QUALITY AND SAFETY OF NEW BLENDED OILS

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Abstract. The article characterizes the peanut (Arachis hypogaea) as an oilseed crop widely spread in the world. It describes its biological value as well as the chemical and fatty acid composition. The study proves the practical importance of developing and introducing new blended functional purpose oils for Ukrainian people. It has been shown that blended oils contain significant amounts of monounsaturated and polyunsaturated fatty acids. The use of blended oils will correct the deficiency of essential fatty acids in the diet of our country’s population. It has been pointed out how promising it is to create new types of blended oils, with a balanced fatty acid composition, by combining peanut and linseed oils. The article describes the characteristics of the new blended peanut-linseed oils with additives made from vegetable raw materials. The evaluated parameters are the quality and safety of the new blended peanut-linseed oils with a garlic extract, rosehip extract, sorrel leaf extract, and black currant leaf extract. The fatty acid composition of the fat in the new blended oils has been studied to determine their quality. The safety assessment of the new oils with the additives from vegetable raw materials has been determined by the content of pesticides (HCH-gamma isomer, heptachlor, and DDT), mycotoxins ( aflatoxin B1 and zearalenone), toxic elements (lead, cadmium, arsenic, mercury, and zinc), iron, and radionuclides (cesium-137 and strontium-90). The results obtained confirm that the new blended oils are safe. The blended oils have a high biological value when the ratio of Ω-6 to Ω-3 fatty acids is 4.9:1, and the ratio of monounsaturated fatty acids to polyunsaturated fatty acids is 1:1, which meets the standards of healthy nutrition. In terms of chemical and radiation safety, the new oils do not exceed the maximum permissible concentrations, confirming the safety of the newly developed oils.

Keywords: peanut, peanut oil, linseed oil, blended oils, fatty acid composition, safety.

Introduction. Formulation of the problem

In today’s world, there is an acute shortage of complete proteins, polyunsaturated fatty acids, vitamins, minerals, dietary fibre, and other nutrients. Balancing nutrients and vitamins in people’s diet is one of the most pressing problems in the third millennium. A source of these substances is nuts. However, their potential has not been fully used yet to produce healthy food. A promising raw material to expand the range of such products is the peanut. The most important component of the peanut as for its nutritional value is oil. In its content, the prevailing substances are unsaturated acids, which makes this nut an important product to fight against atherosclerosis and other cardiovascular diseases, as it helps reduce the level of excess cholesterol in the blood. Peanut proteins are characterized by a high content of essential amino acids, which brings them similar to animal proteins. The peanut is a source of vitamins and minerals that have a positive effect on the activity of the nervous system, heart, liver, and other organs, and accelerate cell growth [1,2].

There are a lot of technologies for peanut products: confectionery, peanut oil, snacks. Peanuts are also used as a multifunctional supplement in bakery products, lactose-free dairy drinks, cheese products, dairy desserts, and condensed dairy products. However, the creation of polyfunctional peanut products in Ukraine is rather limited. There are no directions for the rational use of peanuts in certain technologies of the food industry that would take into account its varietal properties and the specific features...
of its chemical composition. Solving this problem will help expand the range of domestic healthy foods using peanuts and increase, by the rational use of raw materials, the economic efficiency of its processing for nutritional purposes.

**Analysis of recent research and publications**

Peanuts are grown around the world primarily as an oilseed crop. Peanut fat contains about 20% of saturated fatty acids and 80% of unsaturated fatty acids, of which oleic and linoleic are the largest fractions. Proteins contained in peanut kernels are globulins, namely arachine and conarachine, and glutelins [1,2]. The biological value of protein products is due to the content of essential amino acids, which are essential for human activity but cannot be synthesized by the body itself. The vitamin composition of peanuts is characterized by the presence of vitamin E and B vitamins. Their average quantitative content is: E – 6.93 mg/100 g, B1 – 0.438 mg/100 g, B2 – 0.098 mg/100 g, B3 – 13.5 mg/100 g, B5 – 1.4 mg/100 g, B6 – 0.256 mg/100 g, and B8 – 145 mg/100 g. This makes peanuts an important product in the struggle against atherosclerosis, cardiovascular diseases, and high cholesterol in the blood [1,2].

Due to the rich chemical composition, peanut kernels are widely used in various industries for the production of both conventional and health-improving food. Worldwide, about 40% of the peanut is processed into so-called peanut butter, 20% is used in confectionery, 10% is for peanut oil, 10% is for snack products, and the rest is for other peanut-based products.

More than one hundred peanut butter formulations have been developed and patented; they include, in particular, the known method of making oil (USA) that is non-allergenic due to a significant reduction or complete elimination of allergenic peanut proteins [3].

Chinese scientists are also working on formulations of this product. One of their formulations includes peanut kernels, garlic, hot pepper, and salt. The obtained peanut oil is rich in nutrients; it has a spicy taste and long shelf life [4].

Peanut oil is widely used in cosmetology, medicine, and food industry, which testifies to its useful properties. Unrefined peanut oil is obtained by extraction, by cold pressing of peanut pulp or fermented peanut flour. It has a colour ranging from light yellow to red brown, rich sweet aroma, distinct nutty taste, and it is a very popular and traditional ingredient in the exotic Indian, Japanese, Chinese, Korean, and Thai cuisines [5].

Refined peanut oil, which is, unlike unrefined, light yellow in colour, has a less distinct taste and aroma, and is the most popular in American and European cooking. It is often used by vegetarians because of its rich chemical composition and high energy value. It is best to use peanut oil in salads, hot vegetable dishes, meat sauces, and pancakes with fruit fillings. If refined peanut oil is used in deep frying, it does not smoke and allows you to reduce the amount of the oil twice.

Peanut oil is also blended with various vegetable oils; the components added are milk, medicinal herb concentrates (including roots of red sage, garden angelica, and lufta). Enriching peanut oil with vitamins and minerals enhances its biological value and oxidative stability [6].

Many scientists have studied the chemical composition of the peanut. Of particular interest is the study of the fatty acid composition of its fat. Musa Özcan and Serap Seven studied the peanut varieties ÇOM and NC-7 from Turkey. The fatty acid composition of fat was investigated, and the following fatty acids were identified and quantified in it: myristic (0.13–0.23%), palmitic (8.70–13.13%), palmitoleic (0.23–0.47%), stearic (3.77–4.53%), oleic (43.13–55.10%), linoleic (25.13–35.20%), linolenic (0.20–0.30%), arachidonic (1.53–1.90%), gadoleic (0.40–1.37%), and behenic (2.40–3.47%) [2].

The Argentine scientist N.R. Grosso with co-authors also studied the fatty acid composition of peanut fat from the Uruguay varieties 1Uv, 2Uv, 5Uv, 6Uv, 7Uv, 8Uv, and 9Uv. 7Uv was found to be characterized by a higher content of oleic acid (42.53%), whereas 2Uv and 5Uv contained higher percentages of linoleic acid (43.67% and 43.40%, respectively). The content of other acids was as follows: palmitic – 9.33–10.43%, behenic – 2.23–3.40%, stearic – 2.33–2.60%, and arachidonic – 1.0–1.17% [6,7].

Studies of the peanut fat of varieties from Nigeria (Boro Red, Boro Light, Mokwa, Ela, Campala, and Guta) have shown a rather high concentration of oleic and linoleic acids in it [8].

A group of authors [9,10] investigated new varieties of peanuts in Mexico (Col-24-Gro, Col-61-Gto, VA-81-B, Ranferi Díaz, NC-2, and Florunner) and found that the peanuts contained 50–55% of fat, in which the total amount of saturated and unsaturated fatty acids was, on average, 17% and 79%, respectively; the latter contained approximately 30% of linoleic acid and 45% of oleic acid.

The analysis of the above sources indicates that peanut oil contains very little linolenic acid (ω-3). Linseed oil is the best source of this fatty acid.

One of the modern trends in the oil and fat industry is blending of oils in order to obtain optimized fatty acid compositions.

In the Kharkiv State University of Food Technology and Trade, mathematical modelling has helped determine that to produce blended oil with an optimized fatty acid composition, the required ratio of oils (wt. %) is 86% of peanut and 14% of linseed oil.

A significant drawback of polysaturated fatty acids ω-3 and ω-6 is an extreme tendency for...
oxidation. Maintaining the quality of the blend implies protecting the lipids from oxidation, as it produces substances that not only impair the quality of the oil, but can also be detrimental to human health. In this regard, the achievement of oxidative stability of oils is necessary and highly important.

To prevent oxidation, antioxidants are widely used; the mechanism of their action consists in breaking the molecular chains of the reaction. Based on the literature and previous experimental studies, extracts of sage leaves, black currant leaves, garlic, and rosehips were selected as inhibitors. The choice of these plant raw materials is due to their unique chemical composition and known antioxidant properties.

To stabilize the developed blend, the oil extracts of sage leaves, black currant leaves, garlic, and rosehips were added in the amount of 5% to the weight of the blend, which made it possible to increase its oxidation stability 1.2–1.7 times. The ratio $\omega-6: \omega-3$ fatty acids in the new blends is 4.9:1, and MUFA:s:PUFA:s is 1:1, which meets the standards of healthy nutrition [11,12].

The purpose of the present study was to determine the quality and safety of the new blended oils.

To determine the quality of the blended oils, the first objective was to study the fatty acid composition of their fat.

To determine the safety of the blended oils, the objective of our tests was to determine the content of pesticides (HCH-gamma isomer, heptachlor, and DDT), mycotoxins (aflatoxin B$_1$ and zearalenone), toxic elements (lead, cadmium, arsenic, mercury, and copper), iron, and radionuclides (cesium-137 and strontium-90).

### Results of the research and their discussion

The basic criterion of the nutritional value of the oils developed is their fatty acid composition given in Table 1. The results on the content of toxic elements, pesticides, mycotoxins, and radionuclides are given in Table 2.

#### Table 1 – The fatty acid composition of the fat of the blended peanut oils (n = 3, P ≥ 0.95, and ε ≤ 10)

<table>
<thead>
<tr>
<th>Fatty acid</th>
<th>Peanut linseed oil with an extract of</th>
<th>Saturated fatty acids, g/100 g</th>
<th>Monounsaturated fatty acids, g/100 g</th>
<th>Polysaturated fatty acids, g/100 g</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>garlic</td>
<td>rosehips</td>
<td>sorrel leaves</td>
<td>black currant leaves</td>
</tr>
<tr>
<td>myristic</td>
<td>0.58</td>
<td>0.38</td>
<td>0.33</td>
<td>0.34</td>
</tr>
<tr>
<td>palmitic</td>
<td>4.63</td>
<td>4.52</td>
<td>4.91</td>
<td>4.80</td>
</tr>
<tr>
<td>stearic</td>
<td>2.42</td>
<td>2.90</td>
<td>2.39</td>
<td>2.62</td>
</tr>
<tr>
<td>lauric</td>
<td>0.23</td>
<td>0.24</td>
<td>0.18</td>
<td>0.17</td>
</tr>
<tr>
<td>behenic</td>
<td>0.04</td>
<td>0.06</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>arachidic</td>
<td>0.05</td>
<td>0.05</td>
<td>0.08</td>
<td>0.07</td>
</tr>
<tr>
<td>Total</td>
<td>7.95</td>
<td>8.15</td>
<td>7.92</td>
<td>8.05</td>
</tr>
</tbody>
</table>
The new blended oils are characterized by a low content of fatty acids of a low molecular weight, which is 7.92–8.15 g/100 g of the oil. MUFAs are represented by oleic (44.93–45.60 g/100 g) and palmitoleic (0.2–0.42 g/100 g) acids. A small amount of erucic acid was found in the content ranging from 0.03–0.04 g/100 g. PUFAs were presented by linoleic (35.83–36.72 g/100 g) and linolenic (7.3–7.43 g/100 g) acids. The total content of unsaturated acids in the blended oils is 88.63–89.76%, of which PUFAs are 43.13–44.15%, with the ratio of ω-6:ω-3=4:9.1 and the ratio of MUFAs:PUFAs=1:1, which meets the standards of healthy nutrition.

Of the monounsaturated acids, the composition of fat in the blends studied also contains palmitoleic acid. In the largest amount (0.42 g/100 g), it is contained in the blend with the sorrel leaf extract; in the smallest amount (0.2 g/100 g), it is in the blend with the black currant leaf extract.

Of the saturated fatty acids, palmitic is predominant, but its content is insignificant, ranging from 4.52 g/100 g to 4.91 g/100 g.

The content of stearic acid in the blends tested is in the range of 2.39 g/100 g to 2.90 g/100 g.

Other saturated fatty acids identified in the blends under study are lauric and myristic. It has been shown that their content does not exceed 0.58 g/100 g.

It is known that the fat content in food should provide 30% of the energy value of the daily diet [16]. To characterize the fatty acid composition of the fat of the blends under study, it can be stated that an average of 100 g of oils consumed as food satisfies the body’s daily requirement in 9–33% of SFAs, 43–93% of MUFAs, and 39–100% of PUFAs.

The result of determining the content of pesticides (HCH-gamma isomer, heptachlor, and DDT) shows that they are absent in the newly blended oils. This leads to the conclusion that they are not used for growing the peanut. The results of the tests also indicate the absence of mycotoxins (aflatoxin B1 and zearalenone) in the new blended oils. This means that good quality raw materials, i.e., freshly harvested, were used to produce the blended oils. The content of radionuclides (cesium-137 and strontium-90) in the new blended oils does not exceed the maximum permissible concentrations; the difference in their quantity depends on the type of the extract used. Thus, cesium-137 is the least found in the blend with the garlic extract. No toxic elements such as arsenic and mercury have been detected in the new blended oils, whereas lead, cadmium, copper, zinc, and iron are present in quantities not exceeding the maximum permissible concentrations; and lead and cadmium are by one order less. The copper content varies, depending on the type of oil (the type of the extract used), 0.27–0.32 mg/kg; the zinc content – 1.43–2.1 mg/kg; and the iron content – 2.2–3.0 mg/kg. The results show the safety of the new blended oils with the extracts of garlic, rosehips, sorrel leaves, and black currant leaves.

**Conclusion**

Thus, the new blended peanut-linseed oils with extracts of garlic, rosehips, sorrel leaves, and black currant leaves are characterized by a low content of saturated fatty acids, among which palmitic acid is predominant. Monounsaturated fatty acids make up 44–45% of all fatty acids and are represented mainly by oleic acid (99.2%). Polyunsaturated fatty acids make up 43–44% of all fatty acids and are represented mainly by linoleic (83%) and linolenic (16.8%) acids. The ratio ω-6:ω-3=4.9:1, and the ratio MUFAs:PUFAs=1:1, which complies with the standards of healthy nutrition [16].

The content of toxic elements, pesticides, mycotoxins, and radionuclides in the blended oils does not exceed the maximum permissible concentrations set in MBV No. 5061 and HN 6.6.1.1-130, which proves the safety of the newly developed blends. The results of determining the quality and safety of the new blended peanut-linseed oils with extracts of garlic, rosehips, sorrel leaves, and black currant leaves are of practical importance and can be used in the production of blended functional oils.
ЯКІСТЬ ТА БЕЗПЕЧНІСТЬ НОВИХ КУПАЖОВАНИХ ОЛІЙ

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Анотація. У статті надано характеристику арахісу, як олійної культури, наведено його біологічну цінність, хімічний та жирнокислотний склад. Обґрунтовано доцільність розроблення та впровадження нових купажованих олій для переробки соняшнику, пальмового сиру та циперелюбного. Введення змішаних розчинів жирних кислот з магістрального масла арахісу та соняшнику дозволить створити купажовані олії, що відрізняються від інших за кислотним складом, забезпечуючи біогенетичні та жирнокислотні показники.

Ключові слова: арахіс, арахісова олія, купажовані олії, жирнокислотний склад, біогенетична цінність, біологічна цінність.

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