

Variations in morphological and biochemical characters of Seabuckthorn (*Hippophae salicifolia* D. Don) populations growing in Harsil area of Garhwal Himalaya in India

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ABSTRACT

The present investigation was carried out to study the variation in morphological and biochemical characters of different seabuckthorn (*Hippophae salicifolia*) populations growing naturally in and around Harsil and Gangotri area of Uttarkashi district of Uttaranchal, India. Plants showed varied morphology from shrub to tree, fruit shape from round to ovate and fruit colour from greenish-yellow to yellow-orange. Number of leaves per 10 cm running length of branch ranged from 10.83 to 29.83 and leaf area from 2.28 to 9.35 cm². Weight of 100 fruits varied from 11.53 to 18.87g, number of fruits per 10 cm fruiting branch ranged from 10.69 to 99.40 and fruit yield of same length of branch from 1.34 to 15.98 g. Acidity in juice calculated as citric acid varied between 4.89 to 7.93 per cent and total soluble solids ranged between 6.93 to 10.0 °B. Higher juice percentage was observed in this species as compared to *H. rhamnoides* and the range was between 70.70 to 79.23 per cent. Based on the study, it is concluded that wide variations exist in different populations of *H. salicifolia* growing in this region. Intensive survey is required for the selection of some promising forms of *H. salicifolia* in the region and other seabuckthorn growing regions of Garhwal Himalaya.

Key words: Variations, Morphological, Biochemical, Garhwal Himalaya, Seabuckthorn

INTRODUCTION

Seabuckthorn (*Hippophae spp*) in the family *Elaeagnaceae*, is a multipurpose, spinescent, non-leguminous nitrogen fixing, shrub or tree. It is widely distributed in higher latitudes and altitudes of temperate zone in Asia and Europe. In India, it is distributed in Leh and Kargil districts of Jammu and Kashmir, dry temperate regions of Lahaul and Spiti valley of Hi-

machal Pradesh and Garhwal and Kumaon division of Uttaranchal. In Uttaranchal, out of two endemic species of seabuckthorn, *H. Salicifolia* D. Don is widely distributed. This species is reported to exist in abundance in Garhwal Himalayas viz. Gangotri, Harsil, Sukhi, Badrinath area, Yamunotri, Gaurikund and Harki-dun etc. Due to its wide adaptability, drought resistance, strong root system and capacity to fix atmospheric nitrogen through *Frankia* sym-

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biosis, the plant has been widely planted in China to control soil erosion and reclamation of degraded lands (Rongsen, 1992). The leaves, berries and seeds of seabuckthorn have high nutritional and medicinal value and are excellent source of vitamins C, B₁, B₂, E, F, K, P, pro-vitamin A, sugars and organic acids. High content of vitamin C and E and other bioactive substances makes it a suitable species for pharmaceutical, cosmetic and food industry.

In view of the great economic and ecological potential of the species, a number of studies have been conducted in different regions to assess the morphological and biochemical variations in natural growing populations of seabuckthorn in Himachal Pradesh and Ladakh region of Jammu and Kashmir (Khosla *et al.*, 1994; Singh 1994; Singh and Dogra 1995; Dwivedi *et al.*, 2000; Singh and Singh 2004 and Sankhyan *et al.*, 2004). However, no such studies were conducted to assess the variation pattern in naturally occurring populations of seabuckthorn of Garhwal Himalayas. The present study, therefore, was carried out to determine the variations in morphological and biochemical characters of natural populations of seabuckthorn growing in Harsil and Gangotri area of Uttarkashi district of Uttaranchal located in Garhwal Himalayas.

MATERIALS AND METHODS

The present study is an outcome of the survey of naturally growing seabuckthorn populations in Gangotri-Harsil area (2000-3000 m amsl) of district Uttarkashi, a dry temperate region of Garhwal Himalayas. The meteorological data recorded at Harsil revealed that the area received an average

annual precipitation of 910 mm, minimum average temperature of the coldest month (January) -3.2 °C; maximum average temperature of the hottest month (June) was 20.6 °C and relative humidity ranges from 23-100 percent. During the last week of September, 2004, 19 populations were selected for the study from 16 different locations on the basis of observable morphological traits. Details of sampling sites are presented in Table 1. The observations were recorded on 15 plants of each population dividing them into 3 replications. The observations included all morphological traits i.e., number of leaves per 10 cm running branch length, leaf area (cm²), fruit length (mm), fruit diameter (mm), 100 fruit weight (g) and number of fruit and fruit yield (g) per 10 cm of fruiting branch. Harvested fruits were brought to the laboratory for analysis of biochemical and quality characters.

Study sites

The study sites lie between 30° 56' and 30° 44'N latitude and 78° 19' and 79° 02' E longitude in Uttaranchal State. The river Ganga which is known as Bhagirathi in the region flows through the district and all the sites were located on either side of this river or along highway hill slopes. Being a dry temperate zone, most of precipitation is in the form of snow during winters. Scanty rainfall also occurs during rainy season. All study sites were under the thick blanket of snow from November to May. The soil in the region is sandy loam, mixed with pebbles and gravels and depth varies from few centimetres to about one meter. The important trees and shrub species were found to be associated with *Hippophae salicifolia* in the study area were

Cedrus deodara, *Pinus wallichiana*, *Picea smithiana*, *Betula utilis*, *Alnus nepalensis*, *Abies pindrow*, *Juniperus macropoda*, *Prinsepia utilis*, *Rosa webbiana* and *Cotoneaster* spp.

RESULTS AND DISCUSSION

Morphological characteristics

A wide spectrum of variations was observed for different characters studied during the survey. The physiognomic form of plants varied from shrubs to trees up to 6

m in height and 50 cm in diameter at breast height (Table 1). Large tree form of plants makes the species a valuable material for timber and fuelwood in these areas. The fruit shapes were generally round but in some populations ovate fruits were also observed (Table 2). The colour of fruits was reported to be pale green in case of *H. salicifolia* but it changes with the ripening of fruit (Sankhayan *et al.*, 2004). However, the colour of fruits in the study area varied from greenish-yellow to orange-yellow. As regards to variations in morphological characters, high variability was observed

Table 1. Details of sampling sites, habit and habitat of Seabuckthorn (*Hippophae salicifolia* D. Don) populations growing in Harsil area of Uttarkashi district.

S.No.	Place /Location	Altitude (m amsl)	Habit	Habitat
1.	Gangotri	3017	Shrub	Road side hill slope
2.	Bhairon Ghati	2960	Shrub	Road side hill slope
3.	Dharali	2530	Shrub	River bed
4.	Harsil	2500	Tree	River side
5.	Harsil-A	2550	Tree	Road side hill slope
6.	Chormi	2490	Shrub	Road side hill slope
7.	Mukhawa	2480	Shrub	Road side hill slope
8.	Jhala	2607	Shrub	Road side hill slope
9.	Chhormee	2580	Shrub	River bed
10.	Kachora	2650	Shrub	Road side hill slope
11.	Jaspur	2520	Shrub	River bed
12.	Jaspur-A	2518	Shrub	River bed
13.	Sukhi	2516	Shrub	Road side hill slope
14.	Sukhi Top	2590	Shrub	Road side hill slope
15.	Sukhi down	2353	Shrub	Road side hill slope
16.	Sonagad	2196	Tree	Road side hill slope
17.	Sonagad -A	2176	Tree	Road side hill slope
18.	Dabrani	2160	Shrub	Road side hill slope
19.	Gagnani	2075	Shrub	River bed

Table 2. Fruit shape and colour of seabuckthorn populations growing in Harsil area of Uttarkashi district.

Place / Location	Fruit shape	Fruit colour
Gangotri	Round	Yellow
Bhairon Ghati	Round	Yellow
Dharali	Round	Yellow
Harsil	Round	Greenish yellow
Harsil-A	Round	Yellow
Chormi	Round	Greenish yellow
Mukhawa	Round	Yellow
Jhala	Round	Yellow orange
Chhormee	Ovate	Yellow orange
Kachora	Round	Yellow orange
Jaspur	Ovate	Greenish yellow
Jaspur-A	Round	Yellow
Sukhi	Round	Yellow
Sukhi Top	Round	Yellow
Sukhi down	Round	Yellow
Sonagad	Ovate	Greenish yellow
Sonagad -A	Round	Yellow
Dabrani	Round	Yellow orange
Gagnani	Round	Yellow orange

for number of leaves, leaf area and fruits characteristics. Highest number of leaves / 10 cm of branch length was 29.83, recorded at Sukhi down location which was in par with the number of leaves recorded at Kachora (28.42). In general, number of leaves per 10cm branch length showed a decreasing trend with increasing altitude except for Gagnani location (2075m) where it was found growing in lower altitude than its normal zone of occurrence. Leaf area ranged

from 2.28 (Chormi) to 9.35 cm² (Bhairon ghati). The average fruit length ranged from a minimum value of 5.78 mm to a maximum of 7.92 mm where the fruits were ovate in shape. Fruit diameter ranged from 5.51 to 7.24 mm in all locations. However, large variability was recorded for the 100 fruits weight and number of fruits per 10 cm of fruiting branch. 100 fruits weight of different *H. salicifolia* populations are presented in Table 3. In the present study the material collected from Harsil-A, Chhormee, Sonagad, Mukhawa and Jaspur-A showed large fruit size and there is good scope for its improvement. Rongsen (1993) reported fruit weight of 18.5-19.5 g/ 100 fruits for the *H. rhamnoides* and 19.0-20.5 g for *H. salicifolia* in China. Therefore, fruit weight of these *H. salicifolia* populations in the study area is almost comparable with the findings of Rongsen (1993).

The number of fruits /10 cm fruiting length of branch was lowest at Bhairon ghati (10.69) and Gangotri (12.61) and highest number of fruits per unit branch length was observed at Jaspur (99.40) followed by Mukhawa (87.14). Similarly, fruit yield per 10cm length of branch was also highest at Mukhawa (15.98 g) followed by Jaspur (15.49g) while, lowest fruit yield (1.34g) was observed at Bhairon ghati location (Table 3). Singh and Singh (2004) also reported wide variations for these morphological traits in natural populations of *H. salicifolia* and *H. rhamnoides* growing in high altitude cold arid areas of Himachal Pradesh.

Fruit quality characteristics

The important fruit quality parameters studied, such as acidity calculated as citric acid, total soluble solids (°Brix), juice

percentage, seed percent and residue percentage showed a wide range of variability. The acidity in juice ranged from 4.89 percent (Sukhi top) to 7.93 per cent (Gangotri), and total soluble solids ranged between 6.93 °B (Sukhi top) to highest 10.00 °B (Bhairon ghati) along with 9.80 °B of Gangotri location (Table 4). The acidity content in the samples was remarkably high as compared to the findings of Chauhan *et al.*, (2001) who re-

ported the range of 1.72-1.95 acidity for *H. rhamnoides* berries. High and wide variability for the acidity and total soluble solids indicated importance of these populations for selection of genotypes to be used in preparations of different products. TSS: Acidity ratio, a useful parameter in deciding the use of berries for the preparation of different products that ranged from 1.24 (Gangotri) to 1.76 (Bhairon ghati) which was significantly higher than other loca-

Table 3. Means of various morphological characters of Seabuckthorn growing in Hasil area of Uttarkashi district

Place /Location	No. of leaves/ 10cm	Leaf Area (cm ²)	Fruit length (mm)	Fruit diam. (mm)	100 fruit wt (g)	No. of fruits/ 10 cm	Fruit yield/ 10 cm (g)
Gangotri	10.84	6.26	7.20	7.04	13.53	12.61	1.72
Bhairon Ghati	11.83	9.35	7.07	5.92	12.57	10.69	1.34
Dharali	17.79	4.55	6.95	5.94	13.34	34.26	4.57
Harsil	11.50	6.01	6.59	6.49	16.44	19.00	3.12
Harsil-A	11.83	6.65	6.84	6.78	18.87	68.22	12.87
Chormi	24.17	2.28	6.95	6.07	14.07	38.00	5.35
Mukhawa	16.57	3.48	7.53	6.92	18.34	87.14	15.98
Jhala	19.83	5.23	6.41	6.44	15.21	22.89	3.48
Chhormee	21.92	3.43	7.92	6.68	18.62	44.03	8.19
Kachora	28.42	3.44	6.38	6.63	17.19	45.14	7.76
Jaspur	21.58	4.42	7.51	6.30	15.59	99.40	15.49
Jaspur-A	20.57	7.81	7.14	6.55	17.35	84.27	14.60
Sukhi	16.75	3.32	7.05	6.51	14.89	76.88	11.45
Sukhi Top	13.67	3.88	6.10	6.51	17.22	34.07	5.86
Sukhi down	29.83	2.88	5.78	5.55	13.94	48.68	6.79
Sonagad	22.17	6.03	6.54	7.24	18.64	76.37	14.24
Sonagad-A	20.92	3.83	7.01	5.51	11.53	49.83	5.74
Dabrani	23.58	3.40	6.30	6.25	14.08	52.86	7.44
Gagnani	13.00	3.72	6.69	6.35	14.17	34.40	4.87
GM	18.78	4.74	6.84	6.40	15.56	49.41	7.94
CD (0.05)	1.05	0.22	0.26	0.54	0.61	9.27	1.43

tions. Juice yield ranged from 70.70 to 79.23 per cent. Berries collected from Jaspur-A, Harsil-A, Gangotri, Sukhi, Harsil and Mukhawa produced the highest amount of juice as compared to other locations (Table 4). The juice percentage of berries in these locations was comparatively high compared to the earlier findings of Chauhan *et al.*, (2001) and Heilsher and Lorber (1996) who reported 65-68 per cent and 67 per cent juice yield respectively, in berries of *H. rhamnoides*. High juice per-

centage of berries in these locations makes them a valuable material for seabuckthorn improvement programmes. Seed percentage in berries of different sampling sites ranged between 5.90 per cent (Sukhi top) to 8.25 per cent (Chormi) depending on size of seed and pulp content. Similarly, residue percentage of berries after removing seeds and juice was calculated which ranged from 13.57 per cent (Jaspur-A) to 22.52 per cent (Jhala). Low residue percentages were observed in

Table 4. Means of fruit quality characters for different locations in Seabuckthorn growing in Harsil area of Uttarkashi district

Place /Location	Juice acidity (% citric acid)	TSS (°B) (Juice)	TSS : Acidity ratio	Juice (%)	Seed (%)	Residue (%)
Gangotri	7.93	9.80	1.24	78.23	7.87	13.90
Bhairon Ghati	5.68	10.00	1.76	71.45	7.77	20.78
Dharali	5.38	8.93	1.66	74.30	7.60	18.10
Harsil	5.62	9.13	1.63	77.43	6.35	16.22
Harsil-A	6.53	9.83	1.51	78.50	7.14	14.36
Chormi	5.66	9.00	1.59	74.95	8.25	16.80
Mukhawa	5.83	8.13	1.40	77.05	7.74	15.21
Jhala	5.84	9.87	1.69	70.70	6.78	22.52
Chhormee	6.28	9.20	1.47	73.33	7.66	19.01
Kachora	5.49	7.80	1.42	74.95	6.15	18.90
Jaspur	5.59	7.67	1.37	74.82	7.15	18.03
Jaspur-A	6.09	8.23	1.34	79.23	7.20	13.57
Sukhi	5.90	8.33	1.41	77.96	7.14	14.90
Sukhi Top	4.89	6.93	1.42	74.50	5.90	19.60
Sukhi down	5.31	7.93	1.50	70.94	6.63	22.25
Sonagad	6.43	8.87	1.38	70.83	7.77	21.40
Sonagad-A	6.02	9.07	1.52	75.34	7.87	16.79
Dabrani	4.92	7.07	1.44	73.87	7.12	19.01
Gagnani	6.15	8.13	1.32	73.58	7.22	19.20
GM	5.87	8.63	1.48	74.84	7.24	17.93
CD (0.05)	0.14	0.22	0.04	0.86	0.28	0.44

the samples collected from Gangotri (13.90 %), Harsil-A (14.36 %) and Sukhi (14.90 %). The residue percentages in all locations sampled were found low as compared to earlier report of Chauhan *et al.*, (2001) in *H. rhamnoides*.

CONCLUSION

It emerged from the present study that a large variability exists in the *Hippophae salicifolia* growing naturally in Garhwal Himalayas particularly for number of leaves / unit branch length, fruit length, 100 fruit weight, number of fruits per unit length of fruiting branch, fruit yield, titrable acidity, total soluble solids and juice yield. The variability of different characters could be utilized for selection of genotypes suitable for the plantation and utilization in making different value added products. However, more comprehensive survey of seabuckthorn habitat areas of Garhwal Himalayas is required to select some promising forms of *H. salicifolia*.

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