# A STUDY ON OXIDATIVE STABILITY OF VEGETABLE OIL BLENDS WITH OPTIMAL RATIO OF POLYUNSATURATED FATTY ACIDS

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**Abstract:** The characteristic of optimal fatty acid composition of vegetable oils is their balance by the ratio of polyunsaturated (essential) fatty acids, primarily linoleic and α-linolenic, referring respectively to the groups of ω-6 and ω-3. In accordance with the recommendations of physicians, the optimum ratio of ω-6 and ω-3 fatty acids is 5-10:1. There were elaborated recipes on the basis of which the vegetable oil blends with a specified ratio of ω-6 and ω-3 fatty acids were made from sunflower and corn oils with the addition of soy, rapeseed, linseed and grape oils with regard to the actual content of these acids. There was investigated the oxidation stability of the initial vegetable oils and their blends during storage in different conditions.
**Key words:** polyunsaturated fatty acids, optimal ratio

The characteristic of optimal fatty acid composition of vegetable oils is their balance by the ratio of polyunsaturated fatty acids, primarily linoleic and α-linolenic, referring respectively to the groups of ω-6 and ω-3. These acids are essential as they are not synthesized in the body and so must come from foods.

Polyunsaturated fatty acids are the building blocks of cell membranes and ensure the normal development and adaptation of the human organism to adverse environmental factors.

In the absence of essential fatty acid the growth of the organism stops, and some severe diseases may experience. Not only to the total essential fatty acids content is important in the human diet, but also their relationship. In accordance with the recommendations of [1], the optimum ratio of ω-6: ω-3 is from 5:1 to 10:1.

If these acids are not in the optimal ratio, they are poorly absorbed by the body and there is no full metabolism of prostaglandins - hormone-like molecules that are very important for the regulation of body processes.

Nearly all vegetable oils contain fatty acids of ω-6 group. The main source of ω-3 fatty acids are fatty fish and some seafood. As for the oils, the presence of ω-3 fatty acids is characteristic for linseed, soybean oil and also for oil from the seeds of crucifers. Sunflower oil, which is the most-used in the Republic of Moldova, does not contain such acids.

One of the areas of creating fat-based foods with balanced ratio of ω-6 and ω-3 fatty acids is obtaining vegetable oil blends and their subsequent use directly for food products manufacturing, and also as a fat basis for emulsion products (mayonnaise, sauces, etc.) [2].

In drawing up such a vegetable oil blends the recipe quantity of each of the used oils can be calculated by dint of criss-cross rule on the basis of the specific content of ω-6 and ω-3 fatty acids.

With regard to the actual content of linoleic and α-linolenic acids vegetable oil blends were calculated and made from sunflower and corn oils with addition of soybean,

rapeseed, linseed and grape seed oils, with the required ratio of ω-6 and ω-3 fatty acids (Table 1).

In aim to study the oxidative stability of oil blends there was investigated the change of peroxide and acid values in initial oils and created oil blends during storage in the refrigerator and in the non-regulated temperature conditions - at room temperature.

The data regarding the changes of the main indicator of oxidative damage - peroxide value during refrigerator storage of oils are shown in Fig. 1. Analysis of the data shows that some vegetable oils are stable when stored under these conditions, peroxide value after one year of storage does not exceed the storage limit values – 10 milliequivalents of active oxygen/kg oil for refined oils and 15 milliequivalents – for cold-pressed oils (olive oil). Exception – is refined sunflower oil in which after one year of storage peroxide value is 2.4 times higher than the maximum allowable.

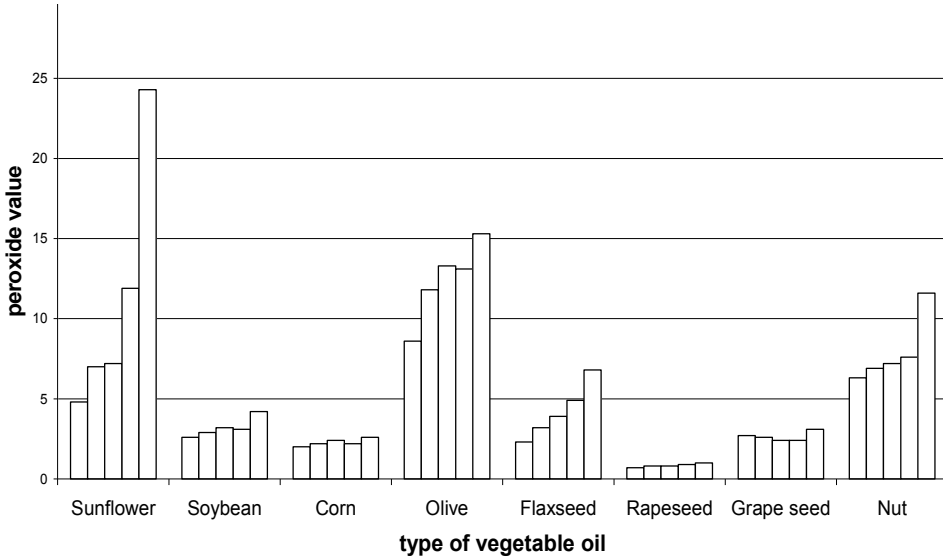


***Fig. 1*** Changes in peroxide value of vegetable oils during refrigerator storage

A great majority of the studied blends of vegetable oils are stable when stored – Fig. 2.

Exception – Blend 6 (sunflower, olive and canola), in which peroxide value after 9 months of storage increased by 8 times compared to the initial. Blends of sunflower and linseed oils also are not stable.

It is known that the oxidation stability of vegetable oils is due to the reactivity of the oxidizing agent (fatty-acid composition), to the presence of the inhibitor (tocopherols and other antioxidants) and to the oxidation initiators (peroxides, secondary oxidation products, transition metals, etc.). The latter compounds lead to an increase in the rate of oxidation [3].

***Table 1.*** Vegetable oil blends with optimal ratio of polyunsaturated fatty acids ω-6 and ω-3

| № oil blend | Composition | | Ratio between ω-3 and ω-6 |
|---|---|---|---|
| | Vegetable oils | Proportion, % | |
| 1 | Sunflower<br>Flaxseed | 89<br>11 | 1:9,2 |
| 2 | Sunflower<br>Flaxseed | 80<br>20 | 1:4,8 |
| 3 | Sunflower<br>Rapeseed | 62,5<br>37,5 | 1:9,9 |
| 4 | Sunflower<br>Soybean | 35<br>65 | 1:10,9 |
| 5 | Sunflower<br>Rapeseed<br>Soybean | 48<br>16<br>36 | 1:10 |
| 6 | Sunflower<br>Olive<br>Rapeseed | 59<br>6<br>35 | 1:10 |
| 7 | Sunflower<br>Grape seed<br>Rapeseed | 50<br>15<br>35 | 1:10,1 |
| 8 | Corn<br>Rapeseed | 69<br>31 | 1:9,6 |
| 9 | Corn<br>Flaxseed | 83,3<br>16,7 | 1:4,8 |
| 10 | Corn<br>Soybean | 40<br>60 | 1:10,5 |

Content of tocopherols in vegetable oils resistant to oxidation - soybean, corn and canola oils is respectively mg/kg: 600-3370, 330-3720, 430-2680. In sunflower oil the content of tocopherols is below – 509-741 mg / kg [4].

In the olive oil the tocopherols content is at sunflower oil's level – 414-663 mg/kg, but it contains 2-3 times more oleic acid, which reduces the rate of oxidation [5].

In grape oil the tocopherols content is also small - 240-410 mg/kg, but this oil is the most resistant oil to oxidation. It can be explained by the fact that from the total tocopherols content 55-77% relates to tocotrienols - the strongest natural antioxidants, which are 40-60 times stronger than tocopherol [6]. So, both grape oil and its blends are stable.

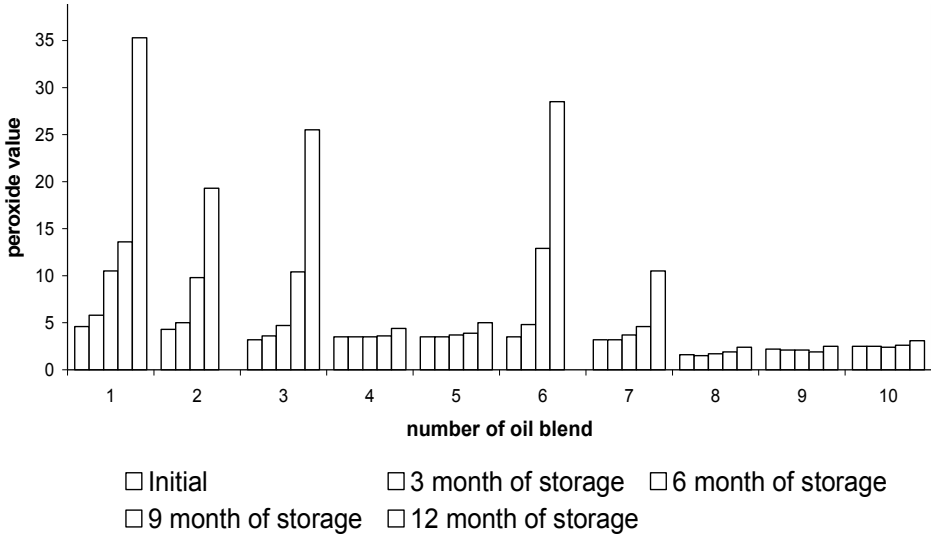


***Fig. 2*** Changes in peroxide value of vegetable oil blends during refrigerator storage

High stability is characteristic for vegetable oil blends based on corn oil, but not only with addition of soybean or canola oil, but also with linseed oil. This can be explained by the presence of tocotrienols in corn oil whose content can reach up to 700 mg/kg [4].

In another series of experiments there was investigated the oxidative stability of several oil blends stored at room temperature (Table 2). The obtained data suggest the high rate of oxidation of the oil blends based on sunflower oil. Blends based on corn oil are short-term stable; however, the duration of storage before reaching the limit peroxide value does not exceed 3 months.

***Table 2.*** Changes in peroxide value of vegetable oil blends (during room-temperature storage)

| **Composition of oil blend** | **Peroxide value** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Initial** | **During storage, weeks** | | | | | |
| | | **2** | **4** | **6** | **8** | **10** | **12** |
| Sunflower Flaxseed | 6,8 | 8,0 | 8,9 | 11,6 | 13,5 | 14,7 | 15,6 |
| Sunflower Rapeseed | 3,9 | 4,5 | 4,7 | 5,8 | 8,3 | 13,7 | 18,8 |
| Corn Flaxseed | 3,0 | 3,3 | 3,7 | 4,2 | 5,6 | 8,0 | 14,4 |
| Corn Soybean | 3,0 | 3,4 | 3,5 | 3,7 | 4,0 | 5,3 | 8,9 |

In all studies, the objects are determined as acid value at the beginning and at the end of storage. This index practically has not changed during the studied methods and duration of storage. The acid values in all oil blends ranged between 0.2-0.5 mg KOH/g oil, which didn't exceed the limit value for refined oil – 0.6 mg KOH/g oil.

The results of the research can be used to justify the methods and shelf life of the vegetable oils blends with optimal ratio of polyunsaturated fatty acids.

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