THE IMPACT OF HAWTHORN LIPOPHILIC EXTRACT ON OXIDATIVE STABILITY OF FOOD PRODUCTS

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Summary: Lipid oxidation may cause a rancid odor, texture and color change of high lipid foods. In order to extend the storage term synthetic antioxidants are mostly used. Nowadays more and more research is performed to find the way to replace the synthetic additives with the natural ones. The aim of this study is to analyse the impact of biologically active compounds on physico-chemical characteristics of lipophilic extracts and their oxidative stability. The results obtained by physico-chemical analysis methods have allowed to explain the importance of replacing synthetic antioxidant compounds with natural antioxidants in the process of producing food products with a high lipid content.

Keywords: oxidation, hawthorn, lipophilic extract, antioxidants.

Introduction

Food industry more and more tend 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 hawthorn (*Crataegus)*.

There is an increased interest in berries because they are characterized by a large area of cultivation and they are rich in nutritionally important antioxidants, vitamins and minerals [1,2]. In this research, we studied mainly hawthorn (*Crataegus)*.

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 [3].

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. The industrially manufactured complex food products usually contain antioxidants of synthetic origin (propyl gallate - E-311 or octyl-E-312, butylhydroxyanisole (BHA) - E-320, etc.) and their effect on health human is not very beneficial [4].

The aim of this study is to analyze the physico-chemical characteristics of hawthorn lipophilic extract against deodorized sunflower oil and to evaluate its oxidative stability in high lipid food products.

Materials and methods

Hawthorn berries *(Crataegus)* were harvested in the north area of Republic of Moldova in 2016. Reagents sulfuric acid solution H2SO4 (2M), hydrogen peroxide solution H2O2 (0.1 M), ammonium molybdate solution (3%); potassium iodide KI (1.8 M), sodium thiosulfate N2S2O3 (5.09 mM), concentrated nitric acid HNO3; hexane, 70% ethyl alcohol, phenolphthalein, glacial acetic acid were purchased from Merck, Germany. The hawthorn 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) [5,6]

Peroxide Value determination was performed by the volumetric method and the results obtained were calculated according to the following relationship:

$$\boldsymbol{PV = \frac{(S - B) \times N \times 1000}{mass\ of\ sample, g}} \quad \text{, [mEq O2/kg]} \qquad (1)$$

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 [7]

For the determination of HPSA, in the titration flasks, 1 ml of sample was mixed with 1 ml of hydrogen peroxide solution H2 O2 (0.1 mM). Then 2 drops of ammonium molybdate, 10 ml of H2SO4 (2M) sulfuric acid and 7 ml of KI potassium iodide (1.8 M) were added. The obtained solution was titrated with sodium thiosulfate N2S2O3 (5.09 mM) until the yellow color disappeared. The volume (V1) of sodium thiosulfate Na2S2O3 (5.09 mM) used for titration was recorded.

Determination of acid value (AV) [8]

Determination of AV was performed by the volumetric method and the results obtained were calculated according to the following relationship:

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

where:
VKOH – volume of potassium hydroxide, [ml]
NKOH – concentration of potassium hydroxide, [mol/dm3];
m – mass of sample, [g]

Sensory evaluation [9]

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).

Results and discussions

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

Table 1. *Phisico-chemical characteristics of hawthorn extract.*

Nr.	Characteristics	Blank sample (sunflower oil)	Hawthorn extract
1.	**HPSA, %**	46,7 ±1,2	47,1 ±1,2
2.	**Acid Value, mg KOH/g**	0,48 ±0,04	0,42 ±0,04
3.	**Peroxide Value, m_{echiv} O_2/kg**	4,68 ±0,13	3,68 ±0,13

As shown above the peroxide value of hawthorn lipophilic extract is within acceptable limits according to normative documents (max. 10 m_{echiv} O2/kg according to [5]). The value for hawthorn extract (PV=3,68 ±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 is slowing down. Acid value for hawthorn extract (AV=0,42 ±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 hawthorn lipophilic extract (HPSA=47,1 ±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 hawthorn berries.

To investigate further the oxidative stability of the lipophilic extract in foods were prepared samples of mayonnaise type sauces according to a preset recipe [10].

In order to analyze the organoleptic parameters was made a sensory evaluation and the results are shown below (fig. 1)

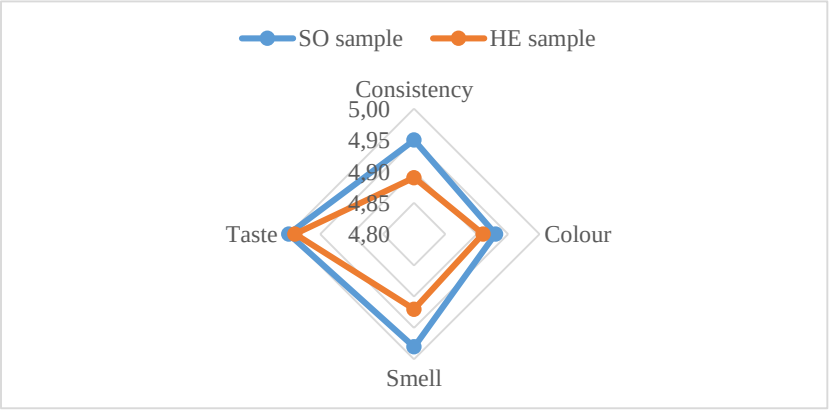

Fig. 1. *Sensory analysis of mayonnaise type sauce (SO sample – sunflower oil sample, HE sample – hawthorn extract sample)*

It was carried out that the sample prepared with the addition of hawthorn extract is characterized by its pleasant taste and odor characteristic for mayonnaise close to the blank sample. Consistency is homogeneous, creamy and very good. The color is yellowish cream characteristic for mayonnaise sauce.

Further to ensure the oxidative stability of the extracts were determined the phisico-chemical characteristics of the mayonnaise type sauces and the results are shown below (Table 2.).

***Table 2**. Phisico-chemical characteristics of mayonnaise type sauces*

Nr.	Characteristics	Blank sample (sunflower oil mayonnaise)	Hawthorn extract mayonnaise
1.	**Acid Value, mg KOH/g**	0,38 ±1,2	0,35 ±1,2
2.	**Peroxide Value, mechiv O_2/kg**	2,33 ±0,04	1,0 ±0,04

The peroxide value for mayonnaise sauce is within acceptable limits (max. 10 m_{echiv} O2/kg) [5]. It was found that mayonnaise samples enriched with hawthorn extract showed a considerably lower peroxide value compared to the blank sample, which is due to the fact that the peroxides formation process is slowing down.

It was established that hawthorn extract is characterized by the lower value of Acid Value (0,35 ±1,2 mg KOH/g), which is explained by the slowing down of free fatty acids formation and the oxidation process of the product itself. The values for both samples remain within the permissible limits according to the normative documents [5].

Conclusions

The results obtained from the determination of the phisico-chemical characteristics of hawthorn lipophilic extracts are within the permissible limits of max. 10 m_{echiv} O2 active / kg for Peroxide Value and max 0,6 mg KOH/g for Acid Value. The hawthorn extract is characterized by a higher antioxidant activity (HPSA=47.1%) compared to the blank sample which fact is explained by a higher content of biologically active compounds in local berries like hawthorn. The sensory evaluation of high lipid food samples showed that the mayonnaise type sauce enriched with hawthorn extract is characterized by a pleasant taste and flavor and a characteristic consistency and color for a mayonnaise sauce. Also 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 hawthorn 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.

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