Estimation of nutritional value and antioxidant activity of sea buckthorn leaves (*Hippophae rhamnoides* L.) – abstract

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As food and feed costs increase, the animal production industry needs to look for alternative sources of feed materials, in particular products obtained from agri–food processing, which are residues from the processing of plant raw materials. Due to the carbon footprint of a sustainable food chain and economic and social factors, the use of by– products from fruit production is becoming increasingly important in animal nutrition. Both disqualified products and fruit processing by-products, can be effectively used in animal nutrition as a source of functional feed ingredients to produce better quality animal products. Food industry by–products are often redundant for processors and therefore cheaper to obtain by animal producers. An example of such a raw material is sea buckthorn (*Hippophae rhamnoides* L.). All parts of sea buckthorn are a source of many nutritional and health–promoting substances. Currently, mainly fruits and seeds are used. After harvest, the leaves remain and can be used as fodder material with equally high nutritional value.

The aim of the research was a comprehensive assessment of the nutritional value, profile of bioactive ingredients and antioxidant potential of sea buckthorn leaves of four cultivars – 'Ascola', 'Habego', 'Hergo' and 'Leikora', collected in three years – 2014, 2015, 2016.

In the research material the levels of basic nutrients, dietary fiber fractions and amino acid composition were assessed. Protein quality was also assessed using two amino acid standards (for animals and humans). The antioxidant potential of ethanol extracts of sea buckthorn leaves was determined using ABTS, DPPH and PCL techniques, as well as qualitative and quantitative analysis of phenolic compounds. The levels of polyphenols, flavonoids, flavonols, anthocyanins, proanthocyanidins and total tannins were specified. Analyzes were also carried out to determine the content of rutoside, quercetin, delphinidin, peonidin, cyanidin, and chelerythrine.

The first publication [P–1] showed differences in the chemical composition of leaves sea buckthorn. The analyzed sources of variability (year, genotype) influenced both the basic and amino acid composition as well as the content of bioactive substances. Protein content in sea buckthorn leaves was high and amounted to an average (variety and harvest year) of 18.26

g/100 dry matter. Average content of exogenous amino acids in sea buckthorn leaf protein was 37.88 g/16 g N, considering the standard for an adult human (MH), and 44.23 g/16 g N, related to the animal standard (WE). Irrespective of protein standard (MH, WE), the first amino acid limiting the quality of sea buckthorn leaf protein, was tryptophan. Limiting amino acid index value (CS) in the case of tryptophan was statistically modified by all tested factors. The results of the analyzes carried out on the basic and amino acid composition indicate that sea buckthorn leaves may be a valuable raw material for use as feed material, as a partial replacement for typical protein sources in animal nutrition.

The assessment of the antioxidant potential of food is carried out using tests in various systems and using different reaction mechanisms. In the second publication [P–2], tests were used to assess the ability of extracts to inhibit free stable radicals: $DPPH^{\bullet+}$ and $ABTS^{\bullet+}$. The use of the DPPH radical to assess the antioxidant potential allows for the assessment of only hydrophobic antioxidants, unlike the ABTS radical, which reacts both with hydrophobic and hydrophilic antioxidants. The study also uses one of the non–standard methods for assessing antioxidant potential – photochemiluminescence (PCL) method. Sea buckthorn leaf extracts showed strong antioxidant activity in DPPH and ABTS tests (RSA, from 56.33 to 98.25%). The research material significantly reduced both the $DPPH^{\bullet+}$ and $ABTS^{\bullet+}$ radicals in the tested samples. Due to the lipophilic nature of the $DPPH^{\bullet+}$ radical, a slight difference was observed in the antioxidant activity of the tested varieties measured by the DPPH method compared to the ABTS test. The antioxidant potential of sea buckthorn leaves was also assessed using the PCL method. This method did not confirm differences in the antioxidant potential of raw materials from different growing seasons. Phenolic compounds, also measured quantitatively, are generally considered to be the main factors determining the antioxidant capacity of plants. The content of total flavonoids in sea buckthorn leaves was high and amounted to 281.76 mg QEE/1 g of dry matter. The average flavonol content was 80.19 mg QEE/ 1 g dry matter. The content of individual flavonoids in the tested material showed statistical differences with the analyzed experimental factors – variety and growing season. The origin of the raw material (growing season) had a significant influence on the content of proanthocyanidins, anthocyanins and total tannins. The tested sea buckthorn leaves are a rich source of PAC (up to 18.517 mg/ 1g dry matter). It has been shown that sea buckthorn leaves are also an excellent source of rutoside, quercetin, delphinidin, peonidin and cyanidin. Analyzes in publication P–2 confirmed the presence of chelerythrine in sea buckthorn leaves.

The research conducted in the doctoral thesis constitutes both a comprehensive analysis of the nutritional value of sea buckthorn leaves and an assessment of their antioxidant

properties. Research has shown that the by–product resulting from the production of sea buckthorn fruit can be a valuable feed material with high health-promoting potential.

Keywords: *Hippophae rhamnoides* L., macronutrients, secondary metabolites, antioxidant potential, by–product, functional additive

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