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# Chemical and Nutritional Constituents of Sea Buckthorn Juice

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**Abstract:** Sea buckthorn juice is one of the imperative product obtained from the sea buckthorn berries, is now commercially very important. The juice provides a nutritious beverage, high in suspended solids, and very high in vitamins especially in vitamin C and carotenoids. It contains different kinds of nutrients and bioactive substances including vitamins, fatty acids, free amino acids and elemental components. These components vary substantially among individuals, populations, origins or subspecies. The available compositional data regarding sea buckthorn juice is tabulated to produce a comprehensive source of recent information on chemical and medicinally important constituents of different origin and varieties. The presence of valuable chemical and nutritionally important constituents in sea buckthorn juice, and from the scientific knowledge of their importance, it is clear that sea buckthorn juice is one of the most important source of these materials, and can be use as alternative nutritional sources in the commercial market.

**Key words:** Sea buckthorn berries, vitamins, Juice

## Introduction

Sea buckthorn is a deciduous spiny shrub or small tree between two to four meter high, widely distributed throughout the temperate zone of Asia and Europe (Lu, 1992). Li and Schroeder (1996) have recently reviewed the fruit characteristics, Asiatic geographical distribution and cultural practices of sea buckthorn. The plant is hard, drought and usually cold tolerant, useful for the land reclamation and farmstead protection (Zhang, 2000). In the northern climate, frequent winter injury causes yield and economic losses and is the primary factor limiting extension of the crop northwards (Prokkola, 2001). The distribution ranges from Himalayan regions including India, Nepal, Bhutan, Pakistan (Skardu, Swat, Gilgit) and Afghanistan, to China, Mongolia, Russia, Kazakstan, Hungary, Romania, Switzerland, Germany, France and Britain, and northwards to Finland, Sweden (Jeppsson, 1999) and Norway (Yao, 1994). The wide distribution of sea buckthorn is reflected in its habit-related variation not only in morphology, yield, growth rhythms and cold hardiness, but also in berry related characters such as fresh weight, chemical and sensory attributes (Lu, 1992; Yao, 1994; Yang and Kallio, 2001). In spite of several importance of whole sea buckthorn plant, the most important part are berries, from which the juice is extracted and that is the reason why the sea buckthorn berries gain popularity in whole world (Beveridge *et al*., 1999). In the present study the main objective is to review over the present literature on the chemical and medicinal constituents of sea buckthorn juice of different origin and varieties, so as to get a clear concept over the compositional importance for the future nutritional research.

**Sea buckthorn Berries:** The growth of sea buckthorn berries generally undergoes three phases. The first phase is characterized by a period of accelerating seed growth, followed by a short transition period with declined rate of seed growth. The third phase is of the fast growth of the berry flesh and initial fast growth of seed with seed weigh subsequently declining (Demenko *et al*., 1986). The final phase is generally referred to as berry maturation. In Finland (Berezhnaya *et al*., 1993; Yao and Tigerstedt, 1993; Yao, 1994) and most part of the world including Pakistan, sea buckthorn fruits generally ripen around the beginning of September. Fully ripe berries generally range in weight from 4-60 g/100 berries, with the color varying from yellow, through orange to red (Rousi and Aulin, 1977; Li, 1999). The literature describing the processing of sea buckthorn berries is rather limited (Liu and Liu, 1989; Zhou and Chen, 1989). Normally the process begins with the harvesting of berries in the fall. The berries remain on the branches all winter if left undisturbed (Li and Schroeder, 1996). Mechanical harvesting equipments are being developed for sea buckthorn *(Hippophae rhamnoides* L.) berries (Olander, 1995; Bantle *et al.,* 1996; Gaetke and Triquart, 1992). Tests were conducted using a branch shaker to determine whether berries of the Indian Summer' cultivars could be removed by shaking. Combinations of shaking frequency (7.7, 10.9, 14, 20 and 25 Hz) and shaking amplitude (13, 19, 25 and 32 mm) were tested at different harvest dates (Mann *et al.,* 2001). Unfortunately, mechanical harvester and direct juicing harvesters often cause damage to the tree or crop (Dolgosheev and Varlamov, 1998; Pesoness, 1999). After this, the berries are then inspected for cleaning. The diseased and damaged or pest infected berries, stems, leaves and other debris collected during harvesting are removed. Washing the berries with water or addition of a wetting agent or detergent in the wash water would be beneficial. The temperature is normally kept at 40°C (Zhang *et al*., 1989a). The berries are now ready to extract juice for further processes.

**Extraction of Juice:** Juice extraction from the sea buckthorn berries is carried out using pressing technique. This technology can be used as standard for the removal of liquid mash, described by Bump (1989). The usual press types utilize cloth presses, serpentine belt presses and screw presses. The use of both decanter and high-speed centrifuges for sea buckthorn juice was reported by Zhang *et al.* (1989b). The decanter centrifuge technology is a recent innovation that allows the continuous extraction of juice from a fruit or other vegetables (Beveridge, 1997). The juice extracted by pressing method is usually high in suspended solids, providing a very turbid product (Zhou and Chen, 1989). The turbidity results from the presence of both insoluble solids and oil droplets suspended in the aqueous juice which produce a vary complex juice system (Oomah *et al.,* 1999). On centrifugation the sea buckthorn juice formed a fat rich creamy layer on the surface, an opalescent juice layer in the middle and a sediment on the bottom of the tube. At 4°C or lower temperature the fat layer formed centrifugally is very firm because at least some of the fat has solidified making sampling of the lower layer and isolation of the fatty layer relatively simple with minimal contamination by the adjacent layers (Beveridge and Harrison, 2001).
Another easy method for the extraction of juice is the frozen sea buckthorn berries are washed, thawed and crushed in fruit mill. The cold berries are strained through sieves starting at 2 mm diameter and ending with 0.8-0.1 mm diameter. The last sieve retains the seeds and some peel, and this retenate can be used to extract seed oil. The remaining mash is heated to 50-60°C and is made 5-10% with in crystalline sugar. The soluble solids are thus increased enhancing easy separation of these solids. The mixture is allowed to stand for 1-3 hours and then separated by centrifugation into a turbid juice and solid pasty sediment. The pasty sediment is then treated with proteolytic, pectinolytic and cellulytic enzyme activities preparation for 2-6 hours at 55°C, and then centrifugation separation is applied. The juice can be used for mixed juice drinks, nectars, or other fruit juices.

**Color of Juice:** The sea buckthorn juice is yellow in color; the high amount of carotene is responsible for this yellow coloration. The presence of some of the other pigments also contributes to the color. Granules or clumps are embedded in the juice, which are actually the material containing spherical droplets that are yellow-brown in color (Beveridge and Harrison, 2001). The oil droplets also contribute to the yellow coloration.

**Chemistry of Juice:** The chemical composition of sea buckthorn berries varies with the origin, climate and method of extraction. The juice obtained through centrifugal procedures is about 67% (Heilscher and Lorber, 1996). Indian Summer juice gave an average pH of 3.13 and an average titratable acidity of 1.97% calculated as malic acid (Beveridge *et al.,* 2002). Following are some of the important components of sea buckthorn juice.

**Vitamin C:** Sea buckthorn fruits of subspecies, *sinensis* have been revealed as containing much higher concentrations of vitamins A, B2, C than other fruits and vegetables such as carrot, tomato, orange etc. Sea buckthorn berries also show appreciable levels of vitamin B1, P and K (Lu, 1992). The high vitamin concentrations make sea buckthorn fruit highly suitable for the production of nutritious soft drinks. In *H. rhamnoides*, extensive variations in vitamin C have been revealed among individuals, populations and subspecies (Table 1). The vitamin C concentration ranges from 28 to 310 mg/100g of berries in the European subspecies rhamnoides (Rousi and Aulin, 1977; Jeppsson and Gao, 2000; Yao *et al*., 1992), from 40 to 300 mg/100g of berries in Russian cultivars belonging to subspecies *mongolic*a, from 460 to 1330 mg/100g of berries for subspecies *fluviatilis* (Xurong, 2002), and from 200 to 2500 mg/100g of berries in Chinese subspecies *sinesnsis* (Ma *et al*., 1989; Yao *et al*., 1992; Zheng and Song, 1992).Temperature (Yao, 1993), different harvesting time, origin (Kallio *et al*., 2002) and processing (Beveridge *et al.*, 2002) also affect the vitamin C contents of the juice.

**Mineral Elements:** There are many mineral elements present in berries/juice of sea buckthorn. Potassium is the most abundant of all the elements investigated in berries or juice (Chen, 1988; Tong *et al.,* 1989; Zhang *et al.,* 1989a; Kallio *et al*., 1999). More than tenfold variation of elemental concentrations was observed for Mo and Fe in juice as well as for Fe in dry mass within Chinese sea buckthorn. Kallio *et al*. (1999) compared eight elements between Chinese and Finnish sea buckthorn and found that Finnish berries had less iron, calcium and lead but more cadmium than the Chinese berries. It was found that the fruit maturity affects the level of N, Ca, K, Na, Mg, Cu, Fe, Zn, and Mn (Bounous and Zanini, 1988). In liqueurs prepared from sea buckthorn, traces of Al, As, Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Na, Li, Pb, Rb, and Zn were detected by Harju and Ronkainen (1984). The Finnish berries contain less amount of Fe, Ca, and Pb, but more cadmium than the Chinese berries (Table 2).

Table 1: Vitamin C content in Sea buckthorn berries / juice of different origins

| Varieties | Range | Average | References |
|---|---|---|---|
| Subsp. *Sinensis* | 502 – 1061 | 709 | Ma *et al*. (1989) |
| Subsp. *Sinensis* | 200 – 780 | 490 | Zheng and song (1992) |
| Subsp. *Sinensis* | 600 – 2500 | 1550 | Yao *et al*. (1992) |
| Chinese sea buckthorn | 1348 | 1348 | Liu and Liu (1989) |
| Chinese sea buckthorn | 513 – 1676 | 1038 | Zhang *et al*. (1989) |
| Subsp. *rhamnoides* | 165.7 – 293.3 | 233 | Rousi and Aulin (1977) |
| Subsp. *rhamnoides* | 150 – 310 | 230 | Darmer (1952) |
| Subsp. *rhamnoides* | 27.8 – 201 | 114.4 | Yao *et al*. (1992) |
| Subsp. *fluviatilis* | 460 – 1330 | 895 | Darmer (1952) |
| Subsp. *mongolica* | 40 – 300 | 340 | Plekhanova (1988) |

Table 2: Mineral Elemental composition of Sea buckthorn juice and dried berries

| Element | Juice (mglL) | | Dried Berries (mg/kg) | | |
|---|---|---|---|---|---|
| | Chinese Origin | | Chinese Origin | | Finnish origin |
| Aluminum | -- | 2.2 - 16.7 | 2593.9 | -- | -- |
| Arsenic | -- | -- | 24.803 | -- | -- |
| Barium | -- | 0.168 - 0.362 | 11.66 | -- | -- |
| Beryllium | -- | -- | 0.095 | -- | -- |
| Boron | -- | 0.43 - 1.38 | No trace | -- | -- |
| Cadmium | 0.002 - 0.015 | <0.05 | No trace | 0.016-0.055 | 0.044 - 0.105 |
| Calcium | 64 - 256 | 93.9 - 173 | 3119.3 | 800-1480 | 270 - 740 |
| Chromium | 0.47 - 1.00 | 0.108 - 0.287 | 2.54 | -- | -- |
| Cobalt | 0.01- 0.09 | 0.1 | -- | -- | -- |
| Copper | -- | 0.158 - 0.653 | No trace | 3.8-12 | 6.0 - 9.5 |
| Iron | 5.93 - 161 | 4.13 - 10.9 | 3264.3 | 64.282 | 22 - 33 |
| Lanthanum | -- | -- | 6.655 | -- | -- |
| Lead | -- | 0.431 | 1.215 | -- | -- |
| Lithium | 0.06 - 0.15 | 0.132 - 0.303 | -- | -- | -- |
| Magnesium | 53.3 - 165 | 39.8 - 103 | 2222.2 | 470-730 | 560 - 790 |
| Manganese | 0.81- 3.86 | 1.17- 2.6 | 93.68 | 8.7-15 | 8.1 - 17 |
| Molybdenum | 1.18 | 0.03 - 0.058 | 7.29 | -- | -- |
| Nickel | 0.39 - 0.09 | 0.115 - 0.357 | 4.99 | -- | -- |
| Phosphorus | -- | 82.1 - 206 | 959.62 | -- | -- |
| Potassium | 100 - 806 | 147 - 209 | -- | 6440-12200 | 10300 - 14000 |
| Selenium | -- | 7.96 - 11.3 | 5.02 | -- | -- |
| Silicon | -- | -- | 83.78 | -- | -- |
| Sodium | 18 - 89.9 | 17.7 - 125 | -- | -- | -- |
| Strontium | 0.08 - 0.45 | 0.19 - 0.616 | 5.15 | -- | -- |
| Tin | -- | 0.045 - 0.259 | 8.66 | -- | -- |
| Titanium | -- | 0.103 - 0.814 | 44.91 | -- | -- |
| Vanadium | -- | 0.002 - 0.009 | 2.73 | -- | -- |
| Yttrium | -- | -- | 0.97 | -- | -- |
| Zirconium | -- | -- | 0.875 | -- | -- |
| Zinc | 2.09 - 6.31 | 0.431 - 1.25 | 30.44 | 8.8-27 | 14 - 27 |
| References | Tong *et al*., 1989 | Zhang *et al.*, 1989a | Chen, 1988 | Kallio *et al.*, 1999 | |

Difference may be originating from the natural contents of elements in the soil as well as contamination in both soil and air. Table 3 gives the elemental composition of the Finnish and Chinese seeds and berries.

**Sugars:** Sugar components are important ingredients of sea buckthorn juice; their values are given in the Table 4. Total soluble sugars reported for Chinese origins ranged from 5.6-22.7% in raw juice (Ma *et al*., 1989; Tong *et al*., 1989; Zhang *et al*., 1989a; Kallio *et al*., 1999). Chinese origins show higher concentrations of total sugars than Russian ones (Shyrko and Radzyuk, 1989; Kallio *et al*., 1999), which, in turn, are higher in sugars than Finnish origins (Kallio *et al*., 1999). Glucose is a

Table 3: Mineral Elements contents of Sea buckthorn seed and berries of Chinese and Finland origin (Kallio *et al*., 1999)

| Elements | Chinese Berries | | Chinese Seeds | | Finland Berries | | Finland Seeds | |
|---|---|---|---|---|---|---|---|---|
| | Range | Average | Range | Average | Range | Average | Range | Average |
| Cadmium | 16-55 | 35.5 | 5-51 | 28.0 | 44-105 | 149 | 42-102 | 72.0 |
| Calcium | 0.8-1.48 | 1.14 | 0.74-1.65 | 1.195 | 0.27-0.74 | 0.505 | 0.21-0.32 | 0.265 |
| Copper | 3.8-12 | 7.9 | 8-12 | 10.0 | 6.0-9.5 | 7.75 | 8.9-13 | 10.95 |
| Iron | 64-282 | 173 | 41-56 | 48.5 | 22-33 | 27.5 | 34-53 | 43.5 |
| Lead | 0.34-1.1 | 0.72 | 0.04 | 0.04 | 0.03-0.06 | 0.045 | 0.1 | 0.1 |
| Magnesium | 0.47-0.73 | 0.6 | 1.15- 0.40 | 1.275 | 0.56-0.79 | 0.675 | 1.13-1.43 | 1.28 |
| Manganese | 8.7-15 | 11.85 | 11-16 | 13.5 | 8.1-17 | 12.55 | 8.6-16 | 24.6 |
| Potassium | 6.44-2.2 | 9.32 | 5.22-8.45 | 6.835 | 10.3-14.0 | 12.15 | 6.24-8.52 | 7.38 |
| Zinc | 8.8-27 | 17.9 | 20-28 | 24.0 | 14-27 | 20.5 | 24-48 | 36.0 |

major sugar component in all origins tested. Both glucose and fructose account for around 90% of the total sugar content for Chinese and Russian origins (Ma *et al*., 1989; Kallio *et al*., 1999), but only for about 60% for Finnish ones. The presence of sugar alcohols mannitol, sorbitol, and xylitol at low levels has been observed (Makinen and Soderling, 1980).

**Organic Acids:** Large variations in concentrations of acids have been also reported among different origins. Russian berries showed relatively lower concentrations of total acidity (2.1-3.2g/100 ml), Finnish genotypes were intermediate with a range of 4.2-6.5g/100 ml, while Chinese genotypes showed the highest concentrations (Table 5) of organic acid with a range of 3.5-9.1g/100 ml (Ma *et al*., 1989; Zhang *et al*., 1989a; Kallio *et al*., 1999). Of all organic acid components in sea buckthorn juice, malic and quinic acids were major acids together constituting around 90% of all the fruit acids in different origins. However, to what extent the variations in the above mentioned traits have a genetic base is unknown (Kallio *et al*., 1999).

**Amino Acids:** Sea buckthorn juice is rich in various free amino acids. Chen (1988) detected 18 kinds free amino acids in juice of Chinese sea buckthorn (Table 6). The total amino acids content of Chinese Sea buckthorn given by Zhang *et al.* (1989a) contains more apartic acid (426.6 mg/100g) than revealed by Chen (1988) as given in Table 7. Of these, eight free amino acids (threonine, valine, methionine, leucine, lysine, trytophan, isoleucine, and phenylalanine) are essential for the human body.

**Vitamin E and Carotenoids:** Sea buckthorn juice contains large amount of carotenoids and vitamin E. German workers have reported the extraction of yellow carotenoids pigments from sea buckthorn waste using supercritical $CO_2$ extraction. It was clarified that the pressure produces greatest influence on extraction, resulting an increase in the yield (67% at 60 MPa and 85 $^{o}$C) of the carotenoids (Messerschmidt *et al*., 1993). Sea buckthorn fruits are rich in pigments and lipoproteins located in membranes and the fleshy mesocarp. Carotenolipoprotein complexes are located particularly in fruit membranes where polar lipids may function as bridge compounds between the polar (protein) and non-polar (carotenoids) moieties (Pintea *et al.,* 2001)

**Volatile compounds:** The profile of the volatile compounds of sea buckthorn juice was very typical and distinctive from that of other common berries. The compounds were mainly esters of short chain, branched or n-fatty acids and alcohols. The profile of the volatiles is clearly dependent on the time of harvesting of the berries (Yang, 2001). Chinese berries contained higher proportions of ethyl 3-methylbutanoate, butyl pentanoate, 2-methylpropyl 3-methylbutanoate and pentyl 3-methylbutanoate than the Finnish berries, which, again, were rich in ethyl 2-methylbutanoate, ethyl 3-methylbutanoate and ethyl hexanoate. Proper investigations by quantitative sensory profiling and correlation analysis are required in order to evaluate the effects of various volatiles on the overall aroma of sea buckthorn berries (Kallio *et al*., 1999; Ma and Cui, 1987).

**Sea Buckthorn Oil:** The variation of vitamin E content in the sea buckthorn oil depends on whether the oil is derived from seed oil (64.4-92.7 mg/100g of seed), juice oil (216 mg/100g of berries) or pulp after the juice and pulp removal (481 mg/100g of berries). Normally pulp oil contains more vitamin E. Concentration of vitamin E reported by Lu (1993) among species or subspecies are also listed in Table 8. *H. rhamnoides* tends to show higher levels of vitamin E in seed oil than the other species listed. Alpha-tocopherol is the most active form of vitamin E in humans, and is a powerful biological antioxidant (Farrell and Roberts, 1994; Traber, 1999). An extremely high level of alpha-tocopherol (1046 mg/100g pulp oil) was reported for a cultivar of subsp. *mongolica* from Altai (Jablczynska *et al*., 1994). Large variations among most nutrients within origin or between origins offer attractive prospects for breeding work. The

Table 4: Sugar contents of Sea buckthorn berries/ juice of Finnish and Chinese origin

| Sugar (units) | Range | Average | Variety | Reference |
|---|---|---|---|---|
| Glucose (% of total) | 49.5 - 62.1 | 54.2 | Chinese | Ma *et al*. (1989) |
| Fructose (% of total) | 37.3 - 50.4 | 45.4 | Chinese | Ma *et al*. (1989) |
| Mannitol (mg/g) | 17 | 17 | Finnish | Makinen & Soderling (1980) |
| Sorbitol (mg/g) | 13 - 640 | 314 | Finnish | Makinen & Soderling (1980) |
| Xylose (% of total) | 0.1 - 0.7 | 0.42 | Chinese | Ma *et al*. (1989) |
| Xylitol (mg/g) | 15 - 91 | 39.2 | Finnish | Makinen & Soderling (1980) |
| Xylose (mg/g) | 13 - 100 | 45.5 | Finnish | Makinen & Soderling (1980) |

Table 5: Organic acid present in Chinese Sea buckthorn juice ( Beveridge *et al*., 1999)

| Organic acid (units) | Range | Average | Reference |
|---|---|---|---|
| L- malic acid | 1.11 - 2.34 | 1.85 | Ma *et al*. (1989) |
| | 2.82 - 6.08 | 4.57 | Zhang *et al*. (1989a) |
| D- malic acid | 0.015 - 0.054 | 0.033 | Ma *et al*. (1989) |
| Citric acid | 0.042 - 0.234 | 0.111 | Ma *et al*. (1989) |
| Tartaric acid | 0.013 - 0.014 | 0.0135 | Ma *et al*. (1989) |
| Succinic acid | 0.236 - 0.643 | 0.474 | Ma *et al*. (1989) |

Table 6: Contents of various free amino acids in juice of *H. rhamnoides* subsp. *Sinensis* (Chen, 1988)

| Free Amino acid | Level (mg/100g) |
|---|---|
| Aspartic acid | 3.72 |
| Threonine | 6.24 |
| Serine | 5.31 |
| Glutamic acid | 2.65 |
| Glycine | 0.64 |
| Alanine | 2.50 |
| Cysteine | 0.82 |
| Valine | 2.85 |
| Methionine | 1.12 |
| Tryptophan | 0.51 |
| Isoleucine | 0.97 |
| Leucine | 1.94 |
| Tyrosine | 1.79 |
| Phenyl alanine | 3.21 |
| Histidine | 1.06 |
| Lysine | 3.49 |
| Arginine | 0.47 |
| Proline | 12.28 |
| Total | 51.57 |

Table 7: Amino Acid Content of Chinese Sea buckthorn *H. rhamnoides. L* (Zhang *et al.,* 1989a)

| Free Amino Acid | mg/100g |
|---|---|
| Aspartic acid | 426.6 |
| Serine | 28.1 |
| Glutamine | 19.4 |
| Glycine | 16.7 |
| Alanine | 21.2 |
| Cysteine | 3.3 |
| Valine | 21.8 |
| Arginine | 11.3 |
| Ammonia | 41.8 |
| Tyrosine | 13.4 |
| Isoleucine | 17.4 |
| Methionine | 2.3 |
| Proline | 45.2 |
| Phenylalanine | 20.0 |
| Histidine | 13.7 |
| Lysine | 27.2 |
| Threonine | 36.8 |
| Total | 766.2 |

tocopherol fraction was made up to nearly 50% "-tocopherol, 40% $-tocopherol and 10% K-tocopherol (Mironov, 1989). The carotenoids also vary depending upon the source of the oil. It was found that the carotenoids to consist of nearly 20% $-carotene, 30% K-carotene, and 30% lycopene as well as 15% oxygen containing carotenoids. Pulp oil shows higher levels of $-carotene than seed oil, and *H. salicifolia* appears to have the highest level of $-carotene in both pulp and seed oil among species (Table 8). The $-carotene provide greater stability to the oils (Lutfullah *et al.,* 2003; Zeb and Ahmad, 2004). Within *H. rhamnoides*, subsp. mongolica shows the lowest $-carotene level in seed and pulp oil (Lian *et al.*, 2000). Concentration of $-carotene constitute 15-55% of total carotenoids, depending on the origin (Lian *et al*., 2000; Yang and Kallio, 2001). However the concentration of $-carotene and of the total carotenoids are affected substantially by effects of berry maturity, years and practices of fertilization (Zhang *et al*., 1989a; Yang, 2001).

**Conclusion:** To sum up all, sea buckthorn juice is the source of valuable chemical including vitamin C, micro and macronutrients, sugars and organic acids and oil. Since the Hippophae berry/juice was the common

Table 8: Carotenoids and vitamin E content of Sea buckthorn oil from different origins

| Vitamins (mg/100g) | Ranges | Average | Reference | Variety |
|---|---|---|---|---|
| Carotenoids content | 314 - 2139 | 1167 | Zhang *et al*. (1989a) | Caucaus |
| Seed oil | 50 - 85 | 67.5 | Mironov (1989) | Caucaus |
| Pulp oil | 330 - 370 | 350 | Mironov (1989) | Caucaus |
| Seed coat oil | 180 - 220 | 200 | Mironov (1989) | Pamirs |
| Seed oil | trace | -- | Mironov (1989) | Pamirs |
| Pulp oil | 900 - 1000 | 950 | Mironov (1989) | |
| Vitamin E | 40.1 - 103 | 64.4 | Ma *et al*. (1989) | |
| Seed oil | 61 - 113 | 92.7 | Zhang *et al*. (1989a) | |
| Juice oil | 162 - 255 | 216 | Zhang *et al*. (1989a) | |
| From Residue | 390 - 540 | 481 | Zhang *et al*. (1989a) | |

medicine used in ancient, it had pharmacological functions like making expectoration easy, good for lungs and stomach, invigorating the function of the spleen, removing blood stasis and promote blood circulation etc, and the light of the above available compositional data, it is therefore concluded that sea buckthorn juice is the best nutritional/ medicinal source for the human and other animals, and the commercialization of these individual products would be a great achievement in alternative nutritional diet sources.

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