 2012. A survey of ethnobotanically important trees of Central Punjab, Pakistan. *BIOLOGIA (PAKISTAN)*. 58 (1&2): 21-30.
- Zereen, A., Z. Khan and M. Ajaib. 2013. Ethnobotanical evaluation of the shrubs of Central Punjab, Pakistan. *BIOLOGIA (PAKISTAN)*.59 (1): 139-146.
- Zhao, D., P. J. Starks, B. K. Kindiger and C. T. Mackown. 2008. Interspecies variation of forage nitrogen and nonstructural carbohydrate concentrations in perennial coolseason grasses. *Agronomy J.*, 100 (3): 1-8.

Appendix 1. Phytosociological attributes of *Salix-Tamarix-Mentha* (STM) at Bumburet in water course site at an altitude of 1700m-1810m.

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Salix acmophylla</i> Boiss	8.5	9.0	70	10.24	10.05	11.86	32.15a
2	<i>Tamarix dioica</i> Roxb. ex Roth.	7.5	8.0	60	9.03	8.94	10.16	28.13b
3	<i>Mentha longifolia</i> L.	7.0	7.0	50	8.43	7.82	8.47	24.72c
4	<i>Maricaria squamosa</i> Desv.	6.0	6.5	40	7.23	7.26	6.78	21.27
5	<i>Trifolium repens</i> L.	5.0	5.5	40	6.02	6.14	6.78	18.94
6	<i>Plantago lanceolata</i> L.	5.0	5.0	30	6.02	5.59	5.08	16.69
7	<i>Epilobium hirsutum</i> L.	5.0	5.0	30	6.02	5.59	5.08	16.69
8	<i>Plantago major</i> Aitch.	4.5	5.0	20	5.42	5.59	3.39	14.40
9	<i>Juncus articulata</i> L.	4.5	4.5	20	5.42	5.03	3.39	13.84
10	<i>Phragmites karka</i> (Retz.) Trin ex Steud.	3.5	4.0	30	4.22	4.47	5.08	13.77
11	<i>Cynodon dactylon</i> (L.) Pers.	3.5	3.5	10	4.22	3.91	1.69	9.83
12	<i>Taraxicum officinale</i> Weber	3.0	3.0	10	3.61	3.35	1.69	8.66
13	<i>Ranunculus muricatus</i> L.	2.5	2.5	10	3.01	2.79	1.69	7.50
14	<i>Primula denticulata</i> Sm.	2.5	2.5	10	3.01	2.79	1.69	7.50
15	<i>Lactuca serriola</i> L.	2.5	2.5	10	3.01	2.79	1.69	7.50
16	<i>Veronica anagallis-aquatica</i> L.	2.0	2.0	10	2.41	2.03	1.69	6.14
17	<i>Lotus corniculata</i> L.	2.0	2.0	10	2.41	2.03	1.69	6.14
18	<i>Chenopodium botrys</i> L.	1.0	2.0	10	1.20	2.03	1.69	4.93
19	<i>Nasturtium officinale</i> R. Br.	1.0	1.0	10	1.20	1.12	1.69	4.02
20	<i>Viburnum cotinifolium</i> D. Don.	1.0	1.0	10	1.20	1.12	1.69	4.02
21	<i>Capsella bursa-pastoris</i> (L.) Medic.	1.0	1.0	10	1.20	1.12	1.69	4.02
22	<i>Impatiens balsamina</i> L.	0.5	1.5	10	0.60	1.52	1.69	3.82
23	<i>Impatiens edgeworthii</i> Hk. f. FBI	0.5	1.0	10	0.60	1.12	1.69	3.42
24	<i>Sonchus asper</i> (L.) Hill	0.5	1.0	10	0.60	1.12	1.69	3.42
25	<i>Poa annua</i> L.	0.5	1.0	10	0.60	1.12	1.69	3.42
26	<i>Eragrostis poaeoides</i> P. Beave.	0.5	0.5	10	0.60	0.55	1.69	2.85
27	<i>Matricaria aurea</i> L.	0.5	0.5	10	0.60	0.55	1.69	2.85
28	<i>Salix linearifolia</i> E. Wolf.	0.5	0.5	10	0.60	0.55	1.69	2.85
29	<i>Melilotus officinale</i> (L.) Desr.	0.5	0.5	10	0.60	0.55	1.69	2.85
30	<i>Medicago sativa</i> L.	0.5	0.5	10	0.60	0.55	1.69	2.85
	Total	83	89.5	590	99.93	99.23	99.87	299.19

Appendix 2. Phytosociological attributes of *Artemisia-Artemisia-Quercus* (AAQ) at Bumburet in water course site at an altitude of 2110m-2200m.

S #	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Artemisia brevifolia</i> Wall. Ex DC.	7.5	8.0	70	7.42	6.69	7.69	21.80a
2	<i>Artemisia scoparia</i> Waldst. & Kit.	7.0	7.5	70	6.93	6.27	7.69	20.89b
3	<i>Quercus baloot</i> Griffith.	6.5	7.5	70	6.43	6.27	7.69	20.39c
4	<i>Arum jacquemontii</i> Blume	6.5	7.0	60	6.43	5.85	6.59	18.87
5	<i>Impatiens balsamina</i> L.	6.0	7.5	60	5.94	6.27	6.59	18.80
6	<i>Medicago sativa</i> L.	6.0	6.5	60	5.94	5.43	6.59	17.96
7	<i>Artemisia maritima</i> L.	6.0	6.5	60	5.94	5.43	6.59	17.96
8	<i>Juglans regia</i> L.	5.0	6.0	50	4.95	4.18	5.49	14.62
9	<i>Verbascum thapsus</i> L.	5.0	6.0	40	4.95	4.18	5.39	14.52
10	<i>Rosa webbiana</i> Wall ex DC.	5.0	6.0	40	4.95	4.18	4.39	13.62
11	<i>Chenopodium botrys</i> L.	5.0	5.5	40	4.60	4.18	4.39	13.17
12	<i>Ranunculus lanata</i> L.	4.5	5.0	40	4.45	3.76	4.39	12.60
13	<i>Chenopodium album</i> L.	4.5	5.0	30	4.45	3.76	3.29	11.50
14	<i>Taraxicum officinale</i> Weber	4.5	5.0	20	4.45	3.76	2.19	10.40
15	<i>Tribulus terrestris</i> L.	3.0	4.0	20	2.97	3.34	2.19	8.50
16	<i>Adiantum capillus-veneris</i> L.	3.0	4.0	20	2.97	3.34	2.19	8.50
17	<i>Equisetum ramossimum</i> Desf.	3.0	4.0	10	2.97	3.34	1.09	7.40
18	<i>Elaeagnus angustifolia</i> L.	2.0	2.5	20	1.98	2.09	2.19	6.26
19	<i>Cotoneaster microphylla</i> Wall ex Lind.	2.0	3.0	10	1.98	2.51	1.09	5.58
20	<i>Echinops echinatus</i> Roxb.	2.0	2.0	10	1.98	1.67	1.09	4.74
21	<i>Kochia indica</i> Wight.	1.0	2.5	10	0.99	2.09	1.09	4.17
22	<i>Dicanthium annulatum</i> Forrsk. Stapf.	1.5	2.0	10	1.48	1.67	1.09	4.24
23	<i>Sophora mollis</i> (Royle) Baker	0.5	1.5	10	0.46	1.25	1.09	2.80
24	<i>Lotus corniculata</i> L.	0.5	1.0	10	0.46	0.84	1.09	2.39
25	<i>Lactuca serriola</i> L.	0.5	1.0	10	0.46	0.84	1.09	2.39
26	<i>Plantago lanceolata</i> L.	0.5	1.0	10	0.46	0.84	1.09	2.39
27	<i>Anagalis arvensis</i> L.	0.5	1.0	10	0.46	0.84	1.09	2.39
28	<i>Conyza bonariensis</i> (L.) Cronquist	0.5	0.5	10	0.46	0.42	1.09	1.97
29	<i>Indigofera heterantha</i> var. <i>heterantha</i> L.	0.5	0.5	10	0.46	0.42	1.09	1.79
30	<i>Astragalus grahamianus</i> Royle	0.5	0.5	10	0.46	0.42	1.09	1.79
31	<i>Pulicaria salviaefolia</i> Bunge	0.5	0.5	10	0.46	0.42	1.09	1.79
	Total	101	120.5	910	99.29	99.55	100.79	296.19

Appendix 3. Phytosociological attributes of *Quercus-Artemisia-Sophora* (QAS) at Bumburet in at an altitude of 2300m-2410m.

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Quercus baloot</i> Griffith.	9.0	9.0	80	11.69	9.94	8.99	30.62a
2	<i>Artemisia scoparia</i> Waldst. & Kit.	7.0	7.5	60	9.09	8.29	6.74	24.12b
3	<i>Sophora mollis</i> (Royle.) Baker	6.0	6.5	60	7.79	7.18	6.74	21.71c
4	<i>Juglans regia</i> L.	5.5	6.5	50	7.14	7.18	5.62	19.94
5	<i>Salvia nubicola</i> wall. ex Sweet	5.5	6.0	50	7.14	6.63	5.62	19.39
6	<i>Artemisia brevifolia</i> Wall ex DC	5.5	6.0	50	7.14	6.63	5.62	19.39
7	<i>Verbascum thapsus</i> L.	4.0	5.0	40	5.19	5.52	4.49	15.20
8	<i>Cotoneaster microphylla</i> Wall ex Lind.	4.0	5.0	40	5.19	5.52	4.49	15.20
9	<i>Capparis spinosa</i> L.	4.0	5.0	40	5.19	5.52	4.49	15.20
10	<i>Crataegus songarica</i> C. Koch.	4.0	4.5	40	5.19	4.97	4.49	14.65
11	<i>Euphorbia peplus</i> L.	3.5	4.5	40	4.54	4.97	4.49	14.00
12	<i>Cousinia mattfeldii</i> Bornm.	3.5	4.0	40	4.54	4.42	4.49	13.45
13	<i>Pinus wallichiana</i> A.B. Jackson	3.0	3.5	30	3.90	3.87	3.37	11.14
14	<i>Cedrus deodara</i> (Roxb. ex Lamb.) G. Don.	2.5	3.5	30	3.25	3.87	3.37	10.49
15	<i>Taraxacum officinale</i> Weber	1.0	2.0	30	1.29	2.21	3.37	6.87
16	<i>Tulipa stellata</i> Hk. f.	1.0	2.0	30	1.29	2.21	3.37	6.87
17	<i>Bromus tectorum</i> L.	1.0	1.5	20	1.29	1.66	2.25	5.20
18	<i>Cynodon dactylon</i> (L.) Pers.	1.0	1.5	20	1.29	1.66	2.25	5.20
19	<i>Dichanthium annulatum</i> (Forssk.) Stapf.	0.5	1.0	20	0.65	1.10	2.25	4.00
20	<i>Amaranthus viridis</i> L.	0.5	1.0	20	0.65	1.10	2.25	4.00
21	<i>Rhus punjabensis</i> Steward ex Brandis	0.5	1.0	20	0.65	1.10	2.25	4.00
22	<i>Bupleurum thomsonii</i> C.B. Clarke	0.5	0.5	10	0.65	0.55	1.12	2.32
23	<i>Cichorium intybus</i> L.	0.5	0.5	10	0.65	0.55	1.12	2.32
24	<i>Rheum emodi</i> Wall ex Meissn.	0.5	0.5	10	0.65	0.55	1.12	2.32
25	<i>Marrubium vulgare</i> L.	0.5	0.5	10	0.65	0.55	1.12	2.32
26	<i>Nepeta raphanorhiza</i> Bth.	0.5	0.5	10	0.65	0.55	1.12	2.32
27	<i>Periploca aphylla</i> Dcne.	0.5	0.5	10	0.65	0.55	1.12	2.32
28	<i>Mentha longifolia</i> (L.) Huds.	0.5	0.5	10	0.65	0.55	1.12	2.32
29	<i>Ephedra gerardiana</i> L.	0.5	0.5	10	0.65	0.55	1.12	2.32
	Total	77	90.5	890	99.29	99.95	99.96	299.2

Appendix 4. Phytosociological attributes of *Quercus-Sophora-Artemisia* (QSA) at Bumburet in at an altitude of 2550m-2640m.

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Quercus baloot</i> Griffith.	8.5	9.0	80	11.33	10.65	11.42	33.40a
2	<i>Sophora mollis</i> (Royle.) Baker	7.0	7.5	60	9.33	8.87	8.57	26.77b
3	<i>Artemisia scoparia</i> Waldst & Kit	6.0	6.5	60	8.00	7.69	8.57	24.26c
4	<i>Echinops echinatus</i> Roxb.	5.0	5.5	50	6.66	6.51	7.14	20.31
5	<i>Rosa webbiana</i> Wall ex Royle	5.0	5.5	50	6.66	6.51	7.14	20.31
6	<i>Cotoneaster nummularia</i> Fisch. & Mey	5.0	5.5	50	6.66	6.51	7.14	20.31
7	<i>Pinus wallichiana</i> A. B. Jackson	4.0	5.0	50	5.33	5.91	7.14	18.38
8	<i>Chenopodium botrys</i> L.	4.0	5.0	40	5.33	5.91	5.71	16.95
9	<i>Arum jacquemontii</i> Blume	4.0	4.0	40	5.33	4.73	5.71	15.77
10	<i>Dicanthium annulatum</i> Forssk. Stapf.	4.0	4.0	30	5.33	4.73	4.28	14.34
11	<i>Matricaria disciformis</i> (C.A.M.) DC. Prodr.	3.5	3.5	30	4.67	4.14	4.28	13.09
12	<i>Lactuca serriola</i> L.	3.0	3.5	20	4.00	4.14	2.85	10.99
13	<i>Rheum emodi</i> Wall ex Meissn.	2.0	2.5	20	2.66	2.95	2.85	8.46
14	<i>Solanum nigrum</i> L.	2.0	2.5	20	2.66	2.95	2.85	8.46
15	<i>Verbascum thapsus</i> L.	2.0	2.5	10	2.66	2.95	1.42	7.03
16	<i>Marrubium vulgare</i> L.	2.0	2.5	10	2.66	2.95	1.42	7.03
17	<i>Ailanthus altissima</i> (Mill.) Swingle	1.5	2.0	10	2.00	2.36	1.42	5.78
18	<i>Aristida cynantha</i> Nees & Steud.	1.5	2.0	10	2.00	2.36	1.42	5.78
19	<i>Nepeta brachyantha</i> Rech.	1.5	2.0	10	2.00	2.36	1.42	5.78
20	<i>Calamagrostis emodensis</i> Griseb.	1.0	1.0	10	1.33	1.18	1.42	3.93
21	<i>Tulipa stellata</i> Hk. f.	1.0	1.0	10	1.33	1.18	1.42	3.93
22	<i>Lolium rigidum</i> Gaud.	0.5	1.0	10	0.66	1.18	1.42	3.26
23	<i>Bupleurum exaltatum</i> Clarke	0.5	0.5	10	0.66	0.59	1.42	2.67
24	<i>Scrophularia stewartii</i> Penn.	0.5	0.5	10	0.66	0.59	1.42	2.67
	Total	75	84.5	700	99.91	99.90	99.85	299.66

Appendix 5. Phytosociological attributes of *Echinops-Quercus-Marrubium* (EQM) at Bumburet at an altitude of 2780m-2870m.

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Echinops echinatus</i> Roxb.	7.0	7.5	60	10.37	10.27	10.34	30.98a
2	<i>Quercus baloot</i> Griffith.	7.0	7.0	50	10.37	9.58	8.62	28.57b
3	<i>Marrubium vulgare</i> L.	6.0	6.5	50	8.88	8.90	8.62	26.40c
4	<i>Cedrus deodara</i> (Roxb. Ex Lamb.) G.Don	6.0	6.5	40	8.88	8.90	6.89	24.67
5	<i>Pinus wallichiana</i> A. B. Jackson	5.5	5.5	50	8.14	7.53	8.62	24.29
6	<i>Artemisia maritima</i> L.	4.5	5.0	60	6.66	6.84	10.34	23.84
7	<i>Verbascum thapsus</i> L.	4.0	4.5	50	5.92	6.16	8.62	20.70
8	<i>Salix acmophylla</i> Boiss.	4.0	4.0	50	5.92	5.47	8.62	20.01
9	<i>Sophora mollis</i> (Royle.) Baker	4.0	4.0	40	5.92	5.47	6.89	18.28
10	<i>Sedum ewersii</i> Ledeb.	3.5	3.5	30	5.18	4.79	5.17	15.14
11	<i>Galinsoga parviflora</i> Cav.	3.0	3.0	20	4.44	4.11	3.44	11.99
12	<i>Lactuca decipiens</i> (H. & T.) Clarke	3.0	3.0	20	4.44	4.11	3.44	11.99
13	<i>Matricaria disciformis</i> (C.A.M.) DC. Prodr.	3.0	3.0	10	4.44	4.11	1.72	10.27
14	<i>Sonchus oleraceus</i> L.	2.5	2.5	10	3.70	3.42	1.72	8.84
15	<i>Asperugo procumbens</i> L.	2.0	2.5	10	2.96	3.42	1.72	8.10
16	<i>Malcolmia africana</i> (L.) R. Br.	1.0	2.0	10	1.48	2.73	1.72	5.93
17	<i>Geranium rotundifolium</i> L.	1.0	1.5	10	1.48	2.05	1.72	5.25
18	<i>Lamium amplexicaule</i> L.	0.5	1.5	10	0.74	2.05	1.72	4.51
	Total	67.5	73	580	99.92	99.91	99.93	299.76

Appendix 6. Phytosociological attributes of *Indigofera-Cynoglossum-Scrophularia* (ICS) at Bumburet in site at an altitude of 3000m-3090m.

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Indigofera heterantha</i> var. <i>heterantha</i> L.	5.5	6.0	60	10.78	10.61	10.71	32.10a
2	<i>Cynoglossum lanceolatum</i> Forssk.	5.0	5.0	60	9.80	8.84	10.71	29.35b
3	<i>Scrophularia scoparia</i> Penn.	4.5	5.0	60	8.82	8.84	10.71	28.37c
4	<i>Prunus kuramica</i> (Korsh.) Kitam.	4.5	4.5	50	8.82	7.97	8.92	25.71
5	<i>Potentilla supina</i> L.	4.0	4.5	50	7.84	7.96	8.92	24.72
6	<i>Ephedra gerardiana</i> L.	4.0	4.0	40	7.84	7.07	7.14	22.05
7	<i>Viola canescens</i> Wall. ex Roxb.	3.0	4.0	40	5.88	7.07	7.14	20.09
8	<i>Nepeta brachyantha</i> Rech.	3.0	3.5	30	5.88	6.19	5.35	17.42
9	<i>Salvia moorcroftiana</i> Wall. ex Bth.	3.0	3.0	20	5.88	5.30	3.57	14.75
10	<i>Salvia nubicola</i> wall. ex Sweet	2.5	3.0	20	4.90	5.30	3.57	13.77
11	<i>Fraxinus xanthoxyloides</i> (Wall. ex G. Don) DC.	2.5	2.5	20	4.90	4.42	3.57	12.89
12	<i>Lamium amplexicaule</i> L.	1.5	2.0	20	2.94	3.53	3.57	10.04
13	<i>Cedrus deodara</i> (Roxb. Ex Lamb.) G.Don	1.5	1.5	20	2.94	2.65	3.57	9.16
14	<i>Epilobium hirsutum</i> L.	1.5	2.0	10	2.94	3.53	1.78	8.25
15	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	1.5	1.5	10	2.94	2.65	1.78	7.37
16	<i>Spiraea canescens</i> Lour.	1.0	1.5	10	1.96	2.65	1.78	6.39
17	<i>Codonopsis ovata</i> Bth.	1.0	1.0	10	1.96	1.77	1.78	5.51
18	<i>Juniperus excelsa</i> M. Bieb.	0.5	1.0	10	0.98	1.77	1.78	4.53
19	<i>Echinops echinatus</i> Roxb.	0.5	0.5	10	0.98	0.88	1.78	3.64
20	<i>Euphorbia peplus</i> L.	0.5	0.5	10	0.98	0.88	1.78	3.64
		51	56.5	560	99.96	99.88	99.91	299.75

Appendix 7. Phytosociological attributes of *Acantholimon-Juniperus-Epilobium* (AJE) at Bumburet in site at an altitude of 3200m-3310m

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	7.0	7.0	60	9.58	8.53	13.63	31.74a
2	<i>Juniperus excelsa</i> M. Bieb.	7.0	7.0	50	9.52	8.53	11.36	29.41b
3	<i>Epilobium royleanum</i> Hausskn.	6.5	7.0	50	8.91	8.53	11.36	28.80c
4	<i>Oxyria digyna</i> (L.) Hill.	6.0	7.0	40	8.25	8.53	9.10	25.88
5	<i>Juniperus communis</i> L.	6.0	6.5	30	8.25	7.93	6.81	22.99
6	<i>Pinus wallichiana</i> A. B. Jackson	6.0	6.0	30	8.25	7.31	6.81	22.37
7	<i>Indigofera heterantha</i> var. <i>heterantha</i> L.	5.5	6.0	20	7.57	7.31	4.54	19.42
8	<i>Scrophularia scoparia</i> Penn.	4.5	5.5	20	6.16	6.70	4.54	17.40
9	<i>Potentilla supina</i> L.	3.5	4.0	20	4.79	4.88	4.54	14.21
10	<i>Eragrostis poaeoides</i> P. Beave.	3.5	4.0	20	4.79	4.87	4.54	14.20
11	<i>Pimpinella diversifolia</i> DC.	3.5	3.5	10	4.79	4.26	2.27	11.32
12	<i>Matricaria disciformis</i> (C.A.M.) DC. Prodr.	2.5	3.0	10	3.42	3.65	2.27	9.34
13	<i>Salvia nubicola</i> wall. ex Sweet	2.0	3.0	10	2.73	3.65	2.27	8.65
14	<i>Cuscuta reflexa</i> Roxb.	2.0	2.5	10	2.73	3.04	2.27	8.04
15	<i>Taraxacum officinale</i> Weber	2.0	2.0	10	2.73	2.43	2.27	7.43
16	<i>Arabidopsis wallichii</i> (H. & T.) N. Busch.	1.5	2.0	10	2.05	2.43	2.27	6.75
17	<i>Arabis auriculata</i> Lam.	1.0	2.0	10	1.36	2.43	2.27	6.06
18	<i>Anaphalis contorta</i> L.	1.5	1.5	10	2.05	1.82	2.27	6.14
19	<i>Astragalus grahamianus</i> Royle. ex Bth.	1.0	1.5	10	1.36	1.82	2.27	5.45
20	<i>Geranium wallichianum</i> D. Don. Ex Sweet	0.5	1.0	10	0.68	1.22	2.27	4.17
	Total	73	82	440	99.97	99.87	99.93	299.77

Appendix 8. Phytosociological attributes of *Artemisia-Rosa-Quercus* (ARQ) at Rumbor in water course site at an altitude of 1100m-1230m.

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Artemisia brevifolia</i> Wall ex DC	8.0	8.5	80	7.24	6.46	8.33	22.03a
2	<i>Rosa webbiana</i> Wall ex Royle	7.5	8.5	80	6.79	6.46	8.33	21.58b
3	<i>Quercus baloot</i> L.	6.5	8.5	60	5.88	6.46	6.25	18.59c
4	<i>Chenopodium botrys</i> L.	6.5	7.5	60	5.88	5.70	6.25	17.83
5	<i>Mentha longifolia</i> L.	6.0	7.5	60	5.42	5.70	6.25	17.37
6	<i>Sophora mollis</i> (Royle.) Baker	6.0	7.0	60	5.42	5.32	6.25	16.99
7	<i>Trifolium repens</i> L.	5.0	7.0	60	4.52	5.32	6.25	16.09
8	<i>Tulipa stellata</i> Hk. f.	4.5	7.5	50	4.07	5.70	5.20	14.97
9	<i>Echinops echinatus</i> Roxb.	4.5	6.5	50	4.07	4.94	5.20	14.21
10	<i>Aristida cynantha</i> Nees ex Steud	4.5	6.0	40	4.07	4.56	4.16	12.97
11	<i>Chrysopogon echinulatus</i> (Nees ex Steud.) W. Wats	4.5	5.0	30	4.07	3.80	3.12	10.99
12	<i>Artemisia scoparia</i> Waldst & Kit.	4.5	4.5	30	4.07	3.42	3.12	10.61
13	<i>Epilobium hirsutum</i> L.	4.5	4.0	30	4.07	3.04	3.12	10.23
14	<i>Plantago major</i> Aitch.	4.0	4.0	30	3.62	3.04	3.12	9.78
15	<i>Cynodon dactylon</i> (L.) Pers.	3.5	4.0	30	3.16	3.04	3.12	9.32
16	<i>Verbascum thapsus</i> L.	3.5	3.5	30	3.16	2.66	3.12	8.94
17	<i>Plantago lanceolata</i> L.	3.5	3.5	30	3.16	2.66	3.12	8.94
18	<i>Lolium rigidum</i> Gaud.	3.0	3.5	20	2.71	2.66	2.08	7.45
19	<i>Taraxicum officinale</i> Weber	3.0	3.0	20	2.71	2.28	2.08	7.07
20	<i>Ranunculus muricatus</i> L.	3.0	3.0	10	2.71	2.28	1.04	6.03
21	<i>Primula denticulata</i> Sm.	3.0	3.0	10	2.71	2.28	1.04	6.03
22	<i>Lactuca serriola</i> L.	2.5	3.0	10	2.26	2.28	1.04	5.58
23	<i>Veronica anagallis-aquatica</i> L.	2.0	2.5	10	1.81	1.90	1.04	4.75
24	<i>Lotus corniculata</i> L.	2.0	2.5	10	1.81	1.90	1.04	4.75
25	<i>Chenopodium botrys</i> L.	1.5	2.0	10	1.35	1.52	1.04	3.91
26	<i>Cotoneaster nummularia</i> Fisch & May	1.0	1.5	10	0.90	1.14	1.04	3.08
27	<i>Acer pentapomicum</i> J.L. Stewart	1.0	1.5	10	0.90	1.14	1.04	3.08
28	<i>Dichanthium annulatum</i> (Forssk.) Stapf.	0.5	1.0	10	0.45	0.76	1.04	2.25
29	<i>Melilotus officinale</i> (L.) Desr.	0.5	1.0	10	0.45	0.76	1.04	2.25
30	<i>Peganum harmala</i> L.	0.5	1.0	10	0.45	0.76	1.04	2.25
		110.5	131.5	960	99.89	99.94	99.91	299.92

Appendix 9. Phytosociological attributes of *Quercus-Arum-Artemisia* (QAA) at Rumbor in water at an altitude of 1320m-1420m.

S #	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Quercus baloot</i> Griffith	8.0	8.0	80	5.99	5.49	6.55	18.03 _a
2	<i>Arum jacquemontii</i> Blume	7.5	8.0	80	5.61	5.49	6.55	17.65 _b
3	<i>Artemisia brevifolia</i> Wall. Ex DC.	7.5	8.5	70	5.61	5.84	5.73	17.18 _c
4	<i>Juglans regia</i> L.	7.5	8.0	70	5.61	5.49	5.73	16.83
5	<i>Medicago sativa</i> L.	7.5	7.5	70	5.61	5.15	5.73	16.49
6	<i>Echinops echinatus</i> Roxb.	7.5	7.5	60	5.61	5.15	4.91	15.67
7	<i>Taraxacum officinale</i> Weber	7.0	7.5	60	5.24	5.15	4.91	15.30
8	<i>Equisetum ramosissimum</i> Desf.	7.0	7.0	60	5.24	4.81	4.91	14.96
9	<i>Artemisia maritima</i> L.	6.5	7.0	60	4.87	4.81	4.91	14.59
10	<i>Cynoglossum lanceolatum</i> Forssk.	6.0	6.0	60	4.49	4.12	4.91	13.52
11	<i>Verbascum thapsus</i> L.	6.0	6.0	50	4.49	4.12	4.09	12.70
12	<i>Lepidium sativum</i> L.	5.5	6.0	50	4.11	4.12	4.09	12.32
13	<i>Malcolmia africana</i> (L.) R. Br.	5.5	6.0	50	4.11	4.12	4.09	12.32
14	<i>Rosa webbiana</i> Wall ex DC.	4.5	5.5	50	3.37	3.78	4.09	11.24
15	<i>Silene viscosa</i> (L.) Pers.	4.5	5.5	40	3.37	3.78	3.27	10.42
16	<i>Neslia apiculata</i> Fisch.	4.5	5.0	40	3.37	3.43	3.27	10.07
17	<i>Chenopodium botrys</i> L.	4.0	4.5	40	2.99	3.09	3.27	9.35
18	<i>Sedum ewersii</i> Ledeb.	3.5	4.0	30	2.62	2.74	2.45	7.81
19	<i>Silene vulgaris</i> (Moench) Garcke.	3.5	4.0	20	2.62	2.74	1.63	6.99
20	<i>Anagalis arvensis</i> L.	3.0	3.5	20	2.24	2.40	1.63	6.27
21	<i>Chenopodium album</i> L.	2.5	3.0	20	1.87	2.06	1.63	5.56
22	<i>Astragalus subumbellatus</i> Klotzsch.	2.5	3.0	10	1.87	2.06	0.81	4.74
23	<i>Cotoneaster microphylla</i> Wall ex Lind.	2.0	2.5	20	1.49	1.71	1.63	4.83
24	<i>Euphorbia falcata</i> L.	2.0	2.5	10	1.49	1.71	0.81	4.01
25	<i>Dipsacus inermis</i> var. <i>mitis</i> (D. Don) Y. Nasir	2.0	2.0	10	1.49	1.37	0.81	3.67
26	<i>Dicanthium annulatum</i> Forssk. Stapf.	1.0	2.0	10	0.74	1.37	0.81	2.92
27	<i>Sophora mollis</i> L.	1.0	1.0	10	0.74	0.68	0.81	2.23
28	<i>Trifolium repens</i> L.	1.0	1.0	10	0.74	0.68	0.81	2.23
29	<i>Calamintha vulgaris</i> (L.) Druce	0.5	1.0	10	0.37	0.68	0.81	1.86
30	<i>Nepeta raphanorhiza</i> Bth.	0.5	0.5	10	0.37	0.34	0.81	1.52

31	<i>Nepeta sewerzowii</i> Regel	0.5	0.5	10	0.37	0.34	0.81	1.52
32	<i>Conyza bonariensis</i> (L.) Conquist	0.5	0.5	10	0.37	0.34	0.81	1.52
33	<i>Indigofera heterantha</i> var. <i>heterantha</i> L.	0.5	0.5	10	0.37	0.34	0.81	1.52
34	<i>Salvia nubicola</i> wall. ex Sweet	0.5	0.5	10	0.37	0.34	0.81	1.52
		133.5	145.5	1220	99.82	99.84	99.70	299.36

Appendix 10. Phytosociological attributes of *Quercus-Rosa-Fraxinus* (QRF) at Rumbor in water at an altitude of 1570m-1650m.

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Quercus baloot</i> Griffith.	8.0	8.5	80	7.69	7.11	8.16	22.96a
2	<i>Rosa webbiana</i> Wall ex Royle	7.0	8.0	80	6.73	6.69	8.16	21.58b
3	<i>Fraxinus xanthoxyloides</i> (Wall. ex G. Don) DC.	6.0	8.0	70	5.76	6.69	7.14	19.59c
4	<i>Artemisia brevifolia</i> Wall ex DC	6.5	7.0	70	6.25	5.85	7.14	19.24
5	<i>Sophora mollis</i> (Royle.) Baker	6.0	7.0	60	5.76	5.85	6.12	17.73
6	<i>Paeonia emodi</i> Wall ex G. Don	6.0	6.5	60	5.76	5.43	6.12	17.31
7	<i>Juglans regia</i> L.	6.0	6.5	50	5.76	5.43	5.10	16.29
8	<i>Morus alba</i> L.	5.5	6.0	50	5.28	5.02	5.10	15.40
9	<i>Salvia nubicola</i> wall. ex Sweet	5.0	6.0	50	4.81	5.02	5.10	14.93
10	<i>Pinus gerardiana</i> L.	5.0	5.5	40	4.81	4.60	4.08	13.49
11	<i>Verbascum thapsus</i> L.	4.5	5.0	40	4.32	4.18	4.08	12.58
12	<i>Periploca aphylla</i> Dcne.	4.0	4.5	40	3.84	3.76	4.08	11.68
13	<i>Crataegus songarica</i> C. Koch.	4.0	4.5	30	3.84	3.76	3.06	10.66
14	<i>Euphorbia peplus</i> L.	3.5	4.5	30	3.36	3.76	3.06	10.18
15	<i>Cousinia matfeldii</i> Bornm.	3.5	4.0	30	3.36	3.34	3.06	9.76
16	<i>Pinus wallichiana</i> A.B. Jackson	3.5	4.0	20	3.36	3.34	2.04	8.74
17	<i>Cedrus deodara</i> (Roxb. ex Lamb.) G. Don.	3.5	3.5	20	3.36	2.92	2.04	8.32
18	<i>Taraxacum officinale</i> Weber	3.0	3.5	20	2.88	2.92	2.04	7.84
19	<i>Tulipa stellata</i> Hk. f.	3.0	3.0	20	2.88	2.51	2.04	7.25
20	<i>Rubia cordifolia</i> L.	2.0	3.0	20	1.92	2.51	2.04	6.29
21	<i>Cynodon dactylon</i> (L.) Pers.	1.5	2.5	10	1.44	2.09	1.02	4.55
22	<i>Dichanthium annulatum</i> (Forssk.) Stapf.	1.5	2.0	10	1.44	1.67	1.02	4.13
23	<i>Ephedra gerardiana</i> L.	1.0	1.5	10	0.96	1.25	1.02	3.23
24	<i>Cichorium intybus</i> L.	1.5	1.0	10	1.44	0.83	1.02	3.29
25	<i>Rheum emodi</i> Wall ex Meissn.	0.5	1.0	10	0.48	0.83	1.02	2.33
26	<i>Polygonum amplexicaule</i> D Don.	0.5	1.0	10	0.48	0.83	1.02	2.33
27	<i>Marrubium vulgare</i> L.	0.5	0.5	10	0.48	0.41	1.02	1.91
28	<i>Nepeta raphanorhiza</i>	0.5	0.5	10	0.48	0.41	1.02	1.91

	Benth.							
29	<i>Filipendula vestita</i> (Wall. ex G. Don) Maxim.	0.5	0.5	10	0.48	0.41	1.02	1.91
30	<i>Mentha longifolia</i> (L.) Huds.	0.5	0.5	10	0.48	0.41	1.02	1.91
		104	119.5	980	99.89	99.83	99.96	299.32

Appendix 11. Phytosociological attributes of *Quercus-Sophora-Indigofera* (QSI) at Rumbor in at an altitude of 1790m-1900m.

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Quercus baloot</i> Griffith.	7.0	7.5	80	7.52	7.38	9.41	24.31a
2	<i>Sophora mollis</i> (Royle) Baker	7.0	7.0	70	7.52	6.89	8.23	22.64b
3	<i>Indigofera heterantha</i> var. <i>heterantha</i> L.	6.0	6.5	60	6.52	6.40	7.05	19.97c
4	<i>Artemisia scoparia</i> Waldst & Kit	6.0	6.0	60	6.52	5.91	7.05	19.48
5	<i>Juglans regia</i> L.	5.0	6.0	60	5.37	5.91	7.05	18.33
6	<i>Tulipa stellata</i> Hk. f.	5.0	5.5	50	5.37	5.41	5.88	16.66
7	<i>Vitis venifera</i> L.	5.0	5.0	50	5.37	4.92	5.88	16.17
8	<i>Echinops echinatus</i> Roxb.	4.5	5.0	50	4.83	4.92	5.88	15.63
9	<i>Rosa webbiana</i> Wall ex Royle	4.5	5.0	40	4.83	4.92	4.70	14.45
10	<i>Cotoneaster nummularia</i> Fisch. & Mey	4.5	4.5	40	4.83	4.43	4.70	13.96
11	<i>Pinus wallichiana</i> A. B. Jackson	4.5	4.5	40	4.83	4.43	4.70	13.96
12	<i>Chenopodium botrys</i> L.	4.0	4.5	30	4.30	4.43	3.52	12.25
13	<i>Marrubium vulgare</i> L.	4.0	4.0	30	4.30	3.94	3.52	11.76
14	<i>Dicanthium annulatum</i> Forssk. Stapf.	4.0	4.0	30	4.30	3.94	3.52	11.76
15	<i>Chenopodium album</i> L.	3.5	4.0	20	3.76	3.94	2.35	10.05
16	<i>Matricaria disciformis</i> (Cam.) DC.	3.0	4.0	20	3.22	3.94	2.35	9.51
17	<i>Lactuca serriola</i> L.	3.0	3.5	20	3.22	3.44	2.35	9.01
18	<i>Rheum emodi</i> Wall ex Meissn.	2.5	3.0	20	2.66	2.95	2.35	7.96
19	<i>Solanum nigrum</i> L.	2.5	2.5	10	2.66	2.46	1.17	6.29
20	<i>Verbascum thapsus</i> L.	2.0	2.0	10	2.15	1.97	1.17	5.29
21	<i>Centaurea iberica</i> Trev. ex Spreng.	2.0	2.0	10	2.15	1.97	1.17	5.29
22	<i>Ailanthus altissima</i> (Mill.) Swingle	1.0	2.0	10	1.07	1.97	1.17	4.21
23	<i>Conyza bonariensis</i> (L.) Cronquist	1.0	1.5	10	1.07	1.47	1.17	3.71
24	<i>Lactuca persica</i> Boiss.	0.5	1.0	10	0.53	0.98	1.17	2.68
25	<i>Sonchus oleraceus</i> L.	0.5	0.5	10	0.53	0.49	1.17	2.19
26	<i>Pistacia integerrima</i> (L.) Steward ex Brandis	0.5	0.5	10	0.53	0.49	1.17	2.19
		93	101.5	850	99.96	99.90	99.85	299.71

Appendix 12. Phytosociological attributes of *Echinops-Verbascum-Pinus* (EVP) in Rumbor at altitude of 2130m-2250m.

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Echinops echinatus</i> Roxb.	6.5	6.5	80	8.96	7.60	9.87	27.43a
2	<i>Verbascum thapsus</i> L.	6.5	6.5	70	8.96	7.60	8.64	26.20b
3	<i>Pinus wallichiana</i> A. B. Jackson	6.5	7.0	60	8.96	8.18	7.40	24.54c
4	<i>Arum jacquemontii</i> Blume	6.0	6.0	60	8.27	7.01	7.40	22.68
5	<i>Cedrus deodara</i> (Roxb. Ex Lamb.) G.Don	5.5	6.0	60	7.58	7.01	7.40	21.99
6	<i>Codonopsis ovata</i> Bth.	5.0	5.5	50	6.89	6.43	6.17	19.49
7	<i>Salix acmophylla</i> L.	5.0	5.0	50	6.89	5.84	6.17	18.84
8	<i>Sophora mollis</i> (Royle.) Baker	4.5	5.0	50	6.20	5.84	6.17	18.15
9	<i>Pinus gerardiana</i> Wall. ex Lamb.	4.5	5.0	50	6.20	5.84	6.17	18.15
10	<i>Silene viscosa</i> (L.) Pers.	4.0	5.0	40	5.51	5.84	4.93	16.28
11	<i>Sedum ewersii</i> Ledeb.	3.5	4.5	40	4.82	5.26	4.93	15.01
12	<i>Galinsoga parviflora</i> Cav.	3.0	4.0	40	4.13	4.67	4.93	13.73
13	<i>Chenopodium album</i> L.	2.5	4.0	30	3.44	4.67	3.70	11.81
14	<i>Geranium rotundifolium</i> L.	2.5	3.0	30	3.44	3.50	3.70	10.64
15	<i>Sonchus oleraceus</i> L.	2.0	3.0	20	2.75	3.50	2.46	8.71
16	<i>Lamium amplexicaule</i> L.	1.5	2.5	20	2.06	2.92	2.46	7.44
17	<i>Salvia nubicola</i> wall. ex Sweet	1.0	2.0	20	1.37	2.33	2.46	6.16
18	<i>Malcolmia africana</i> (L.) R. Br.	1.0	2.0	10	1.37	2.33	1.23	4.93
19	<i>Nepeta raphanorhiza</i> Bth.	0.5	1.5	10	0.68	1.75	1.23	3.66
20	<i>Rosa webbiana</i> L.	0.5	1.0	10	0.68	1.16	1.23	3.07
21	<i>Marrubium vulgare</i> L.	0.5	0.5	10	0.68	0.58	1.23	2.49
		72.5	85.5	810	99.84	99.86	99.88	299.40

Appendix13. Phytosociological attributes of *Artemisia-Cedrus-Pinus* (ACP) in Rumbor at an altitude of 2550m-2700m.

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Artemisia scoparia</i> Waldst. & Kit.	8.5	8.0	80	7.29	6.34	10.12	23.75a
2	<i>Cedrus deodara</i> (Roxb. Ex Lamb.) G.Don	8.0	8.5	80	6.86	6.74	10.12	23.72b
3	<i>Pinus gerardiana</i> Wall. ex Lamb.	7.5	8.5	70	6.43	6.74	8.86	22.03c
4	<i>Thymus linearis</i> L.	8.0	8.0	60	6.86	6.34	7.59	20.79
5	<i>Scrophularia scoparia</i> Penn.	7.5	7.5	60	6.43	5.95	7.59	19.97
6	<i>Artemisia sacrorum</i> Ledeb.	7.5	7.5	50	6.43	5.95	6.32	18.70
7	<i>Tragopogon gracilis</i> D. Don.	7.0	7.0	50	6.00	5.55	6.32	17.87
8	<i>Quercus dilatata</i> Lindl.	6.0	6.5	50	5.15	5.16	6.32	16.63
9	<i>Potentilla supina</i> L.	6.0	6.5	40	5.15	5.16	5.06	15.37
10	<i>Taraxicum officinale</i> Weber	5.5	6.0	40	4.72	4.76	5.06	14.54
11	<i>Ephedra gerardiana</i> L.	5.5	6.0	30	4.72	4.76	3.79	13.27
12	<i>Viola canescens</i> Wall. ex Roxb.	5.0	5.5	30	4.29	4.36	3.79	12.44
13	<i>Nepeta brachyantha</i> Rech.	5.0	5.5	20	4.29	4.36	2.53	11.18
14	<i>Salvia moocroftiana</i> Wall. ex Bth.	4.5	5.0	20	3.86	3.96	2.53	10.35
15	<i>Impatiens bicolor</i> Royle	4.0	4.5	20	3.43	3.57	2.53	9.53
16	<i>Capsella bursa-pastoris</i> (L.) Medic.	4.0	4.5	10	3.43	3.57	1.26	8.26
17	<i>Salvia nubicola</i> wall. ex Sweet	4.0	4.0	10	3.43	3.17	1.26	7.86
18	<i>Fraxinus xanthoxyloides</i> (Wall. ex G. Don) DC.	3.5	4.0	10	3.00	3.17	1.26	7.43
19	<i>Draba altaica</i> (C.A.M.) Bunge	2.5	3.5	10	2.14	2.77	1.26	6.17
20	<i>Cynodon dactylon</i> L.	2.0	3.0	10	1.71	2.38	1.26	5.35
21	<i>Epilobium hirsutum</i> L.	2.0	2.5	10	1.71	1.98	1.26	4.95
22	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	1.5	2.0	10	1.28	1.58	1.26	4.12
23	<i>Juniperus excelsa</i> M. Bieb.	1.0	1.0	10	0.85	0.79	1.26	2.90
24	<i>Echinops echinatus</i> Roxb.	0.5	1.0	10	0.42	0.79	1.26	2.47
		116.5	126	790	99.86	99.90	99.87	299.65

Appendix 14. Phytosociological attributes of *Ephedra-Juniperus-Cuscuta* (EJC) at Rumbor in site at an altitude of 2980m-3010m

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Ephedra intermedia</i> Schrenk & Meyer	9.0	9.0	80	10.22	9.18	10.81	30.21a
2	<i>Juniperus communis</i> L.	8.0	8.5	80	9.09	8.67	10.81	28.57b
3	<i>Cuscuta lehmanniana</i> Bunge	7.5	8.0	80	8.52	8.16	10.81	27.49c
4	<i>Oxyria digyna</i> (L.) Hill.	7.0	7.0	70	7.95	7.14	9.45	24.54
5	<i>Inula rhizocephala</i> Schrenk Enum.	6.0	6.5	60	6.81	6.63	8.11	21.55
6	<i>Rumex longifolius</i> DC.	6.0	6.0	50	6.81	6.12	6.75	19.68
7	<i>Indigofera heterantha</i> var. <i>heterantha</i> L.	5.5	6.0	50	6.25	6.12	6.75	19.12
8	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	5.5	6.0	40	6.25	6.12	5.40	17.77
9	<i>Juniperus excelsa</i> M. Bieb.	5.0	5.5	40	5.68	5.61	5.40	16.69
10	<i>Scrophularia scoparia</i> Penn.	4.5	5.0	40	5.11	5.10	5.40	15.61
11	<i>Eragrostis poaeoides</i> P. Beave.	4.0	5.0	30	4.54	5.10	4.05	13.69
12	<i>Arenaria griffithii</i> Boiss.	4.0	4.5	30	4.54	4.59	4.05	13.18
13	<i>Potentilla supina</i> L.	3.5	4.5	20	3.97	4.59	2.70	11.26
14	<i>Matricaria disciformis</i> (C.A.M.) DC. Prodr.	3.0	4.0	20	3.41	4.08	2.70	10.19
15	<i>Salvia nubicola</i> wall. ex Sweet	2.5	3.5	10	2.84	3.57	1.35	7.76
16	<i>Pinus wallichiana</i> A. B. Jackson	2.5	3.0	10	2.84	3.06	1.35	7.25
17	<i>Nepeta sewerzowii</i> Regel	2.0	2.5	10	2.27	2.55	1.35	6.17
18	<i>Taraxacum officinale</i> Weber	1.5	2.0	10	1.70	2.04	1.35	5.09
19	<i>Anaphalis contorta</i> L.	1.0	1.5	10	1.13	1.53	1.35	4.01
		88	98	740	99.93	99.96	99.94	299.83

Appendix 15. Phytosociological attributes of *Salix-Salix-Ailanthus* (SSA) in Birir at an altitude of 1200m-1350m.

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Salix acmophylla</i> Boiss	8.5	9.0	80	6.20	5.82	5.47	17.49a
2	<i>Salix tetrasperma</i> Roxb.	8.0	9.0	80	5.83	5.82	5.47	17.12b
3	<i>Ailanthus altissima</i> (Mill.) Swingle	8.0	8.5	80	5.83	5.50	5.47	16.80c
4	<i>Mentha longifolia</i> L.	8.0	8.0	70	5.83	5.17	4.79	15.79
5	<i>Elaeagnus angustifolia</i> L.	7.0	8.0	70	5.11	5.17	4.79	15.07
6	<i>Trifolium repens</i> L.	7.0	7.5	70	5.11	4.85	4.79	14.75
7	<i>Juglans regia</i> L.	7.0	7.0	70	5.11	4.53	4.79	14.43
8	<i>Plantago lanceolata</i> L.	6.5	7.0	70	4.74	4.53	4.79	14.06
9	<i>Epilobium hirsutum</i> L.	6.5	6.5	60	4.74	4.20	4.10	13.04
10	<i>Morus alba</i> L.	6.0	6.5	60	4.37	4.20	4.10	12.67
11	<i>Quercus baloot</i> Griffith	6.0	6.5	50	4.37	4.20	3.42	11.99
12	<i>Artemisia parviflora</i> Roxb.	6.0	6.0	50	4.37	3.88	3.42	11.67
13	<i>Veronica anagallis-aquatica</i> L.	5.5	6.0	50	4.01	3.88	3.42	11.31
14	<i>Artemisia brevifolia</i> Wall. Ex DC.	5.5	5.5	50	4.01	3.55	3.42	10.98
15	<i>Cynodon dactylon</i> (L.) Pers.	5.0	5.5	50	3.64	3.55	3.42	10.61
16	<i>Taraxicum officinale</i> Weber	5.0	5.0	50	3.64	3.23	3.42	10.29
17	<i>Ranunculus muricatus</i> L.	4.5	5.0	40	3.28	3.23	2.73	9.24
18	<i>Chenopodium alba</i> L.	4.0	4.5	40	2.91	2.91	2.73	8.55
19	<i>Chenopodium botrys</i> L.	3.5	4.0	40	2.55	2.58	2.73	7.86
20	<i>Lactuca serriola</i> L.	3.5	4.0	30	2.55	2.58	2.05	7.18
21	<i>Cichorium intybus</i> L.	3.0	4.0	30	2.19	2.58	2.05	6.82
22	<i>Lotus corniculatus</i> L.	2.5	3.5	30	1.82	2.26	2.05	6.13
23	<i>Verbascum thapsus</i> L.	2.0	3.0	30	1.45	1.94	2.05	5.44
24	<i>Nasturtium officinale</i> R. Br.	1.5	2.5	30	1.10	1.61	2.05	4.76
25	<i>Matricaria disciformis</i> (C.A.M.) DC. Prodr.	1.5	2.0	30	1.10	1.29	2.05	4.44
26	<i>Capsella bursa-pastoris</i> (L.) Medic.	1.0	2.0	30	0.72	1.29	2.05	4.06
27	<i>Peganum harmala</i> L.	1.0	1.5	30	0.72	0.97	2.05	3.74
28	<i>Sonchus asper</i> (L.) Hill	1.0	1.5	30	0.72	0.97	2.05	3.74
29	<i>Poa annua</i> L.	0.5	1.5	20	0.36	0.97	1.37	2.70
30	<i>Eragrostis poaeoides</i> P. Beave.	0.5	1.5	10	0.36	0.97	0.68	2.01
31	<i>Salix denticulata</i> Anderson subsp. <i>Denticulata</i>	0.5	1.0	10	0.36	0.64	0.68	1.68
32	<i>Medicago sativa</i> L.	0.5	1.0	10	0.36	0.64	0.68	1.68
33	<i>Urtica dioica</i> L.	0.5	0.5	10	0.36	0.32	0.68	1.36
		137	154.5	1460	99.82	99.83	99.81	299.46

Appendix 16. Phytosociological attributes of *Artemisia-Salix-Arum* (ASA) at Birir in at an altitude of 1550m-1700m.

S #	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Artemisia brevifolia</i> Wall. Ex DC.	8.5	9.0	80	5.59	5.35	7.54	18.48a
2	<i>Salix acmophylla</i> L.	8.5	9.0	70	5.59	5.35	6.60	17.54b
3	<i>Arum jacquemontii</i> Blume	8.0	9.0	70	5.26	5.35	6.60	17.21c
4	<i>Quercus baloot</i> Griffith.	8.0	8.5	70	5.26	5.05	6.60	16.91
5	<i>Rosa webbiana</i> Wall ex Royle	7.5	8.5	70	4.93	5.05	6.60	16.58
6	<i>Anagalis arvensis</i> L.	7.5	8.0	60	4.93	4.76	5.66	15.35
7	<i>Artemisia scoparia</i> Waldst. & Kit.	7.0	8.0	60	4.60	4.76	5.66	15.02
8	<i>Taraxicum officinale</i> L.	7.0	7.5	60	4.60	4.46	5.66	14.72
9	<i>Juglans regia</i> L.	6.5	7.5	50	4.27	4.46	4.72	13.45
10	<i>Medicago sativa</i> L.	6.5	7.0	50	4.27	4.16	4.72	13.15
11	<i>Equisetum ramossimum</i> Desf.	6.5	7.0	40	4.27	4.16	3.77	12.20
12	<i>Artemisia maritima</i> L.	6.0	6.5	40	3.94	3.86	3.77	11.57
13	<i>Ephedra gerardiana</i> Wall ex. Stapf.	6.0	6.5	30	3.94	3.86	2.83	10.63
14	<i>Chenopodium botrys</i> L.	5.5	6.0	30	3.62	3.57	2.83	10.02
15	<i>Sophora mollis</i> (Royle) Baker	5.5	5.5	30	3.62	3.27	2.83	9.72
16	<i>Cotoneaster microphylla</i> Wall ex Lind.	5.0	5.5	30	3.29	3.27	2.83	9.39
17	<i>Verbascum thapsus</i> L.	5.0	5.5	20	3.29	3.27	1.88	8.44
18	<i>Elaeagnus angustifolia</i> L.	4.5	5.0	20	2.96	2.98	1.88	7.82
19	<i>Marrubium vulgare</i> L.	4.5	4.5	20	2.96	2.68	1.88	7.52
20	<i>Cyanodon dactylon</i> (L.) Pers.	4.0	4.5	20	2.63	2.68	1.88	7.19
21	<i>Amaranthus viridis</i> L.	4.0	4.0	20	2.63	2.38	1.88	6.89
22	<i>Dactylis glomerata</i> L.	3.5	3.5	20	2.30	2.08	1.88	6.26
23	<i>Echinops echinatus</i> Roxb.	3.0	3.5	20	1.97	2.08	1.88	5.93
24	<i>Dicanthium annulatum</i> Forrsk. Stapf.	3.0	3.5	10	1.97	2.08	0.94	4.99
25	<i>Pinus wallichiana</i> A. B. Jackson	2.5	3.5	10	1.64	2.08	0.94	4.66
26	<i>Ixiolirion tataricum</i> (Pall.) Herb.	2.5	3.0	10	1.64	1.78	0.94	4.36
27	<i>Poa bulbosa</i> L.	2.5	2.5	10	1.64	1.49	0.94	4.07
28	<i>Papaver dubium</i> L.	1.5	2.0	10	0.98	1.19	0.94	3.11
29	<i>Conyza bonariensis</i> (L.) Conquist	1.0	1.5	10	0.65	0.89	0.94	2.48
30	<i>Tulipa stellata</i> Hk. f.	0.5	1.5	10	0.32	0.89	0.94	2.15
31	<i>Fritillaria imperialis</i> var. <i>chitralensis</i> Hort.	0.5	1.0	10	0.32	0.59	0.94	1.85
		152	168	1060	99.88	99.88	99.90	299.66

Appendix 17. Phytosociological attributes of *Arum-Quercus-Artemisia* (AQA) at Birir in at an altitude of 1910m-2050m.

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Arum jacquemontii</i> Blume	9.0	9.0	90	5.34	4.92	6.97	17.23a
2	<i>Quercus baloot</i> Griffith.	9.0	8.5	90	5.34	4.64	6.97	16.95b
3	<i>Artemisia scoparia</i> Waldst. & Kit.	8.5	8.5	80	5.04	4.64	6.20	15.88c
4	<i>Sophora mollis</i> (Royle.) Baker	8.5	8.5	70	5.04	4.64	5.42	15.10
5	<i>Juglans regia</i> L.	8.0	8.5	70	4.75	4.64	5.42	14.81
6	<i>Sedum ewersii</i> Ledeb.	7.5	8.5	70	4.45	4.64	5.42	14.51
7	<i>Salvia nubicola</i> wall. ex Sweet	7.5	8.0	70	4.45	4.37	5.42	14.24
8	<i>Artemisia brevifolia</i> Wall ex DC	7.0	8.0	70	4.15	4.37	5.42	13.94
9	<i>Verbascum thapsus</i> L.	7.0	7.5	60	4.15	4.09	4.65	12.89
10	<i>Rhus punjabensis</i> Steward ex Brandis	7.0	7.5	50	4.15	4.09	3.87	12.11
11	<i>Tragopogon gracilis</i> D. Don.	6.5	7.5	50	3.86	4.09	3.87	11.82
12	<i>Veronica anagallis aquatica</i> L.	6.0	7.0	50	3.56	3.82	3.87	11.25
13	<i>Taraxacum officinale</i> Weber	6.0	7.0	40	3.56	3.82	3.10	10.48
14	<i>Spergula arvensis</i> L.	6.0	6.5	40	3.56	3.55	3.10	10.21
15	<i>Stellaria media</i> (L.) Cyr.	5.5	6.0	40	3.26	3.27	3.10	9.63
16	<i>Euphorbia peplus</i> L.	5.5	5.5	40	3.26	3.00	3.10	9.36
17	<i>Cousinia mattfeldii</i> Bornm.	5.0	5.5	40	2.97	3.00	3.10	9.07
18	<i>Viola canescens</i> Wall. ex Roxb.	5.0	5.5	30	2.97	3.00	2.32	8.29
19	<i>Pinus wallichiana</i> A.B. Jackson	4.5	5.0	30	2.67	2.73	2.32	7.72
20	<i>Alliaria petiolata</i> (M. B.) Cav. & Grande Boll.	4.5	4.5	30	2.67	2.46	2.32	7.45
21	<i>Tulipa stellata</i> Hk. f.	4.0	4.5	20	2.37	2.46	1.55	6.38
22	<i>Bromus tectorum</i> L.	4.0	4.0	20	2.37	2.18	1.55	6.10
23	<i>Cardamine hirsuta</i> L.	3.5	4.0	20	2.07	2.18	1.55	5.80
24	<i>Cynodon dactylon</i> (L.) Pers.	3.5	4.0	10	2.07	2.18	0.77	5.02
25	<i>Dichanthium annulatum</i> (Forssk.) Stapf.	3.0	3.5	10	1.78	1.91	0.77	4.46
26	<i>Amaranthus viridis</i> L.	3.0	3.0	10	1.78	1.63	0.77	4.18
27	<i>Adonis aestivalis</i> L.	2.5	3.0	10	1.48	1.63	0.77	3.88
28	<i>Bupleurum thomsonii</i> C.B. Clarke	2.5	2.5	10	1.48	1.36	0.77	3.61

29	<i>Cichorium intybus</i> L.	2.0	2.5	10	1.18	1.36	0.77	3.31
30	<i>Rheum emodi</i> Wall ex Meissn.	2.0	2.0	10	1.18	1.09	0.77	3.04
31	<i>Marrubium vulgare</i> L.	1.5	2.0	10	0.89	1.09	0.77	2.75
32	<i>Nepeta raphanorhiza</i> Benth.	1.5	2.0	10	0.89	1.09	0.77	2.75
33	<i>Periploca aphylla</i> Dcne.	1.0	2.0	10	0.59	1.09	0.77	2.45
34	<i>Mentha longifolia</i> (L.) Huds.	0.5	1.0	10	0.29	0.54	0.77	1.60
35	<i>Ephedra gerardiana</i> L.	0.5	0.5	10	0.29	0.27	0.77	1.33
		168.5	183	1290	99.91	99.84	99.85	299.60

Appendix 18. Phytosociological attributes of *Quercus-Pinus-Rosa* (QPR) at Birir in water at an altitude of 2220m-2350m.

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Quercus baloot</i> Griffith.	9.0	9.0	80	10.22	8.69	6.61	25.52a
2	<i>Pinus wallichiana</i> A. B. Jackson	8.0	8.5	80	9.09	8.21	6.61	23.91b
3	<i>Rosa webbiana</i> Wall ex Royle	7.0	7.5	70	7.95	7.24	5.78	20.97c
4	<i>Sophora mollis</i> (Royle.) Baker	6.5	7.0	70	7.38	6.76	5.78	19.92
5	<i>Artemisia scoparia</i> Waldst & Kit	6.0	7.0	70	6.82	6.76	5.78	19.36
6	<i>Cotoneaster nummularia</i> Fisch. & Mey	6.0	6.5	70	6.82	6.28	5.78	18.88
7	<i>Echinops echinatus</i> Roxb.	5.5	6.5	60	6.25	6.28	4.96	17.49
8	<i>Chenopodium botrys</i> L.	5.0	6.0	60	5.68	5.79	4.96	16.43
9	<i>Dicanthium annulatum</i> Forssk. Stapf.	4.0	5.0	60	4.54	4.83	4.96	14.33
10	<i>Trifolium repens</i> L.	4.0	4.5	60	4.54	4.35	4.96	13.85
11	<i>Veronica verna</i> L.	3.5	4.0	60	3.97	3.86	4.96	12.79
12	<i>Arum jacquemontii</i> Blume	3.0	4.0	60	3.41	3.86	4.96	12.23
13	<i>Berberis lycium</i> Royle	2.5	3.5	60	2.84	3.38	4.96	11.18
14	<i>Matricaria disciformis</i> (Cam.) DC.	2.5	3.0	60	2.84	2.89	4.96	10.69
15	<i>Lactuca serriola</i> L.	2.0	3.0	50	2.27	2.89	4.13	9.29
16	<i>Ceratocephalus falcatus</i> (L.) Pers.	2.0	2.5	40	2.27	2.41	3.30	7.98
17	<i>Anagalis arvensis</i> L.	1.5	2.5	40	1.70	2.41	3.30	7.41
18	<i>Solanum nigrum</i> L.	1.5	2.5	30	1.70	2.41	2.48	6.59
19	<i>Verbascum thapsus</i> L.	1.5	2.0	30	1.70	1.93	2.48	6.11
20	<i>Marrubium vulgare</i> L.	1.5	2.0	20	1.70	1.93	1.65	5.28
21	<i>Ailanthus altissima</i> (Mill.) Swingle	1.5	1.5	20	1.70	1.45	1.65	4.80
22	<i>Aristida cynantha</i> Nees & Steud.	1.0	1.5	20	1.13	1.45	1.65	4.23
23	<i>Nepeta raphanorhiza</i> Bth.	1.0	1.5	10	1.13	1.45	0.82	3.40
24	<i>Bupleurum exaltatum</i> Clarke	1.0	1.0	10	1.13	0.97	0.82	2.92
25	<i>Ficus carica</i> L.	0.5	1.0	10	0.56	0.97	0.82	2.35
26	<i>Ephedra gerardiana</i> L.	0.5	0.5	10	0.56	0.48	0.82	1.86
		88	103.5	1210	99.90	99.93	99.94	299.77

Appendix 19. Phytosociological attributes of *Echinops-Marrubium-Rumex* (EMR) in Birir at an altitude of 2480m-2570m.

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Echinops echinatus</i> Roxb.	7.5	8.0	60	7.85	7.34	8.82	24.01a
2	<i>Marrubium vulgare</i> L.	7.5	7.5	60	7.85	6.88	8.82	23.55b
3	<i>Rumex hastatus</i> D.Don	6.5	7.0	60	6.80	6.42	8.82	22.04c
4	<i>Quercus baloot</i> Griffith.	6.5	6.5	50	6.80	5.96	7.35	20.11
5	<i>Cedrus deodara</i> (Roxb. Ex Lamb.) G.Don	6.0	6.5	50	6.28	5.96	7.35	19.59
6	<i>Pinus wallichiana</i> A. B. Jackson	6.0	6.5	40	6.28	5.96	5.88	18.12
7	<i>Artemisia maritima</i> L.	6.0	6.0	40	6.28	5.50	5.88	17.66
8	<i>Impatiens bicolor</i> Royle	5.5	6.0	40	5.75	5.50	5.88	17.13
9	<i>Verbascum thapsus</i> L.	5.0	6.0	40	5.23	5.50	5.88	16.61
10	<i>Polygonum amplexicaule</i> D Don.	5.0	5.5	30	5.23	5.04	4.41	14.68
11	<i>Carduus edelbergii</i> Rech.	4.5	5.5	30	4.71	5.04	4.41	14.16
12	<i>Salix acmophylla</i> L.	4.0	5.0	30	4.19	4.59	4.41	13.19
13	<i>Sophora mollis</i> (Royle.) Baker	4.0	5.0	20	4.19	4.59	2.94	11.72
14	<i>Sedum ewersii</i> Ledeb.	3.5	4.5	20	3.66	4.12	2.94	10.72
15	<i>Lactuca serriola</i> L.	3.5	4.0	20	3.66	3.67	2.94	10.27
16	<i>Galinsoga parviflora</i> Cav.	3.0	3.5	20	3.14	3.21	2.94	9.29
17	<i>Lactuca decipiens</i> (H. & T.) Clarke	3.0	3.5	10	3.14	3.21	1.47	7.82
18	<i>Matricaria disciformis</i> (C.A.M.) DC. Prodr.	2.5	3.0	10	2.61	2.75	1.47	6.83
19	<i>Sonchus oleraceus</i> L.	2.0	2.5	10	2.09	2.29	1.47	5.85
20	<i>Asperugo procumbens</i> L.	1.5	2.5	10	1.57	2.29	1.47	5.33
21	<i>Euphorbia prostrata</i> L.	1.0	2.0	10	1.04	1.83	1.47	4.34
22	<i>Sonchus asper</i> L.	1.0	1.5	10	1.04	1.37	1.47	3.88
23	<i>Polypogon fugax</i> Nees ex Steud	0.5	1.0	10	0.52	0.91	1.47	2.90
		95.5	109	680	99.91	99.93	99.96	299.80

Appendix 20. Phytosociological attributes of *Potentilla-Astragalus-Chenopodium* (PAC) in Birir at an Altitude of 2710m-2820m.

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Potentilla pamirica</i> Wolf.	6.5	7.0	50	12.50	10	14.28	36.78a
2	<i>Astragalus grahamianus</i> Royle	6.0	7.0	40	11.54	10	11.43	32.97b
3	<i>Chenopodium foliosum</i> (Merrich.) Aschers.	5.0	6.5	40	9.61	9.28	11.43	30.32c
4	<i>Pinus gerardiana</i> L.	4.5	7.0	30	8.65	10	8.57	27.22
5	<i>Scrophularia scoparia</i> Penn.	4.5	6.0	30	8.65	8.57	8.57	25.79
6	<i>Ephedra gerardiana</i> L.	4.5	5.5	30	8.65	7.85	8.57	25.07
7	<i>Rumex nepalensis</i> Spreng	4.0	5.0	30	7.69	7.14	8.57	23.40
8	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	4.0	5.5	20	7.69	7.85	5.71	21.25
9	<i>Nepeta brachyantha</i> Rech.	4.0	5.0	20	7.69	7.14	5.71	20.54
10	<i>Oxalis corniculata</i> L.	3.0	4.5	10	5.77	6.43	2.85	15.05
11	<i>Nepeta sewerzowii</i> Regel	2.5	4.0	10	4.81	5.71	2.85	13.37
12	<i>Gallium tricornutum</i> L.	2.0	3.5	10	3.85	5	2.85	11.70
13	<i>Cynoglossum lanceolatum</i> Forssk.	0.5	2.0	10	0.96	2.86	2.85	6.67
14	<i>Juniperus squamata</i> Buch.	0.5	1.0	10	0.96	1.43	2.85	5.24
15	<i>Juniperus excelsa</i> M. Bieb.	0.5	0.5	10	0.96	0.71	2.85	4.52
		52	70	350	99.98	99.97	99.94	299.89

Appendix 21. Phytosociological attributes of *Juniperus-Thymus-Anaphalis* (JTA) in Birir at an altitude of 2950m-3070m.

S#	Plant Species	Density	Cover	Frequency	RD	RC	RF	IV
1	<i>Juniperus excelsa</i> M. Bieb.	7.0	7.0	70	11.20	9.52	11.86	32.58a
2	<i>Thymus linearis</i> L.	6.0	6.5	70	9.60	8.84	11.86	30.30b
3	<i>Anaphalis contorta</i> L.	5.0	6.0	60	8.00	8.16	10.17	26.33c
4	<i>Potentilla sericea</i> L.	5.0	5.5	50	8.00	7.48	8.47	23.95
5	<i>Astragalus nivalis</i> Kar & Kir	4.5	5.5	50	7.20	7.48	8.47	23.15
6	<i>Anaphalis nepalensis</i> (Spreng.) Hand.	4.5	5.0	40	7.20	6.80	6.78	20.78
7	<i>Aster flaccidus</i> var. <i>flaccidus</i> Bunge	4.0	5.0	40	6.39	6.80	6.78	19.97
8	<i>Pimpinella diversifolia</i> DC.	4.0	4.5	40	6.39	6.12	6.78	19.29
9	<i>Matricaria disciformis</i> (C.A.M.) DC. Prodr.	3.5	4.5	30	5.60	6.12	5.08	16.80
10	<i>Cuscuta reflexa</i> Roxb.	3.5	4.0	30	5.60	5.44	5.08	16.12
11	<i>Lamium amplexicaule</i> L.	3.0	4.0	20	4.80	5.44	3.39	13.63
12	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	3.0	3.5	20	4.80	4.76	3.39	12.95
13	<i>Taraxacum officinale</i> Weber	2.5	3.0	20	4.00	4.08	3.39	11.47
14	<i>Arabidopsis wallichii</i> (H. & T.) N. Busch.	2.5	2.5	10	4.00	3.40	1.69	9.09
15	<i>Arabis auriculata</i> Lam.	2.0	3.0	10	3.20	4.08	1.69	8.97
16	<i>Astragalus grahamianus</i> Royle. ex Bth.	1.0	2.0	10	1.60	2.72	1.69	6.01
17	<i>Geranium wallichianum</i> D. Don. Ex Sweet	1.0	1.0	10	1.60	1.36	1.69	4.65
18	<i>Rubia cordifolia</i> L.	0.5	1.0	10	0.80	1.36	1.69	3.85
		62.5	73.5	590	99.98	99.96	99.95	299.89