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## Influence of the Eco-Brand of Oil Flax on the Development of Production of Safe Products

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**Abstract.** In modern competitive conditions, the eco-brand is one of the main prerequisites for the effective development of the country's economy. In an unstable economic situation, the reformatting of Ukrainian society is too sluggish, problems are growing rapidly, which is unquestioningly used by dishonest players in the consumer market. This study examines the trends in internal and global commodity markets, points out the need to develop the market for environmentally friendly goods based on oil flax, improve the quality of flax-containing products by the use of advanced technologies and innovative equipment. The research methods were: monographic, comparison, analysis, mathematical planning, and graphic. It is determined that the main prerequisite for sustainable development of the country in the context of economic globalisation, limited resources, and technology development is the use of eco-branding. To increase the efficiency of fibre processing, a method for processing flax has been developed, which allows expanding the range of products for processing flax straw and creating a waste-free technology. A method for obtaining the uniform fibre from bast-fibre crops has been developed, which allows processing the stems of oil flax. Prospects for using the considered technical and technological developments can contribute to the modernisation of the processing industry, its further development, expansion of the Ukrainian market, increase jobs and attract highly qualified specialists in the relevant field, increase the competitiveness of Ukrainian products on the world market

**Keywords:** flax straw, fibre, competition, non-fibrous impurities, breaking rollers, scutching node, swingling device



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## INTRODUCTION

The instability of the consumer market of Ukrainian goods cannot ensure compliance with the requirements of regulatory documentation for fibrous products and contribute to improving the level of its quality. The national economy of the country is weak, it is influenced by various social, political, and economic factors. At the same time, along with the aggravation of competition for the consumer in the market, the lack of clear norms and rules in regulatory matters, the loss of the raw material base for industry, and the unwillingness of the state to develop high-tech sectors of the economy complicates its general crisis state. With the growth of the global economy in society, the issues of providing the population with high-quality food and non-food environmentally friendly safe goods, which, along with other products, have a certain set of valuable functional properties, come to the fore.

Today, to dominate the Ukrainian and international consumer markets of goods, it is necessary to have a clear strategy for the development of the enterprise, a certain well-developed system of processing raw materials, in which it would be possible to program clear actions in advance in the direction of saving material and labor resources, improving the quality of final products, reducing costs for production transitions and developing the image of a modern high-tech manufacturer [1].

Creating such a brand takes time, and most importantly – significant investments in the development of advanced technologies and equipment. Today, in the context of environmental disasters and the spread of pandemics, it is especially valuable to promote the eco-brand and form the foundations of eco-branding. According to S. M. Ilyashenko, “environmental branding should be considered as a complex process of developing an environmental brand and maintaining voluntary communication between consumers through a stable and reliable set of product differences, offering high quality and satisfaction of needs, attracting the attention and interest of manufacturers, and sustainable social responsibility to prevent negative impacts on the environment” [2].

Promotion of new ideas, expansion of the innovative component in the manufacture of new safe products, which cover a wide range of activities, including product modification, provides an opportunity to ensure the commitment of consumers to the chosen eco-brand and maintain a reliable link between the preservation of the environment and the economic development of society [3].

The development of an eco-brand and eco-branding for a Ukrainian manufacturer is quite a significant

tool in the struggle for consumers. This facilitates access to new and developed markets for goods whose modern product quality requirements are strictly regulated and strict, especially when it comes to safety and environmental properties [4; 5].

At the same time, outdated technologies, globalisation, the contradiction of the provisions of regulatory regulation of economic activity, the crisis in the financial sector do not allow the state to actively influence the quality of goods and the cleanliness of the environment. In such business conditions, special attention should be paid to the environmental component of Ukrainian and imported goods from abroad, since low-quality and counterfeit products, in addition to financial losses in the absence of objective information support, can be dangerous for consumers and the environment. In such a situation, it is necessary to develop a radically new concept of eco-social policy in the country.

The analysis of monographic studies [2; 6] and research papers [7; 8] indicates that in recent years technological, commodity science and economic aspects of the establishment, and assessment of the level of environmental safety of raw materials and products, have been widely discussed. At the same time, the issues of increasing the quality requirements and environmental requirements for textile raw materials, individual stages of textile production and textile products themselves are also raised [9].

The need to address the issues of greening textile materials of the main groups of non-food products is dictated by the need to bring the production of any type of Ukrainian goods to compliance with the requirements of international environmental standards, harmonise the system of Ukrainian environmental standardisation in accordance with international and expand the product range relative to modern consumer demand. Currently, in the international relations market, the level of environmental safety of goods has become one of the main factors determining the level of its competitiveness [10; 11].

Therefore, for Ukraine, which is rapidly moving towards deepening its activities with the European Union, this is especially important and relevant. This issue requires the creation of innovative products that meet the market requirements of developed countries and have certain properties that give it competitive advantages in the fight for the consumer. Thus, *the purpose of the study* is to define directions and technologies for forming markets for safe goods based on the development and distribution of eco-branding of products obtained as a result of processing oil flax.

## MATERIALS AND METHODS

During the study, experimental samples of equipment for extracting fibre from the stems of the flax straw were designed and manufactured, with the help of which the processes of breaking were analysed and factors that significantly affect the processing of bast-fibre raw materials were identified. Based on the planning of experiments with matrices of rotatable planning of the second-order according to Box's plans, the relationship between the technological parameters of the processing of the stem mass and the quality and quantity of the obtained fibre was determined.

To conduct experimental studies on the processing of bast raw materials, oil flax straw of the Pivdenna Nich variety was used, which was prepared using roll-to-roll technology in the climatic conditions of the SE EF Askaniyske in the Khersonska Oblast. The preparation of flax straw was carried out using dew-retting technology, and studies on the processing of bast raw materials were carried out under the same conditions for preparing the material for processing. In the process of processing bast raw materials, precise control was carried out over the process of mechanical processing of stem material by sampling raw materials and instrumental measurement of indicators of separation of the fibrous layer from wood, breaking load, fibre yield, maximum permissible content of shives and garbage impurities. To check the quality properties of bast raw materials and fibrous products, the methods of regulatory documentation specified in DSTU 4149-2003 "Flax straw. Technical specifications", DSTU 5015-2008 "Short linen fibre. Technical specifications".

General scientific and specific research methods were used in the course of the study. To determine the quality properties of samples of raw materials used in the manufacture of environmentally friendly products, the study compared the length and thickness of the stems, the color of the straw, the fibre content, its flexibility and breaking load. To determine the nature of the influence of technical and technological parameters for setting up the operation of equipment during the processing of flax stems, an analysis of changes in the initial characteristics of the fibre was carried out. A graphical method and methods of mathematical statistics were used to process the obtained experimental data and assess changes in the content of impurities in the fibrous product during the raw material processing, determine the percentage of fibre yield and the average weight-length relation of fibres. Mathematical planning of the experiment allowed obtaining regression models of the raw material processing, and the abstract-logical method provided a theoretical generalisation of the findings and

the generation of conclusions. The results obtained indicate the possibility of expanding the range of products based on the stems of bast crops.

## RESULTS AND DISCUSSION

### *Analysis and generalised assessment of the impact of flax on the economic, social, and environmental development of Ukraine*

When forming an overall industrial development strategy aimed at creating environmentally friendly products, it is necessary to adhere to methods of preserving the valuable properties of raw materials at various production stages using innovative technologies and equipment for their implementation. Today, flax is almost the only renewable source of cellulose textile raw materials on the European continent. The fabric made from linen is characterised by significant elasticity, strength and moderate hardness, durability, and resistance to rot. Linen clothing has a positive effect on the emotional and physical state of a person, increases resistance to various ailments and contributes to maintaining health. Today, technical linen products are indispensable in various industries, especially those related to construction, textile, defence, automotive and other areas of Ukrainian economy. Notably, the range of doublings and nonwovens fabrics made of flax, including dressings and medical cotton wool, is not only not inferior in their properties to similar products made of cotton, but sometimes exceeds them [12].

Natural flax components have different functional properties and can be used simultaneously in various sectors of the light industry. The use of flax components requires, in addition to a comprehensive study of the exceptional safe qualities of fibre, also the study of the safe component of mixtures of flax with other types of fibres that are used in the manufacture of goods for various functional purposes. With this approach, it is possible to most rationally substantiate the areas of application of the expanded range of updated materials of flax. The use of oil flax components in the light, pulp and paper industries, construction, and medicine requires partial and comprehensive economic, technological, social and environmental substantiation. Considering the areas of such research, Ukraine should develop a radically new concept of an ecosocial policy for the development of the state.

Bast-fibre plants are among the most important industrial crops that are of great national economic importance. Despite the significant development of the chemical industry towards obtaining fibre products, the value of such crops as sources of fibre production, especially

environmentally friendly ones, does not decrease, and in some areas of the national economy the need for them is quite high and tends to increase. The fibres of bast crops are located in the stems, consist of a large number of elongated cells. Bast crops are difficult to process, as a result of harvesting processes, seeds and stem material of straw or trusts are obtained separately, which are formed into special packaging – rolls or piles. The efficiency of fibre production in modern conditions cannot be ensured without the use of machines with low metal and energy intensity, which indicates the inexpediency of using existing overall technological equipment at Ukrainian enterprises.

In Ukraine, among the group of bast-fibre crops, which includes: flax, hemp, ambary, abutilon, nettle, jute, ramie – mainly the flax and hemp are cultivated. The climatic conditions that have developed on the territory of Ukraine allow growing these plants and get fairly high yields of seeds and fibre. The composition of these crops includes about 75-90% cellulose, 1-3% lignin, and as a result of their processing, strong fibres up to 10 mm and more are obtained [13]. According to statistics on the volume of flax fibre production over the past century, it is clear that the position of Ukraine in the world, as one of the leading producers, has changed to an outsider [9]. Trends in recent years indicate an increase in the acreage of flax, but this valuable crop is not used enough on an industrial scale. This is mainly due to the greater prevalence, technological advancement in the processing of flax and socio-economic circumstances that have developed in Ukraine and the world. The decline in the production of flax fibre is due to changes in the structure of Ukrainian business, insignificant innovation activity of enterprises, lack of incentives, noticeable technical and technological lag of the Ukrainian textile industry from the major countries, increased energy and material consumption, labour intensity of production, lack of working capital and low organisation of economic activity.

The main countries whose natural and climatic zones allow growing flax are: France, China, Ukraine, Russia, Belarus, Poland, India, the Baltic states, etc. According to the food and Agriculture Organization of the United Nations (FAO), currently about seven million hectares of flax are sown annually in the world [14]. The main trend of the last ten years in the development of the global flax complex is the desire of countries to increase the share of flax among other fibres and deepen the degree of its processing. Due to its natural properties, products made from both long flax and oil flax and their processed products are in demand both in the domestic and foreign markets of Ukraine [13; 15]. By

the middle of the 20<sup>th</sup> century, the sown area of flax was about 100 thousand hectares, which indicates a sufficient prevalence of this crop in Ukraine. With the change in the climatic conditions of growing flax, the areas of its cultivation were reformatted, the main regions were the south-eastern regions of Ukraine, namely: Zaporizka, Dnipropetrovska, Khersonska and Mykolaivska oblasts.

Trends in recent years indicate an increase in acreage for this crop, but it is worth noting that flax is still insufficiently used on an industrial scale in the manufacture of various types of goods. Today, there is practically no deep processing of Ukrainian flax in Ukraine, and there are very few producers of finished products. The main consumer of oil flax *in the light industry* are the Kirovograd twine and rope factory and the Kharkiv rope factory, *in the food industry* – OJSC “Nizhinsky Zhirovy Kombinat”, *pharmaceutical* – “Liktravy”, *chemical* – LLC “Factoria”. In addition, the companies “Zhytomyrskyi Lyon” and “Galereya Lyonu” use the fibrous product of oil flax in the manufacture of insulation materials, “Lintex” – in construction and in the automotive industry as sound and noise insulation materials. This is mainly due to the greater prevalence, technological advancement in the processing of flax and socio-economic circumstances that have developed in Ukraine and the world.

With the growth of export prospects for the sale of oil flax seeds, the issue of processing significant volumes of stem material of this crop arose. There is simply not enough capacity in Ukraine for processing significant volumes, especially given that the state of processing equipment is in an extremely neglected state. Only a small number of manufacturers use suitable equipment. Technological equipment of plants for primary processing of bast plants is currently unsuitable, since it is physically and morally obsolete. Today, the production of fibre products in Ukraine requires the development of innovative technologies and advanced efficient equipment that can improve the quality of a safe commercial product, its environmental friendliness, expand the range of popular goods, and give the country independence in the supply of estimated raw materials.

#### **Research on obtaining oil flax fibre and expanding the range of environmentally friendly products**

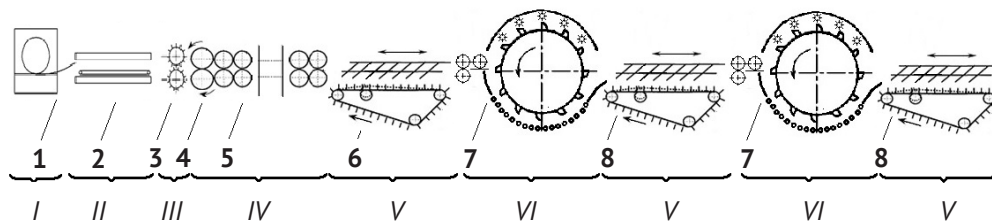
In order to spread the production of oil flax, expand the range of environmentally friendly products and eco-brand in Ukraine, a study was conducted on the introduction of modern design ideas for obtaining fibrous products that can meet the requirements for its use in various industries. Current trends in in-depth processing of bast fibre material have significantly affected the scope of its use. Short fibre is much more widely used in the

textile industry, in the production of various textiles, modern composite materials, flax cotton, bat wool, insulation materials, etc. [16]. All this has caused changes in the technologies of collecting and obtaining fibre products aimed primarily at resource conservation and safety of use [17]. Therefore, the study used the technology of obtaining the same type of fibre, which is less expensive compared to conventional and improves the overall processing culture of the agricultural plant.

The development of technological equipment and nodal connections for efficient processing of oil flax without dividing it into long and short fibres simplifies technological processes for collecting raw materials and further mechanical processing, provides an opportunity to increase equipment productivity and improve working conditions in production. The possibility of forming the uniform type of raw materials significantly reduces the cost of its collection, preparation, transportation, and processing, which reduces the metal and energy intensity of equipment and reduces the cost of the resulting fibrous products. For the effective application of the technological line for processing flax straw with a chaotic arrangement of stems in the mass, the study used the developed effective nodal connections of the scutching part of the machine, which allows obtaining uniform purified fibre from the stem material, without shives and other non-fibrous impurities. The Pivdenna Nich variety of oil flax was taken for experimental studies.

The combination of innovative technical and technological developments included a method that consists of unwinding rolls on roll rewinders, breaking with rollers of various types with the passage of processes of pulling, scutching and cleaning of bast fibre material from impurities on swingling machines at the end of raw material processing. In accordance with the developed method, straw stems are formed in the breaking part of the unit, the raw layer is scraped and thinned using disc, plank, and comb-type cleaning rollers. The cleaning efficiency of raw materials is ensured by the complex interaction of the developed components with the swingling and vibrating device installed between the breaking and scutching machines. In this case, the process of scutching is carried out with the simultaneous action of beater bars and knives installed on the scutching drum [18].

The essence of the developed device is explained in Figure 1, which shows the technological scheme of an experimental unit for obtaining the uniform fibre from oil flax, where I – packaging unwinding part; II – drying part; III – ball forming part; IV – breaking part; V – swingling part; VI – scutching part. The following equipment was used: 1 – decoiler; 2 – drying machine, if necessary; 3 – spiked roller; 4 – breaking machine with a pair of rolls of increased diameter; 5 – breaking machine; 6 – pre-cleaning swingling machine with a vibrating device; 7 – scutching nodes; 8 – swingling machines equipped with a vibrating device [18].



**Figure 1.** Technological scheme of an experimental unit for obtaining the uniform fibre from oil flax, where I – packaging unwinding part; II – drying part; III – ball forming part; IV – breaking part; V – swingling part; VI – scutching part. The following equipment was used: 1 – decoiler; 2 – drying machine, if necessary; 3 – spiked roller; 4 – breaking machine with a pair of rolls of increased diameter; 5 – breaking machine; 6 – pre-cleaning swingling machine with a vibrating device; 7 – scutching nodes; 8 – swingling machines equipped with a vibrating device

The Pivdenna Nich oil flax is sent to decoiler 1 and then to drying machine 2. From the drying node, the stem material is fed evenly through the spiked roller 3 to the first pair of rollers 4 of the breaking machine 5 of the considered device. Due to the increased diameter, these rollers provide retraction of the flax straw with various physical and mechanical properties. Next, the raw material goes to a set of rollers of the breaking machine 5. Due to the use of developed rollers, parallelisation and ordering of stems take place during scutching, and intensive breaking with simultaneous scraping, stretching and thinning of the raw layer is carried out.

After that, the washed and partially cleaned layer of the flax straw is sent to the pre-cleaning swingling machine 6, which is equipped with a vibrating device. The raw material is enriched, ordered, and the shives and other non-fibrous impurities are further removed [19].

In the future, the prepared raw layer is fed to the scutching node 7, where an intensive process of cleaning the fibrous mass from the shives takes place. At the same time, considering the initial condition and quality of the flax straw, it is possible to adjust the intensity of raw processing by changing the size of the gap between the beater bars and scutching knives, as well as between

the grid and the scutching drum of the scutching node 7. After the scutching, the fibrous mass enters the swindling machine equipped with a vibrating device 8. Due to its use, the final cleaning of the fibre from foreign impurities takes place [19].

The complex interaction of meat Rollers of various types during the kneading of the stem layer of the trust with a shaking and vibrating device during the shaking of raw material, which is carried out between the processes of crumpling and tipping, allows for preliminary cleaning of the fibrous mass from free fibre formed during the passage of raw material through the meat machine, and other non-fibrous impurities.

The use of a swingling machine with a vibrating device after the scutching removes the remaining shives from the fibrous product. The vibrating device

of the needle conveyor leads to additional vibrations of the fibrous mass, so that the shives are intensively separated, which increases the efficiency of cleaning the fibrous product. Double processing of linen material with a scutching node and a swingling machine are used to obtain the fibre with the lowest content of foreign impurities.

As a result of processing the Pivdenna Nich flax straw, fibre of varying degrees of purity was obtained depending on the condition of the flax raw material, the number of processing transitions, and the adjustment parameters of processing equipment. Thus, depending on the above factors, due to mechanical processing of the stem material of flax, a different yield of the final product and its characteristics were obtained (Tables 1; 2).

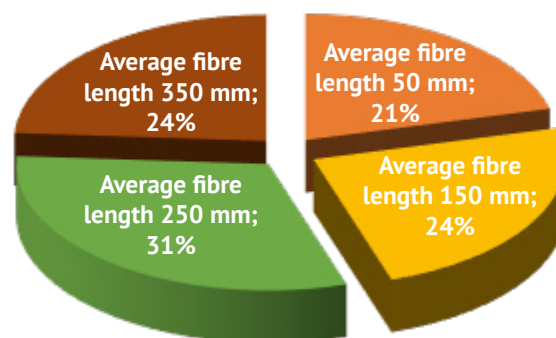
**Table 1.** Yield of fibre and shives processing products from the Pivdenna Nich flax straw after mechanical processing of the stem material

Processing cycle	Output of processed products, %		
	Fibre	Shives in fibre	Shives + irreversible waste
Incomplete straw processing cycle	17.57	4.77	77.66
Complete straw processing cycle	17.44	2.62	79.94

**Table 2.** Properties of the fibrous product from the flax straw of the Pivdenna Nich variety at different stages of processing

Processing cycle	Properties of the fibre product		
	Breaking load of the fibre, daN	Fibre output, %	Shives content, %
Incomplete straw processing cycle	16.09	17.57	4.77
Complete straw processing cycle	15.14	17.44	2.62

According to an incomplete processing cycle of the stem material, the obtained fibre has lower values of quality indicators than that of fibrous products obtained when passing a layer of flax raw materials through all nodes of the experimental unit. At the same time, the quality properties meet the requirements of regulatory documentation for the production of doublings, non-woven fabrics, cotton batting, geotextiles and can be used in the construction and automotive industries as fillers, reinforcing and heat-insulating materials, for stuffing upholstered furniture and mattresses. It should be noted that when choosing the scope of use of fibre products, the value of the average weight-length of fibre is also considered. The distribution of the resulting fibre from flax of the Pivdenna Nich variety along the length obtained by mechanical processing of straw indicates the presence of a significant number of short fibres (Fig. 2).



**Figure 2.** Fibre length distribution diagram of the Pivdenna Nich variety of oil flax straw

Source: authors' personal research

Analysis of the study results indicates that in the case of full-cycle mechanical processing of flax straw of the Pivdenna Nich variety, the obtained fibre, in addition to doublings and nonwoven fabrics, also

meets the requirements of regulatory documentation for the production of textile materials, sanitary and hygienic, cellulose-containing products. Thus, the developed technical and technological solutions allow processing the oil flax straw, expanding the scope of its functional purpose, which strengthens the position of using this crop as a raw material in the manufacture of environmentally friendly types of non-food products.

The combination of ecological properties of oil flax with the properties of other constituent materials to spread environmentally friendly characteristics in the designed products and prevent environmental pollution due to disposal of products can be an actual contribution to the design of a new possible assortment composition of modern safe products that will take a worthy place in the distribution of the eco-brand in the consumer market of the country.

## CONCLUSIONS

In the context of fierce competition, globalisation, liberalisation of markets and a changing external environment,

those enterprises that quickly implement modern trends in the production of safe goods will be effective. The creation of high-quality safe products should take place, first of all, through the development of flax-containing materials with new properties and modern product designs based on advanced technical solutions, preserving the original valuable characteristics of plant raw materials. It is under such conditions that it is possible to increase the level of competitiveness of environmentally friendly products, spread eco-branding among producers, and provide the Ukrainian market with cheap renewable raw materials that would meet the growing demand of consumers in eco-products in both manufacturing and nonmanufacturing activities.

The development of the consumer market of environmentally friendly food and non-food products made from oil flax components, which are able to meet the growing demand of consumers in eco-products in various areas of activity, can become a prerequisite for a long-term strategy for the establishment and expansion of eco-branding in Ukraine.

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## Вплив екобренду льону олійного на розвиток виробництва безпечної продукції

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**Анотація.** У сучасних умовах конкурентної боротьби екобренд виступає однією із основних передумов ефективного розвитку господарства країни. У нестабільній економічній ситуації переформатування суспільства України проходить надто мляво, проблеми швидко наростають, чим беззаперечно користуються недоброчесні гравці на споживчому ринку товарів. У статті розглядається напрям внутрішнього та світового товарних ринків, вказується на необхідність розвитку ринку екологічно безпечних товарів на основі льону олійного, поліпшення якості льоновмісної продукції внаслідок використання передових технологій та інноваційного обладнання. Методами дослідження стали: монографічний, порівняння, аналіз, математичне планування та графічний. Визначено, що основною передумовою сталого розвитку країни в умовах глобалізації економіки, обмеженості ресурсів і розвитку технологій є застосування екобрендингу. З метою підвищення ефективності процесів обробки волокнистого матеріалу розроблено спосіб переробки олійного льону, який дозволяє розширити асортимент продуктів переробки трести льону олійного та створити безвідходну технологію. Розроблено спосіб одержання однотипного волокна з лубоволокнистих культур, який надає можливість переробляти стебла льону олійного. Перспективи використання представлених технічних і технологічних розробок можуть сприяти модернізації переробної галузі легкої промисловості, її подальшого розвитку, розширення ринку України, збільшенню робочих місць і залученню висококваліфікованих фахівців у відповідну сферу, підвищити конкурентоспроможність української продукції на світовому ринку

**Ключові слова:** треста, волокно, конкуренція, неволокнисті домішки, м'яльні вальці, тіпальний вузол, вібруючий пристрій

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