PRODUCT DEVELOPMENT OF SEA BUCHTHORN RESIDUAL POMANCE TEA MIXTURE

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Abstract
Nowadays waste management is becoming increasingly important, as both consumers and companies are producing too much garbage that could be prevented. The food industry generates a large amount of by-products, which are in fact suitable for further processing. This study highlights an untapped area that is the further processing of the sea buckthorn by-product as a tea ingredient. Sea buckthorn berries are a source of polyphenols and carotenoids along with many vitamins, minerals, and trace elements. These biologically active compounds are also found in the residual pomace after food production. In this study dried sea buckthorn pomace (SBP) boiled with water at different temperatures (70 and 100%), with green tea and other flavoring agents (dried elderflower and orange flower) were analyzed. The antioxidant capacity (FRAP) and total polyphenol content (TPC) of the samples were measured. Preliminary experiments have shown that higher temperature water boiled SBP extract contains higher amounts of valuable components. As result of product development, most antioxidants and polyphenols were detected in a mixture of tea, which contained green tea, SBP and elderflower compared to the tested tea samples from the commercial. Nevertheless, each blend contained less valuable ingredients than natural green tea. This is due to the water-insoluble compounds in SBP so that they did not dissolve properly during soaking. Further studies are reasonable in which another sea buckthorn variety will be tested that contains water-soluble antioxidants and polyphenols.

Introduction
Sea buckthorn is from the family of the Elaeagnaceae. It can be a deciduous shrub with a height of 1.5-3 meters or a tree with a height of 8-10 meters [1]. Its 2-4 cm long lance-like leaves are placed rarely and have intact edges [6]. It has a single-seeded, dormant fruit, which is round or ovoid, 6-8 mm in diameter [4]. Sea buckthorn juice contains 8-10% dry matter, 2-4 % sugar, 1-2% fatty oil and valuable acids (mainly malic acid). Two coloring agents, fat soluble carotenoids and water-soluble yellow flavonoids give its colour. It also contains many biologically active substances such as vitamins A, C, B1, B2, E, F, K, P, proanthocyanidins (a type of polyphenol) and sitosterols. Several minerals and trace elements make it more valuable such as calcium, magnesium, potassium, iron, copper, manganese, zinc, folic acid, and titanium [6].
Tea is an indeciduous plant from the camellia family which has three isolable species, native to China, Assam, and Cambodia. This species is a shrub that grows to 2.7-4.5 meters high, is resistant to cold weather, and produces 5 cm long leaves for up to 100 years. It contains many compounds such as polyphenols, caffeine, amino acids, carbohydrates, and minerals. The complexity of the aroma of black tea is demonstrated by the fact that more than 550 compounds have been identified. It is interesting that the six different types of tea are made from the same plant, the difference is only in the way of processing. The six basic types of tea

are white, oolong, green, black, flavored and pressed teas, but there are more than 3000 subtypes.
Our goal, when conducting this experiment, was to find the right mixture of tea components which is the richest in antioxidants and polyphenols by adding sea buckthorn pomace [5].

Material and methods

'Ascola' sea buckthorn berries were used in the experiments which came from the 2018 harvest. In the first step of its processing berries was heated to 80 °C to assist compression and inactivates oxidative enzymes. The juice was extracted manually. Based on previous study the residual pomace was dried at 80 °C in an atmospheric dryer [3]. The extract of pomace was made two ways, with water at 75 °C and 100 °C. The purpose of the experiment was to ascertain if there was a significant difference between the two extracts, and a connection between the temperature of the boiling water and the extraction of the reducing compounds. Two types of green tea (Lipton and Nepal) were compared according to their nutrition value, taste and colour. to find the base of the tea mixture. Other flavorings were used in the tea mixture, these were elderflower and orange flower extracts. The sea buckthorn pomace tea mixture was prepared based on the results of the preliminary experiments. The formulas made during product development were compared with commercially available sea buckthorn tea blends. The mixtures and control samples were analyzed using two methods:

- Antioxidant capacity was determined based on Ferric Reducing Ability of Plasma (FRAP) method, by Benzie and Strain . Antioxidant capacity was defined in ascorbic acid equivalent (mg ascorbic acid equivalent/ 100 L).
- Total Polyphenol Content (TPC) was evaluated using a method by Singleton and Rossi. Results were specified in mg gallic acid equivalent/ 100 L.

Results were calculated and after comparing they were represented by Microsoft Excel.

Results and discussion

Samples were measured to define antioxidant capacity and total polyphenol content in order to find the mixture(s) with the richest biologically active compounds.

Sample shortened name	**Components of the sample**
NG	Nepal green tea
LG	Lipton green tea
SBP 100 °C	Sea buckthorn pomace tea made 100 °C
SBP 75 °C	Sea buckthorn pomace tea made 75 °C
OR	Orange-flower flavouring
ELD	Elder-flower flavouring
NSB	Naturland sea buckthorn tea (commercial)
OSB	Oxalis sea buckthorn tea (commercial)
NG+SBP	Nepal green tea+ sea buckthorn pomace tea
NG+SBP+OR	Nepal green tea+ sea buckthorn pomace tea, orange-flower flavouring
NG+SBP+ELD	Nepal green tea+ sea buckthorn pomace tea, elder-flower flavouring

Figure 1. Components and name of the tested tea types

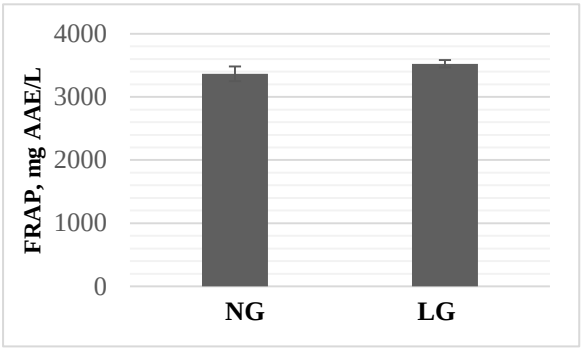


Figure 2. Antioxidant capacity of green teas

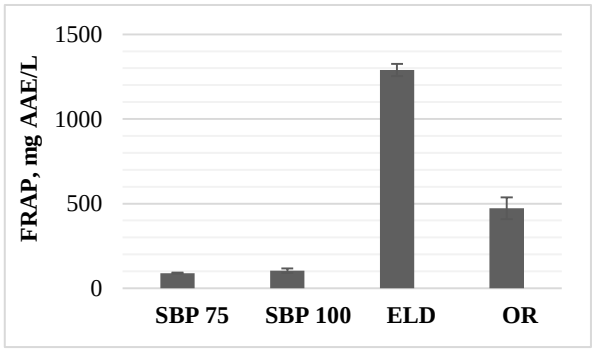
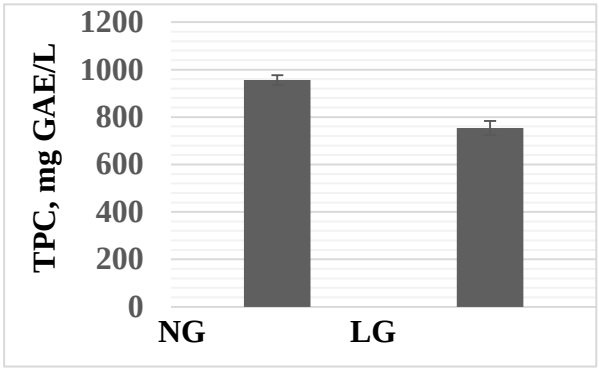


Figure 3. Antioxidant kapacity of flavourings

In Figure 2., total antioxidant content concentrations in mg/ L are shown. There is no significant difference between the two green teas. Additional measurements are necessary which analyze the connection between the quantity of dissolving antioxidants and soaking time.

In Figure 3., total antioxidant content concentrations in mg/ L are shown. As Figure 3 is shown more antioxidant could dissolve from sea buckthorn pomace tea at the higher temperature (104.33 mg AAE/ L). At lower temperature this value is 89.24 mg AAE/L. Therefore 100°C water has no destructive effect, moreover, it slightly raises the amont of dissolving antioxidants. Despite, sea buckthorn pomace extracts have lower values than the orange-flower (472.5 mg AAE/L) and the elder-flower (1289.5 mg AAE/L) extracts, thus presumably there are water-insoluble antioxidants in sea buckthorn pomace.



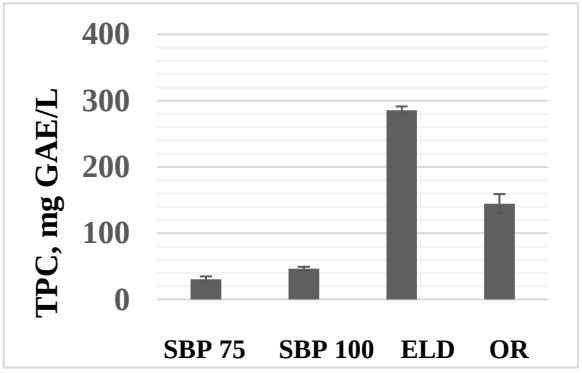
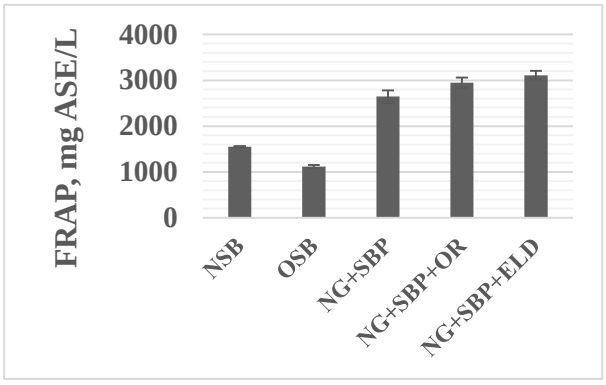


Figure 4. Total polyphenol content of green teas

Figure 5. Total polyphenol content of flavourings

As Figure 4 is represented the analysis of total polyphenol content shows significant difference. More polyphenol dissolved from Nepal green tea during the same soaking time (955.7 mg GAE/L). The difference between the two samples is 26.76 %. After the analysis of the antioxindant capacity and total polyphenol content unquestionably the Nepal green tea is able to the product developement.

Figure 5 is shown a slightly greater value of sea buckthorn pomace tea made with 100 °C water (46.53 mg GAE/L) rather than made with 75 °C (30,86 mg GAE/L). Orange-flower (144.65mg GAE/L) and elderflower (285.61 mg GSE/L) had higher polyphenol content. The percentage difference between pomace extracts is 33,68%, between orange-flower and elderflower it is 49,35 %.



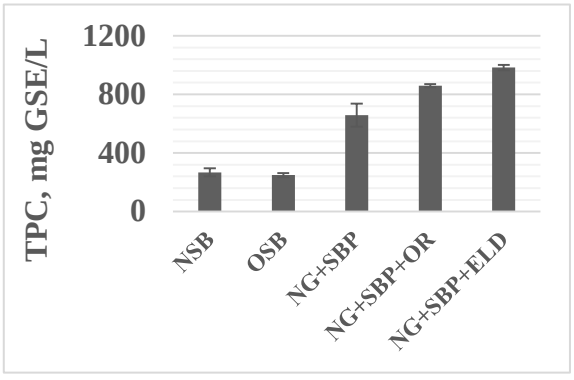


Figure 6. Antioxidant capacity of tea mixtures

Figure 7. Total polyphenol content of tea mixtures

Figure 6. is represented that due to the different components, the percentage difference between control samples is 27.97 %. The basic mixture which contains green tea and sea buckthorn pomace took twice as big value than control samples (2647.37 mg ASE/L). Much more antioxidant could dissolve from orange-flower (472.5 mg ASE/L) and elderflower (1289.5 mg ASE/L) than sea buckthorn pomace (104.33 mg ASE/L). Thus tea mixture in which they are presented also contain a larger amount of antioxidant rather than the basic mixture. The orange-flower tea mixture's antioxidant capacity is 2948.32 mg ASE/L and the elderflower tea mixture's is 3110.59 mg ASE/L. Even so, all of the mixtures showed a lower value than Nepal green tea. The difference between mixtures and green tea is 7.53-21.3%. The reason is the additional sea buckthorn pomace extract, as it has low value because its antioxidants and polyphenols are just partly water-soluble. Accordingly further test needed with an anothor type of sea buckthorn which contains more water-soluble compounds.

Figure 7 is shown there is no significant difference between the control samples. The basic mixture which contains green tea and sea buckthorn pomace took more than twice as big value than control samples (657,36 mg GSE/L). Orange-flower (859,13 mg GSE/L) and elderflower mixture (983,51 mg GSE/L) have more valuable polyphenols. Only elder mixture's polyphenol content was higher than pure green tea, because of the additional sea buckthorn pomace (above).

Conclusion

The management of industrial waste is, without doubt, economic and environmental-friendly. The aim of this study was to extract bioactive compounds from sea buckthorn pomace to reduce industrial waste and create a valuable product. According to our results, elderberry tea mixture contained the most antioxidants and polyphenols. This mixture's values are much better than the control samples (almost four times). Still, except for elderberry mixture's polyphenol content, none of the mixtures reach the pure green tea's value. It is because sea buckthorn contains partly water-insoluble antioxidants and polyphenols. Therefore, further analysis is needed with another type of sea buckthorn.

Acknowledgements

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