ISSN 2664-9969

UDC 664.681
DOI: 10.15587/2706-5448.2024.310427

Alina Tkachenko

STUDY OF ANTIOXIDANT PROPERTIES OF ORGANIC DRIED BLACK MULBERRY

The object of the study is black dried organic mulberry. The subject of research is the antioxidant properties of black dried organic mulberry. The research hypothesis is that due to its antioxidant properties, organic black mulberry can serve as a source for the production of food additives to slow down oxidation processes in fat-containing products.

The study investigated changes in the quality of the fat base for the production of flour confectionery products: butter with sesame oil in a ratio of 80:20 %. Black dried inorganic mulberry was used as a control sample. This made it possible to compare the inhibitory-stabilizing effect on lipids of organic and inorganic raw materials. On the 10th day of storage of the samples, the peroxide number in the fat with the addition of organic mulberry was 1.7 times lower than in the fat base without the addition of stabilizers. The peroxide number in the fat with organic mulberry added was 17.5 ½O mmol/kg. Primary oxidation in the sample with inorganic mulberry also occurred more slowly than in the sample without any additives. On the 10th day of storage, the amount of peroxides was 1.2 times less than the amount of peroxides in the fat base without the addition of mulberry. The fat acid value of black organic dried mulberry added on day 10 was 1.21 mn/KOH, with black inorganic dried mulberry added 1.80 mg/KOH. The sample without added antioxidants had an acid value of 2.12 mg/KOH. The content of ascorbic acid in black dried inorganic and organic mulberries does not differ significantly and is 10.78 and 10.49 mg/100 g, respectively. It has been proven that the content of polyphenolic compounds is 18.2 and 27.2 mg/100 g, respectively, in dried inorganic and organic black mulberries. It is their presence that explains the antioxidant properties of mulberry. Therefore, organic production affects the accumulation of polyphenolic compounds in plants. Polyphenolic compounds have antimicrobial properties, so their higher amount in organic raw materials is dictated by the fact that organic plants must independently fight against microbiological pests without the use of pesticides. Further research will be devoted to the creation of nutritional supplements based on organic black mulberry.

Keywords: *black organic dried mulberry, peroxide number, acid number, ascorbic acid, polyphenolic content, antioxidant properties.*

Received date: 25.06.2024
Accepted date: 23.08.2024
Published date: 29.08.2024

How to cite

Tkachenko, A. (2024). Study of antioxidant properties of organic dried black mulberry. Technology Audit and Production Reserves, 4 (3 (78)), 46–50. https://doi.org/10.15587/2706-5448.2024.310427

1. Introduction

Mulberry belongs to the Morus genus of the Moraceae family and is widely distributed in a variety of climatic and ecological conditions, ranging from tropical to temperate. Moraceae is also known as the mulberry or fig family. This family of flowering plants includes more than twenty-four species and has at least one hundred identified varieties [1]. Mulberry has a very wide economic value. In Fig. 1 shows the industries in which mulberry is used.

The most important use of mulberry worldwide is the production of the silkworm, which feeds exclusively on its leaves. The country with the largest mulberry area is China with approximately 626,000 ha, followed by India with nearly 280,000 ha [2]. Mulberry is also widely used in pharmacy due to its hepatoprotective, neuroprotective, antimicrobial, anti-inflammatory and cancer-protective effects. In the cosmetic industry, mulberry is used for the production of toothpastes, peelings, and gels. Due to the presence of anthocyanins, mulberry can be used as a dye. The study of the chemical composition of mulberry leads to the study of its antioxidant properties. They can be due to the presence of polyphenols, anthocins, catechins and kaempferols in its composition [3].

Scientific sources contain data on the antioxidant properties of black and white mulberries. However, the antioxidant properties of organically grown mulberries are of great interest. The advantages of organic mulberry cultivation are given in [4]. First of all, since mulberry is grown on an industrial scale for the cultivation of mulberry silkworms, the application of chemical fertilizers has a negative effect on the condition of their cocoons. Therefore, there is a trend of increasing organic production of mulberry in the world, which prompts its detailed study.

It should be noted that organic production, according to the law, consists in the complete rejection of the use of GMOs, antibiotics, toxic chemicals and mineral fertilizers. Composting, sheep manure, siderate fertilizers are used as fertilizers for the production of organic mulberry. So, hemp and sesbania are used as siderate fertilizers. In addition, it is a common practice to apply biofertilizers. Some bacteria, such as *Azotobacter chroococcum*, *Azospirillum spp. (A. brasilense,* *A. lipoferum, A. amazonense, A. halopraeferens* and *A. irakense*) are capable of fixing atmospheric nitrogen (biological nitrogen fixation). The bacterium *Bacillus megaterium* dissolves phosphorus and makes it available to plants [4].

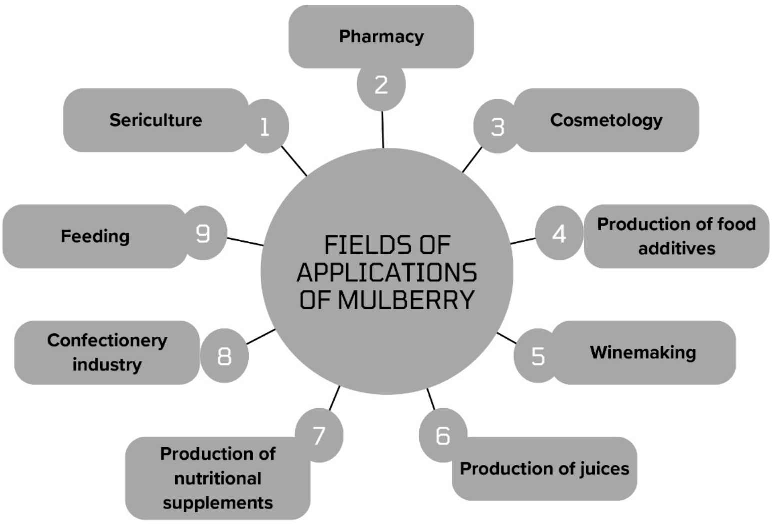

Fig. 1. Fields of using of mulberry

Considering the above, the antioxidant properties of organic mulberry are of scientific interest. The research hypothesis is that organic mulberry has better antioxidant properties than inorganic mulberry and can be used to slow down oxidation in fatty foods.

From a nutritional point of view, mulberry is a very useful product. The physical and chemical composition of black and white mulberry is slightly different. Since the object of our study is black mulberry, in Table 1 provides information on the nutritional value of black mulberry.

As can be seen from the data in Table 1, mulberry does not contain a lot of fat and carbohydrates, but it has a high moisture content.

Data on the content of vitamins and mineral elements are presented in Table 2.

Table 1

Nutritional value of black mulberry fruits [5]

Nutrient	Contents (g/100 g)
Proteins	0.96
Fats	0.95
Carbohydrates	11.75
Humidity	72.96

Table 2

Content of vitamins and mineral elements in black mulberry [6]

Nutrient	Contents (g/100 g)
Calcium	132.00
Magnesium	106.00
Potassium	922.00
Iron	4.20
Ascorbic acid	21.80
Vitamin B1	0.03
Vitamin E	0.87
Vitamin K	0.78

As can be seen from the data in Table 2, black mulberry contains a significant amount of calcium, magnesium and quite a lot of potassium. Mulberry fruits also contain a large amount of ascorbic acid. Since the subject of the study is the study of antioxidant properties, it is the content of ascorbic acid that can have an effect on the ability of mulberry to delay the process of accumulation of peroxides in the fatty base. However, ascorbic acid is heat-labile, so for products undergoing heat treatment, the action of one acid as an antioxidant is not enough. According to research [7], mulberry also contains gallic acid, rutin, catechin, quercetin, kaempferol, and albanol. These substances can also have an effect on antioxidant properties. Research data on white mulberry leaves show that it contains polyphenolic compounds, flavonoids, hydroxycinnamic acids, fatty acids, polysaccharides, α-glucosidase inhibitor – DNJ (1-deoxynoirimycin), etc. [8]. Despite the considerable range of research on the physical and chemical composition of mulberry, its antioxidant properties remain poorly studied.

At the same time, according to the data presented above, mulberry is used for the production of food additives as a dye. But if its antioxidant properties are proven, it can be used for the production of food additives with combined properties. In particular, the use of organic mulberry may be appropriate in the production of organic products, where the use of synthetic food additives is prohibited.

Scientific sources contain data from studies of the antioxidant activity of organic plants. In particular, the source [9] found that organic lemon balm contains a higher amount of polyphenolic substances than inorganic lemon balm. So, the content of polyphenols in ordinary lemon balm is 14.1 mg/g, and in organic – 26.5 mg/g. Research has established that the value of the peroxide number after 10 days of storage was 17 ½O for the sample with the addition of organic lemon balm and 22 ½O for the sample with the addition of ordinary lemon balm.

The study [10] studied the antioxidant properties of organic and inorganic oranges and tomatoes and found that the antioxidant properties of organic products are higher. However, these products show antioxidant properties on the cells of the human body, but cannot be used for the production of food additives that slow down the oxidation of fat-containing products.

Works [11] are devoted to the study of antioxidant properties of plant raw materials. In particular, it was established that carrot powder has a high content of carotenoids – 211.85 mg/100 g, which is 7 times more than apple seed powder. At the same time, apple seed powder contains 1.5 times more α- and β-chlorophylls than carrot powder. Studies of natural additives of rowan and hawthorn fruits, lemon balm leaves, as well as buckthorn grass and common sedum to change the quality of fats used in the production of flour confectionery showed that the components of buckthorn grass and lemon balm leaves showed the highest antioxidant effect. However, these sources mainly consider the antioxidant properties of wild-grown raw materials, and not organic ones.

The above-mentioned review of scientific sources proves the need to study the antioxidant properties of organic mulberry, which in the future can lay the foundation for a new direction in the food industry – the creation of organic food additives.

The aim of research is to study the antioxidant properties of organic dried black mulberry. Taking into account the specified goal, the tasks of the research are:

1. To analyze the changes in the peroxide value of the fat base with and without the addition of organic dried black mulberry during storage.
2. To analyze changes in the acid number of the fatty base with and without the addition of organic dried black mulberry during storage.
3. To determine the amount of ascorbic acid in dried.
4. To analyze the content of polyphenolic compounds of organic dried black mulberry.

2. Materials and Methods

The object of research is organic dried black mulberry (Fig. 2). *The subject of research* is its antioxidant properties.

Fig. 2. Organic dried black mulberry

For a comparative study of antioxidant properties, a mixture of butter was used as a fat base in the proportions shown in Table 3. Organic black mulberry was used in dried form.

Table 3

Characteristics of research samples

Sample No. 1	Fat base for flour confectionery: organic butter + sesame oil 80:20 % + 10 % dried mulberry
Sample No. 2	Fat base for flour confectionery: organic butter + sesame oil 80:20 % + 10 % dried organic mulberry
Sample No. 3	Fat base for flour confectionery: organic butter + sesame oil 80:20 % + 10 % dried organic mulberry

The peroxide and acid numbers of lipids were determined by the titrometric method. Determination of the content of ascorbic acid (vitamin C) is based on the property of ascorbic acid before oxidation into dehydroascorbic acid. 2,6-dichlorophenolindophenol, oxidizing ascorbic acid, is reduced to a colorless compound (leucoform). Determination of the content of polyphenolic substances was determined by the spectrophotometric method by reaction with the Folin-Chocalteu reagent [11, 12].

3. Results and Discussion

Changes in the peroxide value of the fat base (organic butter + organic sesame oil) with the addition of organic and inorganic mulberry and without the addition of any additives for 10 days are shown in Fig. 3.

The data of Fig. 3 indicate a higher antioxidant activity of organic mulberry compared to inorganic. On the 10th day of storage of the samples, the peroxide number in the fat with the addition of organic mulberry was 1.7 times lower. It should be noted that the primary oxidation in the sample with inorganic mulberry also occurred more slowly than in the sample without any additives, however, on the 10th day of storage, the amount of peroxides was 1.2 times less than the amount of peroxides in the fat base without the addition of mulberry. Changes in the acid number are presented in Table 4.

Research data show that the increase in acid number in samples with the addition of organic non-conventional raw materials was slower than with the addition of inorganic non-conventional raw materials. In particular, on the 10th day of storage, the acid number of samples with the addition of organic mulberry was 1.5 times lower than in samples with the addition of inorganic mulberry.

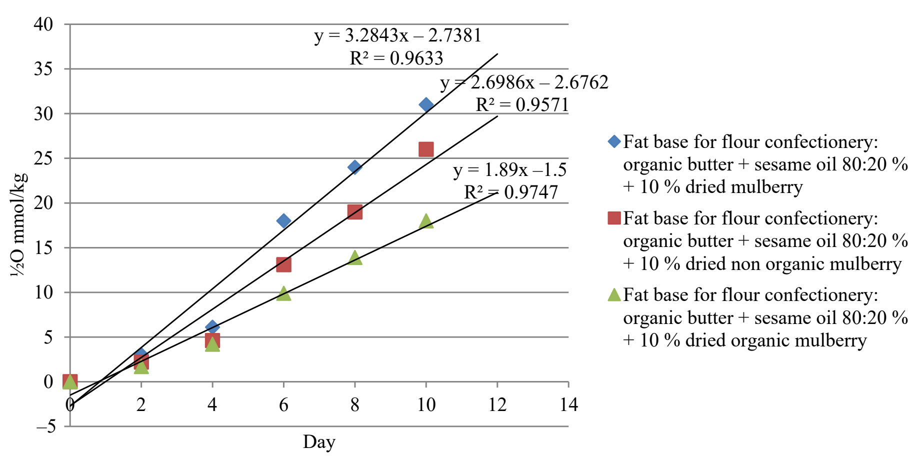

Fig. 3. Changes in the peroxide value of the fat base with the addition of organic and inorganic mulberry during 10 days of storage in a thermostat, ½O mmol/kg, $n=5$, $p<0.5$

Table 4

Study of changes in the acid number of the fatty base

Sample	Day		
	0	5	10
Fat base for flour confectionery: organic butter + sesame oil 80:20 % + 10 % dried mulberry	0.25±0.02	0.65±0.02	1.80±0.01
Fat base for flour confectionery: organic butter + sesame oil 80:20 % + 10 % dried organic mulberry	0.25±0.01	0.45±0.01	1.21±0.03
Fat base for flour confectionery: organic butter + sesame oil 80:20 % + 10 % dried organic mulberry	0.24±0.02	0.90±0.04	2.12±0.02

In a theoretical review of the literature, it was noted that mulberry has a significant content of ascorbic acid. However, as is known, this substance is heat-labile and its quantity may decrease during drying. Therefore, it is possible to investigate the content of ascorbic acid in black organic and inorganic dried mulberries.

Research has established that the content of ascorbic acid in black dried inorganic and organic mulberries does not differ significantly and is 10.78 and 10.49 mg/100 g, respectively.

As mentioned above, the antioxidant effect can be due to the content of polyphenolic substances. The results of the study of their content in organic and inorganic black mulberry are shown in Fig. 4.

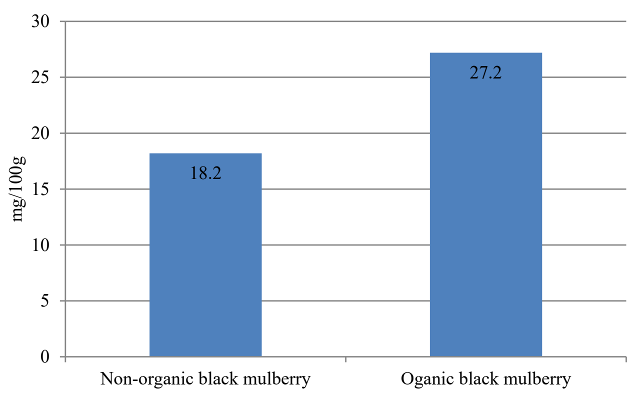

Fig. 4. The content of polyphenolic compounds in organic and inorganic black mulberry

The obtained data indicate high antioxidant properties of dried black mulberry. It has been proven that the content of ascorbic acid decreases significantly during the drying process. Therefore, ascorbic acid does not act as the main antioxidant substance of mulberry. The main substance is polyphenolic substances. Their content in organic black dried mulberry is 27.2 mg/100 g. It has been proven that the content of polyphenolic substances is higher in organic mulberry than in inorganic. This indicates that the method of cultivation affects the amount of polyphenolic compounds.

The strength of the study is that the antioxidant properties of black dried organic mulberry have been proven. These data can serve as a basis for the development of organic nutritional supplements with antioxidant activity based on mulberry.

The weakness of the study is that the content of polyphenolic compounds in organic mulberry was identified only in a general form and their composition was not determined by the chromatographic method.

The prospects for further research are the development of organic food additives based on organic mulberry.

The influence of martial law conditions. Limited access to laboratories, which today are located in the occupied territories, became an obstacle to conducting experimental research during martial law.

The development of the market of organic food products is a promising scientific and practical direction of the food industry. Commodity characteristics of organic raw materials are poorly studied and require detailed experimental studies.

4. Conclusions

In the course of the study, it was shown that on the 10th day of storage of the samples, the peroxide number in the fat with the addition of organic mulberry was 1.7 times lower than in the fat base without the addition of stabilizers. The peroxide number in the fat with the addition of organic mulberry was 17.5 ½O mmol/kg. Primary oxidation in the sample with inorganic mulberry also occurred more slowly than in the sample without any additives. On the 10th day of storage, the amount of peroxides was 1.2 times less than the amount of peroxides in the fat base without the addition of mulberry.

The acid number of fats with the addition of black organic dried mulberry on the 10th day was 1.21 mg KOH, with the addition of black inorganic dried mulberry – 1.80 mg OH. The sample without the addition of antioxidants had an acid value of 2.12 mg/KOH.

The content of ascorbic acid in black dried inorganic and organic mulberries does not differ significantly and is 10.78 and 10.49 mg/100 g, respectively.

It has been proven that the content of polyphenolic compounds is 18.2 and 27.2 mg/100 g, respectively, in black dried inorganic and organic mulberry.

Conflict of interest

The author declares that she has no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

Financing

The research was performed without financial support.

Data availability

The manuscript has no associated data.

Use of artificial intelligence

The author confirms that she did not use artificial intelligence technologies when creating the current work.

References

1. Jan, B., Parveen, R., Zahiruddin, S., Khan, M. U., Mohapatra, S., Ahmad, S. (2021). Nutritional constituents of mulberry and their potential applications in food and pharmaceuticals: A review. *Saudi Journal of Biological Sciences, 28 (7),* 3909–3921. https://doi.org/10.1016/j.sjbs.2021.03.056

ISSN 2664-9969

2. Rohela, G. K., Shukla, P., Muttanna, Kumar, R., Chowdhury, S. R. (2020). Mulberry (*Morus spp.*): An ideal plant for sustainable development. *Trees, Forests and People, 2,* 100011. https://doi.org/10.1016/j.tfp.2020.100011
3. Gungor, N., Sengul, M. (2008). Antioxidant Activity, Total Phenolic Content and Selected Physicochemical Properties of White Mulberry (*Morus AlbaL.*) Fruits. *International Journal of Food Properties, 11 (1),* 44–52. https://doi.org/10.1080/10942910701558652
4. Sakthivel, N., Ravikumar, J., Mukund, V., Bindroo, B., Sivaprasad, B. (2024). Organic farming in mulberry: recent breakthrough. *Technical bulletin*.
5. Ercisli, S., Orhan, E. (2007). Chemical composition of white (*Morus alba*), red (*Morus rubra*) and black (*Morus nigra*) mulberry fruits. *Food Chemistry, 103 (4),* 1380–1384. https://doi.org/10.1016/j.foodchem.2006.10.054
6. Aljane, F., Sdiri, N. (2016). Morphological, phytochemical and antioxidant characteristics of white (*Morus alba L.*), red (*Morus rubra L.*) and black (*Morus nigra L.*) mulberry fruits grown in arid regions of Tunisia. *Journal of new sciences, Agriculture and Biotechnology, 35 (1),* 1940–1947.
7. Bae, S.-H., Suh, H.-J. (2007). Antioxidant activities of five different mulberry cultivars in Korea. *LWT – Food Science and Technology, 40 (6),* 955–962. https://doi.org/10.1016/j.lwt.2006.06.007
8. Grajek, K., Wawro, A., Pieprzyk-Kokocha, D. (2015). Bioactivity of Morus Alba L. Extracts – An Overview. *International Journal of Pharmaceutical Sciences and Research, 6 (8),* 3110–3122.
9. Tkachenko, A. (2023). Comparative study of the antioxidant properties of organic and inorganic melissa. *Technology Audit and Production Reserves, 4 (3 (72)),* 19–23. https://doi.org/10.15587/2706-5448.2023.286687
10. Cruz-Carrión, Á., Ruiz de Azua, Ma. J., Muguerza, B., Mulero, M., Bravo, F. I., Arola-Arnal, A., Suarez, M. (2023). Organic vs. Non-Organic Plant-Based Foods – A Comparative Study on Phenolic Content and Antioxidant Capacity. *Plants, 12 (1),* 183. https://doi.org/10.3390/plants12010183
11. Syrokhman, I. V., Hyrka, O. I. (2008). Vplyv antyokysliuvachiv na zminu yakosti soievoi olii. *Naukovyi visnyk LNUVMBT imeni S. Z. Gzhytskoho, 10 (2 (37)),* 164–166.
12. Gensler, M., Rossmann, A., Schmidt, H.-L. (1995). Detection of Added L-Ascorbic Acid in Fruit Juices by Isotope Ratio Mass Spectrometry. *Journal of Agricultural and Food Chemistry, 43 (10),* 2662–2666. https://doi.org/10.1021/jf00058a020
13. Ibragc, S., Salihovic, M., Tahirovic, I., Toromanovic, J. (2014). Quantification of some phenolic acids in the leaves of *Melissa officinalis L.* from Turkey and Bosnia. *Bull Chem Tech Bosnia Herzegovina, 42,* 47–50.

Alina Tkachenko, *PhD, Associate Professor, Department of Commodity Research, Biotechnology, Examination and Customs, Poltava University of Economics and Trade, Poltava, Ukraine, e-mail: alina_biaf@ukr.net, ORCID: https://orcid.org/0000-0001-5521-3327*