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UTILIZATION OF SEABUCKTHORN FRUIT FOR THE PREPARATION OF GRANULES

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Seabuckthorn preserved fruit pulp of 11.8 ºBrix, procured from "Skardu", was utilized for the preparation of granules. Various parameters of the process such as concentration of the pulp, temperature and time of drying, pH of concentrate, effect of various stabilizers and their concentration were optimized. Physico-chemical characteristics, nutritional and microbiological analyses of the pulp and the granules prepared were carried out. The product prepared from the pulp of 66 ºBrix dried in cabinet dryer at 50 ºC for 6 h resulted in the form of orange coloured granules which possessed a good taste, natural flavour and contained almost all the nutrients present in the fresh pulp.

Key words: Seabuckthorn granules, *Hippophae rhamnoldes*, Medicine.

Introduction

Seabuckthorn (*Hippophae rhamnoldes*) is a deciduous shrub and is widely distributed throughout the temperate zones of Asia and Europe and all over the subtropical zones of Asia at high altitude (Rongsen 1992). A typical seabuckthorn plant usually consists of a bush bearing clusters of juicy fruit. The fruit is generally about the size of small pea and is greenish in colour in the beginning but turns orange or red as it matures. The small orange coloured fruit is a storehouse of vitamin and important bioactive substances. The fruit contains 60 to 80 % juice in which sugar, organic acids, amino acids and vitamins are highly evident (Javed 1997). Seabuckthorn has been reported to contain more than 190 compounds in the seeds, pulp and juice. These compounds include fat soluble vitamins (A, K, E), 22 fatty acids, 42 lipids, carbohydrates, vitamins C, B_1, B_2, folic acid, tocopherol, flavonoids, phenols, terpenes and tannins (Polacchi 1985). Many of the substances that are found in seabuckthorn have beneficial effect on health and are expected to reduce the risk of heart diseases (Yang, 1995) and also have a role in cancer prevention (Mingyu 1995; Zhemin and Deming 1995). The vitamin C content is 5 to 100 times higher than any other fruit or vegetable known. The soluble sugar content accounts for 7.1 % which is less than that found in the common apple (8 to 10%), orange (8 to 13%), thus it is rather insignificant. But the organic acid content accounts for 4.4% which is more than that found in most fruits (for example, lemon is well known for its high acid content and it only contains 1 to 2 %). Its pulp and seeds contain high quality oil which is regarded to be very important for its medicinal value. Although the oil content of seabuckthorn is not as much as the amount found in 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 (Jasra *et al* 2000). Carotene content of the pulp oil is 54.0 to 102.0 mg 100 g^{-1} which is more than that found in any fruit or vegetable and vitamin E content of the seed oil is 65.7 to 104.0 mg 100 g^{-1}, which is also more than that found in any oil crop (Zhiben 1987). Besides carotene vitamins E and K and phospholipids in both pulp and seed oil were determined by Zhang *et al* (1989). The vitamin K contents are about 109.8 to 230.0 mg 100 g^{-1} (seed oil) and 58.9 to 64.4 mg 100 g^{-1} (pulp oil) which are more than those contained by most horticultural crops. Vitamin K is called the coagulation vitamin because it plays a catalytic role in forming prothrombin and it can promote normal coagulation of the blood. The phospholipid contents range from 0.69 to 1.77% in seed oil and 0.24 to 0.27% in pulp oil (Zhang *et al* 1989). Chinese seabuckthorn juice and dried fruit residue contained flavonoid 0.20 and 0.55 %, respectively (Zhuyin 1979).

The pulp oil contains 68.8% and seed oil contains 88.9% unsaturated fatty acids. According to medical theory, unsaturated fatty acids are beneficial for the health of the human body, especially linoleic and linolenic acids which are often used for curing diseases relating to the cardiovascular system and to high blood fat content (Zhiben 1987). There are 23 micro elements in seabuckthorn fruit. These micro elements are considered to play an important role in living things and the human body. They display high catalytic activity in some

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biochemical reactions and are parts of enzymes which activate or passivate the reaction (Tigong 1988). It has been summarized (Javed 1997) that seabuckthorn fruit is a raw material for producing nutritive food, curative medicines and valuable cosmetics; moreover seabuckthorn sweet granules contain series of bioactive substances which can be used to relieve coughing, reduce sputum, help digestion and promote blood circulation. It may also increase the metabolism, build up the physique and delay the aging of tissues. It can be used as medicine as well as instant drink (Fuhen 1991). In view of the high demand of the seabuckthorn and its products in the world market and the existence of substantial plantation and fruit, which has no utility at present, it is advisable to develop appropriate technology for the preservation and transformation of the fruit into exportable products.

The object of present studies is to develop a process for the preparation of seabuckthorn granules in view of its reportedly multifarious advantages, particularly in the health protection field and biochemical value of the fruit and its products.

Materials and Methods

Procedure. Seabuckthorn pulp, procured from "Skardu", was filtered through cloth to remove sand and other foreign matter. The pulp (11.8º Brix) was concentrated to various degree Brix (33.0, 66.0 and 75.0º Brix) by rotary vacuum evaporator. pH of the pulp of various concentrations was adjusted to 2.5, and preservative and stabilizer were added. After the addition of sugar the material was passed through sieve. The granules were equally distributed over the surface of stainless steel trays. The trays were placed in a cabinet dryer for 2, 4, 6 and 8 h at 40, 50, 60 and 70º C respectively. The dried granules were packed in polyethylene bags.

Analytical work. The pulp and the granules prepared were analyzed for protein content by the Kjeldhal method using Kjeltes System 1028 Distilling Unit and was calculated using nitrogen conversion factor 6.25. Moisture content was determined by the hot air oven method (Polacchi 1985). Vitamin C content, tannic acid, oil and sugars were determined by the method given in AOAC (1990). Carotene was determined spectrophotometrically according to AACC (1995). Total soluble solids, pH, acidity, ash content and reducing sugars were determined according to the procedures of Ruck (1963) and Mortensen and Wallin (1989).

Sensory evaluation. Sensory evaluation was made on 9 point hedonic scale as described by Larmond (1977) and Amerine *et al* (1965), where 9 as the highest score and 1 as the lowest were used to test for flavour, texture, colour and general acceptability of the seabuckthron granules. The Chinese granules were used for reference. The product was served to a panel of 5 judges on three separate days and mean score of each product was calculated. Average score of five parameters i.e. colour, flavour, taste, texture and acceptability of the product was calculated.

Mineral analysis. Ash was made by drying the sample in an oven to a constant weight before ashing in muffle furnace at 800 ºC and left until white ash was obtained (AOAC 1990). Ash was dissolved in 10 ml of 1:1 concentrated hydrochloric acid; volume was made upto 100ml and filtered. Sodium and potassium were determined in the ash using flame photometer (Vogel 1961). Calcium was estimated as oxalate and tested titrimetrically. The filtrate and washings were consumed for magnesium determination. It was precipitated, dried, ignited and weighed. Phosphorus was assessed by spectrophotometer, Unicam sp. 600 series. Iron was determined colorimetrically using spectrophotometer (Vogel 1961). Atomic Absorption Spectrophotometer Model Unicam 969 was used for aluminum and silicon determination.

Bacteriological analysis. Product prepared was examined microbiologically for total viable bacterial count, yeast and mould, total coliform, *Salmonella* and *Shigella*. Total count was determined by using nutrient agar; yeast and mould count was carried on malt extract agar. Coliform on lactose broth, *Salmonella* on bismuth sulphite agar (APHA 1978) and *Shigella* on McConkeys and disoxycholate agar (Jacobs and Grestein 1960).

Statistical analysis. The data obtained for each parameter were subjected to statistical analysis to determine the level of significance by using the procedure as described by Steel and Torrie (1980).

Results and Discussion

Studies were carried out to prepare seabuckthorn granules of acceptable taste, flavour and colour. Pulp and granules prepared from the pulp of 11.8, 33.0, 66.0 and 75.0º Brix were analyzed chemically (Tables 1 & 2). Effect of concentration of pulp, temperature and time on the preparation of granules were studied (Tables 3 & 4). It was observed that when pulp of 11.8º Brix was used for the preparation of granules, it did not dry completely, took long time and high temperature was required for its complete drying. The granules had very low vitamin C content and lacked seabuckthorn flavour. The granules prepared from the concentrate of 33.0º Brix also took much time and required high temperature to achieve the desired level of moisture and had low vitamin C content. The granules prepared from the concentrate of 66.0º Brix had a good colour, flavour and dried in 4 to 6 h in a cabinet dryer at 50ºC for the desired level of moisture (5 %). The granules

Table 1
Chemical composition of Seabuckthorn pulp*

Constituents	Contents
ºBrix	11.80 (± 0.02)**
Moisture content (%)	80.00 (±0.22)
Dry matter (%)	20.00 (± 0.35)
Reducing sugars (%)	2.12 (± 0.03)
Total sugars (%)	4.79 (± 0.07)
Oil content (%)	1.73 (± 0.08)
Protein (%)	1.14 (± 0.08)
Tannic acid (%)	0.52 (±0.01)
Ash (%)	0.83 (± 0.02)
Acidity (%)	2.24 (± 0.05)
Pectin (%)	0.25 (± 0.01)
Fibre (%)	0.075 (± 0.02)
Vitamin C (mg 100 gm^{-1})	96.0 (± 0.18)
Carotene (mg 100 gm^{-1})	10.3 (±0.17)

*Average of triplicate readings
**Standard deviation of triplicate readings

prepared from the concentrate of 75.0º Brix also dried in 4 to 6 hours at 50ºC but the colour changed to brown yellow and the taste was not acceptable.

All the four samples of seabuckthorn granules were organoleptically evaluated by a panel of 5 judges on three separate sittings and mean score of the five parameters were recorded (Table 5). The flavour and colour of the granules prepared from the concentrate of 66.0º Brix was liked very much, while the flavour and colour of granules prepared from 11.8 and 33.0º Brix were liked slightly and that of 75.0º Brix were disliked. The texture and taste of granules prepared from the pulp of 11.8 and 33.0º Brix were neither liked nor disliked and concentrate of 75.0º Brix was disliked. The taste of granules prepared from 66.0º Brix was liked extremely while the texture was liked very much. The overall acceptability of granules prepared from 11.8 and 33.0º Brix were neither liked nor disliked and granules prepared from 66.0º Brix was readily acceptable. A considerable amount of aluminum, phosphorus, potassium, sodium, calcium, magnesium and silicon was observed while minor quantity of iron was found (Table 6). All the four products were analyzed bacteriologically for total viable bacterial count, coliform bacteria, yeast, mould, *Salmonella* and *Shigella*. The overall bacteriological status of the product was observed to be excellent (total count ranged from 49 to 100 only). Low total count indicated that suitable sanitary conditions were maintained throughout the processing procedures.

Table 3
Effect of temperature on the moisture content of granules after 6 h dehydration*

Concentration of the pulp (ºBrix)	Moisture Content (%)			
	40 ºC	50 ºC	60 ºC	70 ºC
11.8	24 (±0.20)**	20 (±0.23)	18 (±0.22)	15 (±0.21)
33.0	21 (±0.27)	17 (±0.21)	15 (±0.23)	12 (±0.23)
66.0	11 (±0.21)	5 (±0.19)	5 (±0.19)	5 (±0.20)
75.0	10 (±0.18)	5 (±0.20)	5 (±0.18)	5 (±0.24)

*Average of triplicate readings
**Standard deviation of the triplicate readings

Conclusion

It may be concluded from the above observations that granules produced from 66.0º Brix seabuckthorn pulp under these set of conditions contain excellent sensory qualities and are

Table 2
Chemical composition of Seabuckthorn granules prepared from the pulp of different concentrations*

Concentration of pulp (ºBrix)	Tannic acid (%)	Oil (%)	Protein (%)	Carotene (mg $100g^{-1}$)	Vitamin C (mg $100g^{-1}$)	Acidity (%)	Ash (%)
11.8	0.023 (±0.02)**	0.078 (±0.01)	0.052 (±0.02)	0.468 (±0.06)	4.36 (±0.07)	0.91 (±0.05)	0.83 (±0.04)
33.0	0.195 (±0.03)	0.650 (±0.02)	0.427 (±0.03)	3.862 (±0.04)	36.00 (±0.24)	1.90 (±0.07)	0.79 (±0.03)
66 0	0.450 (±0.02)	1.480 (±0.05)	0.977 (±0.06)	8.820 (±0.12)	82.30 (±0.31)	2.85 (±0.10)	0.73 (±0.02)
75.0	0.458 (±0.04)	1.520 (±0.07)	1.000 ±0.09)	9.090 (±0.21)	84.70 (±0.28)	2.85 (±0.04)	0.73 (±0.04)

*Average of triplicate readings
**Standard deviation of triplicate readings

Table 4
Effect of time on the moisture content of granules at 50° C*

Concentration of the Pulp (°Brix)	Moisture Content (%) 0 hour	2 hours	4 hours	6 hours	8 hours
11.8	50.0 (±0.42)**	30 (±0.32)	23 (±0.40)	20 (±0.33)	18 (±0.36)
33.0	42.0 (±0.38)	24 (±0.28)	20 (±0.35)	17 (±0.34)	14 (±0.30)
66.0	32.5 (±0.29)	16 (±0.24)	9 (±0.31)	5 (±0.26)	5 (±0.41)
75.0	26.0 (±0.30)	14 (±0.30)	8 (±0.28)	5 (±0.36)	5 (±0.29)

*Average of triplicate readings
**Standard deviation of triplicate readings

Table 5
Sensory evaluation of the product*

Parameter	Granules of 11.8 (°Brix)	Granules of 33.0 (°Brix)	Granules of 66.0 (°Brix)	Granules of 75.0 (°Brix)	Reference
Flavour	6.3 (±0.20)**	6.5 (±0.27)	8.0 (±0.17)	6.2 (±0.2)	6.0 (±2.20)
Colour	6.0 (±0.22)	6.2 (±0.22)	8.0 (±0.21)	4.3 (±1.8)	6.5 (±2.70)
Texture	5.2 (±0.21)	5.5 (±0.18)	8.0 (±0.20)	4.4 (±1.4)	8.0 (±1.40)
Taste	5.1 (±0.15)	5.2 (±0.16)	8.5 (±1.90)	4.1 (±2.4)	5.5 (±0.18)
Acceptability	5.2 (±0.23)	5.3 (±0.18)	8.2 (±1.50)	3.3 (±1.6)	6.5 (±2.60)

*Average of triplicate readings
**Standard deviation of triplicate readings

Table 6
Mineral composition of seabuckthorn granules (mg $100g^{-1}$)*

Aluminum	Calcium	Potassium	Phosphorus	Magnesium	Iron	Sodium	Silicon
10.20 (±2.1)**	2.90 (±0.4)	5.07 (±0.7)	7.30 (±0.9)	1.40 (±0.41)	0.54 (±0.2)	34.0 (±6.2)	3.50 (±0.6)

*Average of triplicate readings
**Standard deviation of triplicate readings

readily acceptable; however concentration beyond 66.0° Brix adversely affected the sensory characteristics of granulated seabuckthorn.

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