

## Modeling composition of the mixed oils by blending

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### Keywords:

Oil  
Blending  
Fat  
Acid  
 $\Omega$ -3 acid  
Oxidation

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### Article history:

Received 23.04.2014  
Received in revised form  
20.06.2014  
Accepted 30.06.2014

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### Abstract

**Introduction.** In order to enrichment food ration essential fatty acids of the population investigated blending of vegetable oils which give a balanced composition of polyunsaturated fatty acids, and conventional flavor characteristics.

**Materials and methods.** Physico-chemical quality of oils were determined by standard methods; design of experiments and optimization of technological processes was performed experimental and statistical method based on the software package Pascal; fatty acid composition of oil determined by method of gas chromatography.

**Results.** Researched and updated the fatty acid composition of vegetable oils cold-pressed. Has been developed and scientifically based the composition of blendson the basis of sunflower oil with the addition of camelina oil, flax and walnuts, which ensure a rational ratio  $\omega$ -6/ $\omega$ -3 fatty acids with the recommendations of their consumption. Investigated autocatalytic oxidation and hydrolytic blends when stored at a temperature of  $20 \pm 2$  ° C with free access of light and air. A substantial slowing of the accumulation of peroxides and free fatty acids by blending of 35% of the nut or 40% of camelina oil with corresponding amount of sunflower oil. Obtained data on a reduced stability of the blended oils with linseed oil. Identified the guaranteed storage life of blended oils based on sunflower oil.

**Conclusions.** Developed blended oils differ a balanced ratio of essential fatty acids,  $\omega$ -6 /  $\omega$ -3 from 10: 1 to 3:1, and can be used as a component of the fatty human diet and for the production of health-preventive purposes.

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## Introduction

Maintaining the health and increasing longevity of the individual - one of the most pressing problems of our time. One of the approaches to solving this problem is the creation of functional foods, which do not differ in taste and appearance of traditional, improve health, promote the reduction of disease and use of daily demand. [1]

Fat and oil products should be not only carrier of energy and a plastic material but also an important source of physiologically functional ingredients polyunsaturated fatty acids (PUFA), fat soluble vitamins, phospholipids, and other bioactive components. Of particular importance is presence in the products of essential polyunsaturated fatty acids to which in the first place should include linoleic (C18: 2) and linolenic (C18: 3) acids. Linoleic acid is the main representative of the family of long chain fatty acids omega-6 ( $\omega$ -6) and  $\alpha$ -linolenic acid - equivalent of long chain fatty acids omega-3 family ( $\omega$ -3). Polyunsaturated fatty acids perform two functions: they are components of the phospholipids of all cell membranes, on which depends the transfer of pulses and work the receptors and precursors for the synthesis of lipid mediators (eicosanoids), which are important in the regulation of many physiological processes [2, 3]. Omega-3 fatty acids improve the immune system, reduce blood coagulation, TAG level in the blood and the risk of coronary heart disease [4].

Remains debatable question regarding the optimal ratio of individual lipid classes of fatty acids food products, but most scholars are unanimous that the greatest biological effectiveness of lipids leads levels of omega-3 fatty acids. The ratio of  $\omega$ -6 /  $\omega$ -3 polyunsaturated fatty acids, it is recommended by the Institute of Nutrition in the diet of a healthy person should be 10: 1, and nutritional therapy - from 3: 1 to 5: 1 On the basis of clinical and experimental studies of scientists acid ratio  $\omega$ -6 and  $\omega$ -3, it is recommended is from 4: 1 to 2: 1 [5].

British Nutrition Foundation considers the ideal ratio between PUFA families  $\omega$ -6 and  $\omega$ -3 as a 6: 1 To achieve this, the ratio of the UK population is recommended to increase the intake of oily fish, containing a significant amount of PUFA  $\omega$ -3 family. Din N. Jehangir contends that the consumption of oily fish once a week by 50% reduces the risk of stenocardia and atrial fibrillation in patients with cardiovascular disease, regardless of comorbidities [6].

To  $\omega$ -6 fatty acids include linoleic (C18: 2),  $\gamma$ -linolenic (C18: 3n6), and arachidonic (C20: 4). Linoleic acid in the body can be elongated and desaturated to arachidonic and the last is a precursor to the formation of eicosanoids. Linoleic acid-rich overwhelming amount of vegetable oils. Exception is olive oil, which is dominated oleic acid ( $\omega$ -9), which contributes to lower of plasma cholesterol levels and necessary for the balance of polyunsaturated fatty acids.

The structure of  $\omega$ -3 fats includes the three essential fatty acids: eicosapentaenoic acid (C20: 5) and docosahexaenoic acid (C22: 6) and  $\alpha$ -linolenic acid (C18: 3n3). In the body of  $\alpha$ -linolenic acid by the elongation and desaturation is converted into eicosapentaenoic acid - a precursor for the synthesis of eicosanoids, and docosahexaenoic acid - an important structural component of the phospholipids of cell membranes.

Research of scientists found that a living organism does not synthesize linoleic and linolenic acids, they can only come from food. Depending on the initial fatty acid eicosanoids are synthesized which have different structures and biological effects on the organism, often directly proportional. Eicosanoids formed from  $\omega$ -3 fats, namely eicosapentaenoic acid, have anti-inflammatory, anti-allergic effect, blood thinners and prevent the thrombus formation, improve blood circulation, dilate blood vessels and reduce blood pressure. Conversely, eicosanoids synthesized from arachidonic acid ( $\omega$ -6) contribute to the development of inflammation, allergy, platelet aggregation and thrombus formation,

blood vessels constrict. Exception is prostaglandin E1 which is derived from  $\gamma$ -linolenic acid ( $\omega$ -6) and has anti-inflammatory effect and slows exemption of histamine, reducing allergic inflammatory component. Clinical research proves that deficiency in the cells of essential polyunsaturated fatty acids (especially  $\omega$ -3) forms a high potential of inflammation [7].

Therefore it is very important is the introduction of the diets of these fat products that will provide the desired physiological needs of the body's balance of essential acids,  $\omega$ -6 and  $\omega$ -3.

An important argument in favor of vegetable oils is their safety as they contain  $\alpha$ -linolenic acid which is a precursor necessary for the metabolism of the body and can accumulate in the body and consumed as needed.

However, the oil from sunflower seeds contains primarily family PUFA  $\omega$ -6 (62.58% in our research), and the ratio of  $\omega$ -6/ $\omega$ -3 PUFA does not conform to the formula of balanced nutrition. Is why we calculated the fatty acid composition blends "sunflower  $\times$  each of unconventional oils" in the following proportions: 50  $\times$  50; 55  $\times$  45; 60  $\times$  40; 65  $\times$  35; 70  $\times$  30; 75  $\times$  25; 80  $\times$  20; 85  $\times$  15; 90  $\times$  10; 95  $\times$  5. In further research elected blends, the fatty acid composition of which is within the range recommended by nutritionists: acid ratio of  $\omega$ -6 to  $\omega$ -3 10: 1 to 3: 1 is:

№ 1 - Sunflower oil 65%  $\times$  walnut oil 35%

№ 2 - Sunflower oil 75%  $\times$  25% linseed oil,

№ 3 - Sunflower oil 60%  $\times$  40% camelina oil.

## Materials and methods

As the research subjects was selected prevalence in the diet of the population of Ukraine vegetable oils obtained by cold pressing of the first technology spin - sunflower, soybean, rapeseed, linseed, mustard and unconventional oils – camelina hemp seed, maranth, sesame, cedar, pumpkin, walnut, wheat germ oil, fruits of sea buckthorn and grape seed. Also studied widely represented in the trading network olive oil varieties "Extra virgin".

Fatty acid and the isomer composition of vegetable oils was analyzed on a gas chromatograph Agilent 6890 (USA) with capillary column, programmed mode and ionization-flame detector Methods by preparation methyl esters according to ISO 5509-2002, analyzing the method of gas chromatography according ISO 5508-2001.

Method of preparation of the methyl esters according to ISO 5509: 2000 analyzing method of gas chromatography of methyl esters of fatty acids - ISO 5508: 1990 Sample preparation was as follows: the sample was dissolved in 2 ml of heptane was added by pipette 200 microliters of methanol solution of NaOH and shaken for 5 - 10 min. , then added to a solution 1 g of sodium hydrogen sulfate monohydrate and carefully agitated. After deposition of salts was separated upper layer containing the methyl esters of fatty acids. Detection of fatty acids was performed on a gas chromatograph: injector S/S with the allocation flows column Sp2380, length 100 m, internal diameter 0.25 mm, the coating thickness 0.2 micrometers. Chromatography conditions: temperature of injector - 280°C, discharge stream - 100: 1, the temperature detector - 290 °C. The column operates at a constant stream with speed of 1.2 ml/min, carrier gas helium. Temperature gradient column thermostat from 60 to 250°C. Research oxidative stability of blends was performed during storage at room temperature with free access of light and air. Samples of fat blends were stored in glass cups at 20  $\pm$  2°C. As a control, use sunflower oil. During storage every 7 days selected samples to determine the peroxide (according to ISO 3960: 1998) and acid

(according to ISO 660: 1996, NEQ) numbers. Oxidation blends stopped when the number of peroxide value reached more than 10 mmol $\frac{1}{2}$ O / kg. When exceeding this value vegetable oil is considered dangerous for health and becomes inedible product category. According kinetic curves defined oxidation induction period of oxidation, which is used for the prediction deadline storage oil.

## Results and discussion

Biological and food respectively, the value of vegetable oils characterized by the composition and the ratio of fatty acids. Table. 1 shows the fatty acid composition of vegetable oils investigated oilseeds and fruit seeds.

**Table 1**  
**Fatty acid composition of vegetable oils**

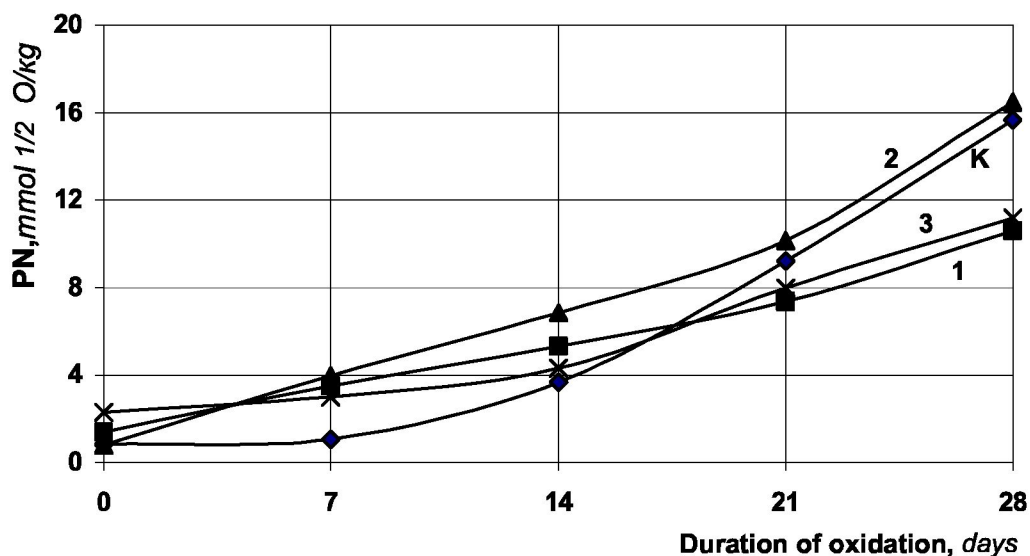
Vegetable oils	Fatty acids,%				Ratio $\omega$ -3/ $\omega$ -6
	Saturated fatty acid	Monounsaturated $\omega$ -9 (oleic)	Polyunsaturated		
			$\omega$ -6 (linoleic)	$\omega$ -3 ( $\alpha$ -linolenic)	
Sunflower	11,34	24,61	62,58	0,09	1:695
Soy	15,64	21,36	55,60	5,73	1:10
Rape	6,86	58,99	18,68	9,13	1:2
Corn	11,31	43,1	44,90	0,65	1:69
Olive	15,53	72,06	7,12	0,59	1:12
Flaxseed	10,24	17,30	14,31	57,26	1:0,25
Camelina	9,96	15,99	19,26	33,85	1:0,6
Hempseed	10,74	13,53	55,40	15,32	1:3,6
Mustard	4,87	33,53	10,96	11,25	1:1
Amaranth	17,83	23,97	53,75	1,31	1:41
Sesame	11,31	38,0	40,71	0,34	1:130
Pumpkin	19,71	21,47	58,38	0,14	1:417
Walnut oil	8,21	16,56	61,35	13,58	1:4,5
Wheat germ oil	18,24	14,86	57,03	6,69	1:8,5
Sea buckthorn oil	29,32	5,82	16,84	4,94	1:3,4
Grapeseed oil	11,51	19,6	68,15	0,45	1:151

According to table. 1 sunflower and corn oils contain high amounts of  $\omega$ -6 acids and small -  $\omega$ -3 acids and therefore have no optimum fatty acid composition. Soybean oil is recommended for consumption ratio  $\omega$ -3/ $\omega$ -6 PUFA (1:10). For rapeseed and mustard oil are of relatively low levels of saturated fatty acids (7.4%), high oleic acid level (33-59%) and the average level of linolenic acid (9-11%) and thus is favorable balance of  $\omega$ -3/ $\omega$ -6 as 1:1-2. Olive oil characteristically high oleic acid and low levels of PUFA. In linseed and camelina oil content of irreplaceable  $\alpha$ -linolenic acid is much higher than the recommended levels, which indicates their high physiological value and feasibility of using enrichment  $\omega$ -3 acid foods. A distinctive feature of camelina oil is gondoinovoy content (14%) and erucic

(about 3%) acids. Walnut oil and hemp have a sufficiently high content of  $\alpha$ -linolenic acid, but their use is limited to the high cost and nonproliferation. Other oils do not conform to the recommended dietary intake of PUFA ratio  $\omega$ -3/ $\omega$ -6.

We have developed blends based on sunflower oil with additives camelina oils, flax and walnuts with a fatty acid content families of  $\omega$ -6:  $\omega$ -3 from 10:1 to 3:1. This ratio corresponds to a nutritionist recommended "ideal" ratio of essential fatty acids diet. Basis for the blend elected sunflower oil. This is a traditional non-deficient product daily demand and consumption. Taste of Ukrainian sunflower oil consumer evaluates as "correct" neutral.

Having investigated blends and to determine them PN plotted changes PN of blended oils within 28 days (Fig. 1)



**Fig 1. Changing the of peroxide number of blended oils during 28 days:**

- K - Sunflower oil
- №1 - Sunflower oil 65% × walnut oil 35%
- №2 - Sunflower oil 75% × 25% linseed oil
- №3 - Sunflower oil 60% × 40% camelina oil

Time to reach PN = 10 mmol  $\frac{1}{2}$  O/kg is guaranteed shelf life of oils. It has been established that the addition of linseed oil in an amount of 25% negatively affects the stability of the vegetable oil, such oxidize faster than other blends. The longest period of storage - 27.5 days with free access to air and light - is number one with a blend containing 35% of walnut oil.

High resistance is noted as a sample number 3, which is period of storage 25.7 days. Thus, high resistance to oxidation processes are different blends of sunflower oil camelina and walnut oil.

Such blends appropriate to apply the treatment and prevention of atherosclerosis, to improve the effectiveness of diet therapy and correction of lipid metabolism in patients with type II diabetes, diseases of the cardiovascular system.

Investigation of autocatalytic oxidation and hydrolytic of blends at their storage at a temperature of  $20 \pm 2$  ° C, with free access of light and air showed that blend with linseed oil oxidizes rapidly. Therefore, it was removed from further research. Obtained by oxidation curves calculated kinetic parameters of the oxidation process of blended oils (Table 2).

**Table 2**

**Kinetic parameters of oxidation of blended oils**

Sample	Kinetic parameters	
	$k_p2 / k_7 \cdot 10^{-5}$	$k_7 \cdot 10^{-4},$ $dm^3 \cdot mmol^{-1} \cdot c^{-1}$
1. Sunflower Oil 60% + 40% camelina oil	0,52	15,7
2. Sunflower oil 65% + walnut oil 35%	0,44	18,5

$Kp2/k7$  parameter value shows the ratio of rates of initiation and termination of the reaction rate of oxidation of the substrate. Parameter value greater than zero indicates the antioxidant properties of biologically active substances contained in blends. Thus, sunflower - camelina blend with parameter equals 0.52  $k_p2/k_7$  more stable during storage than sunflower - walnut blend with the value  $k_p2/k_7$  - 0,44. The obtained values of the constants  $k_7$  indicate that the addition of camelina oil or walnut improve the inhibitory properties of the oxidation of the investigated blends.

Established antioxidant activity of additives camelina oils or walnut used for the prediction of the oxidative stability of oils blended.

### Conclusion

Thus, we can say that the main indicator of biological and, accordingly, the nutritional value of oil is a fatty acid content. Their ratio in the diet affects the condition of the human organism, the problem of excessive weight and premature aging.

To get products increased biological value appropriate to use the principle of blending oilsthat allows to reach balance on the fatty acid composition and provides the functionality of the product. Economic efficiency and simplicity of the technology of blending oils recovered their production in the discharge actual and perspective.

Developed blends of sunflower oil with camelina and walnuts are stable to oxidation and can be recommended for the production of health-preventive foods.

Detected that blending traditional sunflower oil with other types of vegetable oils discloses an opportunity to solve two problems: improving the biological value of fat through the optimal balance of fatty acid composition and increases their resistance to oxidative damage. Therefore, this type of fatty foods is a priority for their nutritional value.

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