SRSTI 65.09.05 **https://doi.org/10.58805/kazutb.v.2.15-14**

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DETERMINATION OF THE CONTENT OF FATTY ACIDS IN FLAX SEEDS

Abstract. This article presents studies on the fatty acid composition of flax seeds grown in the Republic of Kazakhstan.

Omega-3 fatty acids are involved in the construction of cells in many tissues of our body. Their positive impact on human health is very great. Polyunsaturated fatty acids are precursors of local hormones of cellular regulation, which influence the processes of inflammation, immunoregulation, regulation of blood flow, etc. The most important polyunsaturated fatty acids are eicosapentaenoic (EPA), docosahexaenoic (DHA), arachidonic (AA). They are synthesized in the human body from linolenic and linoleic acids, which are rich in vegetable oils. But since the human body produces a small amount of eicosapentaenoic and docosagensaenoic acids, it is important to get them with food in the required amount.

We have studied the ratio of Omega-6 to Omega-3 in flax seeds. Proportions are just as important as the origin (animal, vegetable) or the quality of fats. As we know, with an imbalance, that is, an excessive intake of Omega-6 into the human body, substances begin to compete for desaturase enzymes.

As a result of a study to determine the content of fatty acid in flax seeds, it was found that the content of Omega-3 in the test sample is 68% higher than Omega-6, which indicates the usefulness of using flax seeds in the food industry.

Keywords: flax seeds, polyunsaturated fatty acids, omega-6 to Omega-3 ratios, gas chromatography.

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ЗЫҒЫР ТҰҚЫМДАРЫНДАҒЫ МАЙ ҚЫШҚЫЛДАРЫНЫҢ ҚҰРАМЫН АНЫҚТАУ

Аңдатпа. Бұл мақалада Қазақстан Республикасында өсірілген зығыр тұқымдарының майқышқылдық құрамын зерттеу бойынша зерттеулер келтірілген.

Омега-3 май қышқылдары денеміздегі көптеген тіндердің жасушаларын құруға қатысады. Олардың адам денсаулығына оң әсері өте зор. Полиқанықпаған май қышқылдары қабыну процестеріне, иммунорегуляцияға, қан ағымын реттеуге және т.б. әсер ететін жергілікті жасушалық реттеу гормондарының прекурсорлары болып табылады. Олар адам ағзасында өсімдік майларына бай линолен және линол қышқылдарынан синтезделеді. Бірақ адам ағ-

засында аз мөлшерде эйкозапентаен және докозагенсаен қышқылдары өндірілетіндіктен, оларды тамақпен бірге қажетті мөлшерде алу маңызды.

Біз зығыр тұқымындағы Омега-6-дан Омега-3-ке қатынасын зерттедік. Пропорциялар шығу тегі (жануар, өсімдік) немесе майлардың сапасы сияқты маңызды. Біздің білуімізше, теңгерімсіздік, яғни адам ағзасына Омега-6 шамадан тыс қабылдау кезінде заттар десатураза ферменттері үшін бәсекелесе бастайды.

Зығыр тұқымдарындағы май қышқылының құрамын анықтау бойынша зерттеу нәтижесінде зерттелетін үлгінің Омега-3 құрамы Омега-6-ға қарағанда 68% – ға көп екендігі анықталды, бұл тамақ өнеркәсібінде зығыр тұқымын қолданудың пайдалы екендігін көрсетеді.

Түйінді сөздер: зығыр тұқымдары, полиқанықпаған май қышқылдары, Омега-6-ның Омега-3-ке қатынасы, газ хроматографиясы.

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ОПРЕДЕЛЕНИЕ СОДЕРЖАНИЯ ЖИРНЫХ КИСЛОТ В СЕМЕНАХ ЛЬНА

Аннотация. В данной статье приведены исследования по изучению жирнокислотного состава семян льна выращенных в Республике Казахстан.

Жирные кислоты омега-3 участвует в построении клеток многих тканей нашего организма. Их положительное влияние на здоровье человека очень велико. Полиненасыщенные жирные кислоты являются предшественниками локальных гормонов клеточной регуляции, которые оказывают влияние на процессы воспаления, иммунорегуляцию, регуляцию кровотока и т.д. Важнейшими полиненасыщеннми жирными кислотами являются эйкозапентаеновая (EPA), докозагексаеновая (DHA), арахидоновая (AA). Они синтезируются в организме человека из линоленовой и линолевой кислот, которыми богаты растительные масла. Но так как в организме человека производится малое количество эйкозапентаеновой и докозагенсаеновой кислот, важно получать их с пищей в необходимом количестве.

Нами были изучены соотношения Омега-6 к Омега-3 в семенах льна. Пропорции так же важны, как и происхождение (животное, растительное) или качество жиров. Как нам известно, при дисбалансе, то есть чрезмерном поступлении Омега-6 в организм человека, вещества начинают конкурировать за ферменты десатуразы.

В результате исследования по определению содержания жирной кислоты в семенах льна было установлено, что содержание Омега-3 в исследуемом образце на 68% больше, чем Омега-6, что говорит о полезности использования семян льна в пищевой промышленности.

Ключевые слова: семена льна, полиненасыщенные жирные кислоты, соотношения Омега-6 к Омега-3, газовая хроматография.

Introduction. Fatty products should be not only a source of energy and plastic material, but also an important supplier of physiologically functional ingredients: polyunsaturated fatty acids, fat-soluble vitamins, phospholipids and other biologically active components.

The absence of these acids inhibits the growth of a young organism, reduces reproductive functions, negatively affects the process of thrombosis, vascular tone and other functions. Important-linoleic and linolenic acids are products of biosynthesis that occur in plant organisms, where they are formed from oleic acid (C18:1). In the human body, a whole set of ω-6−acids is formed from linoleic acid, which eventually turns into arachidonic acid, and α-linoleic acid into eicosapentaenoic acid [1].

Researchers from the University of California at Los Angeles, led by Professor William Aronson, have proven that the omega-3 dietary supplement slows down the development of prostate cancer in Men [2].

Dutch scientists from the University of Wageningen have shown how small doses of omega-3 PUFA reduce the frequency of development of ventricular arrhythmia and fatal myocardial infarction in patients with diabetes [3].

Leading nutritionists believe that pharmacological and dietary control of arachidonic acid metabolism is a new, interesting concept in the treatment of skin diseases [4].

Many modern studies show that the inclusion of omega-3 polyunsaturated fatty acids in the diet, especially EPC [5], can help solve a number of problems associated with the aforementioned inflammations.

According to modern sources, the consumption of PUFA as an important nutritional factor should correspond to 4-6% of the energy value of the daily diet. The diet of a healthy person should contain omega-6 to omega-3 PUFA (5-10) :1. C18: 2 optimal daily intake of 8-10 g per day, C18:3 – 0,9-1,2 and C20:5 – 0,3-0,4 "no," he said. In various forms of pathology, the proportion of omega-3 PUFA increases in their ratio to Omega – 6 [6].

In the diet of a healthy person, it is very important that the ratio of PUFA ω-6:ω-3 is optimal. Initial studies recognized that the optimal ratio of these acids is -10:1 [7].

There are certain differences between different peoples of the world in the consumption of these essential fatty acids and their relationship to each other. Thus, in Eskimos, the ratio of ω-6 to ω-3 is 1:0.37, for residents of England-8:1, in the United States-10:1, in Denmark – 1:3.6, in Norway-1:4.7, in Japan-2:1 [8, 9].

The American Association of cardiologists recommends eating fish at least twice a week for undocumented people with coronary heart disease (CHD). Patients who need to reduce the concentration of triglycerides in the blood serum are recommended to use 2-4 g of EPA+DHA per day under the supervision of a doctor [10].

It is not easy to make recommendations for the consumption of fatty acids, since optimal needs depend not only on the type of pathology, but also on the age and gender of the person. In general, about 3-6% of the total fat intake is recommended for 1% linoleic and 1% α-linolenic acid and about 0.4% eicosapentaenoic and docosahexaenoic acids. It should be noted that the total number of acids consumed is not ω-6 and ω-3, their ratio is also important [11].

Currently, it is believed that the daily requirement for linoleic acid is 6-10 G, the minimum is 2-6 G, and its total content in dietary fats is at least 4% of the total caloric content. Therefore, the content of lipid fatty acids in foods designed to feed a young, healthy body should be balanced: 10-20% polyunsaturated,

50-60% polyunsaturated and 30% saturated, some of which should be of medium chain. This is achieved by using 1/3 of vegetable fats and 2/3 of animal fats in the diet. For the elderly and people with cardiovascular diseases, the content of linoleic acid should be about 40%, the ratio of polyunsaturated and saturated acids should be 2:1, the ratio of linoleic and linolenic acids should be 10:1 (Institute of nutrition for RM) [12].

Objects and methods of research. Method of gas chromatography. Chromatographic methods the most accurate types of analysis to date, the gas chromatography method has been used to determine the fatty acid content of linseed oil. The oil was obtained by cold pressing, as well as by hexane extraction from seeds according to the experimental versions according to GOST 5791 and GOST 8989.

Triglycerides in the blood are fat equivalents in methyl esters acids by overeating methanol with a solution of methylate sodium. The oil (2-3 drops) was dissolved in 1.9 cm^3 hexane. 2 cm^3 of sodium methylate in methanol with a concentration of 0.1 Mol/DM3 was added to the solution. The reaction mixture was mixed intensively for 2 minutes, infused for 5 minutes and filtered through a paper filter. The resulting solution was obtained using a chromatograph with a mass spectral detector "Clarus 600 C/D/S/T/ MS". Capillary column length 30 m, diameter 0.25 mm, fixed phase VRX-70, film thickness 0.25 microns.The speed of the carrier gas (NE) is 0.75 mL/min.the sample volume is 0.5 µl, the flow separation is 1÷40. the injector temperature is 230^0C. Temperature program of the speaker thermostat: initial temperature-100^0C-2 min., temperature rise to 185^0C at a rate of 5^0C/min, isotherm 185^0C-10 min. quantitative determination was carried out according to the data of the flame-ionized detector (temperature-230^0C); the structure of methyl esters of acids according to the data of the mass-spectrometric detector (input interface temperature – 180^0C, required temperature – 200^0C, ion current – 1,5 a, electron energy – 70 EV). The obtained mass spectra were processed by the MS-library" NIST 2005". The analysis is repeated 3 times, and confidence intervals with a 95% significance are calculated using Excel.

Results and discussion. Among plant-based foods, flaxseed ranks first in terms of omega-3 fatty acids, which help build cell membranes and support the immune and nervous systems. Polyunsaturated omega-3 fatty acids belong to micronutrients and play an important role for the human body.

Polyunsaturated fatty acids are essential for the proper development of young organisms, as well as for maintaining human health. These acids belong to the families ω-6 and ω-3. Among the general effects of essential acids, the main place is occupied by antioxidant activity. Omega-3 and 6 protect cell membranes from the destruction of free radicals. They protect the cell composition from the effects of lipid peroxidation products.

Table 1

Content of fatty acids in flaxseed

№	Fatty acids	Concentration	
		mass	%
1	MethylButyrate	4,909639	2,4353
2	MethylHexanoate	196,118451	97,2809
3	Methyl Octanoate	0,010843	0,0054
4	Methyl Decanoate	0,007521	0,0037
5	MethylUndecanoate	0,040279	0,0199
6	MethylLaurate	0,017901	0,0088
7	MethylTridecanoate	0,011203	0,0055
8	Myristoleicacid methyl	0,053663	0,0266
9	Methyl Myristate	0,085161	0,0422
10	Cis-10-Pentadecenoic acid m ethyl ester	0,044389	0,0220
11	Methyl Pentadecanoate	0,214296	0,1063
12	Methyl Palm itoleate	0,003111	0,0015
13	Methyl Palmitate	0,005108	0,0025
14	Cis-10-H eptadecenoic acid methyl ester	0,025521	0,0126
15	Gamma-Linolenic acid Methyl	0,009468	0,0047
16	Linolelaidic acid methyl ester	0,013717	0,0068
17	Cis – 9 – Oleic acid methyl	0,019590	0,0097
18	Methylcis-5,8,11,14,17– Eicosapentaenoat	0,006398	0,0032

According to the data in Table 1, the linoleic acid / omega-3 methyl ester (Linolelaidicacidmethylester) was 0.0068% of the total number of fatty acids in the sample studied. Scientists have proven that omega-3 fatty acids are important for the body. It is also found in Omega-3 multidimensional acids, rapeseed oil, soy, etc.

The content of gamma-linolenic acid in 100 grams of flaxseed was 0.0047% of the total amount of fatty acids. As we know, Gamma-Linolenic acid Methyl (GLA) is a polyunsaturated fatty acid that belongs to the omega-6 Series. GLA is an important fatty acid and enters the human body from the outside: in combination with food or as a supplement to it. In addition, omega-6 in GLA is converted into the human body under the influence of certain enzymes. In its pure form, GLA is found in mother's milk, which accounts for 100% of the baby's diet in the first year of life.

CIS-9-methyl oleic acid / omega – 9 (Cis – 9 – Oleic acid methyl) is one of the most important fatty acids, without which proper metabolism is impossible, that is, metabolism in the human body, a highly unsaturated fatty acid is part of lipids. It plays an important role in nutrition, promotes the fight against cholesterol, insulin resistance, strengthens the immune system and, as a result of recent research, prevents the development of breast cancer. Thus, the omega – 9 content in the studied sample was 0.0097%.

PUFA lipid compounds are of great importance, but there is an important point – fatty acids must be in a certain ratio to bring benefits, not harm.

Proportions are as important as the origin (animal, vegetable) or quality of fats (cold-pressed oil instead of refined oil, fresh fish instead of frozen or smoked fish, soaked nuts instead of fried)

Foods that many people are used to (sunflower and butter, meat, nuts, seeds) are high in omega-6. The ratio of omega-6 to Omega-3 should be 4:1 or 5:1. However, the modern Western diet implies a completely different relationship between 16:1 and 30:1.

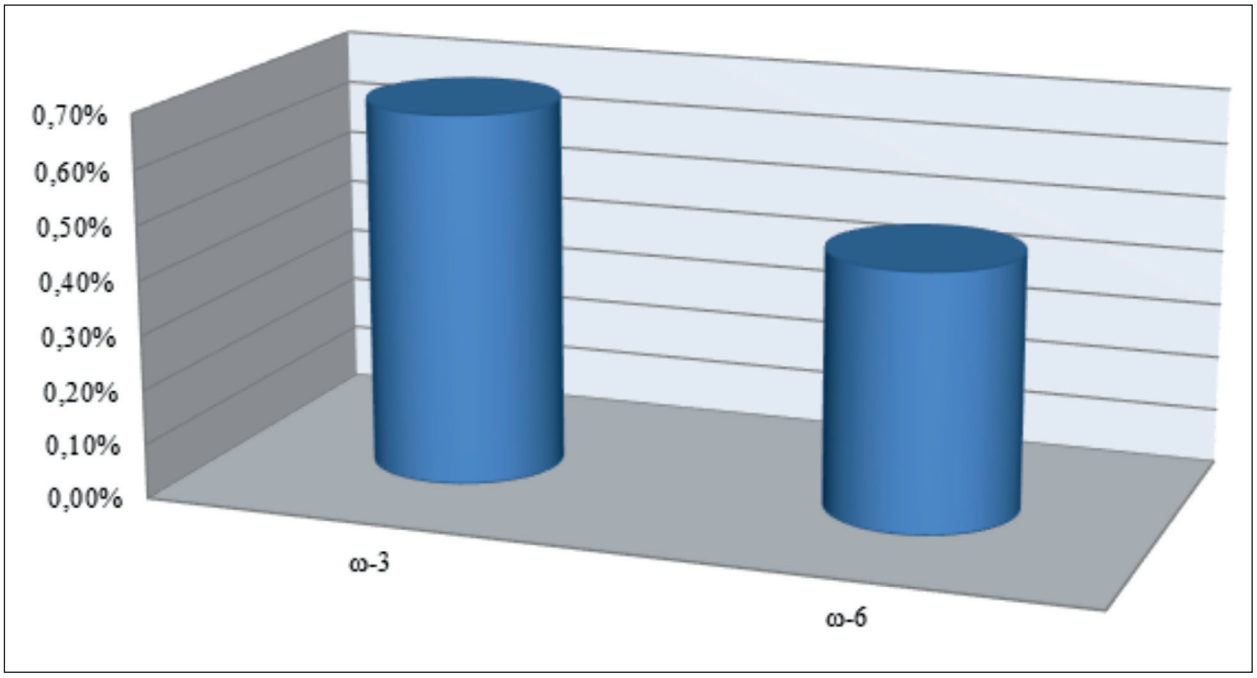

Figure –1-Comparative dynamics of essential fatty acids (ω-6 and ω-3) in flax seeds. (Omega-3 – 0.0068%; Omega-6-0.0047%)

So, as you can see in Figure 1, when determining the fatty acid content of flax seeds, we found that the omega-3 content in the sample under study is 68% higher than omega – 6 (Figure 1), which allows us to enrich the Omega-3 food products found in flax seeds. Flaxseed oil is one of the few products that has the perfect balance of omega-6 and omega-3.

With an imbalance, i.e. excessive intake of omega-6, substances begin to compete for desaturase enzymes. Desaturase is a substance that penetrates all cell membranes, including the membranes of muscles, skin, mucous membranes, and meninges. These are human desaturases that are involved in the synthesis of some important acids-linoleic arachidone, alpha-linoleic eicosapentaenoic, docosahexaenoic eicosapentaenoic, etc.

As a result, cell tissues lack only lipids (omega-3), and the concentration of the rest (omega-6) increases. Omega-6 protects the gastrointestinal tract, but does not help the heart; omega-3, on the contrary, activates the heart, but does not support the gastrointestinal tract. Against the background of excess omega-6, instead of improving health, health is disrupted: muscle pain occurs, cognitive abilities deteriorate, depression develops, and cholesterol levels in the blood increase.

The solution to the problem is to independently calculate the lipid content in food or use special functionalities with an optimal ratio of Omega – 3 and Omega-6.

Conclusion. Flaxseed oil is one of the few products that has the perfect balance of omega-6 and Omega-3. Thus, when determining the fatty acid content of flax seeds, it was found that the amount of omega-3 in the sample under study was 68% more than omega-6, which made it possible to enrich the vegetable milk recommended by us with the Omega-3 found in flax seeds.

References

1. Tutelyan V.A., Nechaev A.P., Kochetkova A.A. Functional fat products in the structure of nutrition // Oil and fat industry. 2009.− no. 6, pp. 6-9.

2. The same fish oil. Omega in portions and grams http://zdravkom.ru/”>zhurnal ZdravKom

3. Plasma and dietary omega-3 fatty acids, fish intake, and heart failure risk in the Physicians’ Health Study – American Journal of Clinical Nutrition, doi: 10.3945/ajcn.112.042671, October 2012.

4. GOST ISO 23065-2015. Milk fat from fortified dairy products. Determination of the content of omega-3 and omega-6 fatty acids in milk fat by gas-liquid chromatography. – Introduced on 2016-03-01. – M.: Publishing house of standards, 2015. – 14 p.

5. Faseb J. Biochemistry and physiology of n-3 fatty acids. 1992, -no 6.

6. Ipatova L.G., Kochetkova A.A., Nechaev A.P. New directions in the creation of functional fatty products // Food industry. 2007.− no 1.

7. Caster W.O.// J. Nutr, 1976. Vol.106. pp.1809-1811.

8. Nechaev A.P. Oils and fats, 2007.– Vol..88, no. 8, pp.26

9. Gerster H.// Int. J. Vitan.Nutr. Res. 1998. no 1.−64. pp.159

10. Trans Fat Monitoring Reports. Official website of Health Canada: http://www.hc-sc.gc.ca

11. Hansen R.A., Savage C.J.// J.Vet.Intern.Med. 2002. Vol.136, pp.2844-2848.

12. Nechaev A.P. Food chemistry / A.P. Nechaev and others: ed. A. P. Nechaeva. – St. Petersburg: GIORD, 2015, p.672.