# ANALYSIS OF THE ANTIOXIDANT PROPERTIES OF SEA BUCKTHORN JAMS DURING STORAGE

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## Abstract

In the frame of this research, sea buckthorn jams were prepared by blending sea buckthorn pulp with apple pomace powder in varying proportions to achieve especially good organoleptic characteristics and texture without the addition of pectin. Apple pomace is a by-product of apple juice production, and it might be suitable for replacing pectin in jam products. Sea buckthorn is an excellent ingredient of functional foods, having outstandingly useful biologically active compounds. It has positive impact on human health primarily as a result of its high C-vitamin, flavonoid, and carotenoid content.
In this study, we compared the following quality parameters of sea buckthorn jam samples: water soluble dry matter content, titratable acid, polyphenol contents, antioxidant activity, and carotenoid components. Sea buckthorn jams were prepared from 'Leikora' berries by adding different proportions of apple pomace (0, 0.5, 1, 1.5, 2%). One jam was prepared for being used as control by adding pectin. Determination of dry mater content was fulfilled based on Codex Alimentarius 3-1-558/93 formula. Total titratable acid content was determined based on MSZ EN Nr 12147:1998 Hungarian Standard. Antioxidant status was determined by Ferric Reducing Antioxidant power (FRAP) assay and total polyphenol content using spectrophotometer; with high performance liquid chromatography (HPLC) β carotenoid was also identified and quantified. Consumer panel testing of the jams was carried out by sensory testing.
Significant differences were shown in the quality parameters of sea buckthorn jams. Increasing the amount of apple pomace added to the sea buckthorn -apple jams resulted in higher polyphenol content of the samples. The loss of polyphenols was decreasing during storage, the more apple pomace was added to the samples. Adding apple pomace, was also favorable as it lowered the loss of β carotenoid during storage. Increasing the pomace proportion resulted in higher antioxidant capacity; however, the more apple pomace was added, the antioxidant capacity was decreasing in a higher degree during storage. The pomace did not have any negative effect on the sensory attributes, but it favorably affected the changes of valuable components during the storage; thus it might be a suitable replacement of pectin.
***Key words****: Apple pomace, Sea buckthorn, Jam, Antioxidant, Carotenoid, Polyphenol content.*

## Introduction

In the 21th century, the stress caused by being rushed every day and the lack of physical activity due to the lifestyle of the society (including sitting work) lead to such diseases as obesity, cardiovascular problems, or the diabetes. In many cases it would be sufficient to pay attention to the diverse diet, eat fruits and vegetables ordinary, and even if only to a minimal extent, but to do some physical work every day. The treatments of those people who suffer from the previously mentioned common diseases are extremely expensive, so the preventing these problems is very important. Nowadays, more and more advertising campaign focuses on the positive effects of fruit consumption, and several scientific research pursues to confirm that also.

Special attention should be payed to those prominent fruit species which contain bioactive compounds. However we know many good sources of bioactive compounds (plants, animals, various microorganisms, or even non-natural materials), that of plant origin have the greatest potential (Guaadaoui et al. 2014; Dóka et al. 2014; Wani et al. 2016). Fruits have huge beneficial effect on human health thanks to their active ingredients, primarily to their C-vitamin, flavonoid, carotenoid, and tocopherol content (Krejcarová et al. 2015).

There are many fruit species which contain significant amount of bioactive compounds however not consumed fresh, only after processing. Among these, sea buckthorn (*Hippophae rhamnoides* L.) is an outstanding species. Due to its bioactive compounds it is especially suitable for functional food production. Several research groups are dealing with the valuable ingredients, and health benefits of sea buckthorn (Ali and Ahmad, 2015; Chakraborty et al. 2015; Song et al. 2014; Korekar et al.2011). Sea buckthorn is mostly consumed in the form of juices, jams, dried fruits, and dietary supplements.

The aim of this research is to comprehensively analyze the health benefits of a significant sea buckthorn cultivar of the Hungarian growing, and to carry out consumer panel testing of sea buckthorn-apple jams with various compositions, at least three times during storage; furthermore, to follow the changes in the biologically active components, and in the sensory attributes during the storage.

## Experimental

*Raw materials*

Pulp of the sea buckthorn (SB) cultivar 'Leikora' (provided by the Bio Berta Kft.) and the apple cultivar 'Rosmerta' was used to prepare the SB-apple jam samples. We used powder made of the pomace of 'Rosmerta' for the jams, as natural thickening agent.

*Preparation of jam samples*

The apples were cut into four pieces and then baked on 180 $^{o}$C in an oven. The sea buckthorn berries were heated to 80 $^{o}$C by an induction cooker. Finally the pulp of both fruits were gained by pressing them with a high performance press.

The apple pomace, which contains skin, stalk, and seeds parts remained from the pressing, was dried in two steps. At the beginning of the process the drying was done on 70 $^{o}$C and atmospheric conditions, and later the temperature was reduced to 50 $^{o}$C to avoid the damage of the low moisture content materials.

The jam samples were prepared by adding apple pulp in 33 %, sea buckthorn pulp in 50 %, and sugar in 17 % proportions. First the pulps were mixed, heated to 80-85 $^{o}$C, and then the sugar was added.

We weighted out 1 kilogram per sample, then the proper amount of pomace was added to the samples to set the required concentrates. We used two control jams, one was free of pomace or any other thickening agent, and one contained 1% pectin instead of pomace (table 1).

The changes of the six kinds of jams were constantly tracked during the storage. The following parameters were measured, in the 6$^{th}$, 9$^{th}$, and 12$^{th}$ month of the storage period: soluble solid content (Brix$^{o}$), acid content, polyphenol content, and FRAP value by spectrophotometry, and β carotenoid content by HPLC. On the same dates sensory testing were carried out, evaluating the color, taste, secondary taste, odor, secondary odor, acidity, sweetness, and texture of the samples. Data was analyzed with the SPSS 14.0 software. Univariate analysis was carried out to separate homogenous groups by the Duncan test. The RSD value was set to 5 %.

*Experimental methods*

The soluble solid content of the samples was determined by a digital refractometer in Brix %, according to the Codex Alimentarius 3-1-558/93 manual. We measured the titrable acid content according to the MSZ EN 12147:1998 Hungarian regulation. The total acid content (m/m %) was expressed in citric acid equivalent. We determined the total phenolic content with the method of Singleton and Rossi (1965). The absorption was measured on 765 nm, and the results were shown in mg gallic acid/liter (mg GS/l) dimension.

Table 1. Types and codes of jam samples

| **Sample code** | **Jam type** |
|---|---|
| 0 | Free of apple pomace and pectin |
| 1 | 0,5 % apple pomace |
| 2 | 1 % apple pomace |
| 3 | 1,5 % apple pomace |
| 4 | 2 % apple pomace |
| P | 1 % pectin |

We used the modified method of Benzie and Strain (1996) for measuring the water soluble antioxidant capacity (FRAP) of the samples. The absorption of the samples on 593 nm was calculated from the calibration curve made with ascorbic acid, and the values were given in mmol ascorbic acid/liter (mM AS/1) dimension.

The identification and quantification of β carotenoid was done by HPLC method. Carotenoids were extracted from 5 g samples in dark, using 15 ml THF (tetrahydrofuran). The samples were shaked for 12 hours on 4 °C, and on 150 rpm. We placed the supernatant into 1,5 ml Eppendorf tubes and centrifugated it for 5 minutes on -5 C°. The supernatant was then filtered with micro filter and injected into the HPLC instrument. Every measurement was repeated 3 times. The retention time of β carotenoid was 12 minutes.

## Results and discussion

The soluble solid content of the prepared jam samples ranged between 27 and 29 %. Fluctuation in the values with the storage time were only few tenths, the changes were not significant. The acid content of the samples ranged from 1,8 to 2% at the preparation, which neither has changed significantly during the storage.

We can characterize the antioxidant status of the jam samples excellently by analyzing the polyphenol content, antioxidant capacity, and β carotenoid content, and by following the changes of these during the storage period.

When the samples were prepared, there was linear relationship between the polyphenol content, and the amount of added pomace in the jams, as it is shown in Table 1. The more pomace were added, the better values the jams had. In the 6$^{th}$ month of storage the polyphenol content was lower in all of the samples except in sample 0 (free of pomace and pectin). In the second period of storage the polyphenol content was decreasing even more. The least amount of reduction (25%) was measured in sample 3 (1,5 % apple pomace addition). In the case of the other samples containing apple pomace, the reduction was between 32 to 33 %; while it was 46 % (sample P) and 64 % (sample 0) in the case of those samples which did not contain any apple pomace.

In the 12 month long storage period, the antioxidant capacity showed different tendency than the polyphenol content. In the case of all samples the antioxidant capacity was increasing (by 30 to 50 %) in the first part of the storage period, then in the rest of the storage time it was decreasing. The lowest amount of reduction was showed in the samples containing apple pomace. The reduction was 5% in the sample containing 0,5 % pomace, 26% in the sample of 1 % pomace, and 38 % in that of 1,5 % apple pomace. In the case of the samples free of pomace, sample 0 and sample P, the degree of reduction was 10 and 31 %, respectively. In the case of the samples having high pomace content, 1,5 and 2 %, the antioxidant capacity was decreasing in a very high amount: 38 and 53 %, respectively.

Table 1. Changes in the polyphenol content, β carotenoid content, and FRAP values of sea buckthorn-apple jams during storage

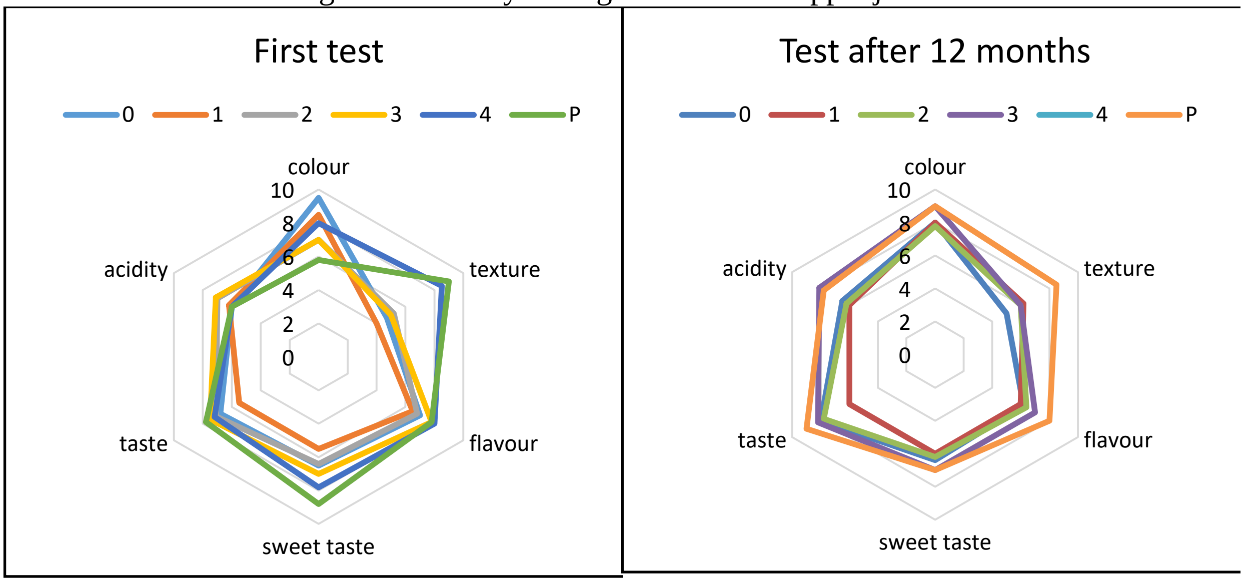
| | | **sample 0** | **sample 1** | **sample 2** | **sample 3** | **sample 4** | **sample P** |
|---|---|---|---|---|---|---|---|
| **Polyphenol content (mg GS/l)** | freshly prepared | 1919 | 2219 | 2169 | 2373 | 2673 | 2019 |
| | 6th month of storage | 2000 | 1840 | 1927 | 2227 | 2469 | 1660 |
| | 12th month of storage | 1169 | 1481 | 1469 | 1790 | 1794 | 1169 |
| **FRAP (mM AS/l)** | freshly prepared | 4,6 | 3,7 | 5,0 | 7,2 | 6,5 | 5,5 |
| | 6th month of storage | 9,8 | 10,2 | 9,1 | 13,9 | 12,2 | 11,8 |
| | 12th month of storage | 5,8 | 4,2 | 6,4 | 10,0 | 10,2 | 7,2 |
| **β carotenoid content (mg/ml)** | freshly prepared | 0,188 | 0,145 | 0,122 | 0,101 | 0,093 | 0,084 |
| | 6th month of storage | 0,133 | 0,102 | 0,097 | 0,082 | 0,115 | 0,112 |
| | 12th month of storage | 0,067 | 0,144 | 0,147 | 0,062 | 0,116 | 0,045 |

The β carotenoid content of the individual samples changed differently during storage. We can see that higher apple pomace concentrates coincide with lower β carotenoid content. A possible explanation for this is that, according to the literature, apple does not contain β carotenoid at all.

However, during storage the added pomace hinders the degradation of β carotenoids. In the end of the 12 month long storage, in the samples containing no apple pomace (sample 0 and P) the carotene content dropped drastically to 64 and 46 %, respectively. In contrast, no significant change was measured in the samples containing apple pomace (sample 2 and 4), or the change was very slightly (0,7%, sample 1). Sample 3 was an exception, where the reduction was 38 %; this should be clarified by further investigations.

The sensory testing data is suggesting that the lower pomace concentrate of the samples results in more preferable color. However, the samples containing high amounts of pomace had more favorable taste and odor.
Sample 3 and 4 reached outstandingly high scores. Concerning acidity, the samples containing no pomace were not preferred.

Figure 1. Sensory testing results of SB-apple jams




With the increase of added pomace the testers liked more the sweetness of the samples; the best score was given to sample 4. The results regarding the texture are very clear. The more pomace is added to the samples, the better scores were given, and the best score was given to the sample containing pectin, probably due to its gelling effect. Summarizing the data, we can say that sample 4 and P were the most favored ones by the consumers.

## Conclusion

Adding apple pomace to the SB-apple jams increases their polyphenol content. The more apple pomace is added the degree of polyphenol reduction is the less. Those jams which do not contain added apple pomace were decreasing in their β carotenoid content; in contrast, those which contain apple pomace lost much less β carotenoid. It can be concluded that high pomace content is accompanied with high proportion of antioxidant capacity loss; however, the presence of pomace in the samples resulted in high antioxidant capacity (10,0 – 10,2 mM AS/L).
We came to the conclusion, that adding 0,5 to 1 % of apple pomace to SB-apple jams affected positively the changes of valuable components during storage. Although above a certain concentration, the favorable effect can not be shown. The further investigations should focus on the flavonoid composition of the samples, and their antioxidant capacity should be analyzed with other methods, in order to confirm the protective effect of apple pomace.

## Acknowledgements

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