Antioxidant properties of pumpkin seed oil addition to functional drinks

Mamurjon Yangiboyevich Xo‘jjiyevev
mxojjiyev@bk.ru
Feruza Jo‘raqulovna Bozorova
Bukhara State Technical University

Abstract: This article examines the antioxidant properties of pumpkin seed oil when added to plant-based functional beverages. The aim of the study was to determine the effect of adding pumpkin seed oil (at concentrations of 1-5%) on the oxidative stability of beverages during storage. Soy milk- and vegetable oil-based emulsions were used as a model system. Antioxidant activity was assessed using DPPH, peroxide value, and thiobarbituric acid index (TBA). Adding 3% pumpkin seed oil reduced the oxidation rate by 26-31% compared to the control. The greatest increase in tocopherol (34%) and carotenoid (29%) content was recorded with a 3% addition. A metrological control method based on spectrophotometry and chromatography, compliant with international standards, was developed. The obtained data confirm the high potential of pumpkin seed oil as a natural antioxidant in the production of functional beverages.

Keywords: pumpkin seed oil, functional drinks, antioxidants, oxidative stability, tocopherols, DPPH method, peroxide value, TBA index, spectrophotometry, emulsion, plant drinks

Introduction

health drinks - are becoming increasingly popular in the modern food industry. Such products not only perform a nutritional function, but also provide additional benefits, such as strengthening the body's immunity, slowing down the aging process, and preventing cardiovascular diseases.

One of the main problems of functional drinks is the rapid oxidation of the fatty components in their composition. This process spoils the taste, color, and smell of the product and even leads to the formation of toxic compounds (for example, aldehydes). Therefore, the use of natural antioxidants to ensure stability against oxidation is an urgent issue.

Pumpkin seed oil is widely recognized as a rich source of potent natural antioxidants, such as vitamin E (especially γ -tocopherol), phytosterols, polyphenols, and carotenoids. However, its antioxidant effects when added to functional beverages, particularly in emulsified form, have not been sufficiently studied.

The aim of this work is to scientifically evaluate the antioxidant effect of pumpkin seed oil by adding it to functional beverages at different concentrations, as well as to propose practical metrological methods for quality control.

Analysis of scientific works (with examples from European countries)

In European countries, pumpkin seed oil is mainly produced in Austria, Germany and Slovakia as “Styrian pumpkin seed oil” and is recommended for gastroenterological health. Studies conducted by the BOKU University (University of Natural Resources and Life Sciences) in Austria (Rezig et al., 2020) showed that the γ -tocopherol content of pumpkin oil is 4-5 times higher than that of regular sunflower oil.

A research team in Switzerland (Zimmermann & Walczyk, 2022) demonstrated that adding pumpkin seed oil to soy-based emulsions could reduce the TBC index by 28%. Furthermore, a study

in Poland (Kowalska & Nowak, 2021) found that the activity against DPPH radicals reached 76% at a 3% addition.

German Ministry of Food and Agriculture (BMEL) recognized pumpkin seed oil as a "promising natural antioxidant" in its "Natural Antioxidants in Beverages" program published in 2023.

However, most of the work has been conducted only in laboratory conditions, and the adaptation of metrological monitoring systems to practical production has not been sufficiently studied. It is this gap that forms the basis of this study.

Method for evaluating the stability against oxidation by adding pumpkin seed oil to functional beverages.

Execution procedure:

- An emulsion made from soy milk (85% water, 10% soybean oil, 5% emulsifier) was used as the base.
- Pumpkin seed oil was cold pressed, filtered and added to the emulsion at 1%, 2%, 3%, 4%, 5%.
- The samples were stored at 25°C for 21 days.
- levels were measured every 3 days.
- Control sample - emulsion without pumpkin oil.
- Methodology (with examples)
- Activity against DPPH radicals:

Mix with 0.1 mM DPPH solution and measure absorbance at 517 nm.

Result: Radical neutralization activity at 3% addition = 76.4% (control - 48.2%).

Peroxide number (PS):

Method: Titration based on GOST 6673-76.

Result: On day 21, PS in the 3% mixture = 2.8 meq O_2/kg (control - 4.0 meq O_2/kg).

TBK index (malondialdehyde content):

Method: Reaction with thiobarbituric acid, measurement at 532 nm.

Result: When adding 3%, TBK = 0.42 mg MDA/kg (control - 0.61 mg MDA/kg).

Tocopherols content:

Method: HPLC (ISO 9936:2017).

Result: γ -tocopherol = 38.7 mg/100g (control - 28.9 mg/100g).

Spectrophotometric control:

Carotenoids were observed at wavelengths of 450 nm and polyphenols at 765 nm.

Result (percentage gains)

Activity against DPPH radicals: +58%

by peroxide number : -30%

TBK index (oxidation products): -31%

γ -Tocopherol content: +34%

Carotenoid content: +29%

Shelf life of the drink: +7 days (starting time of rancidity)

Organoleptic evaluation (overall expert rating): +22%

Results and discussion

The results of the study showed that 3% pumpkin seed oil added to functional beverages had the highest antioxidant effect. Lower amounts (1-2%) did not have a sufficient effect, while higher amounts (4-5%) worsened the organoleptic properties of the beverage (off-flavor and oily feel).

The DPPH and TBK results provided complementary information: pumpkin seed oil slows down lipid peroxidation by neutralizing free radicals, which increases the safety and consumer quality of the product.

The metrological control system - a combination of spectrophotometry and HPLC - is based on standardized methods that are easy to use even for industrial enterprises. This will also allow Uzbekistan to export functional beverages.

Conclusion

Pumpkin seed oil acts as a powerful natural antioxidant when added to functional drinks. 3% is recommended as the optimal concentration. This additive not only increases the oxidation resistance of the product, but also enriches its biological value. The developed metrological methodology meets international requirements and can be used in practical production. In the future, the production and export of such drinks under the "healthy nutrition" brand is promising.

References

1. Rezig, L., et al. (2020). Pumpkin seed oil: A rich source of g -tocopherols and phytosterols. Journal of Functional Foods, 64, 103689. https://doi.org/10.1016/j.jff.2019.103689

2. Zimmermann, BF, & Walczyk, R. (2022). Antioxidant capacity of pumpkin seed oil in plant-based emulsions. European Food Research and Technology, 248(4), 1125-1134. https://doi.org/10.1007/s00217-021-03942-8

3. Kowalska, K., & Nowak, J. (2021). Effect of pumpkin seed oil on oxidative stability of soy-based beverages. Journal of Food Science and Technology, 58(9), 3456-3463. https://doi.org/10.1007/s13197-020-04912-5

4. EFSA Panel on Dietetic Products (2023). Scientific opinion on the use of natural antioxidants in functional beverages. EFSA Journal, 21(2), e07741. https://doi.org/10.2903/j.efsa.2023.7741

5. GOST 6673-76. Masla rastitelnye. Method of determination of perekisnogo chisla.

6. ISO 9936:2017. Animal and vegetable fats and oils - Determination of tocopherol and tocotrienol contents.

7. Brand-Williams, W., et al. (1995). Use of a free radical method to evaluate antioxidant activity. LWT - Food Science and Technology, 28(1), 25-30. https://doi.org/10.1016/S0023-6438(95)80008-5

8. UzDST 3198:2020. Functional food products. General technical requirements.