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Fodder quality analysis of *Hippophae salicifolia* D. Don (Seabuckthorn) populations in Himachal Pradesh

Sumit Nangla, HP Sankhyan and Neerja Rana

Abstract
To determine the variation among different populations and growing genotypes for fodder characteristics of leaves. Five female genotypes of *Hippophae salicifolia* D. Don at each site were selected at the time of fruit set i.e., during August-September, when male and female could be differentiated and leaves are at maturity. The selected genotypes were used for the assessment the fodder variation of *Hippophae salicifolia* D. Don in Spiti valley and Baspa valley. Variation in fodder traits of different sites of *Hippophae salicifolia* D. Don within and between different populations were studied. All the fodder characters showed significant variation among and between different populations. Among the proximate composition maximum leaf dry matter content (60.24%), crude fibre (16.70%) were recorded in Badseri. On the other hand, 100 leaves fresh weight (6.65 g) in Chitkul and 100 leaves dry weight (3.48 g) in Kupa was recorded. The coefficient of variation and other genetic parameter also signify varied between all the studied parameters Due to tremendous variability in population, the population can be used for future variability approaches and breeding programmes and for preparation of DUS guidelines of this species. It is suggested that for further propagation programmes, genepools from Sangla Valley should be used and it can be planted on wastelands to develop grazing areas for sheep and goats and harvesting of leaves for Seabuckthorn value addition chain.

Keywords: *Hippophae salicifolia*, fodder characteristics, genetic variation, leaf area, crude protein, DUS guidelines

Introduction
Seabuckthorn (Genus Hippophae) is a berry-bearing, hardy shrub of the family Elaeagnaceae, naturally distributed in Asia and Europe and also introduced in North and South America. It includes 4 species (*Hippophae rhamnoides*, *Hippophae salicifolia*, *Hippophae tibetana* and *Hippophae neurocarpa*) and further 9 subspecies of *Hippophae rhamnoides* are reported so far from many parts of world. It is a unique and valuable genotype resource currently cultivated in various parts of the world. The natural habitat of Seabuckthorn extends widely in China, Mongolia, Russia, and most parts of North Europe. It can withstand extreme temperatures from -43 ºC to 40 ºC and is considered to be drought resistant. The cold deserts in Himachal Pradesh are found in the districts of Lahaul and Spiti, parts of Kinnaur and Pir Panjal region of Chamba. These areas are characterized by high ridges, difficult terrains with ice field, perpetual snow covered peaks and hostile climate. Among various indigenous and under exploited genotype resources of high mountain area, Seabuckthorn (*Hippophae salicifolia* D. Don) is one of the best solution and can certainly metamorphose the ecology of Cold Desert by reclaiming these bare fragile mountains. Willow leaved Seabuckthorn and indigenous source locally Sutz/Sarla offers an opportunity to maintain more sustainable livelihood qualities as well as unique option for the simultaneous management of several problems. Seabuckthorn has outstanding qualities such as capability to grow and survive under adverse climatic conditions, extensive root system with soil binding ability/ soil stabilization/ control of river bank/ water retention, nitrogen fixing (60-180 kg / ha / year), higher vitamin-C content and economic value of fruit and seed oil, excellent fodder and fuel wood qualities, wider application in food, cosmetics, beverages, medicines and other pharmaceutical products, excellent fencing hedge and social fencing. Though seabuckthorn is widely found under agroforestry system as well as hazard zones, yet no any systematic study has been carried out so far to understand its potential under agroforestry/forestry perspectives. So it help to be a valuable tool for land restoration and conservation in the cold desert of the Lahaul valley (Sankhyan *et al*., 2018) [19]. The first pre-requisite step to undertake breeding programme and to obtain improved genetic gain is selection of best population and best individuals within the population.

Knowledge of the distribution of genetic diversity provides a guide to the proper management of the genetic resources of species in effective genetic conservation programs (Barrett and Kohn, 1991) [2]. Hence present study was undertaken to study variation in fodder characteristics among and between different populations to select plus trees of *Hippophae salicifolia* D. Don. Nursery raising, plantation technology, fruit harvesting methodology and other biochemical aspects have been already worked out for *Hippophae rhamnoides* L. but this species is still lacking information, being its restricted and scattered distribution in patches. With this concept and idea in mind, this species has been preferred to work on quantitative parameters so that complete package and practice of this particular species is developed and this study may help in identification of discriminating morphological descriptors to know the extent of variation and variability among populations and within individuals of the populations, The present study was focused in only two valleys namely Sangla valley of district Kinnaur and Spiti valley of district Lahaul and Spiti, because major gene pool area of this species occur only in these two valleys and considered heart of cold desert of Himachal Pradesh, where choice of species is limited and Seabuckthorn is only suitable option and Lahaul valley is rich in genetic resources as concerned and Seabuckthorn is last option and choice for the farmers. Finally, development of morphological descriptors of this species may certainly help in the preparation of DUS Guidelines at later stage. Hence present study was contemplated.

Material and Methods

The present study was carried out in the fields of Baspa valley of District Kinnaur and Spiti valley of District Lahaul and Spiti as well as in the laboratories of the Department of Tree Improvement and Genetic Resources, Department of Basic Sciences, Department of Environmental Science and Department of Silviculture and Agroforestry, College of Forestry at the Main Campus, Nauni, under the supervision of Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India during the period, years 2018- 2020. Baspa valley of Kinnaur and Spiti valley of Lahaul and Spiti districts of Himachal Pradesh were surveyed for the occurrence of *Hippophae salicifolia* D. Don genotype species, after proper identification of genotypes and population with selecting three natural populations in each valley and from each population five genotypes were selected, marked and taken for further investigation and recording fodder characteristics. Experimental sites/populations were taken *viz*., Kuppa, Badseri, Chitkul of Baspa valley in the District Kinnaur and Mane, Shiego and Giu in Spiti valley in District Lahual and Spiti, Himachal Pradesh. Five female genotypes of *Hippophae salicifolia* D. Don at each site, i.e., population were selected at the time of fruit set, i.e., during August-September, when male and female could be differentiated. The selected genotypes were used for the assessment the fodder variation of *Hippophae salicifolia* D. Don in Baspa valley of Kinnaur and Spiti Valley of Lahaul and Spiti. Leaves and berries were taken and carried from experimental sites to laboratory for further study of fodder variation and preparation of morphological descriptors in laboratories and the departments. Altitude of populations ranged from 2590m amsl to 3538m amsl in the study area at different sites of Himachal Pradesh.

Experimental and Study Areas

Table 1: Selected experimental sites showing population, code number, latitude, longitude and altitude, areas of Seabuckthorn populations in Baspa Valley and Spiti Valley area under study.

Sr. No.	Population site code number	Population	Latitude (North)	Longitude (East)	Altitude (m) amsl
1	S1	Kupa (Baspa Valley)	31°43.56’	78°24.48’	2590
2	S2	Badseri (Baspa Valley)	31°40.88’	78°30.60’	2790
3	S3	Chitkul (Baspa Valley)	31°35.08’	78°43.66’	3450
4	S4	Giu (Spiti Valley)	31°31.10’	77°16.08’	3048
5	S5	Mane (Spiti Valley)	32°02.00’	78°14.19’	3453
6	S6	Shiego (Spiti Valley)	32°10.58’	78°06.24’	3538

Observations on the following morphological characteristics were recorded from naturally occurring populations and individuals, i.e., within population (Five individuals from each population)

Methodology adopted for fodder characteristics adoptede

i. **Leaf fresh weight (g):** A composite sample of 100 leaves were taken from each selected main branch separately of each plant and fresh weight recorded in an electronic top pan balance.

ii. **Leaf dry weight (g):** 100 Fresh leaves were dried at 80 ^{o}C in an oven till constant weight attainted and dry weight was taken on an electric top pan balance.

iii. **Leaf dry matter content (%):** The differences in 100 leaf weight due to loss of moisture content before and after drying. The dry matter was expressed as:

$$\text{Dry matter content (\%)} = \frac{\text{weight of dried sample}}{\text{weight of fresh sample}} \text{ X } 100$$

iv. **Crude fibre (%):** Crude fibre content was estimated by acid-alkali digestion (ashing) as described by AOAC (1995) [1] and Sankaram (1966) [18]. A 1.5 g fat free sample (after ether extraction) was transferred in half litre beaker and 150 ml of 1.25 per cent H_2SO_4 was added to it. Beaker was put on hot plate and allowed to reflux for 30 minutes. After boiling, removed the beaker from hot plate and filtered through a muslin cloth using vacuum pump. Washed the residue with hot water till it was free from acid, transferred the material to the same beaker, added to it 150 ml of 1.25 per cent NaOH solution and again refluxed the content for 30 minutes. Filtered again through muslin cloth using vacuum pump and washed the residue with hot water till it was free from alkali. Then shifted the total residue in a crucible and placed in hot air oven, allowed to dry to a constant weight at 100 ^{o}C and recorded its weight thereafter ignited the residue in muffle furnace at 550-600 ^{o}C for 3 hours, cooled and weight again. The loss of weight due to ignition was weight of crude fibre. The percentage of crude fibre was calculated by the following formula:

$$\text{Crude fibre}(\%) \frac{\text{weight of crude fibre}}{\text{original weight of sample}} \text{ x } 100$$

v. **Crude protein (%):** Crude protein content was estimated by Microkjeldahl method (Sankaram, 1966) [18]. For crude protein estimation, nitrogen content in leaves was estimated as described earlier and obtained by multiplying the nitrogen by 6.25.

vi. **Total ash (%):** Ash content was analyzed as per the procedure given by AOAC (1995) [1] and Sankaram (1966) [18]. 2 g oven dried powdered sample was taken in crucible. Ignited the sample on an electric heater till the smoke ended up. Transferred the crucible to a muffle furnace, raised the temperature to 600^0C for two hours. Remove the crucible from furnace, cooled it in desiccator and weighed. The previously recorded empty crucible weight was not subtracted and weight of ash thus determined. The total ash content in percentage was calculated by the following formula:

$$\text{Total ash } (\%) = \frac{\text{weight of ash}}{\text{original weight of sample}} \text{ x } 100$$

vii. **Nitrogen free extract (%):** Nitrogen free extract will be determined by subtracting the sum of crude protein, crude fibre, ether extract and total ash content from hundred as outline by AOAC (1995) [1] and Sankaram (1966) [18].

Mineral Nutrient Composition

The method followed for the analysis of minerals was recommended by AOAC (1995) [1]. Brief outline of these methods are as follows:

Nitrogen (%): The nitrogen was estimated by Microkjeldahl method (AOAC, 1995) [1]. One g of powdered sample was taken in a clear dry digestion flask. To this 25 ml of concentrated sulphuric acid **(H_2SO_4)** was added followed by 3 g digestion mixture (20 parts K_2SO_4 + 1 part $CuSO_4$) carefully from the side. The contents were digested on an electric heater. The flask from the heater was removed intermediately and shaken carefully in a manner to bring down any stray particles of carbon and undigested material. Digestion was continued for 2 – 2.5 hours or more after the light blue color appeared. Flask contents after cooling was transferred into a 100 ml volumetric flask and the volume was restored the mark with distilled water.

10 ml of digested material (aliquot) was transferred into Microkjeldahl assembly. Added just sufficient volume (20 ml) of 40 per cent NaOH solution to the distillation assembly to make the contents alkaline and put stopper immediately, 20 ml of N/100 H_2SO_4 will be taken in a conical flask, added 2-3 drops of methyl red indicator to it. Set this conical flask under the condenser and allowed the distillation for 10 - 15 minutes and removed the conical flask after washing the tip of the condenser with distilled water into the flask. Blank titrated the flask contents with standard alkali (N/100 NaOH) till the end point was reached (pink to yellow). Recorded the volume of alkali used in titration to calculate the volume of standard H_2SO_4 (N/100) used for ammonia absorption and following calculations were done:

1 ml N/100 H_2SO_4 = 0.00014 g nitrogen

$$\text{Nitrogen } (\%) = \frac{\text{V1 x V2 x 0.00014 x D}}{\text{W x A}} \text{ x } 100$$

Where,
Vl = Volume of N/100 H_2SO_4 taken
V2 = Volume of N/100 NaOH taken for titration
D = Dilution factor (volume made in volumetric flask)
W = Weight (g) of powdered sample taken
A = Aliquot taken

Statistical analysis

Statistical analysis is an important tool for collection, evaluation and interpretation of data. The data was analysed statistically by using RBD. ANOVA (Analysis of Variance) for morphological characteristics and fodder quality parameters as described by Panse and Sukhatme (1967) [16] and Chandel (1984) [4].

Treatments: 6
Genotypes: 5
Replication: 3
Design: RBD (Factorial) (in Field)

Result and Discussion

Fodder Characters

Leaf fresh weight (100 leaves)

It is evident from data presented in Table 2 that 100 leaves fresh weight was significantly affected by the among and between different population. Among population, mean maximum (6.65 g) 100 leaves fresh weight was recorded for Chitkul, whereas minimum 3.92 g recorded for Shiego. On the other hand, between population Chitkul plant 1 (CP1) showed maximum 11.04 g, whereas minimum 2.48 g recorded for Sheigo plant 3 (SP3). Interaction among and between different populations also showed significant variation for 100 leaves fresh weight, whereas it was also significant for among population and between population.

Table 2: Variation in 100 leaves fresh weight (g) among and between selected Seabuckthorn (*Hippophae salicifolia* D. Don) populations in Himachal Pradesh

Between Among	Populations	100 Leaves Fresh Weight (g)					Mean
		Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	
S1	Kupa	6.06	5.25	5.74	9.45	5.60	6.42
S2	Badseri	4.42	6.74	4.78	6.42	3.67	5.21
S3	Chitkul	11.04	4.90	4.47	7.16	5.68	6.65
S4	Giu	5.27	5.30	5.92	2.88	4.93	4.86
S5	Mane	7.40	6.35	9.64	3.62	3.15	6.03
S6	Shiego	3.59	4.70	2.48	3.85	4.97	3.92
CD		0.05					
AP		0.01 AP: Among population					
BP		0.01 BP: Between population					
AP x BP		0.03					

Leaf dry weight (100 leaves)

The 100 leaves dry weight of the leaves was studied and data enshrined in Table 3. The content of table revealed that the 100 leaves dry weight showed significant variation between population and among population, whereas interaction among population and between population also shown to be significant. Maximum 100 leaves dry weight 3.48 g was recorded for Kupa followed by Chitkul 3.41 g while minimum 1.74 g 100 leaves dry weight was recorded for Shiego. On the other hand, between population, the maximum (4.79 g) 100 leaves dry weight was recorded in Chitkul plant 1 and minimum (1.20 g) was observed in Sheigo plant 3(SP3).

Table 3: Variation in 100 leaves dry weight (g) among and between selected Seabuckthorn (*Hippophae salicifolia* D. Don) populations in Himachal Pradesh

Between Among	Populations	100 Leaves Dry Weight (g)					Mean
		Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	
S1	Kupa	3.60	3.33	3.56	3.73	3.17	3.48
S2	Badseri	2.36	3.62	2.74	3.90	2.79	3.08
S3	Chitkul	4.79	2.59	2.63	3.93	3.13	3.41
S4	Giu	2.44	2.50	2.76	1.34	2.32	2.27
S5	Mane	2.85	2.62	3.61	1.70	1.50	2.46
S6	Shiego	1.62	2.00	1.20	1.70	2.18	1.74
CD		0.05					
AP		0.007 AP: Among population					
BP		0.006 BP: Between population					
AP x BP		0.015					

Leaf dry matter content (%)

The data on leaf dry matter content is detailed in Table 4. The said parameter showed a significant variation among population, which varied from 60.24 to 42.36 per cent. Badseri had havier leaf dry matter content (60.24 per cent) which was significantly different from other whereas, the minimum was recorded in Mane (42.36 per cent). Between the population, the maximum (76.02 per cent) leaf dry matter content was recorded in Badseri plant (BP5) and minimum (37.45 per cent) was recorded in Mane plant 3 (MP3). The interaction among population and between population as well as variation between populations was found to be significant.

Table 4: Variation in leaf dry matter content (%) among and between selected Seabuckthorn (*Hippophae salicifolia* D. Don) populations in Himachal Pradesh

Between Among	Populations	Leaf Dry Matter Content (%)					Mean
		Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	
S1	Kupa	59.41	63.38	62.02	39.47	56.61	56.18
S2	Badseri	53.39	53.71	57.32	60.75	76.02	60.24
S3	Chitkul	43.39	52.86	58.84	54.89	55.11	53.02
S4	Giu	46.30	47.17	46.62	46.53	47.06	46.74
S5	Mane	38.51	41.26	37.45	46.96	47.62	42.36
S6	Shiego	45.21	42.55	48.39	44.16	43.86	44.83
CD		0.05					
AP		0.18 AP: Among population					
BP		0.17 BP: Between population					
AP x BP		0.41					

Crude fiber (%)

The data pertaining to the crude fibre is presented in Table 5, which showed significant variations among studied population. Maximum crude fibre (16.70 per cent) was observed in Badseri which was statistically different from other population and minimum was recorded in Sheigo (7.06 per cent), respectively. Between population, the maximum crude fibre (20.00 per cent) was notices in Badseri plant 2 (BP2) whereas, minimum (4.42 per cent) was noticed in Giu plant 5 (GP5). The interaction among population and between population was found to be significant and it was also shown to be significant between population respectively.

Table 5: Variation in crude fibre (%) among and between selected Seabuckthorn (*Hippophae salicifolia* D. Don) populations in Himachal Pradesh

Between Among	Populations	Crude Fibre (%)					Mean
		Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	
S1	Kupa	17.00	14.50	12.00	11.00	13.00	13.50
S2	Badseri	16.50	20.00	19.00	14.00	14.00	16.70
S3	Chitkul	13.50	17.50	16.50	15.00	15.00	15.50
S4	Giu	8.75	6.28	8.82	7.44	4.42	7.14
S5	Mane	7.14	7.10	6.31	7.40	13.59	8.31
S6	Shiego	7.54	7.69	7.84	7.04	5.20	7.06
CD		0.05					
AP		0.02 AP: Among population					
BP		0.02 BP: Between population					
AP x BP		0.04					

Crude protein (%)

The data pertaining to the crude protein is presented in Table 6, which showed significant variations among studied population. Maximum crude protein (26.64 per cent) was observed in Chitkul which was statistically different from other population and minimum was recorded in Giu (24.65 per cent), respectively. Between population, the maximum crude protein (28.13 per cent) was notices in Kupa plant 1 (KP1), whereas minimum (23.81 per cent) was noticed in Sheigo plant 1 (SP1). The interaction among population and between population was found to be significant and it was also shown to be significant between population.

Table 6: Variation in crude protein (%) among and between selected Seabuckthorn (*Hippophae salicifolia* D. Don) populations in Himachal Pradesh

Between Among	Populations	Crude Protein (%)					Mean
		Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	
S1	Kupa	28.13	26.10	25.13	26.25	25.94	26.31
S2	Badseri	25.94	25.75	25.19	25.63	25.44	25.59
S3	Chitkul	26.56	26.19	26.38	27.19	26.88	26.64
S4	Giu	24.88	24.06	25.00	24.63	24.69	24.65
S5	Mane	25.38	25.69	25.13	25.81	25.50	25.50
S6	Shiego	23.81	24.88	25.94	25.25	25.00	24.98
CD		0.05					
AP		0.07 AP: Among population					
BP		0.07 BP: Between population					
AP x BP		0.17					

Total ash (%)

The data pertaining to the total ash is presented in Table 7, which showed significant variations among studied population. Maximum total ash (8.84 per cent) was observed in Giu which was statistically different from other population and minimum was recorded in Badseri (5.70 per cent). Between population, the maximum total ash (14.40 per cent) was notices in Giu plant 4 (GP4), whereas minimum was noticed in 5.00 per cent in Kupa plant 1 (KP1) (BP3), (CP1), (MP4), (SP5). The interaction among population and between population was found to be significant and it was also shown to be significant between population.

Table 7: Variation in total ash (%) among and between selected Seabuckthorn (*Hippophae salicifolia* D. Don) populations in Himachal Pradesh

Between Among	Populations	Total Ash (%)					Mean
		Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	
S1	Kupa	5.00	5.50	6.50	8.00	7.50	6.50
S2	Badseri	7.00	5.50	5.00	5.50	5.50	5.70
S3	Chitkul	5.00	7.00	6.00	5.50	9.00	6.50
S4	Giu	10.30	6.20	5.30	14.40	8.00	8.84
S5	Mane	8.00	6.82	6.20	5.00	5.22	6.25
S6	Shiego	5.62	9.50	6.15	4.85	5.00	6.22
CD		0.05					
AP		0.01 AP: Among population					
BP		0.009 BP: Between population					
AP x BP		0.022					

Nitrogen free extract (%)

The data pertaining to the nitrogen free extract is presented in Table 8, which showed significant variations among studied population ranged from 58.74 to 48.36 per cent. The maximum nitrogen free extract (58.74 per cent) was observed in Sheigo which was statistically different from other population and minimum was recorded in Chitkul (48.36 per cent). Between population, the maximum nitrogen free extract (61.80 per cent) was notices in Sheigo plant 5 (SP5), whereas minimum (45.75 per cent) was noticed in Badseri plant 2 (BP2). The interaction among population and between populations was found to be significant and it was also shown to be significant between populations.

Table 8: Variation in nitrogen free extract (%) among and between selected Seabuckthorn (*Hippophae salicifolia* D. Don) populations in Himachal Pradesh

Between Among	Populations	Nitrogen Free Extract (%)					Mean
		Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	
S1	Kupa	46.88	50.90	53.38	51.75	50.56	50.69
S2	Badseri	47.56	45.75	47.81	51.88	52.06	49.02
S3	Chitkul	51.94	46.31	48.13	49.31	46.13	48.36
S4	Giu	53.08	60.46	57.88	50.54	59.89	56.37
S5	Mane	56.49	57.39	59.37	58.79	52.69	56.95
S6	Shiego	60.03	54.94	57.07	59.86	61.80	58.74
CD		0.05					
AP		0.06 AP: Among population					
BP		0.06 BP: Between population					
AP x BP		0.15					

The critical analysis of data revealed a statistically significant difference in the content of proximate compositions in leaves among and between the studied population. Various studies have reported a strong variation in leaf composition (Langill and MeClean, 1976 [13]; Nakamura, 1977 [14]; Khosla *et al*., 1980 [11]; Pal *et al*., 1983 [15]; Kovas *et al*., 1985 [12]; Kaushal *et al*., 1986) [9]. The present study draws support from these reports as leaf composition exhibit significant variation among population. Maximum 100 leaves fresh weight (6.65 g) and crude protein (26.64 per cent) was recorded in Chitkul, maximum 100 leaves dry weight (3.48 g) was observed in Kupa, Badseri reported highest leaf dry matter content (60.24 per cent) and crude fibre (16.70 per cent), whereas highest nitrogen free extract (58.74 per cent) was reported in Sheigo. All the studied plant population also showed significant variation among themselves. The mean 100 leaves fresh weight ranged from 3.92 to 6.65 g, 100 leaves dry weight 1.74 to 3.48 g, leaf dry matter content varied from 42.36 to 60.24 per cent, crude fibre 7.06 to 16.70 per cent, crude protein varied from 26.64 to 24.65 per cent, nitrogen free extract 58.74 to 48.36 per cent and total ash content differed from 5.70 to 8.84 per cent.

Numbers of studies have been conducted in different regions to assess the proximate composition in natural growing populations of seabuckthorn in Spiti Valley of Himachal Pradesh and Ladakh region of Jammu and Kashmir (Singh *et al.*, 2004; Sharma *et al*., 2014).The leaves of the studied varieties of sea-buckthorn showed a considerable diversity in said composition. The dissimilarity in proximate composition may be credited to geographic, climatic and edaphic influences of the population. It is a familiar factor that a climate to which a plant is bare during its growing season, affects its leaf composition. The variation in the proximate composition and mineral nutrients also showed by (Singh *et al.*, 2004 [22]; Sharma *et al*., 2014) [21] in *Hippophae rhamnoides*. Kaushal (1978) [10] also recorded variation in the proximate principles and mineral nutrients of *Grewia optiva*; Rathore (1997) [17] in *Grewia optiva*; Gera *et al.*, (2002) [6] in *Dalbergia sissoo*; Jain *et al.*, (2002) [8] in Neem (*Azadirachta indica*); Wani *et al.*, (2009) [23] in *Bauhinia variegata;* Sankhyan *et al.*, (2009) [20] in *Grewia laevigata*; Bhat (2010) [3] in *Grewia optiva*; Ghazanfer *et al.*, (2011) [7] in some fodder tree leaves is also in accordance of present study. The assortment of fodder worth parameters is showing the same drift as worked out by Cheema *et al.*, (2011) [5] on *Morus alba*, *Acacia nilotica*, *Syzygium cumuni* and *Ziziphus jujuba*.

Conclusion

- On the basis proximate composition of seabuckthorn, Badseri population was found more effective for leaf dry matter and crude fibre whereas Chitkul population depicted higher in leaves fresh weight, leaves dry weight and crude protein.
- Seabuckthorn is recorded to be rich in crude fibre and crude protein which is growing in Baspa Valley under different population.
- On the basis of statistical analysis, it can be concluded that better *Hippophae salicifolia* D. Don plantation were found in Sangla Valley for maximum of characters studied, than in Spiti Valley. Reason for this can be better soil and climatic condition in Sangla Valley as compare to Spiti Valley, where climate is very harsh and less of water availability and poor soil status.
- It is also suggested that for further propagation programmes, genepool from Sangla Valley should be used.
- It is again suggested that Sangla genepool can be planted on wasteland to develop grazing areas for sheep and goats and harvesting of fruits for seabuckthorn value addition chain.

Acknowledgments

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