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DETERMINATION OF TRANSISOMERS OF FATTY ACIDS IN BAKERY AND CONFECTIONERY PRODUCTS

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Currently, the problem of high content of trans-isomers of fatty acids in food products has become widely discussed throughout the world, as large-scale studies have proven the connection between the consumption of trans fats and the development of cardiovascular diseases, type II diabetes, and obesity. In 2018, the upper limit of trans-isomers of fatty acids was regulated in TR CU 024/2011 «Technical regulations for oil and fat products» no more than 2% of the fat content in the product. However, these restrictions apply exclusively to oil and fat products, and for other types of food products there are no such restrictions and the content of TFA in them is not regulated. In this regard, the purpose of the research is to assess the food safety of bakery and confectionery products obtained using margarines based on hydrogenated oils produced from domestic raw materials of the Republic of Kazakhstan. The article presents the incidence of circulatory system diseases and changes in prices for margarine products. The content of trans-isomers of fatty acids in 10 types of bakery and confectionery products was determined. It was found that the content of trans-isomers in all the studied samples does not exceed 2%, and the daily intake rate of trans-isomers of fatty acids was also determined.

Keywords: transisomers of fatty acids, hydrogenated oils, margarine, vegetable fat, bakery products, confectionery products, IR spectroscopy.

НАН ЖӘНЕ КОНДИТЕРЛІК ӨНІМДЕРДІҢ ҚҰРАМЫНДАҒЫ МАЙ ҚЫШҚЫЛДАРЫ ТРАНСИЗОМЕРЛЕРІНІҢ МӨЛШЕРІН АНЫҚТАУ

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Қазіргі уақытта азық-түлік өнімдеріндегі май қышқылдары трансизомерлерінің жоғары деңгейі мәселесі бүкіл әлемде кеңінен талқылануда, өйткені ауқымды зерттеулер транс майларын тұтыну мен жүрек-қан тамырлары ауруларының, II типті қант диабетінің және семіздіктің дамуы арасындағы байланысты дәлелдеді.2018 жылы май қышқылдарының трансизомерлерінің жоғарғы шегі КО ТР 024/2011 «Май және тоң-май өнімдерінің техникалық регламентінде өнімдегі май мөлшерінің 2%-дан аспауы керектігін орнатты. Дегенмен, бұл шектеулер тек май және май өнімдеріне қатысты, ал тамақ өнімдерінің басқа түрлері үшін мұндай шектеулер жоқ және олардағы трансизомерлерінің мөлшері реттелмейді. Осыған байланысты зерттеудің мақсаты Қазақстан Республикасының отандық шикізатынан өндірілген гидрогенизацияланған майлар негізіндегі маргариндерді қолдану арқылы алынған нан және кондитерлік өнімдердің тағамдық қауіпсіздігін бағалау болып табылады. Мақалада қан айналымы жүйесі ауруларының жиілігі мен маргарин өнімдерінің бағасының өзгеруі тамамдалған. Нан және кондитерлік өнімдердің 10 түріндегі май қышқылдарының трансизомерлерінің мөлшері анықталды. Барлық зерттелген үлгілердегі трансизомерлердің мөлшері 2%-дан аспайтыны анықталды, сонымен қатар май қышқылдарының транс-изомерлерінің тәуліктік қабылдау нормасы да анықталды.

Түйін сөздер: май қышқылдарының трансизомерлері, гидрогенизацияланған майлар, маргарин, өсімдік майы, нан өнімдері, кондитерлік өнімдер, ИҚ спектроскопиясы.

ОПРЕДЕЛЕНИЕ СОДЕРЖАНИЯ ТРАНСИЗОМЕРОВ ЖИРНЫХ КИСЛОТ В ХЛЕБОБУЛОЧНЫХ И КОНДИТЕРСКИХ ИЗДЕЛИЯХ

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В настоящее время проблема высокого содержания трансизомеров жирных кислот в пищевых продуктах стала широко обсуждаемой во всём мире, так как в проведённых крупномасштабных исследованиях была доказана связь потребления трансжиров с развитием заболеваний сердечно-сосудистой системы, сахарного диабета II типа, ожирения. В 2018 году произошла регламентация верхнего предельного уровня трансизомеров жирных кислот в ТР ТС 024/2011 «Технический регламент на масложировую продукцию» не более 2% от содержания жира в продукте. Однако, эти ограничения касаются исключительно для масложировых продуктов, а для остальных видов пищевых продуктов отсутствуют данного рода ограничения и содержание ТЖК в них не регулируются. В связи с этим, целью исследований является оценка пищевой безопасности хлебобулочных и кондитерских изделий полученных с использованием маргаринов на основе гидрогенизированных масел произведенных из отечественного сырья РК. В статье приведены по заболеваемости системы кровообращения и изменение цен на маргариновую продукцию. Определены содержание трансизомеров жирных кислот в 10 видах хлебобулочных и кондитерских изделий. Установлено, что содержание трансизомеров во всех исследуемых образцах не превышает 2%, также опеделена суточная норма потребления трансизомеров жирных кислот.

Ключевые слова: трансизомеры жирных кислот, гидрогенизированные масла, маргарин, растительный жир, хлебобулочные изделия, кондитерские изделия, ИК спектроскопия.

Introduction. One of the recipe components of bakery and confectionery products are fats. Their content in the recipe can vary widely from 5% and higher [1-3]. Both vegetable oils (sunflower, rapeseed, cottonseed, corn) and margarines or special-purpose fats are used as fat components [4]. Despite the restriction in the countries of the Customs Union, including our country, since 2018 of trans-isomers of fatty acids (TFA) in oil and fat products, as has been written in the media in recent years, their amount in hard margarines and special-purpose fats for the bakery and confectionery industry remains high - up to 20% of the fat content in the product according to TR CU 024/2011 «Technical Regulations for Oil and Fat Products». In bakery and confectionery products using hydrogenated fats, the amount of TFA can reach up to 6.7%, and in potato chips - up to 35% [5-8]. As a result, with the consumption of 100 g of baked goods or flour confectionery, the human body can receive 5 times more TFA than the WHO recommended norms - 1% of the daily caloric intake, but is this really the case in the realities of the Republic of Kazakhstan?

The danger of TFA is associated, first of all, with an almost 2-fold increase in the risk of cardiovascular diseases due to an increase in cholesterol and low-density lipoprotein levels. As a result, the risk of sudden death increases [9,10]. The impact of TFA consumption on public health is actively studied in foreign countries; in our country, studies of this kind have not been conducted. The changes that occurred with the tightening of technical regulations in 2018 also require an assessment of the changing situation. The prevalence of alimentary-dependent diseases does not tend to decrease, which also determines the relevance of this study. At the same time, the impact of restrictions on TFA to 2% in 2018 for the Republic of Kazakhstan was studied.8 years have passed since the introduction of this restriction; during this period, the dynamics of population mortality from diseases of the circulatory system was studied, since most studies in recent years indicate a negative impact of TFA on the circulatory system. According to the ASPR RK

Bureau of National Statistics, the average mortality rate for diseases of the circulatory system before the introduction of restrictions was 0.2%, and after 0.18%, while on average over the past 6 years the mortality rate has decreased by only 0.02%, which does not give a more tangible effect for the population of the Republic of Kazakhstan. If we calculate the average number of deaths, then the introduction of restrictions led to a reduction in deaths by an average of 6 people over 6 years. Interestingly, the indication of the TFA content on food labels saved up to 500 lives per year in the United States due to a decrease in the incidence of cardiovascular diseases [11]. We also analyzed the change in retail prices for margarine before and after the introduction of restrictions, the results are presented in Figure 1.

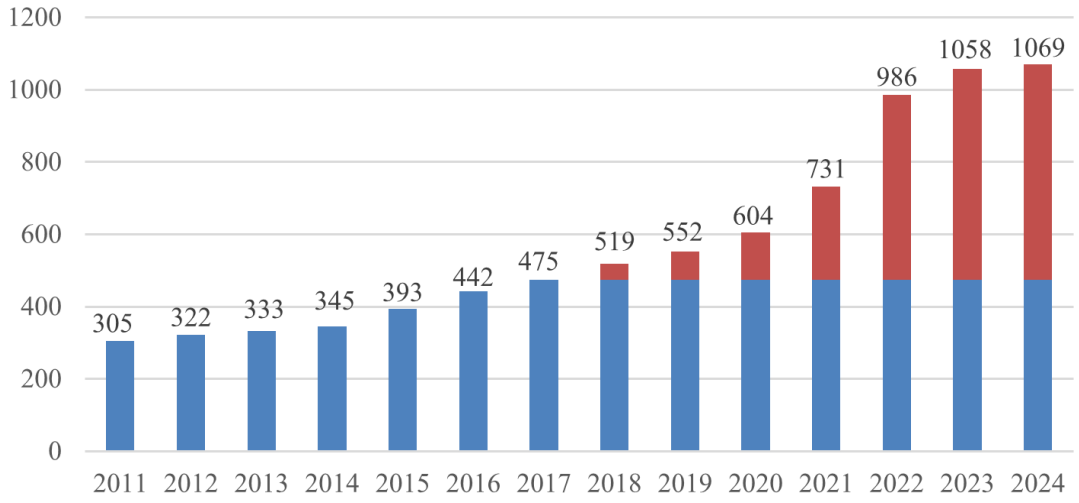


Fig.1 - Change in retail prices for margarine for 2011-2024

As can be seen from Figure 1, retail prices for margarines have grown rapidly after the introduction, if we take into account the average price values, then for 2018-2024 they have grown almost 2,1 times compared to 2011-2017. The introduction of restrictions on TFA to 2% of the fat content for oil and fat products led to an increase in the import of palm oil, an increase in the cost of margarines by 2,1 times, and did not give a significant effect in improving the health of the population of the Republic of Kazakhstan. In this regard, the purpose of the research is to assess the food safety of bakery and confectionery products obtained using margarines based on hydrogenated oils produced from domestic raw materials of the Republic of Kazakhstan.

Materials and methods. The objects of the study are: hydrogenated oil, margarine, sugar cookies, oatmeal cookies, crackers, gingerbread, prolong cookies, waffles, flatbreads, buns, fudge, confectionery glaze. The studies were conducted from September 2024 to January 2025.

For the studies, vegetable fat of 99.7% fat content, based on hydrogenated oils from Maslo-Del LLC, with a transisomer content of 10%, was provided; margarine «3 wishes» Pampushka, 55% fat content of Eurasian Foods JSC, was purchased as a control sample. Experimental baking was carried out in the laboratories of processing oilseed raw materials and deep processing of plant products, using a U1-ETK dough mixer, SB 500-70 dough sheeter, XL 413 proofer and HV 693 convection oven.

After the experimental baking, the mass fraction of fat in the finished bakery and confectionery products was determined according to GOST 5668-2022 and GOST 31902-2012. The analyzed sample of products was weighed on scales with the result recorded in grams to the third decimal place, placed in a filter paper cartridge. The cartridge with the sample was placed in a Soxhlet apparatus and fat

was extracted with diethyl ether for 5 hours. The resulting mixture was evaporated in a water bath in a fume hood. The flask with the obtained fat was dried in a drying cabinet at a temperature of 100°C until constant weight, then cooled in a desiccator for 20 min. In this way, 100 g samples of extracted fat were prepared for each product.

The content of trans isomers in the extracted fats was determined according to GOST 33441-2015 «Vegetable oils. Determination of quality and safety indicators by near infrared spectroscopy» on an IR Fourier spectrometer IR Spirit-TX (Shimadzu, Japan). Absorption spectra were recorded in the range of 4000-400 cm^{-1}, with a resolution of 8 cm^{-1}, 64 scans, with subsequent mathematical calculation of the values of the determined indicators.

Mass fraction of trans isomers of unsaturated fatty acids in products X, %, according to GOST R 54687 - 2011 «Confectionery products. The method for determining the mass fraction of trans-isomers of unsaturated fatty acids» is calculated using the formula:

$$X = \frac{Y \times T}{100} \quad (1)$$

where, Y - mass fraction of fat in the product under study, %;

T - mass fraction of trans fatty acids, %.

Statistical analyses were performed using the Statgraphics Centurion 19 software package.

Results and discussion. Experimental baking of bakery and confectionery products was carried out at the Astana branch of the Kazakh Research Institute of Processing and Food Industry LLP. The results of the experimental and control baking are presented in Figure 2.



Fig.2 - Samples of bakery and confectionery products with the addition of vegetable fat and margarine

As a result, it was established that, in terms of organoleptic indicators, products prepared with the addition of vegetable fat based on hydrogenated oil are not inferior to products with the addition of margarine. Also, the mass fraction of fat in bakery and confectionery products was determined; the results of the studies are presented in Table 1.

Table 1 - Mass fractions of fat in bakery and confectionery products

№	Product name	Mass fraction of fat, %	ND on research methods

1	Sugar cookies	10,6	GOST 31902-2012
2	Oatmeal cookies	11,2	GOST 31902-2012
3	Crackers	10,4	GOST 31902-2012
4	Gingerbread	10,7	GOST 31902-2012
5	Prolong cookies	10,3	GOST 31902-2012
6	Waffles	10,5	GOST 31902-2012
7	Flatbreads	9,4	GOST 5668-2022
8	Buns	3,5	GOST 5668-2022
9	Fudge	9,7	GOST 31902-2012
10	Confectionery glaze	11,1	ГОСТ 31902-2012

Analyzing Table 1, it can be established that the mass fraction of fat in bakery and confectionery products varied from 3.5% to 11.2%. The content of TFA in the original oil and fat products was determined, the results of the studies are shown in Table 2.

Table 2 - TFA content in the original fat and oil products

№	Product name	Mass fraction of fat, %	TFA content, %
1	Vegetable fat based on hydrogenated oil	99,7	10,0
2	Margarine	55,0	0,31

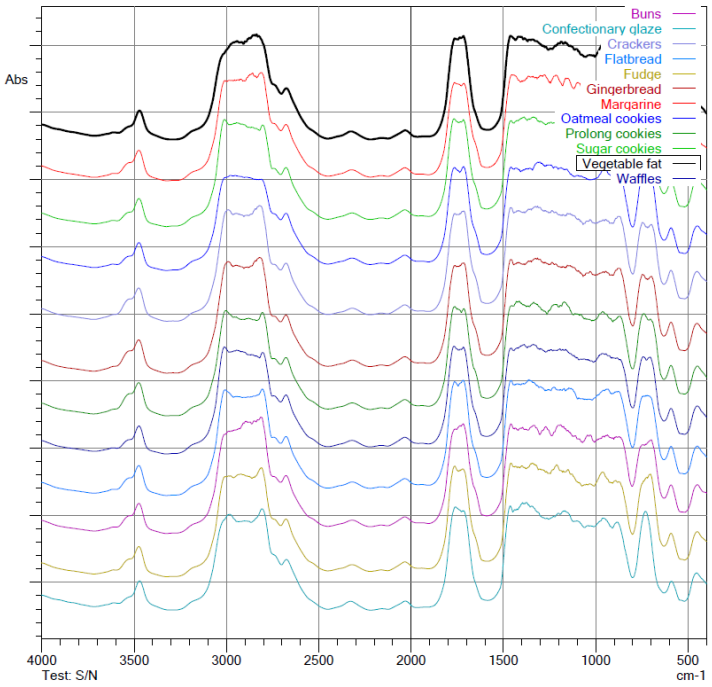


Fig.3 - IR spectra of the analyzed samples

The results of the studies showed that vegetable fat based on hydrogenated oil exceeds the 2% standard and is not suitable for direct oral use. Margarine with a TFA content of 0.31% complies with the standards of TR CU 024/2011. However, it is important to note that vegetable fat is presented as a fat product with a fat content of 99.7%, and margarine is an emulsion product with a fat content of 55%. If margarine with a fat content of 55% were prepared based on vegetable fat, the TFA content would decrease to 5.5%. Figure 3 shows the IR spectra of the analyzed samples.

Next, the content of trans-isomers of fatty acids in bakery and confectionery products with the addition of vegetable fat based on hydrogenated oil was determined; the results are presented in Table 3.

Table 3 - Content of trans-isomers of fatty acids in bakery and confectionery products

№	Product name	Mass fraction of fat, %	TFA content in extracted fat, %	TFA content in finished products, %
1	Sugar cookies	10,6	9,57	1,01
2	Oatmeal cookies	11,2	7,89	0,88
3	Crackers	10,4	9,28	0,97
4	Gingerbread	10,7	9,27	0,99
5	Prolong cookies	10,3	9,56	0,98
6	Waffles	10,5	9,76	1,02
7	Flatbreads	9,4	7,58	0,71
8	Buns	3,5	7,82	0,27
9	Fudge	9,7	8,63	0,84
10	Confectionery glaze	11,1	10,48	1,16

As can be seen from Table 3, the TFA content in all the listed bakery and confectionery products does not exceed 2%. Although vegetable fat is not suitable as an independent oil and fat product for direct oral use, it is quite suitable as an ingredient for other food products, such as bakery and confectionery products.

According to the Order of the Chairman of the Sanitary and Epidemiological Control Committee of the Ministry of Health of the Republic of Kazakhstan dated 06/09/2023 No.69-NK, which approved the methodological recommendations «Norms of physiological needs for energy and nutrients for various groups of the population of the Republic of Kazakhstan», the recommended fat content of the total energy value of the daily diet for children under 6 months is 40-60%, up to 2 years - up to 35%, 2-18 years - 25-35%, adults - up to 30%.

At the same time, the recommended content of saturated fats in the diet is no more than 10% of the total caloric content of the daily diet. Consumption of trans-isomers of fatty acids should not exceed 1% of the caloric content of the daily diet. Also, according to the ASPR RK Bureau of National Statistics, at the end of 2023, the energy value of food products consumed by the population of the Republic of Kazakhstan was 3,129 kcal per day, of which the fat content is 32.6%, that is, 1020 kcal per day. The maximum limit for the consumption of trans-isomers is 31.3 kcal per day. Then, the maximum level of trans-isomers in the daily diet would be 3.1%, which is higher than the established norm of TR CU 024/2011 TFA no more than 2%. However, it is worth understanding that this indicator includes not only oil and fat products, but all food products.

Conclusion. As noted earlier, the use of

vegetable fat based on hydrogenated oil does not exceed the standard content of TFA in bakery and confectionery products, they can be considered safe for health. Taking into account the daily consumption of these products, we consider it necessary to allow domestic manufacturers of oil and fat products to produce fats for special purposes for the bakery and confectionery industry based on hydrogenated oils, bypassing the retail consumer market, and directly make deliveries between business representatives. It is necessary to work out the principles and stages of sales, introduce tools for monitoring the safety of such sales so that industrial margarines do not end up on consumer shelves. Against the background of the economic situation in the country, associated with the rise in the dollar and the growth of inflation for food products, this decision could give a positive impetus to the entire food industry of our country.

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