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Ecological Assessment Of Spring Oilseed Crops And Prospects For The Production Of Superior Quality Oils In Ukraine.

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ABSTRACT

The article is devoted to the study of the issue of growing spring oilseeds in Ukraine and the production of high-quality oils. It was given the comparative ecological assessment of sunflower, Camelina (Camelina sativa), linseed flax and other crops of their placement in crop rotations, it was highlighted the importance of quality oils and the possibility of their improvement. It was proved that instead of the usual commercial cultivation of sunflower, it was advisable to occupy most of the areas with high-oleic type hybrids, and other oilseeds as well as alternative to sunflower, which provided high profitability of production. It was determined that the sunflower hybrids and varieties of linseed flax and Camelina (cultivar of the Steppe 1) reacted positively with increasing of seed yield on nutrition optimization through the application of modern biological products. Thus, the yield of flax varieties on average for two years in all studied preparations increased by 0.27 t/ha (26.2%), and the most optimal variant did by 0.34 t/ha and 33.0 %. Respectively, the yield of sunflower hybrids increased by 0.48 t/ha (29.8%) and the most optimal variant did 0.70 t/ha; 43.5 %. Similarly, and the yield of Camelina even more significantly increased on average for three years of cultivation. It was considered prospects of production of oilseeds and improved quality oils. It was shown that the expansion of the range of oils due to soya bean oil, Camelina seed oil and linseed oil promote a healthy lifestyle.

Keywords: high-oleic sunflower, Camelina, linseed flax, soy, fatty acid composition, balanced content of ω-3, ω-6 fatty acids, blended oils.

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INTRODUCTION

The market of oilseeds is one of the most promising for Ukraine. Oilseeds are in demand in the world and domestic market; they provide profitability of agricultural enterprises. The area under most oilseeds grows annually, however, mainly due to sunflower, but modern conditions require changes not only of the quantitative indicators but they also require changes of the qualitative indicators of products after processing of specific crops. Trends in the healthy lifestyle spreading would lead to the decreasing of the use of animal fats and the increasing in the consumption of vegetable oils and with high levels of their quality additionally.

In Ukraine, in the group of oilseeds, sunflower has the largest acreage, which accounts for almost a quarter of world production, and its gross harvest in recent years has reached 11-13.6 million tons (table.1).

In addition to the acreage of soybean crop, rapeseed (0.7-1.2 million hectares) and mustard (50-70 thousand hectares) occupy the following places from the total acreage of spring oilseeds, their acreages vary significantly over the years. An important culture of this group of oilseeds is Camelina, but its potential is not yet determined enough, the intensive cultivation technology of Camelina is practically absent, that crop acreage is still very small then.

At the same time, taking into account the very large areas under sunflower in Ukraine and its ability to dry the soil, besides the lack of precipitation and modern climate change, the urgent relevance of the search for alternative oilseeds rises for competing with sunflower. In our opinion, it is necessary to consider less common and even insufficiently studied cultures, such as oilseed flax, varieties of mustard, oilseed radishes, Camelina and others. In particular for the stabilization of oil production volumes it is proposed to solve the ecological problems of optimization of structure of sowing areas by expanding the list of oilseed crops with Camelina which is still rare in Ukraine. After all, in the days of KievanRus one of the most popular oil was Camelina seed oil along with linseed oil and hemp oil [1].

Table 1: Production of main oilseeds in Ukraine in 2014-2016*

crop	Crop acreage, thousand ha			Yield, t/ha			Gross yield, thousand tons		
	2014	2015	2016	2014	2015	2016	2014	2015	2016
Sunflower	4,987	4,962	6,073	2,00	2,23	2,16	9,995	11,087	13,627
rapeseed	1,058	0,671	0,455	2,59	2,63	2,59	2,236	1,768	1,154
Soya	1,700	1,967	1,869	2,16	1,88	2,16	3,687	3,694	4,277
In total	7,552	7,600	8,397	-	-	-	15,918	16,549	19,058

*** According to the State statistics service of Ukraine**

Camelina could be an alternative to the sunflower and the spring rapeseed due to its high agro-ecological plasticity to the growing conditions. It has a short period of vegetation and it is able to effectively use the moisture reserves, Camelina could be grown as an intermediate crop for reseeding of winter crops. In comparison with other crops of the cabbage family Camelina is almost not infested by pests and it is not affected by diseases, and Camelina also provides a stable yield of seeds in various soil and climatic zones [2-4]. In particular, Camelina is characterized by high resistance of pods to the shedding of seeds compared to rape, which allows to combine harvesting it according toits minor crop losses.

In recent years the interest to the valuable crop of Camelina is growing due to the oversaturation of crop rotations with grain and sunflower, as well as due to the high quality of vegetable oil from it. Camelina seed oil has a valuable composition of polyunsaturated fatty acids: linoleic (omega – 6) – 15-25 %, and alpha-linolenic (omega – 3) – 50-55% with a relatively low content of erucic acid, which indicates the possibility of its widespread use as a food, therapeutic and dietary oil [5-6]. The possibility of formation of stable productivity of Camelina with high quality of seeds is determined for the cultivation of that oilseed and a number of other spring oilseeds in the Western Forest Steppe [7].

MATERIALS AND METHODS

The study of Camelina, sunflower and linseed flax were carried out in the conditions of academic and research practical center of Mykolaiv NAU for 2014-2017 yrs. The soil of experimental plots is presented by the southern Chernozem. the soil layer of 0-30 cm contains humus (after Tyurin) – 2,9-3,2 %, light-hydrolyzed nitrogen 62 mg/kg of soil, nitrates (after Grandval-Lajoux) – 20-25 mg/kg of soil, mobile phosphorus (afterMachigin) – 36-40 mg/kg soil; exchangeable potassium (X-ray photometer) – 320-340 mg/kg of soil, pH is 6.8 to 7.2.

In one of the experiments, the object was Camelina of the spring variety Steppe 1.Two-factor experiment: Factor A is presowing treatment of seeds. 1) processing of seeds by water as control; 2) processing of seeds by Urea-K6; 3) processing of seeds by Escort-Bio; Factor B is foliar dressing 1) processing by water as control; 2) processingby Urea-K2; 3) processing by yellow Crystallone; 4) processingby Crystal D2; 5) processingby Escort Bio.

Plant nutrition with those preparations was carried out in the phases of full germination, flowering, filling of seeds, as well as in all these phases. Plants were treated with biopreparations Urea-K2, D2 and yellow Crystallone at the rate of 1 l/ha, and an Escort of Bio – 0,5 l/ha at the norm of working solution of 200 l/ha. In the planting day seeds were manually processed with biological products according to the scheme of experiment at a rate of: Urea K6 – 1 l/t of seeds, with 10 % concentration of the working solution, and the Escort Bio 500 ml**/** seeds hectare rate with 1 % concentration of the working solution.

For the study it was taken hybrids of high-oleic sunflower such as NC Ferti and Tutti which have been introduced into production in recent years.

The scheme of experiment with sunflower is given in Table 2 and Table 3.

In 2016-2017yrs the study of linseed flax was carried out with varieties of Vodogray and Orpheus according to the scheme presented in the Table4. The crops of plants in the phase of formation of herringbone and the beginning of budding were treated with a preparation "Nutrivant plus" at the rate of 2 kg/ha Before sowing it was applied the complete fertilizer $N_{30}P_{30}K_{30}$, which served as a background.

The replication of those experiments was three-foldup to four-fold, the area of cultivated plots was 45-60 m^2, the area of registration plots was 30-36 m^2.

The agricultural technique of growing of the studied crops was adopted by the zonal technology for the Steppe zone, except for the factors taken for study.

Weather conditions in the years of study were somewhat different, but they were typical for the southern Steppe zone of Ukraine.

The study and determination were performed according to the generally accepted methods and state standards.

RESULTS AND DISCUSSION

In our studies, conducted in the most optimal variants with Camelina the yield of its seeds was obtained at the level of 1.6 t/ha. It was determined the positive reaction of the culture on the processing of seeds before sowing and plants in the main phases of vegetation by modern growth-regulating biological products (Fig.1).

As determined by the study, the yield of Camelina significantly depends on the treatment of seeds and sowing of plants with biopreparations, their selection and the period of foliar dressing. It should be noted the yield to the greatest degree rises in consequence of the combination of threefold seed treatment by Escort-bio of plants in the phase of full germination, flowering and filling of seeds. However, almost the same level of productivity is formed by the background of seed treatment by Urea K6 of plants once in the phase of seed filling, which clearly illustrates Figure 1.

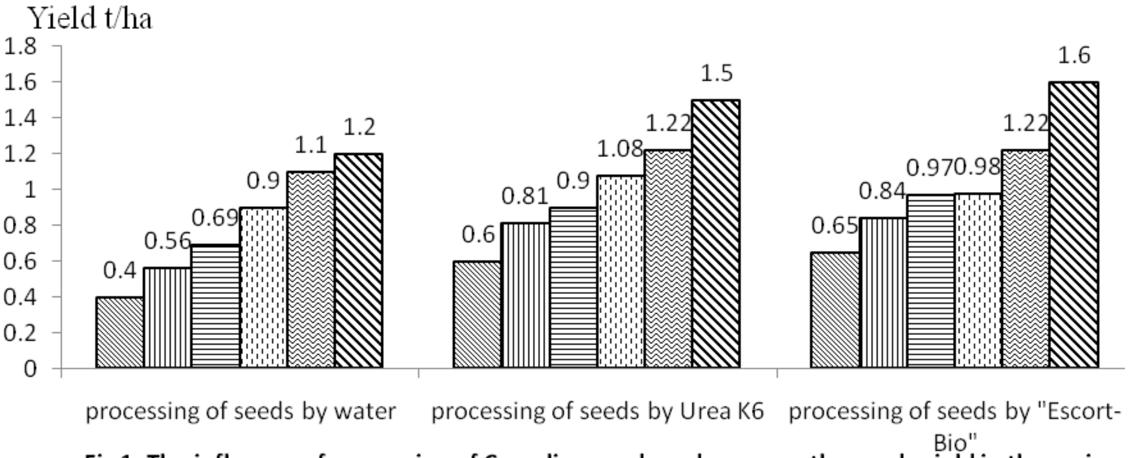

Fig 1: The influence of processing of Camelina seeds and crops on the seeds yield in the main stages of vegetation ((average in all studied biopreparations and yellow Crystallone in 2014-2016yrs)t/ha

This resource-saving approach to nutrition of a relatively new crop of Camelina showed that in addition to significant crop growth (by 396.2% compared to absolute control), the quality of seeds was significantly improved. Thus, it formed a sufficiently high oil content-39.6-41.2 % depending on the variant and significantly improved its quality composition.

The content of palmitic acid, stearic acid and eicosan acid (C16:0; 18:0 and C20:0) is slightly reduced compared to the control, and the content of oleic acid (C18:1), linoleic acid (C18:2) and linoleic acid (C18:3) was increased, on the contrary. In particular the content of linoleic acid was increased from 45.82% to 53.06 – 54.47% while by reducing the content of erucic acid (C22:1) in accordance with 1.95 to 1.29 – 1.71 %.

Growing sunflower in different areas of Ukraine it should be provided the advantage primarily to high-oleic hybrids, which oil, unlike conventional, contains of 70-80% oleic acid, as well as soy, rapeseed, Camelina and linseed oils. It is known it would be grown and produced sunflower oil most of all in Ukraine. The main consumer of high quality sunflower oil is the population of Europe. More than 10 years ago, scientific institutions in Europe began to create new varieties and hybrids of sunflower with a changed composition of oil. High-oleic sunflower gradually displaces conventional hybrids in the fields of Europe not only due to the unique properties of the oil, but primarily due to the higher purchase price of commercial sunflower with a high content of oleic acid [8]. In recent years along with the cultivation of traditional sunflower farmers of Ukraine are working on elements of technology for the production of high oleic sunflower hybrids.

Our study of two high-oleic sunflower hybrids determined nutrition backgrounds to be taken for studying significantly influenced on the yield of their seeds.

This most important indicator depends on the studied factors and changes under the influence of weather and climatic conditions (Table2).

Tutti, the hybrid of high-oleic sunflower was more productive in the conditions of the experiments. The yield of its seeds was 8.7% higher than its level in hybrid NK Ferti, which is obviously due to the longer growing season.

Table 2: Yield of seeds of high-oleic sunflower hybrids depending on the nutrition background, t / ha

Nutrition background (factor B)	Hybrid (factor A)					
	2016 yr		2017 yr		Average for 2 yrs	
	Tutti	NC Ferti	Tutti	NC Ferti	Tutti	NC Ferti
Without processing(control)	1,89	1,72	1,32	1,30	1,61	1,51
quantum-technical processing of seeds + plants in the phase of 2-3 leaves	2,19	2,10	1,56	1,51	1,88	1,81
quantum-technical processing of seeds + plants in the phase of 2-3 and 5-6 leaves	2,38	2,30	1,78	1,72	2,08	2,01
quantum-technical processing of seeds + plants in the phase of 2-3 and 5-6 leaves + boron-active	2,51	2,41	2,10	1,94	2,31	2,18
least significant difference 05	0,17	0,14	0,15	0,13		

An important indicator in the cultivation of oilseeds for oil producers is the fat content of the seed kernel. The fat content of the seed kernel of the studied sunflower hybrids is higher than the fat content of the hybrid NK Tutti, which also had a higher content of crude protein – 14.4 %. Application of mineral fertilizers increased the content of crude protein in sunflower seeds and slightly reduced the fat content in the seed kernel. Thus, in the control variant, the content of crude protein in sunflower hybrid seeds was 12.6% in average, and the content of fat in the seed kernel was 53.4 %. When using the mineral quantum-technical fertilizer, the content of protein in the seeds of studied sunflower hybrids increased by 0.9%, and the content of fat decreased by 1.0 %.

Optimization of plant nutrition leads to increasing in the content of crude protein and decreasing in the content of fat in the seed kernel (Table.3).

The qualitative indicators of the grown crop are represented by the following elements: the content of fat content and the content of crude protein in seeds.

The total indicator to be characterizes the yield and quality of seeds is the conditional yield of oil per hectare.

It was determined the greatest conditional yield of oil provides by optimization of plant nutrition of both sunflower hybrids, namely: seed processing before sowing and plants in phases 2-3 and 5-6 leaves with quantum-technical preparations is compatible with boron-active. For the cultivation of a hybrid of NC Ferti, its indicator in that variant was 1.50, and such indicator of Tutti hybrid was 1.72 t / ha of oil on average for two years of study.

Table 3: The quality of seeds of studied sunflower hybrids depending on the optimization of the nutrition background

Hybrid	Nutrition background			
	Without fertilizers	quantum-technical processing	quantum-technical processing + boron-active	LSD_{05}
Content of fat in seed kernel, %				
NC Ferti	52,3	51,4	50,3	0,9
Tutti	54,5	53,4	52,7	0,7
Content of crude protein in seeds, %				

NC Ferti	12,2	13,1	14,0	0,3
Tutti	12,9	13,9	14,4	0,4
Conditional yield of oil, t/ha				
NC Ferti	1,12	1,47	1,50	
Tutti	1,25	1,67	1,72	

We identified a similar reaction to the optimization of nutrition in studies with two varieties of linseed flax (Table 4).

Table 4: The influence of the nutrition background on the yield of linseed flax varieties, the content of fat in seeds and its conditional yield (average for 2016-2017yrs)

Variety (factor A)	Nutrition background (factor B)	Yield of seeds, t/ha	Content of fat in seeds, %	Conditional yield of oil, t/ha
Vodogray	Without fertilizers (control)	1,06	45,1	0,478
	$N_{30}P_{30}K_{30}$–background	1,17	46,1	0,539
	Background + Nutrivantplusoleaginous (phase 1)	1,25	47,8	0,598
	Background + Nutrivantplusoleaginous (phases 1+2)	1,39	48,1	0,669
Orpheus	Without fertilizers (control)	0,99	40,2	0,398
	$N_{30}P_{30}K_{30}$ - background	1,11	42,4	0,471
	Background +(phase 1)	1,21	43,1	0,522
	Background +(phases 1+2)	1,34	43,8	0,587
least significant difference 05	Vodogray	0,11	0,3	
	Orpheus	0,08	0,5	

phase 1- formation of herringbone
phase 2-at the beginning of budding

As evidenced by the data, the yields of seed varieties Vodogray depending on application of mineral fertilizers and growth-regulating preparation ‘Nutrivantplus’ on average over two years, are rising up to 1.17-1.39 t/ha compared with 1.06 t/ha in the control, and the yields of seed varieties Orpheus are rising up 1.11 - 1.34 t/ha and compared with 0.99 t/ha in the control. It is positive fact that simultaneously with the yield increasing the optimization of plant nutrition has a positive effect on the content of fat in seeds and affects its conditional yield per unit area: it should be noted that from the studied flax varieties, the higher yield of seeds was formed by the variety of Vodogray. The main thing is the seeds of this variety contain more fat and it provides a much higher conditional oil yield per unit area compared to the linseed flax variety Orpheus.

Purpose of the study was to highlight the current state and prospects of the production of oils of the most common and yet little-studied crops, depending on their fatty acid composition.

For the purpose of purposeful change of composition and properties of natural oils in domestic and foreign practice, methods of selection and genetic engineering of oil crops, fractionation, enzymatic inter etherification of oils, mixing (blending) of vegetable oils of different cultures, including non-traditional vegetable sources are developed and used [9, 10].

Most important acid in natural oils is oleic acid, which amount in products varies within the following limits: olive oil 75%, non-erucic rapeseed oil - 60%, tallow - 50%. Other oils contain much less oleic acid (usual sunflower oil, corn oil, soy oil - only 25%). The importance of oleic acid is sufficient resistance to its free radical oxidation, it does not form eicosanoids – sufficiently active regulators, suppressing the immune system and promote thrombogenic action. In the human body, the oleic acid undergoes easier than other fatty acids enzymatic β-oxidation to form carbon dioxide, water and 150 ATP molecules [11].

Oils obtained from crops containing high content of oleic acid, in particular, high oleic sunflower oil, have unique properties, namely:

a) oxidation stability, the oil storage life is extended by 4-5 times;
b) the processing of oil into margarine needs for 10-15% less energy;
C) they have a positive effect on human health due to the content of ω-3, ω - 6 and ω-9 fatty acids, as well as natural antioxidants, vitamin E.

According to the recommendations of the World Health Organization, the complex of these unsaturated fatty acids helps to strengthen human immunity, prevents diabetes, obesity, and reduces the risk of cardiovascular diseases.

According to its composition and properties, the oil obtained from high-oleic sunflower is a natural analogue of olive (in terms of oleic acid content), so the demand for such oils grows and would reach at least 8% per year by 2020. In the European community, demand for high-oleic sunflower oil would also grow from 690 thousand tons in 2011yrup to 1346 thousand tons in 2020yr, respectively, it would be increased an acreage under sunflower, necessary to meet the demand for high-quality oil. Thus, according to data of the company "Syngenta" in 2016, the area under high-oleic sunflower in the world was about 1.4 million ha + new area of 0.5 million hectares, and in 2020 it would increase accordingly up to 1.9 million hectares + new area of 1.0 million hectares.

The share of high-oleic sunflower hybrids is only 2-3 % of the total area under sunflower. Its increasing under that crop was hampered by two factors: low level of awareness about the benefits of "healthy" oil and instability and low yield of newly created sunflower hybrids, from which they started that direction.

Representatives of the company "Syngenta" are convinced that Europe could not provide itself with "healthy oil" on its own, so the expansion of the areas under high-oleic sunflower in Ukraine, obtaining high-quality oil, its export, and possibly consumption in the domestic market is promising in the coming years.

Taking into account the fatty acid composition none of the natural oils does not correspond to modern ideas about the ideal oil [12]. On the one hand, the ideal oil must be balanced in content of ω-3, ω-6, ω-9 fatty acids, and on the other hand, it should include antioxidants protecting the oil from oxidation. An important indicator for the oil is the ratio ω-3/ω-6 fatty acids. Polyunsaturated fatty acids could enter the body with nutrition in any amount, but the implementation of their biological action is possible only if the optimal ratio of ω-3/ω-6 fatty acids [13,14] is observed.

Here is the average content of individual fatty acids in vegetable oils (Table 5) [13,15].

Table 5: Fatty acid composition of some vegetable oils

Oil	Content of fatty acids in the oil, %					Ratio ω-3/ω-6 of fatty acids
	Saturated oils		unsaturated oils			
	Palmitic oil	Stearic oil	oleic oil ω-9	Linoleic oil ω-6	Linolenic oil ω-3	
Sunflower oil	6,10	5,24	24,61	62,58	0,09	1:695
Soybean oil	13,15	4,16	21,36	55,60	5,73	1:10
rapeseed oil	4,4	1,8	60,4	18,68	9,13	1:20
olive oil	13,26	4,3	75	7,12	0,59	1:12
Linseed flax oil	5,14	5,1	17,30	14,31	57,26	1:0,25
Camelina seed oil	6,4	1,5	17,0	19,3	50,2	1:0,38

The effective use of polyunsaturated fatty acids in a healthy young body is due to the ratio of linolenic and linoleic acids 1:10, and in cases of lipid metabolism disorders, this ratio can vary from 1: 5. For an ordinary Ukrainian, who practically does not use linseed flax oil, Camelina oil, soybean oil, rapeseed oil, the main oil is sunflower oil and the products of its processing, the ratio ω-3/ω-6 fatty acids in such food is 1:43,8 [15], which is almost 8 times higher than the normal ratio for ω-6 fatty acids.

The soybean oil is characterized by optimal ratio of ω-3/ω-6 fatty acids, it contains a significant amount of linoleic acid (55.6%). Soybean at the present stage of development of the agricultural market is the most dynamic crop in terms of area growth and gross production compared to other oilseeds. Soybean consumption is directed in two directions: 60 % of its total volume is exported, 40 % of its total volume is processed into oil. According to the authors [4] the good oil should have increased content of monounsaturated oleic acid and the decreased amount of saturated oils. On the basis of genetic engineering, a new type of transgenic soybean was created, whose oil is characterized by a high content of oleic acid (55-75%) due to low concentrations of linoleic and saturated fatty oils [16]. It should be noted the increasing of the content of linolenic acid leads to the increasing of the oxidizing ability of the oil.

The biological properties of vegetable oils are not limited to fatty acid composition. The particular importance has related compounds, antioxidants such as tocopherols and carotenoids which protect the oil from oxidative damage, and they are natural sources of intake of vitamins A and E. Linseed flax oil is the leading vegetable oil having the content of essential α - linolenic acid (57,26 %), then it contains valuable biologically active substances: tocopherols (116 mg %) and carotenoids (380 mg %), as they have a positive effect on human health [13]. The oil content in flax seeds is determined by both varietal characteristics and conditions of cultivation [17]. The effectiveness of the oil-production depends on climatic factors such as light, heat, moisture. The study of these factors helped to create a climatic theory of the oil-production. In accordance with this theory the process of the plant oil-production is a function of plant genes and ecological factors. The change of those factors affects on the qualitative and quantitative composition of fatty acids. With the advance of oil plants from the South to the North, the oil content of seeds and the content of unsaturated acids in the fatty acid composition of lipids increase. Such process is an adaptation adjustment to the action of low temperatures [18].

Flax seeds contain up to 50% of fatty oil, the content of which also depends on a number of factors, primarily on varietal characteristics, weather conditions and technological methods [19]. Ecological conditions significantly affect the chemical composition of fats. The content of saturated fatty acids (palmitic acid, stearic acid), unlike unsaturated ones (oleic acid, linoleic acid, linolenic acid), rarely changes in oil flax, and according to data of many researchers it changes at range from 5-6% for palmitic acid and 4-5% for stearic acid [15]. However, the content of linolenic acid depends on the species, variety and genotype it can vary significantly from 3-9% to 63-69 % [20]. Linseed flax oil with a high content of polyunsaturated fatty acids, especially linolenic acid, is used for technical purposes mainly, and oil with a low content of acids is used for food purposes [15].

The researchers determined that the weather conditions significantly affected the process of oil-production in seeds during the ripening period: the accumulation of unsaturated acids in the oil increases with decreasing temperature and increasing the provision of plants with moisture [21]. Thatwas confirmed by our studies when growing linseed flax in the southern Steppe of Ukraine on the southern black soil.

Thus, in 2016, which is more favorable for moisture, according to our studies conducted at the academic and research practical center of Mykolaiv NAU, seeds of linseed flax varieties Golden And Orpheus were noted for low content of palmitic acid (3,61-4,47%), stearic acid (1,78-2,35%), oleic acid (9,17-14,98 %) and linoleic acid (9,54-12,95 %) and high linolenic acid (62-76 %). In the conditions of the southern Steppe of Ukraine in the less favorable for moisture 2017, the seeds of linseed flax, on the contrary, contained more palmitic acid (6,23-6,89 %), stearic acid (3,84-4,67 %), oleic acid (14,93-21,59 %) and linoleic acid (13,15-15,26 %) and less linolenic acid (51,13-59,17 %) and in general, the oil content of flax is defined below (42,3-44,6 %). The increase in the concentration of linolenic acid, which is confirmed by our studies, was due to the lower content of oleic and linoleic acids. Similar results and patterns obtained by us in studies with Camelina, as described above.

For creating a vegetable oil with the desired properties, blending is also used, that is, a combination of two - or multi-component systems of natural vegetable oils. The composition of the mixture includes both unrefined oils (sunflower, soybean, rapeseed, corn) and unrefined (sunflower, linseed, wheat germ oil). In order to increase the nutritional and biological value of blended oils, they are enriched with fat-soluble vitamins and phospholipids. This direction does not require large financial investments, complex equipment and time-consuming, so the development of technological bases for the production of mixed refined and unrefined vegetable oils with optimal or improved composition of fatty acids are currently quite relevant.

CONCLUSION

Thus, taking into account the above material and taking into account the impact on human health, the best vegetable oils are soybean oil, linseed oil, Camelina oil and oil taking from the seeds of high-oleic sunflower hybrids currently. Prospects for the production of oils of improved quality in Ukraine is the expansion of the area under linseed flax, Camelina, soy, high-octane sunflower hybrids, the observance of technology of cultivation of oil crops, compliance with the privacy policy on their seeds, cooperation of farmers with the processing of domestic and foreign agencies, the oil and fat industry, the growth of exports of high-quality oil in Europe and Asia, the creation and introduction into mass production of blended oils with specified fatty-acid composition.

Analysis of the oilseeds quality showed that the oil content and fatty acid composition of Camelina and flax oil is not inferior to conventional sunflower, and they exceed sunflower ones in almost all major indicators. Cultivation of poorly investigated Camelina culture was also highly profitable as from 390.3 % in control to 1156.3 % in the best case, the net profit was respectively 16053 UAH / ha and 71285 UAH / ha, which indicated its ability to compete with sunflower.

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