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EVALUATION OF THE OXIDATIVE STABILITY OF SEA BUCKTHORN (*HIPPOPHAE RHAMNOIDES L.)* LIPOPHILIC EXTRACTS

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Abstract. Food industry more and more tends to replace the synthetic compounds in foods with natural ones. A safe and effective possibility would be to use biologically active compounds extracted from local natural berries such as sea buckthorn (*Hippophae rhamnoides L*). In this paper there were evaluated the antioxidant capacity and physico-chemical characteristics of seabuckthorn lipophilic extracts. There were performed the analysis of the impact of biologically active compounds on the physico-chemical characteristics of lipophilic extracts and mayonnaise type sauces and the investigation of their oxidative stability. The results obtained using high-performance analysis methods have allowed the argumentation of the importance of replacing synthetic antioxidant compounds with natural antioxidant compounds in the production process of high-lipid food products.

Keywords: *antioxidants, extraction, high-lipid food products, oxidation.*

Introduction

Nowadays, more and more manufacturers in the food industry tend to replace synthetic food additives with natural substances, biologically active compounds obtained from natural resources of plant origin that are stable and safe for consumption. Therefore, local berries, including the sea buckthorn (*Hippophae rhamnoides L.),* show increased interest due to their organoleptic and physico-chemical characteristics.

In this research, we studied sea buckthorn *(Hippophae rhamnoides L*.). The aim of this study is to obtain stable and high quality lipophilic extracts of sea buckthorn, to analyze the physico-chemical characteristics, to obtain high quality mayonnaise type sauces with the addition of sea buckthorn lipophilic extracts and to analyze the sensory characteristics and the oxidative stability of the food products.

The importance of sea buckthorn as a medicinal plant is determined by the content of biologically active compounds in fruits, leaves, and even in peel. The sea buckthorn is a natural concentrate of vitamins (C, P, B1, B2, E, K), carotenoids, folic acid, isoramnetol, unsaturated fatty acids and phytosterols, nicotinic acid, volatile oils, etc. The sea buckthorn fruits have orange color due to the content of carotenoids, which is much higher than in carrots or squashes [1]. Food products oxidation is caused by lipid oxidation process and as a result may occur a color change, rancid odor and texture of food may be modified which

negatively influences the sensory qualities of foods. Natural plant extracts are a good alternative for synthetic food additives, also enriching the nutritional value of the food [2-4]. Pastries, meat products, dairy products with the addition of natural plant extracts, spices, and fruit powder were obtained [5 - 9].

In complex foods, the impact reduction of lipid oxidation can only be ensured by appropriate packaging and antioxidants that block the propagation or decomposition of the hydroperoxides and is manifested by the inhibition of the oxidation process [10, 11].

Materials and methods

Sea Buckthorn berries *(Hippophae rhamnoides L.)* were harvested in the central area of Republic of Moldova in 2016. Reagents sulfuric acid solution H_2SO_4 (2M), hydrogen peroxide solution H_2O_2 (0.1 M), ammonium molybdate solution (3%); potassium iodide KI (1.8 M), sodium thiosulfate $N_2S_2O_3$ (5.09 mM), concentrated nitric acid HNO_3; hexane, 70% ethyl alcohol, phenolphthalein, glacial acetic acid were purchased from Merck, Germany. The sea buckthorn berries were air dried, then ground and sieved.
The extraction was carried out in deodorized refined sunflower oil with a solvent ratio of 1 g plant: 10 ml of oil. The extraction process was carried out by 2 shaking at 22 ° C for 24h. The extracts were decanted and stored in dark glass bottles at + 4 ° C.

Determination of Peroxide Value (PV). Peroxide Value determination was performed by the volumetric method [12,13] and the results obtained were calculated according to the following relationship:

$$\boldsymbol{PV} = \frac{(\boldsymbol{S}-\boldsymbol{B})\times\boldsymbol{N}\times\mathbf{1000}}{\boldsymbol{mass\ of\ sample,g}}, \text{ [mEq } O_2\text{/kg]} \quad (1)$$

where:
B – volume of titrant, [ml of blank],
S – volume of titrant, [ml of sample],
N – normality of sodium thiosulfate solution,

The antioxidant capacity of lipophilic extracts. For the determination of HPSA[14], in the titration flasks, 1 ml of sample was mixed with 1 ml of hydrogen peroxide solution H_2O_2 (0.1 mM). Then 2 drops of ammonium molybdate, 10 ml of H_2SO_4 (2M) sulfuric acid and 7 ml of KI potassium iodide (1.8 M) were added. The obtained solution was titrated with sodium thiosulfate $N_2S_2O_3$ (5.09 mM) until the yellow color disappeared. The volume (V_1) of sodium thiosulfate $Na_2S_2O_3$ (5.09 mM) used for titration was recorded.

Determination of acid value (AV). Determination of AV [15] was performed by the volumetric method and the results obtained were calculated according to the following relationship:

$$\boldsymbol{AV} = \frac{\boldsymbol{V_{KOH}\cdot N_{KOH}\cdot 5.611}}{\boldsymbol{m}}, \text{ [mgKOH/g]} \quad (2)$$

where:
V_{KOH} – volume of potassium hydroxide, [ml];
N_{KOH} – concentration of potassium hydroxide, [mol/dm^3];
m – mass of sample, g.

Sensory evaluation. A sensory evaluation of sauce samples was conducted after preparation. Sensory characteristics: taste, flavor, color, consistency and overall acceptability were evaluated by a 20-member panel on 5-point scale, with 1 being the lowest and 5 the highest according to Juyun Lim, (2011) [16].

Results and discussions

Results obtained through analysis of different methods of research have found out that oxidation process can be slowed down by using lipophilic extracts fortified with biologic active compounds. It was determined that lipophilic extract samples enriched with natural antioxidants are characterized by a higher antioxidant capacity compared to samples that were not enriched with natural antioxidants and the values are shown in figure 1.

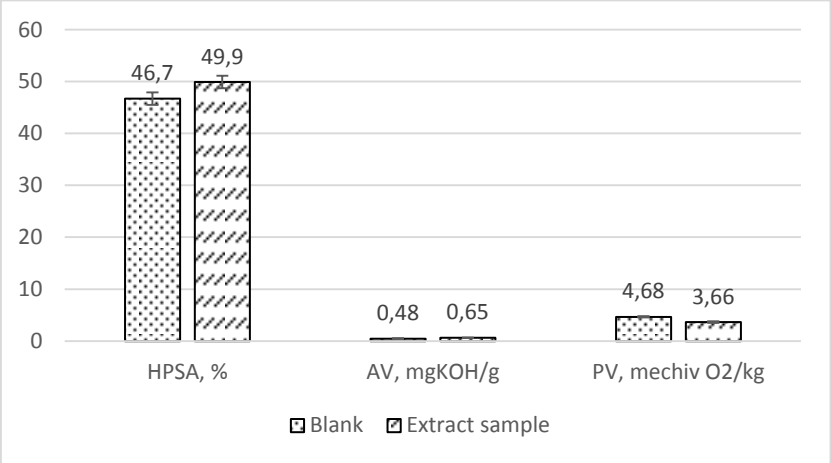

Figure 1. Phisico-chemical characteristics of sea buckthorn extract.

As it is shown above, the peroxide value of sea buckthorn lipophilic extract is within acceptable limits according to normative documents (max. 10 m_{echiv} O2/kg according to [12]). The value for sea buckthorn extract (PV=3,66 ±0,13 m_{echiv} O2/kg) is lower than the blank sample which fact shows that due to biologically active compounds in analyzed lipophilic extract the oxidation process slows down. Acid value for sea buckthorn extract (AV=0,65 ±0,04 mg KOH/g) also indicates a decrease compared to blank sample which is explained by the oxidative degradation decrease.

Besides that, the antioxidant capacity of sea buckthorn lipophilic extract (HPSA=49,9 ±1,2%) is higher than the blank sample which is explained by the concentration of biologic active compounds extracted which naturally can be found in sea buckthorn berries.

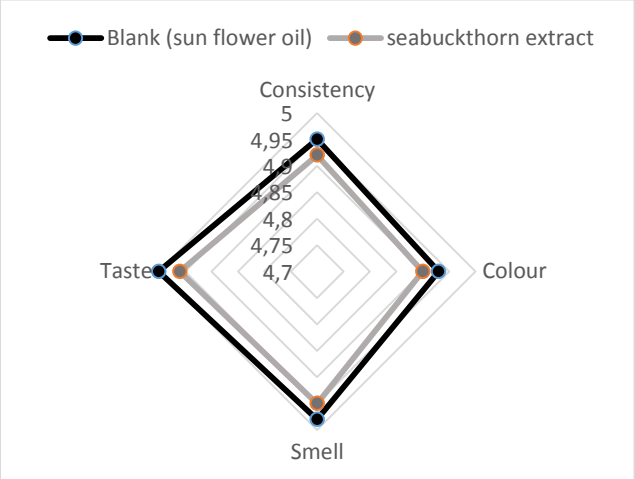

Figure 2. Sensory analysis of mayonnaise type sauce (blank - sunflower oil sample, sea buckthorn extract sample).

In order to investigate further the oxidative stability of the lipophilic extract in foods, there were prepared samples of mayonnaise type sauces according to a preset recipe [17]. In order to analyze the organoleptic parameters it was made a sensory evaluation and the results are shown below (figure 2).

It was carried out that the sample prepared with the addition of sea buckthorn extract is characterized by its pleasant taste and odour characteristic for mayonnaise close to the blank sample. Consistency is homogeneous, creamy and very good. The color is yellowish cream characteristic for mayonnaise sauce. According to the study [18], acids produced most important changes: lightness, radical scavenging activity, and increase of polymeric colour, browning and degradation indices, chroma and colour parameter.

Further, to ensure the oxidative stability of the extracts there were determined the physico-chemical characteristics of the mayonnaise type sauces and the results are shown below (figure 3).

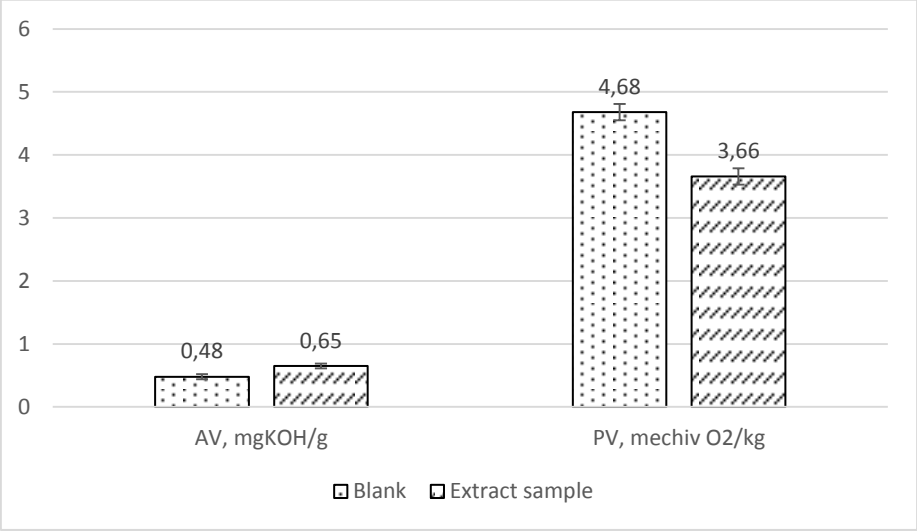

Figure 3. Physico-chemical characteristics of mayonnaise type sauces.

The peroxide value for mayonnaise sauce is within acceptable limits (max. 10 m_{echiv} O_2/kg) [12]. It was found out that mayonnaise samples enriched with sea buckthorn extract showed a considerably lower peroxide value compared to the blank sample, which is because the peroxides formation process slows down.

It was established that sea buckthorn extract is characterized by a slightly higher value of Acid Value (0,65 ±0.04 mg KOH/g), which is explained by the presence of the free fatty acids. The values for both samples remains within the permissible limits according to the normative documents [12].

Conclusions

The results obtained from the determination of the physico-chemical characteristics of sea buckthorn lipophilic extracts are within the permissible limits of max. 10 m_{echiv} O_2 active / kg for Peroxide Value and max 0,6 mg KOH/g for Acid Value. The sea buckthorn extract is characterized by a higher antioxidant activity (HPSA=49.9%) compared to the blank sample which fact is explained by a higher content of biologically active compounds in local berries like sea buckthorn. The sensory evaluation of high lipid food samples showed that the mayonnaise type sauce enriched with sea buckthorn extract is characterized by a pleasant taste and smell and a characteristic consistency and colour for a

mayonnaise sauce. In addition, the quality parameters of the investigated samples are within the maximum permissible limits according to the regulations and protocols.

This research demonstrates the possibility to use sea buckthorn lipophilic extract in the food products production. An important benefit is the possibility to use natural antioxidants obtained from local resources in order to substitute the synthetic ones. This way food products enriched with natural antioxidants will be safe and healthier for consumption.

Acknowledgments

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