Evaluation of chemical constitute, fatty acids and antioxidant activity of the fruit and seed of sea buckthorn (*Hippophae rhamnoides* L.) grown wild in Iran

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In this investigation, the chemical compositions of berries from sea buckthorn were studied. The amount of ascorbic acid and \(\beta\)-carotene determined by HPLC was 170 mg/100 g FW and 0.20 mg/g FW, respectively. Total phenols, anthocyanins, acidity and total soluble solids (TSS) contents were 247 mg GAE/100 g FW, 3 mg/L (cyanidin-3-glucoside), 5.32\% and 13.8\%, respectively. Fruit antioxidant activity determined by the ferric reducing ability of plasma (FRAP) method was 24.85 mM Fe/100 g FW. Results confirmed the presence of six dominant fatty acids (determined by GC) in fruit including linoleic (34.2\%), palmitoleic (21.37\%), palmitic (17.2\%), oleic (12.8\%), linolenic (5.37\%) and stearic acid (1.67\%). Five dominant fatty acids of the seeds were linoleic (42.36\%), linolenic (21.27\%), oleic (21.34\%), palmitic (6.54\%) and stearic acid (2.54\%). The nitrogen content was 3.96\%. The P, K, Ca, Mg, Fe, Zn, Mn, Cu, Cd and Cl contents of fruit were 491, 1674, 1290, 990, 291, 29.77, 108.37, 17.87, 0.021 and 2.18 mg/kg DW, respectively.

**Keywords:** ascorbic acid; fatty acid; fruit; sea buckthorn; seed

1. Introduction

Sea buckthorn (*Hippophae rhamnoides* L.) is a spiny shrub or tree belonging to the Elaeagnaceae family. This plant is beneficial for esophagitis, aphthous ulcers, acid reflux, peptic ulcers, cerebrovascular diseases regulate immunofunctions, attenuate inflammation and anti-carcinogenic (Zadernowski et al. 1997; Li & Beveridge 2003). The berries of sea buckthorn contain organic acids, phenols, carbohydrates, carotenoids, proteins, minerals and fatty acids (Kallio et al. 1999; Chauhan & Varshneya 2012; Yildiz et al. 2012; Pop et al. 2014). The characteristic property of sea buckthorn fruit/pulp lipid is the high content of palmitoleic acid.
This high concentration of palmitoleic acid may have cholesterol and triglyceride lowering as well as stroke-suppressing effects (Yang et al. 2000; Yang & Kallio 2001). Palmitoleic acid and palmitic acid are the major fatty acids in the fruits. Oleic, palmitic, linoleic and linolenic acids are the major fatty acids in the seeds (Yang & Kallio 2001; Cakir 2004). The aim of this investigation was evaluation of some phytochemical constitute of fruit and seed of sea buckthorn. There was no data on the fruit and seed constitutes content of sea buckthorn grown in Iran.

2. Results and discussion

The amount of ascorbic acid in berries was 170 mg/100 g FW (Table S1). In previous studies, the ascorbic acid content of sea buckthorn berries ranged from 28 to 1330 mg/100 g (Yao et al. 1992; Jeppson & XiangQun 2000; Tang & Tigerstedt 2001). Origin, temperature, harvesting time, ripening and geographical factors affect the ascorbic acid content of sea buckthorn berries (Jeppson & XiangQun 2000; Yang 2009; Zheng et al. 2011). β-Carotene, total phenolics and total anthocyanin contents of berries were 0.20 mg/g FW, 247 mg GAE/100 g FW and 7.1 mg/L cyanidin-3-gluco side, respectively (Table S1). The total phenolic content for sea buckthorn fruit in this study was 1.5–3 times higher than that reported for this fruit in Europe (Gao et al. 2000). Yildiz et al. (2012) reported that the total phenolic content in fruit was ranged from 220 to 260 mg GAE/100g FW. The anthocyanin content of different sea buckthorn genotypes has previously been reported to be 0.5–25 mg/L (Sabir et al. 2005), that is in accordance with our results. Genetic and environmental conditions affect the total anthocyanins in plants (Naczk & Shahidi 2004).

The results showed that total antioxidant activity of the fruits was 24.85 mM/100 g FW, which was higher than previous study (Kruczek et al. 2012). The differences can be explained by differences in the environmental conditions of the regions under study which may affect the quality of the fruits. The N content of the fruits was 3.96%. The P, K, Ca and Mg contents were 491, 1674, 1290 and 990 mg/kg, respectively. The Fe, Zn, Mn, Cu, Cd and Cl contents were 291, 29.77, 108.37, 17.87, 0.021 and 2.18 mg/kg, respectively (Table S2). Fruit maturity and soil condition affects the level of minerals (Bounous & Zanini 1998). Difference between our results and other studies may be originating from the natural contents of elements in the soil.

Our results confirmed that linoleic (34.2%), palmitoleic (21.37%), palmitic (17.2%), oleic (12%), linolenic (5.37%) and stearic acid (1.67%) were dominant fatty acids in fruit (Table S3). Macadamia and sea buckthorn oil are botanical sources of palmitoleic acid with high concentrations (Li & Beveridge 2003). The sea buckthorn fruit/pulp has high content of palmitoleic acid (Yang & Kallio 2001). Palmitoleic acid is low in seed oils, but is characteristic of the oil in the fruit pulp (Gao et al. 2000). Result about fruit fatty acids in this study was almost same as the previous studies. A little difference between our findings and other studies could be the results of growth conditions and environmental factors. The fatty acid composition of sea buckthorn fruit oil depends on the climatic and environmental conditions where is grown (Li & Beveridge 2003). Linoleic acid was the most abundant fatty acid in seeds. Concentration of five dominant fatty acids of seed including linoleic, linolenic, oleic, palmitic and stearic acid were 42.36%, 21.27%, 20.34%, 5.54% and 2.54%, respectively (Table S3). In this study more than 80% of the fatty acids in seeds were unsaturated. The seed oil comprises two essential fatty acids including linolenic and linoleic acids. In general, the pulp oil contains more saturated fatty acids than the seed oil (Kallio et al. 1999).

3. Conclusion

Results showed that sea buckthorn fruit is a rich source of vitamin C, citric acid, phenols, carbohydrates, beta carotene, fatty acid and minerals. Moreover, the seed was rich in unsaturated fatty acid acids.
Supplementary material

Experimental details relating to this article are available online, alongside Tables S1–S3.

Disclosure statement

No potential conflict of interest was reported by the authors.

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