KAPITEL 2 / *CHAPTER 2* [2]

CURRENT STATE OF PRODUCTION AND PROSPECTS OF THE USE OF OILY FLAX SEED IN THE FOOD INDUSTRY

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Introduction

Nutrition is one of the most important factors determining human health. It is possible to improve the nutrition of the population due to the use in the recipes of food products of traditionally grown, collected, harvested and processed in Ukraine natural plant raw materials, which have a high biological value. One of the traditional and annually updated types of domestic raw materials used in the food industry is linseed oil, including seeds. Flax seeds are currently very popular as a food supplement. Bread products with the addition of flax seeds acquire a delicate taste due to a large amount of fat, as well as an attractive-looking crust. Studies have shown that consuming bread enriched with flax seeds for four weeks lowers cholesterol by 7-9%. The possibility of using flax flour for the preparation of gluten-free confectionery has also been proven.

Analyzing the world experience of using flax seeds and oil, we can conclude that the scope of their application is expanding every year and has a rapid growth trend. This is explained by the unconditional value of seeds, namely the presence of various organic compounds.

Taking into account the rapid development of innovative technologies, the development, expansion and systematization of consumer characteristics of flaxseed food products is an urgent task today.

2.1. Peculiarities of the morphological structure and agrotechnics of oil flax

Linseed oil is an important source of raw materials for the production of technical oil in our country. Its seeds contain 42-50% fat, which dries quickly (iodine number - 175-195), forming a thin, smooth, shiny film. The botanical name of flax Linum usitatissimum means "most useful". Good-quality oil is widely used in many industries: in the paint industry for the production of natural oil, varnishes, enamels, various paints for underwater work; electrical engineering, aviation, automobile construction,

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shipbuilding, foundry production, metalworking, etc., as well as in soap making, medicine. Linseed oil is indispensable in the production of lithographic paints, linoleum, oilcloth, and waterproof fabrics. Sometimes fresh linseed oil is used in food in its natural form.

Flax is an important medicinal plant. Flaxseed oil is used in the dietary nutrition of patients with disorders of fat metabolism, atherosclerosis, ischemic heart disease, brain diseases, hypertension, diabetes, liver cirrhosis, hepatitis, fatty liver disease. Flaxseed oil contains a minimum amount of cholesterol and a large amount of unsaturated fatty acids, the use of which with food reduces the cholesterol content. The mucus released when the seeds are soaked has good softening properties for intestinal diseases.

Oil production waste: cake and meal is a valuable concentrated feed, containing up to 1.2 feed units, 31-38% digestible protein and about 9% fat. It is superior to other plants in terms of fodder qualities, as it is easily digested by animals. Feeding it to cows increases milk yield and fat content, fattening steers significantly increases weight gain.

The stalks of linseed oil contain 10-15% of fiber suitable for making coarse fabrics. The raw material for the production of cigarette paper and cardboard is straw, which contains up to 50% cellulose. Slabs used in construction are made from waste (firewood). In addition, flax wood briquettes are a good fuel.

Flax has been a part of human life since ancient times: it was used in India, China, Egypt, Transcaucasia 4-5 thousand years BC. Flax stalks with pods and seeds, remnants of linen fabrics, threads, and ropes have been found in fragments of Swiss stone age buildings. For 5 thousand years BC, the culture of flax was well known in Egypt - mummies were wrapped in linen cloth.

Primitive Slavic tribes also knew this culture well and knew how to make yarn from flax, and oil from seeds. At the beginning of Kievan Rus, as chroniclers testify, all tribes were engaged in weaving. In the 12th-16th centuries, flax became the main technical crop of all Russian principalities, it was widely used in trade with overseas countries, and a state duty was imposed on it. In Ukraine, flax began to be sown from the 6th century.

Flax oil occupies more than 70% of the cultivated area of flax in the world. Recently, the production of linseed oil has been intensively developing in Canada and the USA [1-4]. According to FAO data, the area of flax crops around the world is almost 3.5 million hectares [5].

In Ukraine, the area under flax cultivation has been growing in recent years. So, in 2022-2023, the area sown with flax amounted to 33.1 thousand hectares, which is 20% more than the previous season. This indicator is the maximum for the last five seasons according to UkrAgroConsult analysts [6].

At the same time, the yield decreased by 44% - to 0.86 t/ha, which is the lowest indicator for the last four seasons. The gross collection is 27.5 thousand tons, that is, 34% less than in 2021-2022.

In 2022-2023, flax oil partially lost its export orientation, the share of exports in the harvest decreased to 44%, while in the previous year exports amounted to 83%. Strengthening the position of Kazakhstan in foreign markets, which increased exports by 31% of flax exports for the period September-May 2021-2022.

According to analysts' forecasts, in 2023-2024, the area of oilseed crops will be expanded due to their higher profitability compared to grain crops, oilseed linseed is no exception, remaining a niche crop. Sown area may become the maximum in the last 6 years. The current weather conditions give reason to expect a higher yield than the average for the last three years. The harvest of flax is expected at the level of 40-41 thousand tons [7].

The increase in cultivated areas is explained by the fact that long-leaved flax does not require large capital investments, since its cultivation is 1.1-1.3 times cheaper than sunflower production. At a price of 12,000 t/t and a yield of 0.7-0.8 t/ha, its profitability is positive.

Unfortunately, the market for falsified seeds in Ukraine is large: many producers grow flax varieties of unknown origin and with questionable seed quality. This affects the crop yield and the final price of the grown products [8].

Specialists of the Research Institute of Oil Crops noted that high-quality and certified seeds produced in the form of commercial flax are sold at lower prices, as a result of which farmers lose the yield of this crop. According to experts in the field, one of the main tasks in growing flax is the varietal purity of the seed material. Specialists carry out two types of cleaning of flax crops: the first - during the flowering period, when the color of the flowers of the main varieties disappears, impurities can be distinguished from other varieties, the second - at the early yellow stage. ripening taking into account the height of the plant, the shape of the bush and the yield obtained. According to the current instructions, crop varieties are tested in the phase of full flowering of the plant.

Varietal renewal in the seed area of the farm takes place once every three years

with the seeds of the first reproduction of the entire area. The seeds must be cleaned of weeds, sorted, without diseases, at least the third time of reproduction, high quality, high germination up to 1000 seeds. Using more seeds for sowing helps to increase germination in the field. It is forbidden to sow seeds affected by the weevil. Seeds of quarantine weeds and live pests and their larvae are not allowed in sowing materials.

One of the main reasons why you should take care of growing flax for oil is the economic component. Due to the high oil content of 45-50% and the potential yield of 2.0-2.5 t/ha, oil flax is a highly profitable crop and very attractive to agricultural producers.

Cultivation of linseed does not require large material costs, as the cost of cultivation is on average 1.1-1.3 times cheaper than sunflower production. The cost price per hectare is 8-10 thousand UAH, and the profit from one hectare reaches 8.0-11.5 thousand UAH. per ton and the yield is 0.7-0.8 c/ha, therefore the profitability is positive [9].

Flax is one of the few promising niche agricultural crops whose economic potential for agribusiness remains almost unknown. In world agriculture, this culture has been known for a long time, but in recent years it has been almost forgotten by domestic agribusiness. In our conditions, both flax and oil flax are grown. Flax is a spinning agricultural crop, from the stem of which fibers are formed with valuable technological properties - flexibility, thinness and high strength. Linseed oil is a culture from which raw materials for the production of technical oil are obtained. Flax is of special agrotechnical importance as the best predecessor of winter grain crops. In addition, flaxseed is in demand as a useful food dietary supplement, and its meal has a high feed value compared to others.

Despite the universal nature of the use of its various species and the important importance in the diversification of agribusiness, the sown areas of long-leaved flax have decreased quite significantly since the beginning of the 2000s, while in some years almost 70 thousand hectares were sown. oil flax. Since 2017, there has been a steady trend towards a reduction in the sown areas of all types of flax. In fig. 1 shows the dynamics of changes in the cultivated area of long-leaved flax in the country.

If we estimate the domestic market demand for long flax today, it is insignificant to interest the farmer to expand the cultivated area. Spinning flax as a separate industry began to decline in the early 2000s. Even today, farmers have changed the direction of specialization in flax growing and are more engaged in the cultivation of oilseed flax as a more competitive agricultural crop.

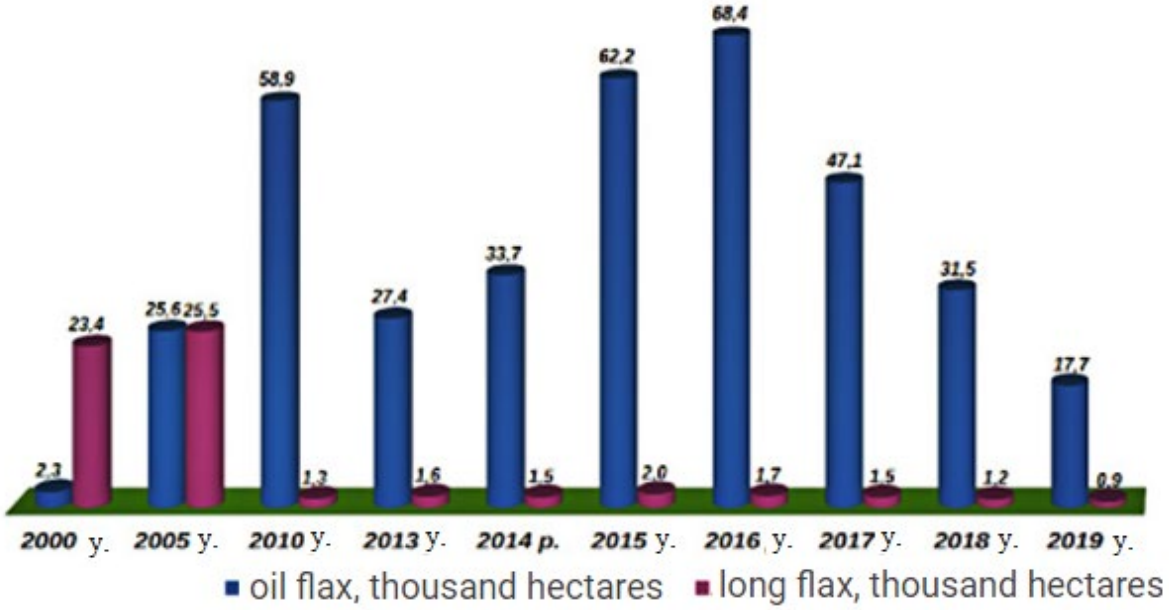

Figure 1 – Dynamics of changes in flax sown areas in all categories of farms in Ukraine for the period 2000-2019

According to many experts of the agricultural market, the cultivation of linseed is one of the most profitable medium groups of non-marginal traditional oil crops. Few people know about the real competitive advantages of linseed cultivation, which ensure its profitability at levels of 100% and higher.

First of all, in this market, the crop is in high demand among traders due to its high oil content, which on average for different varieties is from 44% to 50%, and among farmers - due to the yield of up to 2.0-2.5 t/ha and above. with low production costs during cultivation and minimal use of pesticides. Purchase prices for flax are less dependent on seasonal fluctuations and market conditions than sunflower or other. They also refer to export prices, which are almost an order of magnitude higher than traditional grain and oil crops. In the table 1 shows the import and export of flax by enterprises of Ukraine for this analysis of customs statistics information.

Analyzing the data in the table. 1, it can be concluded that today there is a significant demand for global agricultural products on the domestic market, which are bought in many countries of the world at a fairly attractive price. In 2016-2017, the average annual export price of 1 ton of flax product reached almost $3,000, while for rapeseed, for example, it did not exceed $394.8-412.7.

That is, the difference in profitability of the export of 1 ton of these agricultural crops is actually almost 7 times higher than the sale of flax. At the same time, the total amount of flax exports during 2011-2019 reached 11-57 thousand tons.

Table 1 – Import and export of flax by enterprises of Ukraine

Years	Import volume, t	Price, $ thousand	Average import price of 1 t, $	Export volume, t	Cost, $ thousand	Average export price of 1 t, $
2011	137	110	802,92	10694	18640	1743,03
2012	184	162	880,43	22684	44956	1981,84
2013	84	45	535,71	7087	10935	1542,97
2014	75	83	1106,67	10221	22106	2162,80
2015	127	142	1118,11	12389	29462	2378,08
2016	133	134	1007,52	15300	44089	2881,63
2017	134	72	537,31	19394	56919	2934,88
2018	569	1522	2674,87	5878	12909	2196,16
2019	227	486	2140,97	5887	11269	1914,22

The agrotechnics of growing linseed in Ukrainian fields is well-developed and provided that the technology is strictly observed, soil cultivation and crop care are carried out in a timely manner, as well as the use of high-quality seed material can provide an average yield in the range from 1.5 t/ha to 2.5 t /ha and above.

which, in 2019, in all categories of farms in the Poltava region on a total area of 1.2 thousand hectares, the average yield of oil flax pollution was 1.56 t/ha, and in Lviv and Khmelnytskyi regions, respectively, on 0.7 thousand hectares and 0 ,8 thousand ha, it was about 1.46 t/ha and 1.47 t/ha.

A rather important advantage of flax is that it is a drought-resistant crop due to the peculiarities of the root system. And this is more relevant today than ever for farmers when choosing additional insurance agricultural crops in conditions of unpredictable climate changes and an increase in the area of the territory, which have a negative impact on drought and risk crop loss due to insufficient moisture supply.

There are separate agrotechnological aspects of flax cultivation. This culture requires heat. Flax seeds begin to germinate at a temperature of 3-5°C. However, the specified agricultural crop also essentially depends on the heat precisely in the period during the achievement. This should be kept in mind when planning sowing dates and selecting the appropriate variety for a specific natural and climatic zone of cultivation together with its agricultural technology.

Another agrotechnological aspect of growing occurs in what is demanding on the state of fertility. It is generally known that the best grounds for it are chernozems. At the same time, in the opinion of experts, flax does not compete on heavy waterlogged and saline soils. In addition, it is necessary to know that during the formation of 1 ton

of the crop by weight of content, it carries 2-3 times more nitrogen, phosphorus and potassium from the base than grain crops. Taking into account this fact, flax crops should be placed, first of all, on the basis of a sufficient content of available living substances, which positively affects the development of plants and the formation of the future harvest. However, do not forget to apply optimal amounts of mineral fertilizers. Their dose should be determined on the basis of the planned level of productivity and, after carrying out a corresponding calculation analysis, justify the content of available living substances.

The average seeding rate is from 35 kg to 50 kg per hectare. The more arid the growing area, the higher the sowing rate should be. The approximate market price for the cost of 1 reproduction today is from UAH 24,000 to UAH 30,000 for 1 ton. Commodity consumption costs less. A separate segment of the agricultural market is occupied by organic flax, where the sales price starts from UAH 68-70 thousand per ton.

Given the predicted production costs per hectare in the amount of UAH 17.56 thousand, taking into account the cost of sowing, fertilizers, plant protection products and rent, together with other items of the cost of production, the profitability of growing oilseed flax will be determined by two factors: the obtained average yield and the price of products [10].

In Fig. 2 shows a diagram of the rentability of linseed cultivation in 2019.

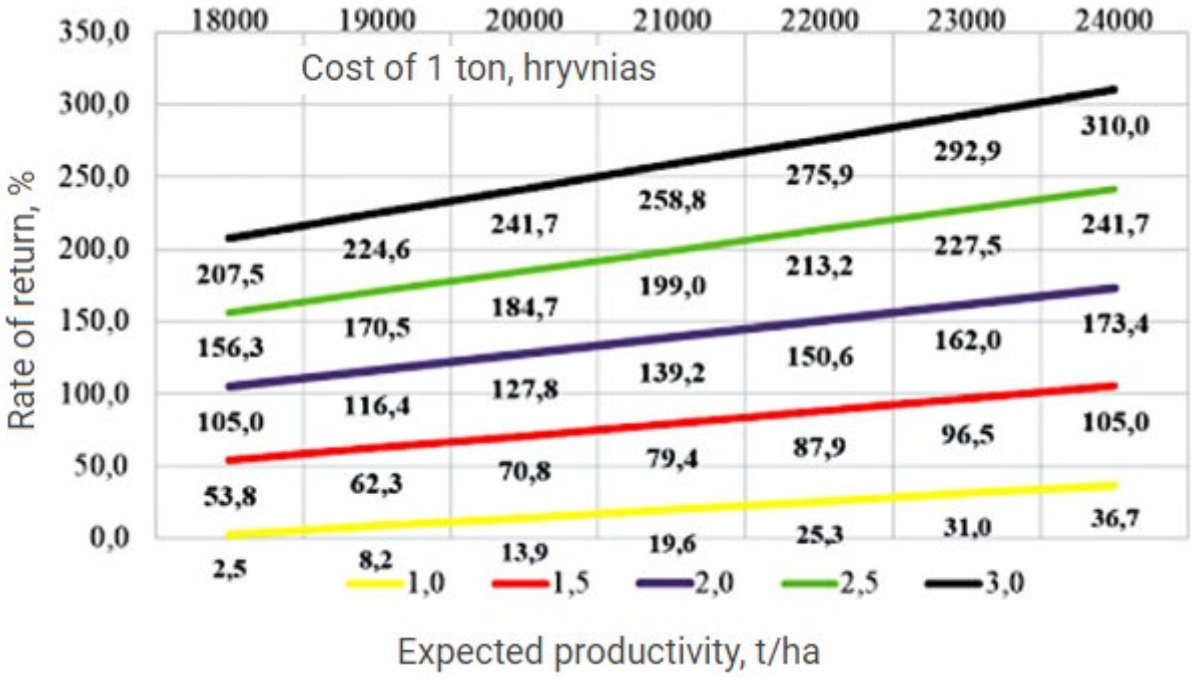

Figure 2 – Diagram of the profitability of flax cultivation oil in 2019

Analyzing the data shown in fig. 3, it can be concluded that with a yield of 1.5 t/ha and a sales price of 18-19 thousand UAH/t, it is possible to obtain a level of profitability no lower than when producing rapeseed or sunflower. The maximum profitability of oilseed flax production can be obtained under the condition of achieving a high yield at the level of 3 t/ha and a favorable price situation at the rate of 22-24 thousand UAH per 1 ton of seeds.

According to the analysis of customs statistics, the average export price of flax seeds for 10 months of 2019 was about UAH 48,000.

A large assortment of varieties, their diversity, high profitability contribute to the rapid spread and annual increase of the cultivated area of this crop. In fig. 3 shows the dynamics of flax cultivation in 2012-2021.

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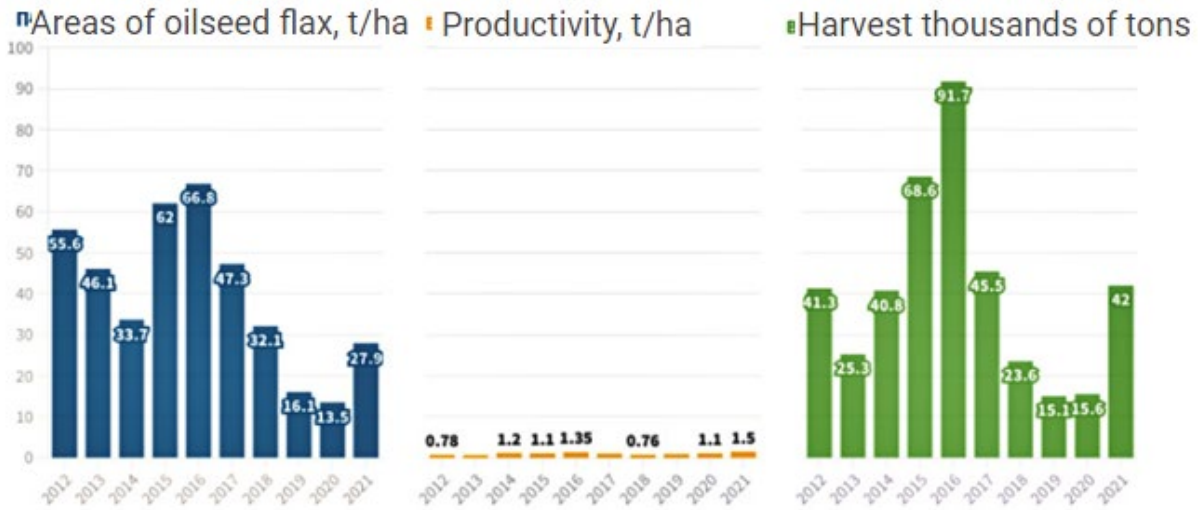

Figure 3 – Dynamics of oil flax cultivation

On average, 25,000-35,000 hectares of oilseed flax were sown in Ukraine over the last decade. According to the statistics service, the largest area was recorded in 2015-2016, and the smallest - in 2019-2020.

The graph also shows lower yields, possibly less than 1 t/ha. Although the productivity potential can reach 2-2.5 t/ha. Unfortunately, in 2022 the indicators are lower than in 2021. After all, the southern region is the leader in the cultivation of flax. The formation of the price of linseed oil is influenced by the global dynamics of prices for agricultural products. In recent years, the price of flax seeds on the domestic market has fluctuated between UAH 10,000 and UAH 27,000/ton.

In fig. 4 shows the average prices for commercial linseed oil in the domestic market of Ukraine in 2018-2021.

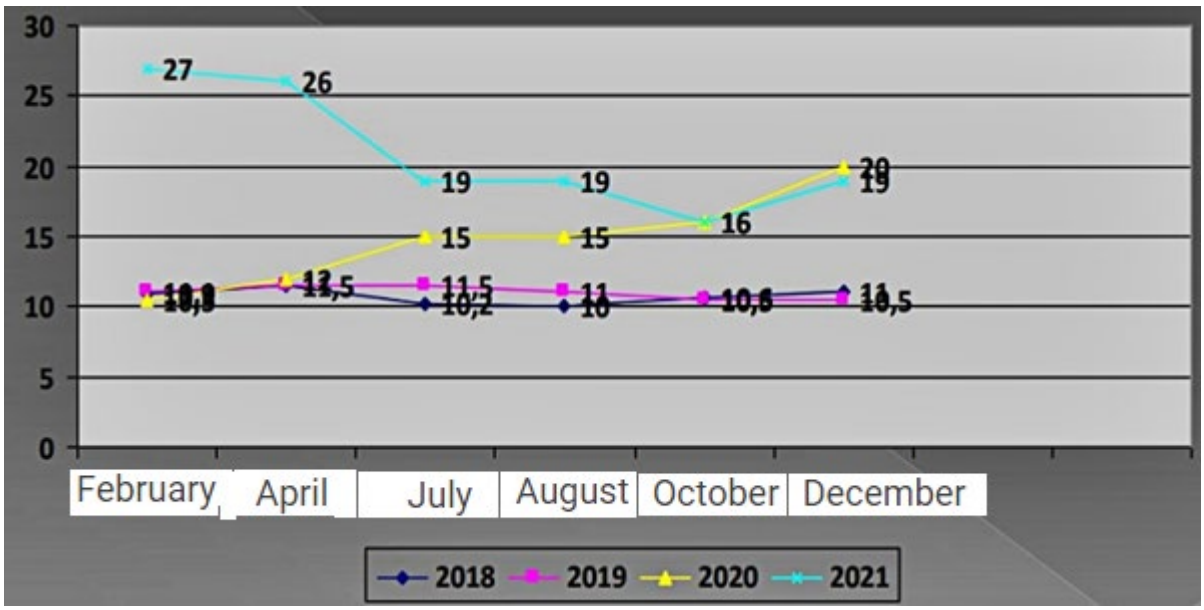

Figure 4 – Average prices for marketable linseed oil on the domestic market of Ukraine in 2018-2021

According to UkrAgroConsult, in the 2022 production season, the highest purchase price of oilseed flax remained at the level of 21-22 thousand UAH. It should be noted that organic flax occupies a separate segment of the agricultural market. Its sale price is 68-70 thousand UAH/t. It should be noted that during the last decade, flax was mainly an export crop. Although from 2018-2021, purchases by domestic processors intensified. Ukrainian farmers sell grown seeds mainly on Internet sites or social networks. The main export directions are potential clients of the EU countries, since this market is relevant for Ukraine not only from the point of view of the economic situation, but also from the point of view of logistics, since it does not depend on the existing sea corridors.

Thus, on the basis of the above, it can be concluded that the advantages of growing oil flax include: firstly, that oil flax is not demanding on natural conditions. Flax is cold-resistant, so it is sown immediately after spring barley. Flax seeds begin to germinate at a soil temperature of 3-5°C, and at 7-8°C they can germinate in 5-7 days. Seedlings withstand short-term frosts up to -3-4°C. Secondly, oil flax loves moisture, but tolerates drought well. The advantage of flax is its drought resistance due to the peculiarities of its root system. This is due to arid climatic conditions. Thirdly, it does not break. The growing season lasts 84-86 days. Seed moisture is not a problem. Although the harvest begins in August, it can be idle until mid-to-late September. At the same time, it does not crumble. Fourth, a small amount of seed material. The standard flax sowing rate is 4.5-5 million seeds/ha, i.e. 30-35 kg/ha. However, some

practicing agrarians said that the rates could be reduced.

The disadvantages of flax cultivation include: firstly, oilseed flax has high requirements for soil fertility. Flax has a higher yield on chernozem, and it is not recommended to sow flax on heavily waterlogged and saline soils. In addition, it is recommended to plant crops mainly on soil with a sufficient content of nutrients. Secondly, linseed is a crop with a small leaf area and cannot compete with weeds. Therefore, special attention should be paid to prevention and control before and after sowing. Thirdly, plant protection methods. Crops are sprayed to protect against pests such as fusarium, anthracnose, rust and flax flea. Affected flax crops are sprayed with herbicides from a tank mixture. Fourth, flax needs fertilizer. Sulfur is added to the soil before planting. Phosphorus and potash fertilizers are applied during the main plowing, and nitrogen fertilizers in the spring. Flax requires compliance with agricultural cultivation techniques. In addition, they will differ for different agro-climatic conditions.

Based on the advantages and disadvantages of growing linseed oil, it can be concluded that linseed is a profitable crop, the cultivation of which costs less than traditional linseed crops. However, you need to develop your own cultivation strategy that will allow you to get high yields. The issue of the sale of seed material remains unresolved. On the one hand, the price of flax is higher, but at the same time it is mainly an export crop. Therefore, traditionally, logistics costs and risks will fall on farmers' wallets and reduce profitability [11].

2.2. Use of linseed oil in the food industry

The consumption of flaxseed and flaxseed oil has become very relevant now. The therapeutic effect of flaxseed is that it contains lignans, which have a wide spectrum of biological activity with antibacterial, antiviral and antifungal effects. Polyunsaturated fatty acids, soluble dietary fibers have an anti-cancer effect, they are called the elixir of youth. In this regard, flax should become a raw material not only for oil and fat products, but also for the production of a wide range of products: bakery, cereal, confectionery, culinary, as well as food additives based on flax processing products. Therefore, the main task of domestic breeders is to create new varieties of flax that would meet the requirements of industry for food purposes, taking into account the need to preserve the functional properties of flax in the process of storage and

processing into food products [1-3, 12].

However, with the growth of export prospects for the sale of linseed, the issue of processing large volumes of stem material of this crop arises. The requirements for food products are increasing - they must not only meet the formed, traditional tastes of consumers, but also belong to the category of healthy food products, not harm the human body, but strengthen it. A new need has arisen in nutrition, in which not only useful, but also ballast substances - food fibers - are recognized as a necessary component of food. In developed countries, the first place is occupied by cardiovascular diseases and oncological diseases. Given the need to prevent such diseases, the food and processing industries implement the task of creating such products that will improve and preserve human health from new sources of biologically valuable food products [4-7, 13].

Distinctive features of flax are the yellow color of the seeds, a thin shell and a low content of linolenic acid. To date, the technology of the flour milling process has been developed, which makes maximum use of the phytochemical potential of the processed raw materials, which involves grinding of grain, which allows obtaining new products of grain processing based on its division of the seed into separate parts: the seed coat, embryo and endosperm as sources of substances. which are used for the prevention of oncological, cardiovascular, gastrointestinal, kidney diseases, diabetes, arthritis and strengthening of immunity. In addition, new varieties of flax are known, containing the fatty acid composition of edible flax close to wheat flour, which provides the possibility of its better storage [14].

The high content of fat in flax flour and bran will allow to enrich wheat flour with fatty acids and obtain new products with increased nutritional, biological and medicinal properties. The greatest advantage of bread with the addition of flax flour and flax bran should be considered its consumer properties, namely taste and smell. Such linseed must comply with safety in accordance with established regulatory documents. A balanced and nutritious diet is absolutely necessary for the full development and life of a person. However, with the development of the chemical industry, the nutritional value and quality of many food products cause not only great doubts, but also the loss of their usefulness. One of the modern trends in the food industry is the introduction of new zero-waste technologies. This implies an increase in the degree of processing of agricultural raw materials with a more complete extraction of useful components from it, and the problem of developing the technology and formulation of enriched food products follows from this. Thus, the use of new processing technologies of flax seeds

allows to isolate from them such biologically active compounds as sterols, squalene, vitamin E and a number of other compounds, and to create on their basis new groups of domestic biologically active drugs, including drugs for medical and medical-hygienic purposes . According to experts' calculations, the value of biologically active substances from flax can reach 80,000 USD per 1 ton of processed flax raw material [15-20].

As for the dairy industry, new technological processes are aimed at the full use of all constituent parts of milk, its complex processing into various food and feed products and semi-finished products. Enterprises are creating specialized workshops and sections for the processing of by-product milk. Complexes of equipment and technological lines for the processing of skimmed milk, whey and milk whey using traditional and new processing methods are being developed.

In the last decade, there has been a clear tendency to increase the production and consumption of low-fat dairy products, in the production of which by-products are widely used. A diverse assortment of drinks and semi-finished products, desserts, puddings, ice cream, and jelly products is produced from skimmed milk, whey, and whey. Flaxseed is currently very popular as a food supplement. Bakery products with the addition of flaxseed acquire both a delicate taste due to the large amount of fat and an attractive-looking crust. Studies have shown that consuming bread enriched with flax seeds for four weeks reduces cholesterol by 7-9%. The possibility of using flax flour for the preparation of gluten-free confectionery has also been proven [20-24]. Proteins and glutinous substances of flaxseed are used in such food products as ice cream, powder sauces and soups.

Flaxseed oil has a unique composition of fatty acids, which is expressed in a high level of polyunsaturated essential fatty acids (PUFA), which are so important for the healthy functioning of the human body. Doctors in Western countries advise patients to add 1-2 teaspoons of linseed oil to their diet to prevent any cardiovascular diseases and alleviate the course of diabetes. It has been established that linseed oil improves the adaptation of newborns, stimulates lactation in women, increases immunity in children with lung diseases, and shortens the duration of treatment for peptic ulcer disease. An improvement in the composition of the blood due to a decrease in the total level of cholesterol was revealed [25].

Margarine, as you know, is a food fat made from a mixture of vegetable oils and animal fats, milk and some other components. Until recently, margarine was made using liquid refined and deodorized vegetable oils. Sunflower, soybean, cottonseed,

sesame and coconut oil were used in most cases. The production of margarine and other soft oils with a reduced content of animal fats has become widespread in connection with the desire to limit cholesterol-forming foods, which include animal fats, in the diet. After discovering the medical and biological benefits of linseed oil, the margarine industry, primarily in Canada and the USA, switched to using linseed oil.

After pressing the oil from the linseed, a cake remains. The level of protein in it increases in proportion to the amount of oil obtained and varies from 25 to 54%. Previously, cake was used only for fodder purposes. Recently, technologies for the production of food products: flour and proteins from flax products are developing rapidly. From flax seeds, you can get up to 70% of complete proteins in the form of complexes from their entire quantity, including more than 20% of pure protein. Currently, there is a food-grade semi-defatted flaxseed flour on the market. It is suitable for use in the food industry in the production of bakery, confectionery and food concentrates, for the enrichment of products with protein, dietary fibers and polyunsaturated fatty acids [26, 27].

Due to the need to use natural emulsifiers and stabilizers, today flax flour is used as a structure-forming natural component of natural origin in the production of mayonnaise. The introduction of flax flour into mayonnaise compositions makes it possible to influence the formation and stabilization mechanisms of oil-fat emulsions, change their viscosity, and increase resistance to thermal oxidation.

Thanks to the structure-forming properties of semi-defatted flax flour, a whey-based dessert product with a jelly-like, loose consistency has been developed. As a result of the calculations, it was established that the energy value of the mixture of milk whey and flax flour is low and amounts to 32.45 Kcal per 100 g, and the biological value is quite high, since the mixture is rich in essential amino acids. . In addition to flour and whey, mixed in a ratio of 1:7, citric acid and cherry syrup were added to the product to give the dessert a delicate taste and a pleasant shade. The product contributes to the full functioning of the gastrointestinal tract, ridding the body of toxins, parasites and lipids.

The main problem in processing flaxseed to extract the protein component is that the seed coat contains polysaccharides that bind the protein molecules during extraction, making it difficult to precipitate and purify the protein during its extraction. In flax seeds, the shell is firmly attached to the core, and its removal by traditional grinding methods is impossible, so flax is processed without separating the shell. In this regard, a technology was developed, which includes preliminary washing of flax

seeds with the help of a vibrating extractor. This makes it possible to obtain polysaccharides from the seed coat, as well as to obtain a new product - flax seed mucilage [28]. In connection with the appearance of a new by-product of flaxseed processing, a fermented milk product based on skimmed milk with the addition of flaxseed mucilage was developed. Thermophilic streptococcus, which has a beneficial effect on human microflora, is able to synthesize and release polysaccharides into the environment during fermentation, which make dairy products denser and slow down their delamination. With long-term systematic intake, the developed product can lead to a decrease in the activity of inflammation of the gastric mucosa. It is also possible to use it, both in the treatment of exacerbation of chronic gastritis, and for the prevention of relapses of the disease, thanks to the content of medicinal flax seed mucus in it [1, 20-24].

Based on the analysis of the nutritional value of linseed oil, it can be concluded that it is a valuable industrial raw material with a high content of phytochemical properties, which allows to increase the biological value of food products. Therefore, today's urgent task is to create functional products from natural raw materials, safe for humans, which should be affordable, nutritious and useful.

In fig. 5 shows examples of the use of linseed oil in the food industry.

Analyzing fig. 8 and the above material, it can be concluded that linseed oil is widely used in the food industry, the main reason being the healing properties of the seeds and its processing products. In Ukraine and on the world market, the number of technologies and recipes based on the use of linseed is increasing every year. Therefore, the further implementation and development of recipes for the production of food products of a wide range of applications will be relevant, taking into account the need to develop functional recipes [1, 20, 25].

In addition, linseed oil is widely used in cosmetology. In fig. 6 shows examples of the use of linseed oil in cosmetology.

The unique properties of flax are related to its chemical composition. The high content of essential oil, omega polyunsaturated acids, vitamins F, A, B, E allows flax seeds to actively influence the human body and restore its normal functioning. Saturated organic acids, vegetable mucus, enzymes and phytoestrogens provide an additional strengthening and health-improving effect.

Figure 5 – Use of linseed oil in the food industry

The main field of application of linseed abroad, in addition to the use of seeds, is the reinforcement of composite polymer materials with linseed fiber. Reinforcement of composite materials can be carried out by oriented or non-oriented fiber and non-woven materials obtained from it, yarn or even fabric. Composite materials reinforced with plant fibers are most widely used in the automotive industry. In this case, various natural fibers can be used to reinforce structural polymer materials: flax, hemp, jute, sisal, coconut. In countries with a developed automobile industry, these materials are usually imported [1-4, 29, 30].

Figure 6 – Use of linseed oil in cosmetology

Cars are increasingly using strong, corrosion-resistant, lightweight polymer composites. In modern cars, they are more than 10% by weight and their content is constantly increasing. Recently, there has been a trend towards an increase in the share of technical textile goods on the market of Ukraine. However, this growth is ensured not by a significant increase in the volume of domestic production, but by imports [2, 3, 29, 30].

The main products of the European Union are food and feed products from hemp and flax, namely the seeds obtained from them for the manufacture of pharmaceuticals. Oil is usually made from linseed for medicinal purposes, it is a more concentrated and effective remedy, but it is much easier to make a paste or infusion from it at home. To do this, the powdered seeds are mixed with warm water in different proportions (more water for infusion, less for paste). Adding seeds to your diet is an easy way to increase your fiber intake. For example, 20 g of chia seeds contain 6.8 g of fiber, flax - 5.4 g,

and pumpkin seeds - 1.3 g.

In fig. 7 shows examples of the use of linseed oil for the production of pharmaceutical preparations.

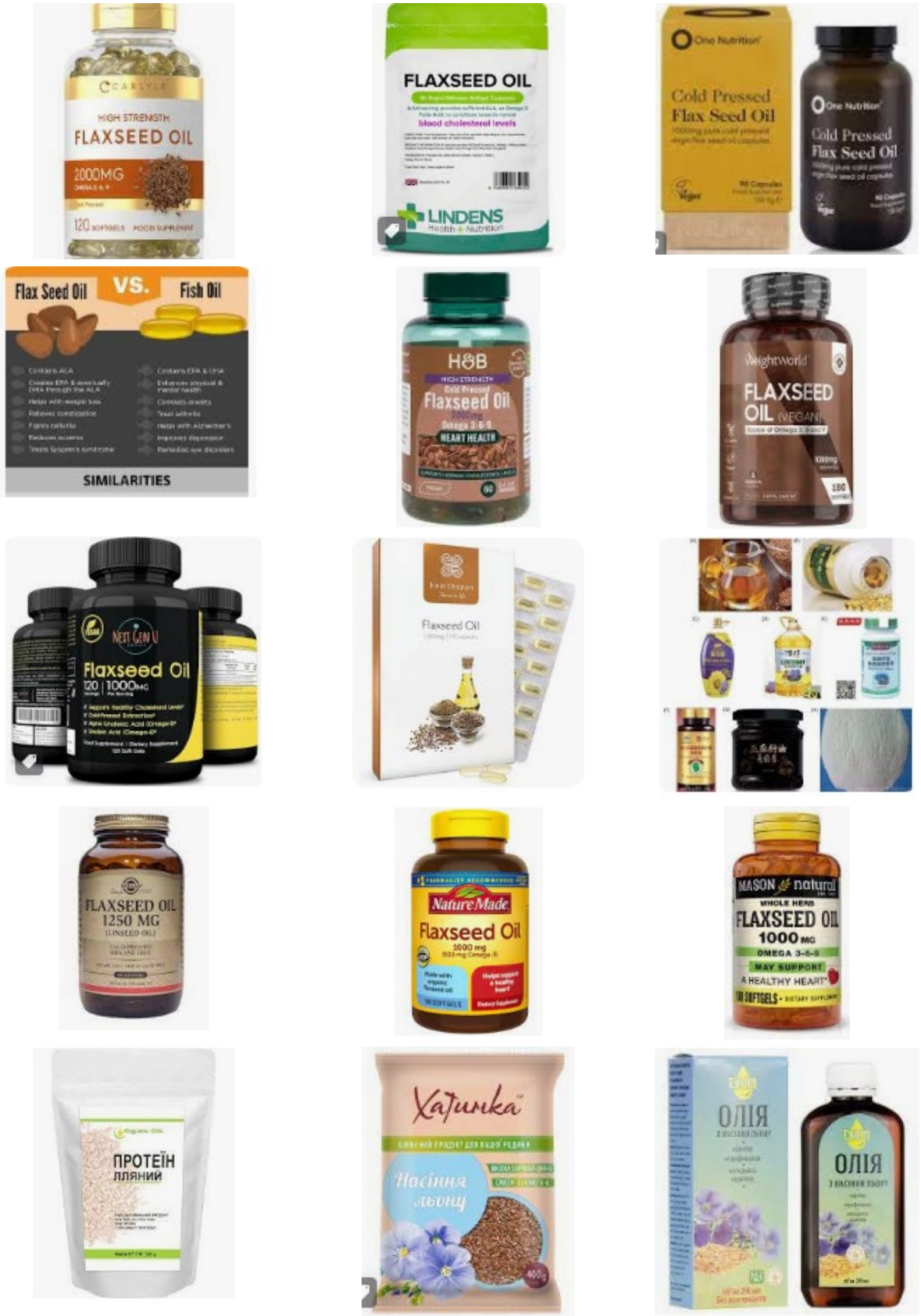

Figure 7 – Use of linseed oil for the production of pharmaceuticals

In Ukraine, linseed is exported as sowing material and as raw material for use in Europe for the food and cosmetic industry. The main part falls precisely on raw materials for industrial processing. In 2018–2019, the number of organic products increased: in 2018, such seeds made up 6% of the total mass of supplies, and in 2019, they accounted for 14% [5-9]. However, until now in Ukraine there are no studies of the quality indicators of this product and regulatory documentation for their determination. As a rule, the quality of "superfoods" is evaluated according to the technical conditions developed by the manufacturer himself.

In domestic publications, there is a complete lack of information about state regulatory documents, according to which it is possible to evaluate the quality and consumer characteristics of functional products made from linseed oil. Unfortunately, the existing legislative and regulatory framework of foreign manufacturers is not available to us.

Conclusions

Thus, on the basis of the conducted analysis of the use of linseed oil, it can be concluded that the area of use in the food industry is difficult to overestimate in connection with the discovery of new properties of the seed. Therefore, from the point of view of ecological safety and balanced use of nature in agro-industrial production, innovative ways of using linseed oil will allow to fill the market of Ukraine with domestic ecologically safe food products, which have tendencies for wide implementation in all spheres of modern production of the food industry, aimed at the production of innovative food products of various functional purposes.

Based on the analysis of the nutritional value of linseed oil and seeds, it can be concluded that it is a valuable industrial raw material with a high content of phytochemical properties, which allows to increase the biological value of food products. Therefore, the urgent task today is to create functional products from natural raw materials that are safe for humans and should be affordable, nutritious and useful. Linseed oil is one of the natural raw materials that has great potential in the production of food products of a wide range of applications. As mentioned above, the possibility of growing flax for seed and oil will provide consumers with fiber products and vegetable fats.

The analysis of literary sources allows us to conclude that the number of

innovative technologies known today that affect the quality of the products is constantly increasing, and the methods of determining the quality of new products are insufficient. However, for the development of the flax industry, it is necessary not only to harmonize the existing regulatory framework, but also to study additional consumer properties taking into account their impact on the human body, namely hygienic, antiseptic, biological properties, as well as energy and therapeutic value. Since, in the future, these products will be used not only within the country, but also on the European market.