Use of bioactive properties of plant extracts to increase the storage stability of mechanically separated turkey meat

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Abstract

Introduction. The research aimed to study the influence of natural antioxidants present in black chokeberry, cranberry, and black currant leaf extracts to stabilize the oxidation processes in mechanically separated turkey meat (MSM) during storage.

Materials and methods. The subject of the study was mechanically separated turkey meat. Plant extracts of black chokeberry (*Aronia melanocarpa*) pomace, cranberry (*Vaccinium Oxycoccus)* pomace, and blackcurrant (*Ribes nigrum L.*) leaf were used as antioxidants. During the storage of the turkey MSM the dynamics of oxidation processes were studied and the acid value, peroxide value, and the content of thiobarbituric acid reactive substances were determined.

Results and discussion. The chemical composition of turkey MSM included proteins, 14.22%, and fat, 17.3% that increases the risk of its oxidative deterioration during sale and storage. The use of plant extracts reduced the intensity of lipid oxidation in mechanically separated turkey meat during 9 weeks of frozen storage. At the end of the experiment, the content of free fatty acids in the control sample was the highest and amounted to 3.81±0.02 mg KOH, which is by 131.83% higher than in the sample with blackcurrant leaf extract, 4.76 times higher than in the sample with cranberry extract, and 7.33 times higher than in the sample with black chokeberry extract. The addition of extracts from black chokeberry and cranberry slow down the hydrolytic changes of product fats by 81.20 and 76.47%, respectively. The addition of black chokeberry and cranberry extracts at an amount of 0.2% contributed to the reduction of the peroxide value after two months of storage of mechanically separated turkey meat to 0.057–0.060 J_2 %, which almost halved the synthesis of peroxides in the product. It was shown that the introduction of black chokeberry and cranberry extracts in a content of 0.2–0.3% inhibits the accumulation of secondary lipid oxidation products by 35.10–39.36%.

Conclusion. Comparative analysis and comprehensive assessment of the oxidation product content in control and experimental samples of mechanically separated turkey meat testify the addition of natural antioxidants reduces the oxidative deterioration of turkey MSM under the frozen storage.

Introduction

Modern resource-saving technologies in the poultry processing ensure its fullest use. When separating pieced meat, part of the muscle tissue (35–40% of the bone mass) remains on the bones. It must be further separated to obtain meat of mechanical collapse, which is a paste-like mass without bones and cartilage. The mechanical separation of meat and bone remains is carried out with the aim of obtaining protein-containing raw materials, in particular mechanically separated poultry meat (MSM), similar in physical and chemical properties to minced poultry, separated from bones manually. However, MSM contains a lot of bone and connective tissue, bone marrow, and fat (Massingue et al., 2018).

MSM, obtained from a cooled carcass of poultry or its parts by the separation or pressing in the form of a minced (paste-like) mass, has a standardized amount (not more than 0.6%) and the size of bone tissue (not more than 0.5 mm) and calcium (no more than 0.3%) (Tasić et al., 2017; Komrska et al., 2011). MSM contains up to 15% protein, making it a popular ingredient in the production of emulsified products. Such minced meat is ideal as a component of recipes, which reduces the cost of products both in combination with beef and pork meat, and on its own. The including of 10–15% of mechanically separated turkey meat in the recipes of emulsified meat-containing food products makes it possible to obtain food products with high sensory parameters, which increases their consumer value (Al-Ghayat et al., 2020; Łaszkiewicz et al., 2021).

The authors (Bozhko et al., 2019a; Tischenko et al., 2019) evaluated the possibilities of using mechanically separated turkey meat in the recipes of meat-containing chopped semi-finished products and cooked sausages. Studies have shown that combining raw materials from poultry meat of different levels of nutritional value allows to obtain meat-containing systems with high functional and technological characteristics.

Along with this, the use of turkey MSM both for sale in the form of minced meat and as a recipe component has a number of negative aspects. According to (Ribeiro et al., 2019; Trindade et al., 2008), the main problem of MSM is its tendency to spontaneous autoxidation, which can be observed already on the first day of storage, causing undesirable changes later.

Substances formed during the oxidation of lipids not only deteriorate the quality characteristics of meat products, but are also capable of causing significant harm to human health (Pérez-Palacios et al., 2020). Furthermore, low microbiological resistance and a specific red color (from bright to dark) are reported, which is due to technological factors of production and biochemical properties of MSM turkey (Takács et al., 2020; Wu et al., 2022).

Changes that impair the quality and safety of MSM and meat products using it can be limited by the application of antioxidants and preservatives. However, due to the distrust of consumers in the use of synthetic additives in the production of food products, the search for the possibility of replacing them with plant ingredients with proven antioxidant and antibacterial properties is being conducted (Ivanov et al., 2021; Munekata et al., 2020; Stabnikova et al., 2021). Ingredients such as dried and ground herbs, as well as essential oils or extracts obtained using various solvents, can be incorporated into meat products in a variety of forms (Estévez, 2021; Pateiro et al., 2021).

The aim of the research was to study the effect of natural antioxidants, namely, black chokeberry extract; cranberry extract; blackcurrant leaf extract to slow down the oxidation processes in the turkey MSM fat complex during its storage.

Materials and methods

Experimental design

The subject of the research was mechanical separated turkey meat. To study the effect of natural antioxidants on the oxidative and hydrolytic deterioration of fat in MSM turkey, selected plant extracts were added to freshly prepared minced meat (t = 0 - +4˚C) during mixing on a high-speed cutter (GoodFood C6VV). The selection of the natural antioxidants concentration was carried out based on the results of previous studies and literature data.

As antioxidants, commercial plant extracts, such as black chokeberry (*Aronia melanocarpa*) pomace extract (EBCP); extract from cranberry (*Vaccinium oxycoccus)* pomace (ECP); black currant (*Ribes grum L.*) leaf extract (EBCL) were used in the study (Figure 1).

a b c

Figure 1. Black chokeberry (a); cranberry (b), and blackcurrant leaf (c)

The extracts were added in the amounts of 0.02% or 0.03% to the mass of raw materials for the experimental samples of minced meat. A sample of minced meat without the addition of an antioxidant was used as a control. The prepared samples were stored at a temperature minus 18 °C for 60 days.

Determination of moisture content

Moisture content was determined by the method of drying (ISO 1442, 2008). 5 g of the sample was placed in a container, dried for 1 hour at 150°C.

Determination of raw protein content

Protein measurements were performed using the Kjeldahl method (ISO 937, 2007). 5 g of homogeneous fillet with 20 mL of concentrated sulfuric acid and 8 g of catalysts were placed in a special container and then heated at 350 °C for 30 min. After mineralization, the sample was quantitatively transferred to a solution of NaOH at a concentration of 33%, sealed, and distilled off with the steam. The resulting steam distillate was transferred to a

container containing several drops of the Tashiro indicator. The titration was performed with a solution of 0.01 N sulfuric acid.

Determination of raw fat content

Content of total fat was determined by the Soxhlet method (ISO 1443, 2008). 4 g of the dried sample in a paper cartridge was placed in an extraction flask of a Soxhlet apparatus. Petroleum ether with a boiling point of 45 °C was used for the extraction. After multiple extractions, the constant weight of the test cartridge was determined. The difference between the initial and final weight shows the percentage of fat.

Determination of ash content

Ash content was determined by heating sample overnight at 520°C in a muffle furnace. The sample was weighed before and after heating to determine the content of ash. The ash content was calculated by the formula:

$$Ash=M_{ash}/M_{dry}\times 100, \quad (1)$$

where M_{ash} is the mass of the ashed sample, M_{dry} is the initial mass of the dried sample.

Lipid oxidation determined by acid value, peroxide value, and the content of thiobarbituric acid reactive substances

The acid value was determined by the batch titration with sodium hydroxide in the concentration in the presence of phenolphthalein alcohol solution (Bozhko et al., 2019b). 3–5 g of the sample was weighted in the conic retort with the volume of 150–200 cm^3 with the error of no more than 0.001 g. The batch was heated on the water bath and, after the addition of 50 cm^3 of neutralized ether-alcohol mixture, was shaken. Then 3–5 drops of phenolphthalein alcohol solution with the mass share of 1 % were added. The received solution while shaking was titrated fast with potassium hydroxide solution with the molar concentration 0.1 mol/dm^3 until the distinct rose coloration appeared and kept for 1 min. The acid value was calculated by the formula:

$$X = (V\times K\times 5.61)/m, \quad (2)$$

where V is volume of potassium hydroxide solution, with the molar concentration 0.1 mol/dm^3, used for titration; K is correction to alkali solution for recalculation on the distinct (0.1 mol/dm^3) one; 5.61 is number of milligrams of potassium hydroxide, contained in 1 cm^3 (0.1 mol/dm^3) of solution; m is forcemeat batch mass, g.

The method of peroxide value determination is based on the batch extraction by the mixture of chloroform and icy acetic acid and further titration by the sodium hyposulfite solution with the previously added starch solution (Bozhko et al., 2019b). 0.8–1.0 g of a batch, weighted with accuracy of no more than 0.0002 g were placed in the conic retort with the stopper, melt on the water bath and 10 cm3 of chloroform and 10 cm^3 of icy acetic acid were gently poured on the retort sides. 0.5 cm3of saturated, freshly prepared potassium iodine solution was quickly added. The retort was closed with the stopper; the content was mixed by turning movements and put into the dark place for 3 minutes. Then 100 cm^3 of distilled water with the previously added 1 cm^3 of starch solution with the mass share of 1% was

gently poured into the retort. After that it was titrated with sodium hyposulfite solution with the molar concentration of 0.01 mol/dm^3 until the blue color will disappear.

To verify the clearness of reagents the control determination without a batch was realized. The peroxide value was calculated by the formula:

$$X = (V–V_1) \times K \times 0.00127 \times 100/m, \quad (3)$$

where V is a volume of sodium hyposulfite solution with the molar concentration 0,01 mol/dm^3, used for titration in the main experiment with the forcemeat batch, cm^3; V1 is a volume of sodium hyposulfite solution (0.01 mol/dm^3), used for titration in the control experiment without a forcemeat batch, cm^3; K is coefficient of correction to sodium hyposulfite for recalculation on the distinct (0.01 mol/dm^3) solution; 0.00127 is a number of grams of iodine, equivalent to 1 cm^3 (0.01 mol/dm^3) of sodium hyposulfite; m is a mass of the studied forcemeat batch, g.

The content of thiobarbituric acid reactive substances was determined by measuring the coloration intensity of the mixture of the studied sample distillate and thiobarbituric acid solution (1:1) after 35 minutes on the water bath on the spectrophotocolorimeter "Spекol-11" (Germany) at the wave length 535 nm (Bozhko et al., 2020). 50 g of forcemeat batch were put into the porcelain mortar, 50 cm^3 of distilled water were measured by the glass cylinder, added to the mortar and ground with the pestle into the uniform mixture. The prepared sample was quantitatively transferred into Kjeldahl retort, remains were washed away from the mortar with 47.5 cm^3 of distilled water and then 2.5 cm^3 of hydrochloric acid were added. The distillation was carried out in Kjeldahl apparatus, collecting 50 cm^{3}of distillate in the volumetric flask. 5 cm^3 of distillate were taken, poured into the retort with the fitted stopper. After the addition of 5 cm^3 of thiobarbituric acid, the retort was closed with the fitted stopper and heated on the boiling water bath for 35 min. Simultaneously, the control was hold, using 5 cm^3 of distilled water instead of the distillate. Then the solutions were cooled in the cold running water for 10 min, and the optic density at the wave length of 535±10 nm as to the control solution was measured.

The content of thiobarbituric acid reactive substances, mg of MA (malonic aldehyde)/kg of the product, was calculated by the formula:

$$X = D \times 7.8, \quad (4)$$

where D is an optic density of the solution; 7.8 is a coefficient of proportional dependency of MA density on its concentration in the solution. This coefficient is a permanent value.

Statistical analysis

The absolute error of measurements was determined by Student criterion, the reliable interval P = 0.95, the number of repetitions in calculations was 3−4, the number of parallel tests of studied samples was 3.

Results and discussion

The characteristics of turkey MSM is shown in Table 1.

Table 1

Characteristics of turkey MSM

Sample	Mousture, %	Protein, %	Fat, %	Ash, %
MSM of turkey	67.83±1.10	14.22±0.97	17.3±0.64	0.50±0,01

The moisture content in mechanically separated turkey meat was 67.83±1.10% that meets the standardized requirements for moisture content less than 70% in MSM. It was found that the mass fraction of crude protein in turkey MSM was 14.22±0.97%, which meets a standard that defines the protein content in MSM not lower than 12%. The fat content in turkey MSM corresponded to the standard and was 17.3±0.64%. A sufficiently high content of protein and fat increases the risk of oxidative deterioration of MSM during the sale of both a separate product and as an ingredient for the production of other meat products.

It has been found that the fatty acid profile of turkey MSM is further formed from lipids present in bone marrow and bone tissue, subcutaneous adipose tissue, skin and abdominal fat (Huang et al., 2019). The higher content of polyunsaturated fats in the fat fraction is due to their intake from bone particles and the spinal cord. Unsaturation of fat determines the degree of its reactivity to oxygen and free radical oxidation (Püssa et al., 2009).

Furthermore, MSM contains heme pigments that are involved in the catalysis of lipid oxidation associated with the formation of highly reactive heme pigment derivatives such as non-protein bound heme iron (hemin, hematin, and heme) and hypervalent heme pigments (Yin et al., 2017). The quality of raw meat is important for the oxidative change of meat after cooking, because primary oxidation products or oxidized lipids from raw meat can continue the oxidation process after heat treatment. The formation of free fatty acids in raw materials, which are formed as a result of hydrolytic deterioration of fats, was determined by the acid value during storage of turkey MSM without plant antioxidants and with plant extracts added to a content of 0.2% (Table 2).

Table 2

Dynamics of the acid value of turkey MSM with 0.2% of plant extracts during the storage, mg KOH

Storage time, weeks	Control sample	EBCP0.2	ECP0.2	EBCL0.2
0	0.25±0.07	0.25±0.02	0.25±0.11	0.25±0.01
1	0.41±0.07	0.26±0.11	0.27±0.03	0.39±0.03
2	0.61±0.03	0.31±0.03	0.30±0.11	0.51±0.01
3	0.98±0.04	0.31±0.03	0.32±0.07	0.90±0.03
4	1.87±0.03	0.35±0.03	0.44±0.20	1.65±0.53
5	2.07±0.02	0.37±0.11	0.71±0.11	1.78±0.06
6	2.31±0.01	0.42±0.03	0.73±0.01	2.09±0.08
7	2.31±0.07	0.49±0.13	0.78±0.01	2.31±0.07
8	3.43±0.02	0.52±0.01	0.78±0.17	2.37±0.03
9	3.81±0.02	0.52±0.01	0.80±0.07	2.89±0.02

Note: EBCP is extract of black chokeberry pomace; ECP is extract of cranberry pomace; EBCL is extract of black currant leaves.

The analysis of obtained data showed that in the control sample, the intensity of hydrolytic processes in the lipid fraction of turkey MSM has more pronounced dynamics compared to the experimental ones. After one month of turkey MSM storage in the frozen state, the concentration of free fatty acids as a result of fat hydrolysis in the sample without antioxidants increased by 7.48 times and amounted to 1.87±0.03 mg of KOH. In experimental samples with a concentration of plant extracts of 0.2%, this indicator ranged from 1.65 to 0.35 mg of KOH. It was shown that addition of black chokeberry or cranberry pomace extracts slowed down the hydrolytic changes in sample fats by 81.20 and 76.47%, respectively. This is explained by the high concentration of phenolic substances contained in high amounts in the peel of the berries (Gramza-Michałowska et al., 2019; Sidor et al., 2019; Stabnikova et al., 2021).

Until the end of the storage period, the observed trend remained. Slowing down of hydrolytic processes in the fat of turkey MSM at the beginning led to inhibition of the formation of free fatty acids during the entire experimental period. At the end of the experiment, the concentration of free fatty acids in the control was the highest and amounted to 3.81±0.02 mg KOH, which is by 131.83% higher than in the EBCL0.2 sample, 4.76 times higher than in the ECP0.2 sample, and 7.33 times higher than in sample EBCP0.2. The lowest effectiveness of the antioxidant preparation EBCL is explained by the lower content of biologically active phenols (D'Urso et al., 2020).

Table 3 presents the results of the study of the acid value dynamics during storage of turkey MSM without plant antioxidants and with plant extracts added to a content of 0.3%.

Table 3

Dynamics of the acid value of turkey MSM with 03 % of plant extracts during the storage, mg KOH

Storage time, weeks	Control	EBCP0.3	ECP0.3	EBCL0.3
0	0.25±0.07	0.25±0.11	0.25±0.11	0.25±0.03
1	0.41±0.07	0.26±0.11	0.27±0.01	0.38±0.03
2	0.61±0.03	0.31±0.11	0.32±0.13	0.47±0.17
3	0.98±0.37	0.32±0.11	0.33±0.03	0.66±0.07
4	1.87±0.03	0.33±0.03	0.40±0.11	0.93±0.07
5	2.07±0.016	0.36±0,07	0.66±0.27	1.27±0.03
6	2.31±0.007	0.38±0.01	0.73±0.13	1.68±0.11
7	2.31±0.07	0.40±0.01	0.74±0.03	1.87±0.07
8	3.43±0.17	0.46±0.01	0.76±0.07	2.24±0.18
9	3.81±0.16	0.50±0.01	0.78±0.13	2.51±0.17

Note: EBCP is extract of black chokeberry pomace; ECP is extract of cranberry pomace; EBCL is extract of black currant leaves.

The hydrolytic degradation of MSM turkey fat increased over time. However, plant extracts inhibited the process of splitting fatty acids from triglycerides. An increase in concentration led to a more intense inhibition of fat hydrolysis, but the effectiveness of antioxidant drugs was different.

At the end of the storage period, the concentration of the experimental samples ranged from 2.51±0.17 to 0.50±0.01 mg of KOH. The most effective antioxidant at a concentration of 0.3% was black chokeberry extract: the intensity of fat hydrolysis in the EBCK0.3 sample was 0.50±0.01 mg of KOH, which slowed down the first stage of lipid oxidation of turkey MSM by 7.62 times. However, the difference between the effectiveness of black chokeberry extract added to turkey MSM to the content of 0.2% and 0.3% is practically absent. The situation with other antioxidants was similar.

Table 4 presents the results of the peroxide value dynamics during the storage of turkey MSM with plant extracts added to a content of 0.2%.

Table 4

Dynamics of the peroxide value of turkey MSM with 0.2% of plant extracts during the storage, J_2 %

Storage time, weeks	Control	EBCP0.2	ECP0.2	EBCL0.2
0	0.015±0.001	0.015±0.001	0.014±0.001	0.015±0.001
1	0.017±0.010	0.015±0.001	0.017±0.007	0.016±0.001
2	0.029±0.003	0.027±0.001	0.019±0.070	0.019±0.030
3	0.300±0.070	0.039±0.001	0.022±0.001	0.022±0.010
4	0.039±0.001	0.039±0.001	0.023±0.003	0.044±0.010
5	0.063±0.005	0.040±0.001	0.036±0.001	0.061±0.017
6	0.082±0.001	0.043±0.003	0.048±0.001	0.076±0.007
7	0.092±0.030	0.055±0.001	0.050±0.040	0.081±0.030
8	0.097±0.001	0.059±0.003	0.510±0.001	0.086±0.010
9	0.103±0.030	0.060±0.001	0.057±0.001	0.090±0.001

Note: EBCP is extract of black chokeberry pomace; ECP is extract of cranberry pomace; EBCL is extract of black currant leaves.

During the storage of turkey MSM, deep processes of lipid oxidation occur, which is confirmed by a gradual increase in the peroxidation number. Lipid oxidation is a free radical chain reaction that proceeds through the general stages of initiation, propagation, and termination (Kalogianni et al., 2020). However, many secondary and tertiary products formed by free radical reactions are also reactive and covalently react with surrounding components, enhancing the effects of lipid oxidation (Zamora et al., 2016). This leads to the accumulation of peroxide compounds and the growth of peroxide value. Thus, in the control sample without antioxidants, during the storage period, peroxide value increased intensively and at the end of the experimental period reached 0.103±0.030 J_2 %, which is 12.62–44.66 % higher compared to the experimental samples. The addition of black chokeberry and cranberry extracts at a content of 0.2% contributed to the reduction of peroxide value after two months of turkey MSM storage to 0.057–0.060 J_2 %, which almost halved the synthesis of peroxides in the product.

Table 5 presents the results of the peroxide value dynamics during the storage of turkey MSM with plant extracts added to a content of 0.3 %.

Table 5

Dynamics of the peroxide value of turkey MSM with 0.3% of plant extracts during the storage, J_2 %

Storage time, week	Control	EBCP0.3	ECP0.3	EBCL0.3
0	0.015±0.001	0.015±0.00	0.015±0.001	0.015±0.001
1	0.017±0.010	0.015±0.007	0.017±0.001	0.017±0.010
2	0.029±0.003	0.026±0.001	0.020±0.010	0.020±0.010
3	0.300±0.070	0.026±0.003	0.024±0.003	0.023±0.003
4	0.039±0.001	0.030±0.001	0.026±0.001	0.030±0.010
5	0.063±0.005	0.038±0.001	0.033±0.001	0.046±0.070
6	0.082±0.001	0.039±0,01	0.041±0.001	0.059±0.001
7	0.092±0.030	0.049±0,01	0.048±0.030	0.061±0.001
8	0.097±0.001	0.050±0,001	0.054±0.010	0.071±0.010
9	0.103±0.030	0.054±0.010	0.057±0.001	0.083±0.003

Note: EBCP is extract of black chokeberry pomace; ECP is extract of cranberry pomace; EBCL is extract of black currant leaves.

The most effective antioxidant at a content of 0.3% was black chokeberry extract. The content of peroxidation products of turkey MSM lipids at the end of storage was 0.054±0.010 J_2 %, which is by 47.57% lower compared to the control. Cranberry pomace extract at a content 0.3% had practically the same effectiveness.

The peroxide value in sample ECP0.3 after 9 weeks of MSM storage was 0.057±0.001 J_2%, which is by 44.66% lower than in the control sample.

This effect is explained by the presence of flavonoids in black chokeberry and cranberry pomace extracts. It is known that the high content of flavonoids has a powerful antioxidant effect in vitro (North et al., 2019). Flavonoids are able to absorb a wide range of active forms of oxygen, active forms of nitrogen and chlorine, such as superoxide, hydroxyl and peroxyl radicals. Unlike berry extracts, blackcurrant leaves extract contains a low concentration of flavonoids, mainly gallic acid, quercetin glycoside, and kaempferol glycoside (Nowak et al., 2016), which explains its weak antioxidant effect.

The thiobarbituric acid reactive substances value is one of the most commonly used parameters to detect lipid oxidation in meat and meat products (Šojić et al., 2019). Thiobarbituric acid reactive substances values at the end of storage of turkey MSM added with different amounts plant extracts are shown in Figure 2.

The effect of different plant extracts on the content of thiobarbituric acid reactive substances in turkey MSM were statistically significant ($p<0.05$). Accumulation of malonaldehyde, which is formed as a result of peroxide degradation, occurred intensively in turkey MSM without the addition of antioxidants. At the end of the storage period, the content of thiobarbituric acid reactive substances in this sample was 0.94±0.18 MA mg/kg. In experimental samples with plant extracts, the level of secondary lipid oxidation products was significantly lower. It was established that the most effective antioxidants were black chokeberry extract and cranberry extract.The content of thiobarbituric acid reactive substances in turkey MSM with these extracts at the end of the storage period was 0.57-0.61 MA mg/kg, which is 35.10–39.36% lower compared to the control sample. At the same time, the concentration of antioxidants in the range if 0.2–0.3 % practically did not affect the final result.

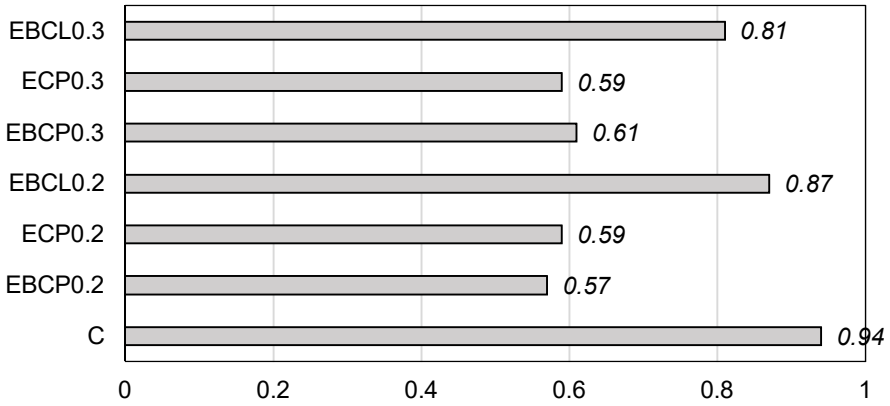

Figure 2. The content of thiobarbituric acid reactive substances in turkey MSM with plant extracts, MA mg/kg: EBCP is extract of black chokeberry pomace; ECP is extract of cranberry pomace; EBCL is extract of black currant leaves; C is control without plant extracts

It is known that the presence of proanthocyanins in black chokeberry and cranberry berries inhibits the formation of secondary lipid oxidation products (Denev et al., 2019). The concentration of substances reacting with thiobarbituric acid in samples with blackcurrant leaves extract was 0.81-0.87 MA mg/kg, which is 7.45–13.83% lower than in the control. This extract had a lower efficiency compared to other drugs, which is confirmed by (Ziobroń et al., 2021).

Conclusions

1. It has been confirmed that the turkey MSM of Ukrainian production meets the regulatory requirements in terms of chemical composition. However, the relatively high content of protein, 14.22±0.97 %, and fat, 17.3±0.64 %, increases the risk of oxidative deterioration of turkey MSM during the sale and frozen storage.
2. It was shown that addition of plant extracts to turkey MSM decreased its oxidative deterioration during the frozen storage.
3. Addition of the extracts from black chokeberry or cranberry pomace slowed down the hydrolytic changes in fats by 81.20 and 76.47%, respectively, which may be explained by the high content of phenolic substances contained in the skin of the berries.
4. During the frozen storage of turkey MSM, deep processes of lipid oxidation occur, which has been confirmed by a gradual increase of the peroxide value. The addition of black chokeberry and cranberry extracts in amount of 0.2% to raw materials contributed to the reduction of peroxide value after two months of storage of turkey MSM to 0.057–0.060 J_2 %, which almost halved the formation of peroxides in the control.
5. It was shown that the level of secondary lipid oxidation products was significantly lower in experimental samples with plant extracts. The most effective antioxidants were black chokeberry and cranberry pomace extracts. The content of thiobarbituric acid reactive substances in turkey MSM with plant extracts at the end of the storage period was 0.57–0.61 MA mg/kg, which was by 35.10–39.36% lower compared to the control sample.

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