Correction of the fatty acid composition of purpose dietary fats

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Abstract. It has been indicated that, according to very numerous studies, substantial indicators of the functionality of fatty products are the ratio of polyunsaturated fatty acids (PUFAs) of ϖ6 and ω3 families, as well as the ratio of the sum of saturated, monounsaturated and polyunsaturated fatty acids (SFA:MUFA:PUFA). Points related to the fortification of the functional properties of fat products of a target (special) purpose by combining their composition with the use of crushed non-defatted (full-fat) masses of oily flax and sesame seeds have been considered. The biological potential of the crushed non-defatted mass of oil flax seeds as a promising component for the enrichment of PUFA of ϖ3 group of new food vegetable-fat composite mixtures for special purposes have been theoretically substantiated. Insofar as margarines, which are often not balanced in terms of the ratio of fatty acids ϖ6 and ω3, are usually included as a fat component in the recipes of many bakery and flour confectionery products, this article proposes pre-mixing margarine with non-defatted crushed mass of oil flax and sesame seeds, without extracting the oil from their composition, before adding it to the dough.

1 Introduction

It is known that nowadays functional foods have an important role in the issue of proper human nutrition. Majority of fatty products are mass consumption products and, accordingly, are reasonably convenient objects for enriching their prescription compositions in order to fortify their functional properties. In this purpose, various methods and technologies for obtaining functional products of various kinds with desired properties – vegetable oils obtained by mixing (blending) and non-conventional oils, fatty products for special purposes, both emulsion and anhydrous, including margarines, dietary oils, spreads, vegetable-fat mixtures (VFM) are developed and applied in domestic and foreign practice. Composite fatty products obtained by changing the composition of the fatty phase in terms of the amount and ratio of fatty acids have great potential in the segment of fortified products. Moreover, it should be indicated that according to very numerous modern studies, a significant indicator of functionality is the ratio of polyunsaturated fatty acids (PUFAs) of the ϖ6 and ω3 families, as well as the ratio of the sum of saturated, monounsaturated and polyunsaturated fatty acids (SFA:MUFA:PUFA). The effectiveness of their biological action, which consists in the normalization of lipid metabolism, is the highest only if their specific ratio is observed. At

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 https://doi.org/10.1051/e3sconf/202339002037

the same time, the recommended ratio of the amount of SFA:MUFA:PUFA is their ratio of 1:1:1, and the optimal ratio of fatty acids of the ϖ6 and ω3 groups for a healthy person, respectively, is a ratio of 10:1, for medical nutrition - from 3:1 to 5:1. At the same time, in products traditionally produced by the oil and fat industry, there is mainly a clear shortage of PUFAs, especially of the ω3 group. A promising raw material for expanding the range of functional oils, fatty and vegetable fat products are oil flax seeds, which have a pronounced physiological effect on the main regulatory and metabolic processes of the human body. They contain a record amount of α-linolenic acid (ω3) for plant raw materials. This causes certain advantages of using flaxseeds and products of their processing for correcting the insufficiency of PUFAs of the ω3 group.

2 Literature review

Blending of vegetable oils is an effective technological method for achieving a given ratio of ϖ6 and ω3 PUFAs by creating two or multi-component systems from natural vegetable oils. At the same time, the main source of PUFAs of the ω3 group, which is very convenient in terms of technology, as described above, can be flaxseed oil [1]. From a physiological point of view, flaxseed oil has a beneficial effect in the prevention and treatment of cardiovascular diseases. acute and chronic inflammation and disorders associated with an overactive immune response [2]. Nevertheless, oils with a high content of PUFAs, especially linolenic acid (ω3 group), in particular, linseed oil, are easily oxidized, intensive oxidative and hydrolytic processes take place in it at the stages of pressing and filtration, and acid and peroxide numbers can increase in it [3]. Therefore, a method for obtaining functional blended oil mixtures with a given fatty acid composition from flax seeds of low-linolenic and high-linolenic varieties has been developed [4]. In this method, the formation of a given fatty acid composition of the oil is carried out at the stage of mixing the seeds, and the oil is extracted by pressing and filtered already with a given fatty acid composition. Studies have shown that in oil with a given fatty acid composition, obtained from a mixture of different varieties of linseeds, the acid and peroxide values are significantly lower compared to oil obtained by mixing ready-made oils.

In order to obtain new fatty products, food additives and natural plant materials in the form of powders, emulsions, extracts from processed products of cereal oil crops, nuts, fruits, etc. are also widely used [5-8].

A range of combined oils from dairy and vegetable raw materials, balanced in biological value, has been developed. A technology for the production of butter with an extract of wheat germ flakes in an amount of 16 to 20% has been proposed, which will enrich the product with valuable proteins, PUFA, dietary fiber, antioxidants and micronutrients. The use of the extract as a bioadditive will expand the range of a new generation of butter with increased biological value [5].

Methods for enriching sunflower oil with wheat germ oil at the stage of pressing sunflower seeds or at the stage of purification of the latter have been proposed [9-11].

It has been proposed to use peanut paste or flour, the "Polis" bio-additive, phospholipids and soy flour, milk fat as functional ingredients in the production of milk fat dispersions [12-14].

Lately, some researchers have developed methods for obtaining functional food products of a mixed raw material composition of a vegetable-fatty nature, i.e., so-called fat-and-flour mixtures (FFS) [15,16], the component composition of which, in addition to fats and oils, also includes crushed (powdered) masses of oily or low oily seeds, as well as their germs.

Fatty products in the form of margarines, fats of special purpose, substitutes and alternatives to animal and vegetable oils and fats are used in the production of many products and half-finished products in the confectionery, baking, milk, food concentrate industries, and public catering. They act as one of the main components of the finished product. In this case, the chemical composition of such fatty products, and, consequently, of other products based on them, can be the basic criterion for determining whether they are belonging to the functional.

Thereby, the search and research of the most accessible, technologically convenient, biologically valuable raw materials for the creation of new types of fatty products for the "healthy" nutrition sector are relevant and have significant scientific and practical importance. In this regard, this article covers the biological potential of the crushed non-defatted (full-fat) mass of oil flax seeds as a promising component of new vegetable-fat composite mixtures.

3 Methods and materials

The main objects of research are vegetable-fat compositions, as well as oilseed raw materials and crushed fat-free masses of this raw material, the fat component (on example of margarine), the use of which in compositions provides the functional properties of these compositions. Seeds of local varieties of flax "Bakhmal-2" and sesame "Tashken-122" were chosen as oilseed raw materials.

Quantitative analysis of fatty acids was carried out based on gas chromatography on a Clarus 600 Perkin-Elmer chromatograph (USA). Conditions for chromatographic analysis are:

column is Restek, Stabilwax; column length is 60 mm; column diameter is 0.32 mm; ID detector is PID; gas carrier is nitrogen; temperature in the thermostat (gradient method): 1-8 min is 80°C, 8-18 min is 130°C and 18-22 min is 180°C; split is 1/10; the volume (quantity) of the injection is 1 mcl.

Two or three-component functional fat mixtures can be obtained by mixing crushed masses from selected seeds with a fat product (margarine).

For a two-component mixture, in which one of the components is margarine, and the other is a crushed mass of oil flax seeds, the ratio of these components to achieve the required (y) is calculated based on the following solution of the system of equations:

$$\left.\frac{m_{fs} * c_{fs}^{w_6} * M_{fs} + m_f * c_f^{w_6} * M_f}{m_{fs} c_{fs}^{w_3} * M_{fs} + m_f * c_f^{w_3} * M_f} = y\right\}$$

$$m_{fs} + m_f = 1$$

where,

mf – is the mass of the fat component, g or kg;

mfs – is the mass of flaxseeds, g or kg;

$c_{fs}^{w_6}$– is the content of linoleic acid in the oil of selected flaxseeds, %;

$c_{fs}^{w_3}$– is the content of α-linolenic acid in the oil of selected flaxseeds, %;

$c_f^{w_6}$– is the content of linoleic acid in the fat component, %;

$c_f^{w_3}$–is content of α-linolenic acid in the fat component, %;

M_{fs} - is the oil content of selected flaxseeds, %

M_f- is the fat content of the selected fat component, %

y- is the required ratio of PUFA of ω6:ω3 families

4 Results and discussion

Since the food industry is increasingly in need of structured fats with a balanced fatty acid composition, an increased content of complete biologically and physiologically significant nutrients, which, by their technological properties, can be used as the main component of margarine, bakery and flour confectionery products, the most promising is the creation of new types of vegetable-fat composites for a specific purpose with a combination of traditionally used fatty products with non-defatted crushed masses of oilseeds with high functional characteristics. In the paper [15], the technology for obtaining functional fat-and-flour mixtures theoretically and experimentally substantiated, where fats, oils and processed products of non-conventional low-oil raw materials, which is the germ product of wheat grain theoretically and experimentally substantiated, the composition of which is characterized by a high content of biologically active substances, including slightly increased (7-14%) by the amount of ω3 fatty acids. However, it should be noted that in order to obtain ϖ6:ω3 balanced fatty acids in fat-and-flour compositions, this is not enough without the additional use of liquid vegetable oils rich in ω3 fatty acids, such as, for example, soybean, camelina, and linseed oils. This makes it difficult to maintain the structured consistency of the obtained fat-and-flour compositions. Therefore, in [16], we proposed the inclusion of crushed non-defatted mass of flaxseeds in vegetable-fat mixtures (VFM) instead of non-defatted wheat germ flour. This will allow eliminating the use of liquid vegetable oils to obtain the desired effect of balancing the ratio of ϖ6 and ω3 fatty acids.

In the recipes of many bakeries and flour confectionery products, margarines are usually included as a fat component, which are often not balanced in terms of the ratio of ϖ6 and ω3 fatty acids. Therefore, before adding to the dough, we suggest pre-mixing margarine with dry heat-treated (at 70-80°C in order to prevent hydrolysis of glucosides and inactivation of enzyme systems) non-defatted crushed mass of oil flax and sesame seeds without extracting oil from their composition. The table shows the fatty acid content (%) of the selected components of the vegetable-fat composition

Table 1. Fatty acid content (%) of the selected components of the vegetable-fat composition.

Name of fatty acids	**The content of fatty acids, in % of the total content**		
	"Bakhmal-2" flax (oil content is 36.2%)	**"Tashkent-122" sesame (oil content is 49%)**	**margarine (fat content is 82%)**
Palmitic, $C_{16:0}$	6.65	7.32	17.93
Stearic, $C_{18:0}$	4.95	5.16	13.21
Oleic, $C_{18:1}$	24.46	41.52	26.52
Elaidinic, $C_{18:1}$	-	-	13.19
Linoleic, $C_{18:2}$ (ϖ6)	***16.81***	***45.77***	***24.45***
Linolenic, $C_{18:3}$ (ω3)	***47.13***	***0.23***	***1.19***
Erucic $C_{22:1}$	-	-	2.24
Other	-	-	1.27
Σ saturated (SFA)	11.60	12.48	31.14
Σ mono-unsaturated (MUFA)	24.46	41.52	39.71
Σ poly-unsaturated (PUFA)	63.94	46	29.15
SFA:MUFA:PUFA ratio	1 : 2.1 : 5.5	1 : 3.3 : 3.7	1 : 1.3 : 0.9
ϖ6 : ω3 ratio	0.35:1	199:1	21:1

In the necessity of obtaining a functional fat composition for prophylactic purposes with a ratio of ω6:ω3 = 10:1 from the selected margarine and crushed mass of flaxseeds, in accordance with the calculation, the components are selected in the following ratio:

– Margarine - 94.1 %
– Ground mass of flax seeds - 5.9 %

The resulting composition has a fat content of 79.3%, with a ratio of SFA: MUFA: PUFA equal to 12.75:25.36:61.89 or 1:1.99:4.86. As can be seen, in this composition, the optimal ratio ω6:ω3 = 10:1 is achieved, however, the ratio of SFA: MUFA: PUFA changes for the worse compared to margarine (UFA:MUFA:PUFA ~ 1:1:1 is considered optimal)

Given the rather high content of oleic acid in sesame oil, it can be assumed that the three-component vegetable-fat composition is also more balanced in terms of the ratio of SFA: MUFA: PUFA, which is a mixture of the selected margarine, crushed non-defatted mass of flax seeds and sesame seeds. In this case, for a three-component mixture, the ratio of these components to achieve the required y is found by solving the following system of equations:

$$\left.\begin{aligned} \frac{m_{fs} * c_{fs}^{w_6} * M_{fs} + m_{ss} * c_{ss}^{w_6} * M_{ss} + m_m * c_m^{w_6} * M_m}{m_{fs} c_{fs}^{w_3} * M_{fs} + m_{ss} * c_{ss}^{w_3} * M_{ss} + m_m * c_m^{w_3} * M_m} = y \end{aligned}\right\}$$

$$m_{fs} + m_{ss} + m_m = 1$$

where,

m_{fs} – is the mass of flaxseeds, g or kg;
m_{ss} – is the mass of sesame seeds, g or kg;
m_m – is the mass of margarine, g or kg;
$c_{fs}^{w_6}$ – content of linoleic acid in flaxseed oil, %;
$c_{fs}^{w_3}$ – content of α-linolenic acid in flaxseed oil, %;
$c_{ss}^{w_6}$ – content of linoleic acid in sesame seed oil, %;
$c_{ss}^{w_3}$ – content of α-linolenic acid in sesame seed oil, %;
$c_m^{w_6}$ – content of linoleic acid in margarine, %;
$c_m^{w_3}$ – content of α-linolenic acid in margarine, %;
M_{fs} – is the oil content of crushed flaxseeds, %;
M_{ss} – is the oil content of crushed sesame seeds, %;
M_m – is the fat content in margarine, %;
y – is the required ratio of PUFA of ω-6: ω-3 families

At the same time, we set the share of margarine (m_3=50-80%) in the composition. At m_3=50, in accordance with the calculation to obtain a composition with a ratio of fatty acids ω-6:ω-3=10:1, the components are selected in the following ratio:

– Margarine - 50.0%
– Crushed mass of sesame seeds - 41.5%
– Crushed mass of flax seeds - 8.5%

The resulting composition has a fat content of 64.4%, with a ratio of SFA: MUFA: PUFA equal to 21.74: 29.16: 39.1 or 1: 1.3: 1.8

– Margarine - 80.0%
– Crushed mass of sesame seeds - 13.2%
– Crushed mass of flax seeds - 6.7%

This composition has a fat content of 74.5%, the ratio of SFA:MUFA:PUFA, equal to 27.3 : 38.9 : 33.8 or 1: 1.4 : 1.2.

5 Conclusion

Therefore, based on the example presented above, it can be concluded that the inclusion of crushed non-defatted masses of oil flax seeds and sesame seeds in margarine in certain ratios according to the calculation allows obtaining compositions balanced in fatty acid composition, and this balance refers to both the ratio of ϖ6:ω3 fatty acids, and to the ratio of the amounts of SFA:MUFA:PUFA. Studies of the effect of the use of such compositions on the quality of bakery and flour confectionery products have confirmed the effectiveness of their use both from a technological and functional point of view.

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