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PHYSICO-CHEMICAL CHARACTERISTICS OF YELLOW VARIETY OF SEABUCKTHORN (*HIPPOPHAE RHAMNOIDES L*)

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This study was carried out to evaluate the physico-chemical composition of seabuckthorn yellow variety wildly grown in northern areas of Pakistan. The sites selected were Skardu, Shigar, Khaplu and Hunza. The analysis of the fruit was carried out in the form of whole berries, pulp and seed. The parameters studied were pH, acidity, sugar, protein, ascorbic acid, moisture, total soluble solids (TSS), ash and oil. Mean moisture contents had the figures of 68.68, 72.18 and 20.39% in whole berries, pulp and seed, respectively. The ash levels from four sites were found in the range of 2.13-2.64 (whole), 0.79-1.01 (pulp) and 1.05-1.28% (seed). Maximum mean concentrations of various parameters determined were 11.06 (TSS), 14.73 (crude oil), 24.86 (crude protein), 1.58% (titratable acidity) and 53.58 mg/100g (ascorbic acid). Highest contents in the pulp for total and reducing sugars were 8.33 and 7.39% while maximum non-reducing level was observed in whole berries (1.43%). Mean total soluble solids (TSS) determined was 9.56 (whole) and 11.06 ^{o}brix (pulp).

Keywords: Seabuckthorn (*Hippophae rhamnoides L*.), yellow variety, physical indices, chemical constituents, nutritional values.

1. Introduction

The multipurpose shrub tree, Seabuckthorn, belongs to the family Elaeagnaceae. The most important specie is *Hippophae rhamnoides* L (Linn). It is a unique and valuable plant 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 -43ºC to 40ºC and is considered to be drought resistant [1]. *Hippophae rhamnoides* Linn, sub-species Turkestanica is found in Chitral and northern areas of Pakistan. Normally it is spread throughout the Karakorum and Himalayan ranges at altitudes of 1500–3500 m. According to a Chinese seabuck-thorn expert, a total of about 3000 hectors seabuckthorn population in Pakistan, promising a harvest of 1200-2500 tons fruits annually [2]. *Hippophae rhamnoides* fruits and juices were found to be rich in proteins, carbohydrates, organic acids, amino acids, globulins and albumins. Fruit drinks were among the earliest seabuckthorn products developed in China. Seabuckthorn based juice is also popular in Germany and Scandinavia [3]. The berries also appeared to be a natural source of Vitamin A, B, B1, B2, C, E, K and P, carotenes and flavonoids. Vitamin C content of seabuckthorn is 3-6 times higher than that of Kiwi fruit [4-6]. About 27 mineral elements are present in seabuckthorn, among these Al, Ca, Fe, Mg, P, Mn, Ti, Si, As and Ba contents are found in high quantity [7].

Based on scientific research, seabuckthorn has become an important medicinal and nutritional product [8]. Although the oil content of seabuckthorn is not much as compared to most oil crops, but its nutritive and medicinal values are much more than those of most oil crops, because it contains a lot of fat-soluble bioactive substances [9]. Shyrko and Radzyuk [10] presented data on the quality and chemical composition of fruit of 20 varieties of seabuckthorn while Heilscher and Lorber [11] compared the composition and nutritive value of berries of this plant to those of other fruits including apple and oranges.

The aim of this study was to analyze the physico-chemical contents of yellow variety of seabuckthorn wildly grown in northern areas of Pakistan. The outcome of this work will bring

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awareness regarding the nutritional and economic importance of this fruit among the growers, government departments and private investors in seabuckthorn growing areas.

2. Experimental

2.1. Collection and preparation of samples

Fully ripened, sound and healthy seabuckthorn berries of yellow variety were collected from four different localities of northern areas i.e. Skardu, Shigar, Khaplu and Hunza. Whole berries were washed crushed with electric blender and were used for physico- chemical analysis. Pulp and seed of the berries were also analyzed for proximate composition, separately.

2.2. Physico-chemical analysis

Levels of selected parameters (moisture, ash, pH, total soluble solids, oil, protein, acidity, ascorbic acid and total sugars, reducing and non-reducing sugars) were determined by standard methods [12]. Crude oil was estimated by intermittent soxhlet extraction apparatus while crude protein was determined by Kjeldahl method. pH was measured by using Inolab Digital pH Meter. The total titratable acidity was analyzed by titrating against standard alkali solution. Total soluble solids (TSS) were determined using hand refractometer at room temperature. Sugars were determined by Lane Eynon method and ascorbic acid by the titrameric method [12].

3. Results and Discussion

Results presented in the tables are the mean values of three independent measurements. In all cases, data are statistically different ($P<0.05$) from each other. Yellow variety contained 68.68, 72.18 and 20.39% moisture, 2.28, 0.91 and 1.37% ash, 14.33, 5.82 and 8.51% crude oil, 5.85, 3.68 and 24.86% crude protein, 3.12, 3.21 and 5.31 pH, 1.25, 1.58 and 1.08% titratable acidity, 6.24, 7.39 and 1.21% reducing sugar, 1.43, 0.93 and 4.95% non-reducing sugar, 7.67, 8.33 and 6.16% total sugar, 40.38, 53.58 and 10.81mg/100g ascorbic acid in whole berries, pulp and seed respectively. Total soluble solids (TSS) contents were 9.56 and 11.06-ºbrix in whole berries and pulp, respectively. Zhiban [13] studied different parts of seabuckthorn and found that the dry content of pulp, seed and whole berries were 22.9, 82.8 and 26.0% respectively.

Results of moisture, ash, pH and TSS are presented in Table 1. As shown in Table 2, maximum moisture content (72.95%), in whole berries was observed collected from Skardu location while minimum level (60.65%) was found in the sample collected from Shigar location. In pulp highest moisture level (77.20%) was found also at Skardu location while lowest level (67.90%) was observed at Shigar site. Minimum moisture concentration (15.44%) was recorded in seed at Hunza location while maximum moisture value of 26.21% was at Skardu location. The locality means for whole berries of seabuckthorn fruit were non-significant. The results shown here are slightly different to those of Ma Zhiben and Yansheng [14]. Ma Zhiben and Yansheng recorded moisture 74.0, 77.1 and 17.2% in whole fruit, pulp and seed respectively. The slight decrease in moisture content in our observations might be due to period between collection and analysis of berries, which might lead to moisture loss during transportation.

The data in Table 1 showed the highest ash content 2.64% at Shigar location while lowest level (2.13%) was found at Skardu location in whole berries. The ash content in pulp was found maximum at Khalpu location i.e. 1.01%, while minimum level of 0.79% was recorded at Shigar site. In seed the maximum ash concentration (1.28%) was observed at Skardu location while minimum (1.05%) was found in samples collected from Shigar. Analysis of variance at $\alpha = 0.05$ for ash percentage of whole berries and pulp showed non-significant effect on location, while for seed location showed non-significant effect. These results were slightly different from the data obtained by Shyrko and Radzyuk, reported ash percentage in fruit is 0.32-0.48% [10]. The slight increase in ash in our observation may be due to genotype, geographical location, soil condition, climate etc.

Table 1 indicates that in the whole berries of seabuckthorn, high pH value (3.20) was observed at Skardu and Shigar location while lowest pH (3.10) was observed in Hunza samples. Similarly, lowest pH (3.17) in pulp was detected at Hunza location while highest value of 3.24 was found at Khaplu location. In seed, maximum pH i.e. 5.89 was found at Khaplu location while minimum pH of 4.71 in samples obtained from Skardu was noticed. The statistical analysis of data revealed that different fractions of fruit had significant effect on pH. The SS and MS errors for pH were found to be 0.032 and 0.011 (whole berries), 0.001 and zero (pulp) and 0.509 and 0.170 (seed), respectively. The coefficient of variation was calculated to be

Table 1. Percent mean levels of moisture, ash, pH and total soluble solid (TSS) in yellow variety of seabuckthorn.

Location	Whole	Pulp	Seed
Moisture			
Skardu	74.95	77.20	26.21
Shigar	60.65	67.90	20.99
Khaplu	71.07	73.32	20.99
Hunza	68.05	70.30	15.44
Means	68.68a	72.18a	20.39a
Ash			
Skardu	2.13	0.85	1.28
Shigar	2.64	0.79	1.05
Khaplu	2.16	1.01	1.15
Hunza	2.21	1.00	1.21
Means	2.28b	0.91b	1.37 b
pH			
Skardu	3.20	3.22	4.71
Shigar	3.20	3.22	5.32
Khaplu	3.17	3.24	5.89
Hunza	3.10	3.17	5.31
Means	3.12a	3.21a	5.30a
TSS			
Skardu	8.0	12.00	ND
Shigar	9.0	10.75	ND
Khaplu	10.25	10.25	ND
Hunza	11.0	11.25	ND
Means	9.56b	11.06a	ND

*Figures with different letters are statistically different (P<0.05) from each other.

ND = not determined.

Table 2. Mean levels of crude oil, crude protein, titratable acidity and ascorbic acid in yellow variety of seabuckthorn

Location	Whole	Pulp	Seed
Crude oil (%)			
Skardu	13.98	5.73	8.25
Shigar	14.34	5.58	8.76
Khaplu	15.25	6.67	8.58
Hunza	13.78	5.32	8.46
Means	14.33a	5.82a	8.51a
Crude protein (%)			
Skardu	7.01	3.41	27.59
Shigar	6.34	3.93	26.81
Khaplu	4.42	3.54	21.56
Hunza	5.64	3.86	23.48
Means	5.85a	3.68a	24.86a
Titratable acidity (%)			
Skardu	1.40	1.80	0.86
Shigar	1.20	1.80	1.00
Khaplu	1.40	1.07	1.20
Hunza	1.00	1.67	1.27
Mean	1.25a	1.58a	1.08a
Ascorbic acid (mg/100g)			
Skardu	35.70	48.64	9.72
Shigar	40.82	56.08	11.61
Khaplu	46.95	58.80	11.37
Hunza	38.07	50.81	10.56
Means	40.38a	53.58a	10.81a

*Figures with different letters are statistically different (P<0.05) from each other.

3.29, 0.70 and 8.55% for whole berries, pulp and seed, respectively. These results are in agreement with Beveridge et al., who reported pH of 2.7 [6]. This slight increase in pH may be due to high sugar content of the subspecies turkistanika studied in present work, than other species [15].

As shown in Table 1, the highest TSS level (11.0ºbrix) in whole berries was recorded at Hunza location, while lowest value of 8.0ºbrix was at Skardu. In pulp the maximum TSS (12.0ºbrix) was found at Skardu location while minimum (10.25ºbrix) was observed at Khaplu location. When statistically analyzed it was observed that there were significant difference among localities in whole berries, while pulp showed no significant effect for both the factors. Our observation is in agreement with the reported range of TSS in seabuckthorn is 10-13ºbrix [15].

Table 2 shows mean values of crude oil, crude protein, titratable acidity and ascorbic acid concentrations. Table 2 shows that the crude oil content in whole berries was found maximum (15.25%) at location Khaplu while minimum (13.78%) at Hunza site. Also in pulp the maximum oil content having value of 6.67% was detected in Khaplu location while minimum concentration of 5.32% was recorded in samples obtained from Hunza. The highest oil percentage (8.76) was revealed in seed of yellow variety at Shigar

location while lowest (8.25) was observed at Skardu location. Statistical analysis of variance for crude oil revealed that whole berries and pulp have significant effect for location. This result is in agreement with the data of Rongsen [15] who determined the oil from seabuckthorn and stated that the oil contents oil were 7.8-17.85% in seed and 2.46-18.45% in pulp

It is evident from Table 2, that among seabuckthorn grown at different localities of northern areas, highest crude protein content (7.01%) was found at Skardu location while lowest content (4.62%) at Khaplu location in whole berries. Maximum protein level (3.93%) in pulp was observed at Shigar while minimum value of 3.41%. was at Skardu site. In seed maximum protein content i.e. 27.59% was at Skardu location and minimum in Khaplu location i.e. 21.56%. Statistical analysis of variance showed that means of protein for seed was significant for location, while for pulp location was non significant. For whole berries localities showed non-significant effect. Our results are slightly different from Ma Zhiben and Yansheng [14] who reported 1.20, 0.4 and 19.6 % protein in whole berries, pulp and seed of seabuckthorn subspecies Sinensis. This increase in our observation may be due to difference in ecological zone, species or climatic conditions.

Titratable acidity of seabuckthorn is shown in Table 2 revealed that highest percent titratable acidity (1.40) was observed in yellow variety at Skardu and Khaplu locations, while lowest (1.0) was found at Hunza. In pulp the maximum acidity (1.80%) was found at Skardu and Shigar, while minimum (1.07%) was detected at Khaplu location. Seed showed highest content (1.27%) at Hunza location and lowest level of 0.86% at Skardu. Analysis for variance showed that seed had significant effect for location, while pulp had non-significant effect for location. For whole berries non-significant effect was shown for location. The results in Table 2 showed low acidity than reported by Jalakas and Karp [16], who recorded the acidity in range of 2.1-3.0%. This decrease in acidity may be due to high sugar content of turkistanika subspecies.

Table 2 also shows the ascorbic acid (mg/100g) in yellow variety of seabuckthorn grown at different location of northern areas. From the table it is evident that whole berries contained high vitamin C (46.95) at Khaplu location, while low content (35.70) was observed at Skardu location. Ascorbic acid (mg/100g) in pulp was found maximum (58.80) at Khaplu location, while minimum (48.64) at Skardu location. When seed was analyzed, it showed maximum vitamin C (11.61) at Shigar location, while minimum content (9.72) was observed at Skardu site. When statistically analyzed localities means showed significant effect for whole berries, pulp and seed. These results are in agreement with Yao et al. [17] who reported that vitamin C concentration varied from 28-201 mg/100g of berries among bushes.

Table 3. Percent mean levels of total, reducing and non-reducing sugars in yellow variety of seabuckthorn.

Location	Whole	Pulp	Seed
Total sugar			
Skardu	7.16	7.99	6.20
Shigar	7.68	8.32	6.03
Khaplu	7.37	8.04	6.20
Hunza	8.48	8.97	6.23
Means	7.67b	8.33a	6.16a
Reducing sugar			
Skardu	5.30	7.14	1.35
Shigar	6.40	7.47	1.16
Khaplu	6.05	6.94	1.08
Hunza	7.20	8.02	1.26
Means	6.23b	7.39b	1.21b
Non-reducing sugar			
Skardu	1.86	0.85	4.85
Shigar	1.28	0.85	4.87
Khaplu	1.32	1.10	5.12
Hunza	1.28	0.95	4.97
Means	1.43a	0.93b	4.95b

*Figures with different letters are statistically different ($P<0.05$) from each other.

Levels of total sugars, reducing and non-reducing are given in Table 3. It is evident from the table that maximum total sugar content (8.48%) was in Hunza location, while minimum (7.16%) at Skardu location in whole berries. Pulp contained highest total sugar (8.97%), at Hunza location, while minimum (7.99%) was observed at Skardu location. Total sugar percentage in seed showed highest value of 6.23 at Hunza location, while lowest level of 6.03 was recorded at Shigar location. Statistical analysis showed significant effect for all except locality means in seed that is non-significant. Our result is close to agreement with Ma Zhiben and Yansheng [14] who recorded

6.29, 7.17 and 5.84% total sugar in whole fruit, pulp and seed of seabuckthorn, respectively. The difference may be due to species [15].

Table 3 indicates that whole berries of seabuckthorn at Hunza contained high percentage of reducing sugar (7.20) at Hunza while minimum (5.30) was observed from Skardu location. In pulp the highest reducing sugar value of 8.02% was observed at location of Hunza, while lowest one (6.94%) was at Khaplu. Reducing sugar content in seed was found highest (1.35%) at Skardu site, while lowest (1.08%) at Khaplu location. Statistical analysis showed significant result (at $\propto$=0.05) for location in whole berries and pulp, while in seed had no significant differences. Our results are in agreement with Ma Zhiben and Yansheng [14], who determined reducing sugar in whole berries, pulp and seed as 6.05, 6.95 and 1.60% respectively. This slight increase may be due to species and altitude [15].

Again, Table 3 shows that non-reducing sugar content in whole berries was high in Skardu location (1.86%), while low content was observed at Hunza location (1.28%). In pulp maximum non-reducing sugar (1.10%) was found at Khalpu location, while minimum (0.85%) was found grown in Skardu and Shigar. When seed was analyzed highest non-reducing sugar (5.12%) was found at Khalpu location, while lowest was observed at Skardu location (4.85%). Statistical analysis showed non-significant differences for localities in all cases i.e. whole berries, pulp and seed. These results are in agreement with Ma Zhiben and Yansheng [14] who reported 0.24, 0.22 and 4.24% in whole fruit, pulp and seed respectively. The slight decrease may be due to species [15].

Our study shows that the wildly grown yellow variety of seabuckthorn fruits having nutritional value level in the same range as reported for other varieties of seabuckthorn grown in other parts of the world. The yellow variety of seabuckthorn is less acidic in nature than the fruit of seabuckthorn grown in other parts of the world so for studied. One of the causes of this difference is that our samples of seabuckthorn fruit containing less ascorbic acid content. The results also show that the amount of contents such as ash, crude oil, sugar and ascorbic acids were comparatively more in fruit samples collected from plants of higher altitudes (Khaplu 7900 ft), while protein, acidity and moisture were less as compared to fruit samples collected from plants of lower altitudes (Skardu 7500 ft). The similar results regarding the effect of altitude on the nutrients composition of the fruits are also reported by Rongsen [15].

In Pakistan, seabuckthorn is widely found in northern areas of the country. Keeping in view its importance, seabuckthorn has high scope to be utilized as natural resource into value-added products to eradicate poverty in northern areas. Development of seabuckthorn jam, syrup, squash, juice, candy, powder and oil etc. on commercial scale will certainly gain importance and could play a viable role in giving boost to the economy and will lead to transfer of technology in the country. The seabuckthorn growers will fetch more money and the consumers will find hygienic and healthy products for consumption.

4. Conclusions

Data of present study revealed that levels of moisture, TSS, acidity, ascorbic acid and total and reducing sugars from high to low in the order of pulp, whole berries and seed while the ash and crude oil contents were in the sequence of whole berries> seed>pulp. Concentration of crude protein and non-reducing sugar was maximum in seed and lowest in pulp. Highest pH was observed in seed while lowest pH in the whole fruit. The outcome of this study will bring awareness regarding the nutritional importance of this fruit among the growers, government departments and private investors in the relevant areas.

References

[1] T.S.C. Li, and W.R. Schroeder, Canadian J. Agric. and Agric. Food, **23** (1999) 23.

[2] R. Khan, Status of seabuckthorn in the northern areas of Pakistan. Annual Report, Karakaram Agricultural Research Institute for Northern Areas (KARINA), (1999).

[3] Q. Huang, H. Zhao, B. Wang and M. Zong, Hippophae, **2** (1991) 43.

[4] L. Rongsen, Feasibility study of seabcukthorn development in Pakistan. MinFAL Technical Report, Ministry of Food, Agriculture and Livestock, Govt. of Pakistan (1996), pp. 7-10.

[5] L.P. Solonenko and E.E Shishkina, Biologiya,Khimiya-i-Farmakologiya Oblepikhi, **37** (1983) 67.

[6] T. Beveridge, B.D. Oomah and A. Smith, J. Agric. Food Chem., **47** (1999) 3480.

[7] C. Tigong, Hippophae Chinese, **1** (1988) 19.

[8] B. Singh, Exploitation of nature for human use through seabuckthorn. http://www.tifac.org.in (2001).

[9] W. F. Guoli, Chinese Oil Fat., **2** (1987) 25.

[10] T.S. Shyrko and A.F.Radzyuk, Vestsi-Akademi-i-Navuk-BSSR-Seriya-Sel'skagas-padarchykh-Navuk, **4** (1989) 74.

[11] K. Heilscher and S. Lorber, Zeitschrift fur dies Lebensmittelwirrtschaft, **50** (1999) 26.

[12] AOAC, Official methods of analysis. The Association of Official Analytical Chemists, Virginia, U.S.A. (1984).

[13] Z.A. Zhiben, J. Guizhou Agric. College, China, **3** (1987) 51.

[14] Ma Zhiban and C. Yansheng, Wuhan Botanical Research, **5** (1987) 397.

[15] L. Rongsen, Hippophae and its general compositions. Proceedings of the 1st Congress of the Int. Seabuckthorn Association, Berlin, Germany (2003) 20.

[16] M. Jalakas K. Kelt and K. Karp, Agronomy Res., **1** (2003) 31.

[17] Y. Yao, P. M. A. Tigerstedt and P. Joy, Soil and Plant Science, **42** (1992) 12.