INVESTIGATION OF THE INFLUENCE OF SESAME ANTIOXIDANTS ON THE OXIDATIVE STABILITY OF PROVITAMIN A

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Abstract: Microbiological oil solutions of provitamin A (β-carotene) as a dietary supplement are not widely used due to their low oxidation stability. The aim of research is determination of the effect of sesame antioxidants on the oxidative stability of provitamin A in oil solutions.

The peroxide number of vegeTable oils is determined by the standard method by the titrimetric method. The value of the period of induction of oil oxidation is determined graphically from the growth curves of peroxide numbers. The content of tocopherols in oils is determined by spectrophotometric method. The content of sesamol and sesamoline in oils is determined by the colorimetric method. The oxidative stability of oils is determined using the accelerated "active oxygen" method.

To plan the experiment and process the data, mathematical methods are applied using the software Microsoft Office Excel 2003.

The oxidation stability of blended oils (a mixture of sesame, high oleic, sunflower and corn refined oils) and its components is investigated. Blended oil has a lower oxidative stability than sesame oil, but higher than corn and high oleic sunflower. The oxidative stability of the blend is enhanced by the antioxidant content of sesamol and sesamoline. The content of the above antioxidants, as well as the amount of tocopherols, is studied in blended oils. The oxidation stability of the obtained solution of provitamin A in blended oils is investigated. The period of induction of oxidation of blended oils with the addition of 0.2 % β-carotene increases by 1.3 times compared with the period of induction of the original blended oil. Blended long-life oil is recommended to be used to stabilize fat-soluble biologically active compounds.

Keywords: sesame oil, sesamol, sesamoline, blended oil, β-carotene, oxidative degradation, oxidative stability.

1. Introduction

The use of β-carotene in food products allows to improve their organoleptic properties, increase biological value, maintain quality during long-term storage, and expand the range of products [1]. On an industrial scale, provitamin A (β-carotene) is most often obtained by chemical and microbiological synthesis [2, 3]. The competitiveness of β-carotene depends on the methods of its isolation and purification [4, 5]. β-carotene, having high biological activity, is prone to oxidative damage in a short time, as a result of which it loses its biological activity [6]. Microbiological β-carotene solutions in domestic oils due to low consumer characteristics, primarily high oxidation ability, are not widely used in the enrichment of oil and fat products [7]. As oil bases for β-carotene, oil is promising, which, through its characteristics, is resistant to oxidative damage. In industry, sunflower and corn oils are used for this purpose [5, 8]. Thus, the development of methods for stabilizing β-carotene solutions from oxidative damage opens up wide opportunities for expanding its scope and increasing industrial production. In previous studies [9, 10], the composition of blended oils with an extended shelf life was justified, which is a mixture of sesame (50 %), high oleic sunflower (20 %) and corn (30 %) refined oils. This blended oil is designed to reduce cost compared to pure sesame oil and at the same time maintain its oxidative stability at a level similar to sesame oil. It is advisable to use such a blend as a basis for fat-soluble biologically active substances prone to oxidative degradation.

The aim of this research is determination of the effect of sesame antioxidants on the oxidative stability of provitamin A in oil solutions.

To achieve this aim it is necessary to solve the following tasks:

1. Investigate the oxidation stability of blended oil and its components.

2. Investigate the content of antioxidants in blended oils.

3 Investigate the oxidation stability of a solution of provitamin A (β-carotene) in blended oil.

2. Methods

Resistance to oxidative spoilage of selected oil mixtures using the "active oxygen" method according to the magnitude of the induction period of the sample, oxidizing at a temperature of 85±1 °C. β-carotene was dissolved with a 30 % oil suspension in an amount of 0.2 % in terms of β-carotene and samples were oxidized at a temperature of 85±1 °C. A 0.2 % solution of β-carotene in refined sunflower oil was used as a control.

Determination of the peroxide value (PV) of oils was done using the titrimetric method. The value of the induction period was determined graphically from the growth curves of peroxide numbers. The oxidation of the oils to PV 10 mmol ½ O/kg was done, given the inappropriate further oxidation. The content of tocopherol in vegetable oils was carried out by the photometric method.

Analysis of oils containing sesamol and sesamoline included the extraction of sesamol from the oil with an alkaline solution. At the next stage, a colorimetric reaction with sulfuric acid in the presence of furfural is used to determine sesamol (a purple-colored product of the colorimetric reaction is formed) in an alkaline extract and sesamoline in an oil solution. Then the absorption spectrum of the oil solution was measured in the range of 255–320 nm to determine the content of sesamoline, it does not give a purple-colored product of colorimetric reaction with the indicated reagents.

The experiments on the oxidation of oil samples (initial blended and with the addition of β-carotene, control samples) were carried out in three parallels. The research results were processed using methods of mathematical statistics: determination of the relative error with a confidence probability of P=95 %. To plan the experiment and process the data, mathematical methods were applied using the software Microsoft Office Excel 2003 (USA).

3. Results

The research results of the oxidative stability of blended oils with a long shelf life and its components are separately shown in **Fig. 1.**

While the PV of corn and high-oleic sunflower oils reached 10 mmol ½ O/kg already at 220±6 and 270±8 minutes of oxidation, respectively, the PV of blended oils reached 10 mmol ½ O/kg by 465±14, and sesame – at 700±20 minutes, respectively. As can be seen from the histogram (**Fig. 1**), in the first 180 minutes of oxidation, an increase in the PV of sesame and blended oils is almost not observed. From 180±5 to 240±7 minutes of oxidation, the content of peroxides in these oils increases (PV varies from 1.7 to 2.6 mmol ½ O/kg for sesame and from 2.2 to 3.1 mmol ½ O/kg for blended). Then (from 240±7 to 450±13 minutes of oxidation for sesame and from 240±7 to 300±9 minutes for blended), the accumulation of peroxides in the studied oils is again stopped (the PV increases from 2.6 to 3.8 mmol ½ O/kg for sesame seeds and from 3.1 to 3.5 mmol ½ O/kg for blended). Further, blended oil is oxidized like corn and high oleic sunflower, and sesame oil has a second (last) threshold for reducing peroxide accumulation – from 510±10 to 600±10 minutes of oxidation (PV increases from 5 to 5.9 mmol ½ O/kg).

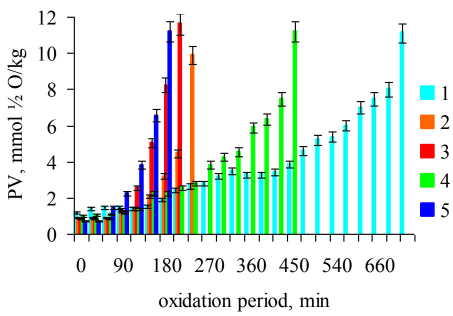

Fig. 1. Dynamics of accelerated oxidation:
1 – sesame oil, 2 – high oleic sunflower oil, 3 – corn oil,
4 – blended oil, 5 – refined sunflower oil (control)

The content of antioxidants in blended oils is studied (**Table 1**).

Table 1
The content of antioxidants in blended oils

Antioxidants	Content
amount of tocopherols, mg %	84,0±0,85
sesamol, %	0,0050±0,0005
sesamoline, %	0,42±0,03

Blended oil of developed composition is used as an oil base for provitamin A (β-carotene) of microbiological origin. It is important to note that natural antioxidants, compared with synthetic ones, are not only safe to consume, but also increase the biological value of stabilized products [11, 12]. **Fig. 2** graphically shows the dynamics of oxidation of oil samples at a temperature of 85±1 °C with the addition of 0.2 % β-carotene compared to control samples.

As can be seen from the histogram (**Fig. 2**), while the PV of refined sunflower oil reached 10 mmol ½ O/kg at 195±6 minutes of oxidation, the PV of refined sunflower oil with 0.2 % β-carotene supplementation is 180±5 minutes. That is, studies have shown that the addition of β-carotene does not increase the induction period of sunflower oil, selected as a control. The PV of blended oils with the addition of β-carotene 0.2 % reaches 10 mmol ½ O/kg at 540±16 minutes of oxidation, and the source of blended oils at 465±14 minutes. Moreover, in the first 150±4 minutes of oxidation, an increase in the PV of the initial blended oil and from blended oil with the addition of 0.2 % β-carotene is almost not observed. From 150±4 to 180±5 minutes of oxidation, the content of peroxides in oils increases (PV increases from 1.4 to 1.7 mmol ½ O/kg in the initial blended oil and from 1.4 to 1.6 mmol ½ O/kg in blended oils with the addition of 0.2 % β-carotene). While from 180±5 for 420±12 minutes of oxidation, the accumulation of peroxides in blended oils with the addition of 0.2 % β-carotene again stops (PV increases from 1.6 to 3.9 mmol ½ O/kg). After this oxidation of blended oil with the addition of β-carotene flows similarly to control samples.

4. Discussion and conclusions

Histogram in **Fig. 1** shows an increase in the oxidative stability of blended oils based on high-oleic sunflower and corn oils compared to pure high oleic sunflower and corn oils. Sesame oil has a higher oxidative stability than blended. The results of these studies indicate a marked increase in the shelf life of blended oil compared to the control – refined sunflower oil, which is usually used as the base for β-carotene solutions. As can be seen from the study of the antioxidant composition of the blend (**Table 1**), this is explained by the fact that tocopherols and specific antioxidants of sesame oil – sesamol and sesamoline – participate in the inhibition of oxidative damage to blended oils.

As can be seen in the histogram (**Fig. 2**), the induction period of oxidation of blended oils with the addition of 0.2 % β-carotene increases by 1.3 times compared with the initial blended oil. At the same time, the induction period of refined sunflower oil (the classic oil base for β-carotene, which is used in the production of this food supplement) is equal to the induction period of refined sunflower oil with β-carotene. That is, β-carotene does not exhibit antioxidant activity in sunflower oil. Studies have shown that the effects of sesamol, sesamoline and β-carotene on the inhibition of oxidative damage of triglycerides are non-additive.

The test results of blended oil makes it possible to recommend it for the production of long-term storage products, in particular, provitamin A concentrates (β-carotene). The obtained research results are planned to be used to find ways to increase the shelf life of other fat-soluble biologically active compounds and food additives of domestic production, in particular chlorophyll (E 140) and lycopene (E 160 d).

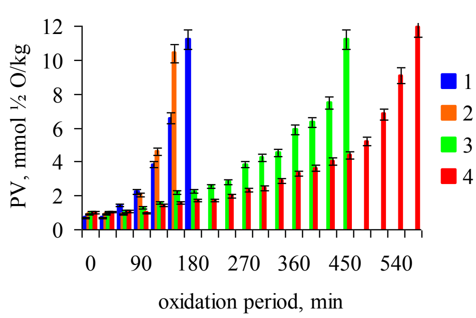

Fig. 2. Dynamics of accelerated oxidation: 1 – refined sunflower oil, 2 – refined sunflower oil with the addition of β-carotene 0.2 %; 3 – blended oil, 4 – blended oil with the addition of β-carotene 0.2 %

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