

Detection of Heavy Elements in the Pulp of Snow-Capped Seabuckthorn Medicinal Plant Using Emission Spectroscopy

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Abstract: Seabuckthorn (SBT) is a very popular plant in high-altitude cold desert areas which has tremendous medicinal properties. The present study used Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES) to analyze SBT fruit pulp extracts concerning heavy metals Potassium, Phosphorus, Calcium, Magnesium, Copper, Manganese, Zinc, Boron, Nickel, Cadmium and Lead. This study found that heavy metals in SBT herbal plant was in the range of 8.65 g/kg Potassium, 1.74 g/kg Phosphorus, 0.692 g/kg Calcium, 0.546 g/kg Magnesium, 39.45 mg/kg Iron, 5.468 mg/kg Copper, 12.68 mg /kg Manganese, 8.25 mg/kg Zinc, 11.36 mg/kg Boron, 0.35 mg/kg Nickel, 0.021 mg/kg Cadmium and 0.027 mg/kg Lead. The findings of this study were compared with the prescribed limits of these metals in WHO guidelines and the content of all these heavy metals was found to be within safe limits.

Keywords: Seabuckthorn (SBT), heavy element, Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES).

1. INTRODUCTION

Medicinal plants have been in use for centuries. According to the World Health Organization (WHO), about 70% of the world's population still depends on traditional medicines to meet their health needs. Since traditional medicines come from natural sources, there is a misconception that traditional medicines are safer than synthetic medicines. As researchers conducted their research, it was found that plants not only contained toxic substances but were also contaminated with environmental pollutants, especially heavy metals. This can cause serious health problems due to prolonged exposure (1). Some metals are also essential nutrients and are toxic only in high concentrations, while others have no known beneficial properties so are particularly toxic. Chemical constituents in plants, including metal ions, are partly responsible for their medicinal and nutritional properties as well as toxic properties (2). The use of herbal medicines for the relief and treatment of many human diseases is increasing worldwide due to their low side effects (3). Medical practitioners are also prescribing herbal teas and herbal extracts as complementary treatments for everyday problems (stress or insomnia) caused by our modern civilization (4). Given the complexity of these drugs and their inherent biological diversity, it becomes essential to evaluate their safety, efficacy and quality. According to WHO conditions, lead, cadmium, chromium and other heavy metals should be controlled to ensure the safety of medicines (5). Many factors contribute to heavy metal pollution on agricultural soils, including fertilizers, pesticides, industrial emissions, and metal production. When agricultural soils become contaminated with heavy metals, they easily enter the human food chain through plants. This can cause serious risks like kidney failure, long-term toxicity, liver damage and cancer (6-9). WHO recommended that product raw materials derived from medicinal plants should be screened for the presence of heavy metals and WHO also set permissible limits for certain heavy metals (10, 11).

Hippophae Rhamnoides L. Commonly known as seabuckthorn (SBT), it belongs to the Elaeagnaceae family and is found in cold desert areas at high altitudes. SBT is found naturally in Central and Northern Europe, Russia, China, Mongolia, Central Asia, and India. SBT berries are resistant to extreme temperatures, tolerating temperatures ranging

from -43°C to $+40^{\circ}\text{C}$. SBT is a good source of a large number of nutrients, vitamin C, vitamin B (mainly B¹, B², B⁶, and B¹²), vitamin E, carotenoids, carbohydrates, proteins, organic acids and flavonoids. Seabuckthorn pulp mainly contains A, B, γ -carotene, lycopene, and zeaxanthin (12, 13). Modern studies have shown that seabuckthorn can serve as a natural remedy for heart diseases, skin problems, liver problems, stomach disease, memory loss, and cancer. The fruits, leaves and other parts of SBT have been used in medicine, cosmetic industry and nutraceutical supplements. Due to its health-promoting and medicinal properties, this plant has been extensively investigated for many decades (14). In addition to its wide therapeutic and cosmetic use, in Romania, SBT is used extensively for ecological restoration. It is a nitrogen-fixing species and can grow on marginal lands, making it recommended as an excellent plant for soil improvement (15, 16). The abundance of healthful elements is found not only in the raw fruits but also in a variety of preparations like jam, juice, marmalades or tincture. SBT berries can also be used to make tea. Whereas tea made from seeds has laxative properties and helps in weight loss. This plant is used not only in naturopathy but also in veterinary medicine as a means to relieve helminthiasis in horses and provide them with more mass and a beautiful shiny coat (17).

One of the major reasons for monitoring the levels of toxic elements in SBT is that pollution in the general environment has increased. Sources of environmental pollution are range from industrial and traffic emissions to soil purification and the use of agricultural resources such as organic mercury, fungicides, pesticides, etc. Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) was used to determine heavy metals in SBT.

2. MATERIALS AND METHODS

2.1 Collection of plant material

Seabuckthorn (SBT) berries were collected from Ladakh, India in December. During and after harvest, SBT berries were transported and stored in non-metallic containers. The berries were washed thoroughly with demineralised water to prevent any metal contamination. Before further processing, diseased fruits and residues resulting from mechanical harvesting, such as leaves and stems, dirt or garden debris, are removed before juicing. The fruit must be freshly plucked or otherwise refrigerated immediately after plucking.

2.2 Processing of seabuckthorn pulp

Frozen berries were heated to 8 to 12 °C before mashing. Then the berries were mashed with the help of mixer grinder. The mash was treated with pectolytic enzymes for 1–2 h at 52 °C and separated into juice and pomace by a decanter machine. To prevent decomposition, the pulp was treated at high temperature for a short time and immediately cooled.

2.3 Standard preparations

About 10 grams of the fruit pulp was treated with 50 ml of HNO₃: HCl (1:1 v/v) and the mixture were kept for reaction in the water bath at 100°C for 120 minutes. After the reaction, the entire mixture was transferred to the silica crucible and later it was introduced in a muffle furnace at 350 °C for 2 hours to destroy any organic matter. The remains of the reaction mixture were obtained after it diluted with deionised water.

2.4 Instrumentation

An Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) was used for the detection of Potassium, Phosphorus, Calcium, Magnesium, Iron, Copper, Manganese, Zinc, Boron, Nickel, Cadmium, and Lead. Some standard operating conditions for an ICP-OES instrument are shown in Table 1.

3. RESULT AND DISCUSSION

Seabuckthorn is a tremendous source of various nutrients with a wide range of Pharmacological activities. Anticancer, antioxidant and anti-inflammatory activity of seabuckthorn fruit is reported in many studies (17, 18). Due to its exceptional chemical composition, SBT has a wide range of various positive biological, physiological, and medicinal effects such as immunomodulating, cardio protective, antibacterial, antatherogenic, antiviral effect, healing effect on acute and chronic wound, anti-radiation, Anti diabetic, hepatoprotective, and dermatological effects (20-22). Heavy metal toxicity is one of the major impediments to the Global acceptance of herbal drugs. The development of herbal drugs involves various processing steps like cultivation, collection, harvesting etc. This may act as a source of heavy metal contamination. The concentration of K, P, Ca, Mg, Fe, Cu, Mn, Zn, B, Ni, Cd, and Pb elements in seabuckthorn

(SBT) medicinal plant was determined by Using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). The results obtained were tabulated in Table 2.

Table 1: Standard operating condition for ICP-OES instrument

RF generator	40.68 MHz
Forward power	1Kw
Nebulizer	ultrasonic
Outer argon flow	12.0 L/min
Intermediate argon flow	1.0 L/min
Inner argon flow	1.0 L/min
Nebulizer uptake rate	1.0 mL/min
Viewing height	15.0 mm

Table 2: heavy metal content of seabuckthorn medicinal plant against the permissible limit

Sr. No.	Element	Symbol	Concentration	Permissible limits (mg/kg)
1	Lead	Pb	0.027 mg/kg	10
2	Cadmium	Cd	0.021 mg/kg	0.30
3	Nickel	Ni	0.35 mg/kg	1.5
4	Boron	B	11.36 mg/kg	NA
5	Zinc	Zn	8.25 mg/kg	50
6	Manganese	Mn	12.68 mg/kg	200
7	Copper	Cu	5.468 mg/kg	10
8	Iron	Fe	39.45 mg/kg	200
9	Magnesium	Mg	0.546 g/kg	NA
10	Calcium	Ca	0.692 g/kg	NA
11	Phosphorus	P	1.74 g/kg	NA
12	Potassium	K	8.65 g/kg	NA

Lead: Lead (Pb) is a toxic substance that tends to accumulate in the body and is potentially harmful to both children and adults. The WHO guidelines suggest the upper limit for lead (Pb) is 10mg/kg (19). According to the results (Table 2), the amount of Pb in SBT fruit pulp was found to be 0.027 mg/kg. Which is within the safe range of prescribed limits, it indicates SBT are safe concerning Pb toxicity.

Cadmium: Metal like Cadmium (Cd) was detected in the seabuckthorn medicinal plant. According to the results, the amount of Cd in SBT fruit pulp was found to be 0.021 mg/kg which was found to be within the prescribed limits. The permissible limit set by WHO/FAO for Cd in China and Thailand was 0.3 mg/kg. Cadmium causes both acute and chronic poisoning, with adverse effects on the kidney, liver, vascular and immune systems (23).

Copper: In the sample taken, heavy metal like Copper (Cu) was found to be 5.468 mg/kg which is within the permissible limit. WHO/FAO has set the standard limit at 10mg/kg for the medicinal plant (1). Medicinal plants in China and Singapore should not contain more than 20 mg/kg and 150 mg/kg Cu, respectively. Increased levels of copper can cause discolouration of hair and skin, metallic taste in the mouth, nausea, dermatitis, etc. Copper deficiency can cause anaemia and congenital disabilities (23).

Nickel: The concentration of Nickel (Ni) was found to be 0.35 mg/kg which is within the prescribed limit by who the permissible limit set by WHO/FAO. The permissible limit set by WHO/FAO for Ni is 1.5mg/kg. Nickel toxicity is not very common among humans because its absorption by the body is very low. Nickel itch, an allergic dermatitis is the

most common condition, which could occur. It may affect the lung and nasal cavity by acting as a carcinogen. Nickel exerts a potent toxic effect on peripheral tissue and reproductive system (23).

Zinc: The concentration of Zinc (Zn) was found to be 8.25 mg/kg. This is within the limits prescribed by WHO/FAO (24). Our bodies only need small amounts of zinc, it is necessary for almost all enzymes to complete chemical reactions. Zinc deficiency can cause growth retardation, hair loss, frequent infections, long wound healing time and diarrhoea etc.

Iron: The concentration of Iron (Fe) in seabuckthorn edible pulp was found to be 39.45 mg/kg. The permissible limit set by WHO/FAO for Fe in edible plants is 200 mg/kg (25). After comparing the metal limits in the studied medicinal plants with those proposed by WHO/FAO, it was found that Fe in seabuckthorn fruit pulp is below this limit. Iron is essential for the formation of haemoglobin and also plays an important role in oxygen and electron transfer in the human body (23). Excessive amount of Fe is harmful to humans. This may cause nausea, vomiting, stomach pain and diarrhoea. Over time, it can damage the liver or brain of the fetus.

Manganese: According to WHO (1998), the permissible limit of Manganese (Mn) in medicinal plants is 200 mg/kg, while the recommended daily intake is 11 mg/day (25). The result obtained from this study shows that the concentration of Mn is 12.68 mg/kg which is below the recommended permissible limit. Manganese is a very essential heavy element for the growth of plants and animals. Its deficiency causes severe skeletal and reproductive abnormalities in mammal.

In this study, the concentration of potassium, phosphorus, calcium, magnesium, and Boron is found to be 8.65g/kg, 1.74 g/kg, 0.692g/kg, 0.546 g/kg and 11.36 mg/kg respectively. According to the guideline issued by WHO, adults should consume potassium at least 3,510 mg/day, calcium 1.5-2 g/day, phosphorus 700 mg/day, magnesium 300-400 mg/day, and boron 20 mg/day. However, for medicinal plants, WHO limits have not yet been established for these elements. But according to previous studies, the limit of these elements is found to be low (26-28). Which means the plant Seabuckthorn is safe for human health. It has no hazardous effect on human health.

4. CONCLUSION

The concentrations of heavy metals determined in seabuckthorn samples are well below the critical limit. Therefore, herbal formulations of these plant species can also be beneficial sources of appropriate and essential trace elements, although caution must be taken to avoid metal toxicity, especially in high doses. Safe levels of the heavy metals analyzed were present in the samples and therefore, generally no adverse effects may occur. It is imperative that medicinal plants be collected from unpolluted natural habitats, good quality control of plant raw materials and determination of the presence of certain contaminants, especially toxic elements, to avoid overconsumption and their cumulative toxicity over long-term use.

5. REFERENCES

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