PROGNOSIS APPLICATIONS NONNARCOTIC HEMP BASED ON THE CRITERIAL CHARACTERISTICS

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Abstract: *The article is devoted to solving the problem of developing the scientific basis for the primary processing of non-narcotic hemp stems in order to produce high-quality fiber that can be used in various industries. The current state of hemp production in Ukraine and other countries of the world was analyzed and also promising uses of hemp raw materials was considered. Criteria characteristics of straw stalks of non-narcotic monoecious hemp must be considered when developing innovative technologies for preparing trusts and its mechanical processing in order to produce fibers suitable for use in various industries, which will contribute to an increase in the production of hemp products, improve its quality, and increase the competitiveness of non-narcotic hemp products as well as the Ukraine's entry into the world market.*

Keywords*: hemp, processing, criteria charcteristics, content of bast, trust, fiber.*

1 INTRODUCTION

The increase in demand for the environmentally friendly products made of natural raw materials despite a big variety of goods from synthetic and artificial fibers is recently observed in the developed countries of the world. It should be noted that thanks to specific natural properties of natural fibers, including hempy, they cannot be replaced with other types of fibers at production of a certain range of products. Besides, fiber of hemp can replace even linen fiber in the most various scopes of application [1-9]. Therefore today hemp draws to itself great attention both researchers and producers. First, it is a commercial crop which is capable to accumulate huge biological weight in comparison with other cultures. Secondly, it can be used for production of the unlimited range of products in various industries. And the third, it is capable to clean the polluted territories and promoting preservation of the environment.

All parts of a plant of hemp, namely: the fiber emitted from stalks, leaves and seeds; are widely used in the textile, food, chemical, pharmaceutical, cosmetic industry and other branches of the national economy. The list of the products made of hemp now approaches 50 thousand names [10-13].

Thanks to high productivity of hemp in comparison with wood of coniferous and deciduous breeds of trees, to high content of cellulose (nearly 80%) and low content of lignin in fiber and also high qualitative of the paper made on the basis of hempy cellulose (to high rates of whiteness, absolute resistance to breakdown and the absolute resistance to tear), the hemp is competitive raw materials for production of different types of paper: valuable, technical filtering, tissue, printing, etc. The paper of fiber of hemp is made in China, India, USA, the countries of South America, Spain, Great Britain and other countries [12, 13].

Valuable properties of the oil received from hemp seeds, namely high saturation its fatty acids (oleic acid - 10-16%, linolenic acid - 50-60%, gamma and linolenic acid - 2-5%), allow to apply it not only in the food industry, but also in cosmetology (as a component of products for care of a body and spirits), paint and varnish, building industry, etc. Production of oil from hemp seeds now actively develops in Canada, France and the countries of South America [14].

The modern technologies applied in China and Romania allow to produce from hemp fibers the fine fabrics which are characterized by high rates of air permeability, hygroscopicity, wear resistance and durability.

It is known that hemp fibers are widely used for production of the reinforced composite polymeric materials applied in the car, an avia - and shipbuilding. Besides, the ability of hemp to accumulate the big biological weight (more than 15 t/hectare) allows to use it as raw materials for receiving biogas, ethanol and liquid biofuel.

Recently, in our country fiber of hemp was a main type of raw materials only for production of twisted products - ropes and ropes of different types and appointment, a twine, driving belts, etc. However, the high prime cost of the twisted products made of natural raw materials forced businessmen to replace natural fibers with chemical.

Reduction of demand for long fiber of hemp became the reason of reduction of the acreage reserved for this culture. It led to decrease in efficiency of enterprises which are engaged in cultivation of hemp and enterprises for hemp processing as they were the main consumers of a hempy raw materials.

Comparing the level of development of enterprises which are engaged in cultivation of hemp and enterprises for hemp processing in Ukraine and in the other countries of the world, it should be noted that this culture, having huge potential, in our country is not used in full. Such position of the industry is caused by two important reasons. First, only recently it was succeeded to overcome the contradictory attitude of power structures towards this culture connected with insufficient knowledge of people of existence of modern industrial grades of not narcotic monoecious hemp (with the minimum contents the cannabinoid substances of connections or their total absence) which are widely used in production in many countries of the world already now. So, the hemp grades created at Institute of bast cultures of NAAN of Ukraine (Glukhov of the Sumy region) grow up in such states as Australia, Austria, Great Britain, Canada, Netherlands, Germany, Czech Republic, Finland, etc. [9.15]. Secondly, reduction of acreage of hemp in Ukraine in comparison with global trends is caused by lack of demand on long and short hempy fiber in our country, which is domestic sales market of hempy products, impossibility of selling of these products in foreign markets, due to their poor quality and also narrow scope of a hempy fiber.

Exit of the industry on hemp processing from crisis can be reached by development of the latest technologies of processing of straw and trusts of hemp that will allow to receive fiber with new technological properties which will conform to requirements of technologies for their further use in textile, pharmaceutical, pulp-and-paper and other industries. Therefore improvement of the existing technologies of receiving trusts and development of new technology of machining of stalks trusts of hemp which will promote expansion of scope of the fiber received from it, is a relevant task of the industry.

2 LITERATURE REVIEW

Created by the Ukrainian selectors Senchenko G.I., Migal M.D., Vyrovets V.G., Layko I.M., etc. not narcotic grades of hemp are known around the world. Thanks to the biological feature of a plant removed by the Ukrainian scientists which consists in lack of psychotropic compound of tetrahydrocannabinol in total with high performance technical grades of hemp allowed to keep a of enterprises which are engaged in cultivation of hemp in such countries as France, Russia, Canada, China and to revive the industry in one and all economically developed countries of the world.

Works of the leading scientists of Ukraine [2, 5, 15] who confirm that changes of not narcotic grades of hemp were resulted by changes in the morphological structure of a fibrous part of stalks of hemp which exclude a possibility of use of traditional technologies of its processing are devoted to studying of features of the anatomic and morphological structure of stalks and the chemical composition of fiber of not narcotic monoecious hemp. Earlier conducted pilot studies of technological properties of stalks of hemp showed that physicomechanical properties significantly differ in a dioecious hemp which was still widely applied in production from properties of modern grades of not narcotic monoecious hemp.

Achievements of domestic and foreign scientists in the field of preprocessing and profound processing of stalks of not narcotic hemp which are opened in scientific works [4, 9, 12, 14] give the chance to claim that these developments are pioneer and are at an initial stage of pilot studies. Their system development demands the further scientific practices directed to a solution of the problem of effective use of a hempy raw materials in various industries.

Researches and the analysis of physicomechanical properties of various forms of hemp for the purpose of definition and assessment of characteristics on which the modes and parameters of technological processes of receiving high-quality hempy products are based is a main objective of work. In article the current state and the prospects of development of enterprises which are engaged in cultivation of hemp in Ukraine, a possibility of the maximum multipurpose use of this crop is also analysed, to contribute to the development of production of consumer goods and expansion of scope of not narcotic monoecious hemp in various industries.

3 RESEARCH METHODOLOGY

In Ukraine industrial crops of technical hemp till September, 2012 were protected. The industry of enterprises which are engaged in cultivation of hemp therefore suffered huge losses, and cultivation of extremely profitable crop at that time was non-profitable that led to sharp reduction of crops of this valuable commercial crop. Recognition at the level of government institutions of uniqueness of not narcotic grades of hemp allowed to make changes to the Ukrainian legislation and to remove protection of crops of plants with the content of tetrahydrocannabinol of less than 0.08% then acreage of the specified culture in the country increased by 3 times.

Comparing the level of development of enterprises which are engaged in cultivation of hemp and enterprises for hemp processing in Ukraine to other states of the world, it should be noted that this culture, having huge potential, in our country is not used in full. If in other countries of the world production of a hempy fiber increased from 57.5 thousand tons in 1996 to 115 thousand tons in 2005, then in our country, on the contrary, during this period rapid reduction of its production and reduction of acreage from 3200 to 1940 hectares was observed [16-18].

This negative trend, unfortunately, remained and until recently: in 2009 the acreage of hemp was only 300 hectares, in 2010 - 800 hectares, in 2011 - 430 hectares, in 2012 - 650 hectares, in 2013 - 860 hectares, in 2014 - 980 hectares, and since 2015 increase in acreage under technical hemp almost by 3 times (Figure 1) is observed.

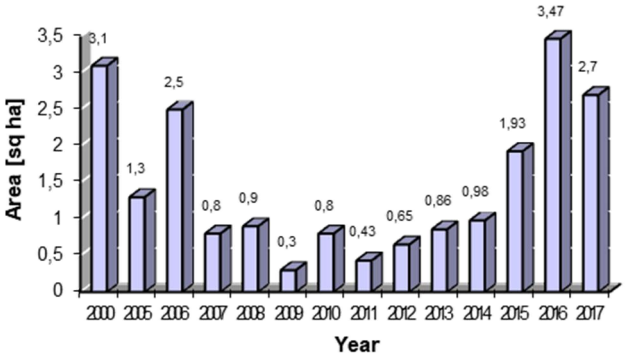

Figure 1 Dynamics of acreage of technical hemp in Ukraine [19]

Increase in demand for hempy raw materials in the world is connected with expansion of the sphere of its use, namely: for replacement of synthetic materials on the basis of natural fiber, production of cellulose, construction materials, products of the food industry and many other things [20]. Thanks to detailed studying of properties of modern not narcotic grades of hemp, development of the latest technologies of its processing allowing to use all components of a stalk of hemp the innovative products with new qualitative characteristics which find broad application in various branches of industrial production [21-23] are created. Fiber content in modern grades of not narcotic hemp is 30-35%. Technical textiles of hemp are used as sea and river ropes, twine, ropes, grids, tarpaulin and canvas and also textile products: fabrics, working clothes, footwear, haberdashery products. In the world not narcotic hemp is used for production of nonwoven and composite materials, geotextiles, cellulose, paper of different types and appointment. Today there is a possibility of use of the whole stalk of not narcotic hemp on the power purposes, in particular, for production of liquid biofuel, ethanol and biogas [24]. A fibre of hemp makes 65-70% of all weight bast stalks and consists mainly of cellulose (45-58%), lignin (21-29%) and pentozan (23-26%). From fibres are made construction and heat-insulating plates, paper, fuel, etc. Hemp is the most suitable raw materials for production of a construction blocks from hemp fibres, than flax. Good strength indicators of a construction blocks from hemp fibres with use fibres of hemp are explained a portlandtsement by the fact that on the enterprises for hemp processing before release of bast fibers of a stalk of hemp are exposed to long hydrothermal processing (within 20-30 days are soaked, then dry). It allows to reduce significantly contents in them the easily hydrolyzed of substances which slow down curing of the portlandtsement. A construction blocks from hemp fibres, light concrete, a kind of wood concrete with application hempy fires as organic filler, is made of mix fibres, binding substance (as a rule, cement), mineral filler (sand) and waters. For a mineralization fibres and accelerations of hardening of mix add chloride calcium, sulfate alumina together with lime-pushonkoy to it or other additives. The volume mass of a construction blocks from hemp fibres is from 400 to 700 kg/m^3. Material has low warm and sound conductivity, is convenient for processing, does not give in to rotting, and is the adverse environment for rodents and insects. It is used for construction of internal partitions in rooms and also for warm and sound insulation. The main producers are France, Australia, Ireland, Germany and Ukraine [25].

It is known that process of preprocessing of bast fiber raw materials consists of a number of consecutive operations which nature and quantity depend on the anatomic structure of stalks and also on many economic and organizational factors. It should be noted that broad use of technologies of nonconventional use of a hemp production, thanks to scientific developments in processing industry, will contribute to innovative development of a hemp breeding of Ukraine [26]. At the same time nearly the only solution of problems which face the enterprises for processing the bast fiber materials is profound processing of low-grade short fiber in various industries, fuller use of production wastes, etc. Complex processing of hemp raw materials is an indispensable condition of overall performance of the enterprise. Besides, now in Ukraine selectors created new highly productive grades of not narcotic monoecious hemp, however processing them on traditional technology does not allow receiving quality fiber. Therefore the solution of an issue of primary and profound processing of modern not narcotic grades needs to be carried out, since correction of the modes and parameters of technological processes of receiving fiber. For the purpose of justification and development of technology of preprocessing of modern grades

of not narcotic hemp a number of pilot and theoretical studies of physicomechanical properties of stalks and fiber by not narcotic monoecious hemp and cannabis on the basis of the Kherson National Technical University is conducted. For determination of the main technical characteristics on two types of hemp two sexual types (fimble and female hemp) grades of dioecious hemp as the Ermakovsky local and all sexual types of a high-performance grade of monoecious hemp USO-31 were chosen. By results of these researches it is established that stalks of straw of not narcotic monoecious hemp of various sexual types are characterized by uniformity on such morphological and technological to indicators as length and diameter of stalks, the maintenance of a bass and its explosive loading. Therefore preprocessing of not narcotic monoecious hemp does not demand application of the specific technological modes for plants of each sexual type that is characteristic of preprocessing of stalks of a fimble and a female of hemp dioecious.

Complex researches of physicomechanical properties trusts not narcotic monoecious hemp and cannabis showed that between them there are considerable differences in quality and quantitative indices. Despite increase in explosive loading, decline in quality of fiber of not narcotic monoecious hemp in comparison with cannabis is observed, namely: increase in linear density and reduction of flexibility. The difference in properties demonstrates that technologies which were applied on the dioecious hemp processing plants earlier cannot be used for modern grades of not narcotic monoecious hemp. Therefore there was a need of the detailed analysis and assessment of physicomechanical and technological properties of various forms of hemp. For quantitative assessment of distinctions on physicomechanical characteristics of monoecious not narcotic hemp from similar characteristics of dioecious hemp it is necessary to use methods of mathematical statistics: comparison of two averages selective for selections with randomly the distributed populations - big independent selections [26]. Such assessment is necessary for definition of physicomechanical characteristics most of which differ between two forms of hemp. A dioecious hemp and monoecious hemp further it is accepted to call these characteristics "criteria". Taking into account these characteristics it is necessary to adjust the modes and parameters of technological processes of receiving trusts and its machining.

Let's consider application of the theory of mathematical statistics for assessment of differences of two forms of hemp - a dioecious hemp (fimble and a female hemp) and all types of monoecious hemp (a monoecious female hemp, the monoecious feminized fimble, feminized fimble and monoecious masculinised female hemp) on the following indicators: diameter of stalks of straw and the maintenance of a bass in stalks, an exit of long fiber about trusts, explosive loading and linear density of fiber.

From the theory of mathematical statistics it is known that when independent selections have large volume (not less than 30 everyone), averages selective are distributed approximately normally and selective dispersions are rather reliable estimates of general dispersions. In this interpretation general dispersions can be considered known. Under our assumptions the approximate criterion of comparison of two averages selective takes place. In order that at the chosen significance value α to check a null hypothesis H_0: $M(X) = M(Y)$ about equality of population means of two populations with unknown general dispersions at the competing hypothesis H_1: $M(X) \neq M(Y)$ it is necessary to calculate value of criterion on the presented formula, it is estimated, W_c:

$$W_c = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{D_в(X)}{n} + \frac{D_в(Y)}{m}}} \quad (1)$$

where $\bar{x}$ is an average selective values of criteria characteristics of dioecious hemp; $\bar{y}$ is average selective values of criteria characteristics of monoecious hemp; $D_в(X)$ is selective dispersion for dioecious hemp; $D_в(Y)$ is selective dispersion for monoecious hemp; n is number of measurements of each characteristic dioecious hemp and m is number of measurements of each characteristic of monoecious hemp.

Then according to the table of values of function of Laplace Φ find a critical point of $W_{кр}$ from equality:

$$\Phi(W_{кр}) = \frac{1-\alpha}{2} \quad (2)$$

If $|W_c| < W_{кр}$, then indicators of physicomechanical characteristics of different sexual types of two forms of hemp differ slightly.

If $|W_c| > W_{кр}$, then indicators of physicomechanical characteristics of different sexual types of two forms of hemp differ considerably and these characteristics have to be used for correction of the modes and parameters of technological processes of receiving trusts and its machining. Significance value $\alpha = 0.05$.

Calculate values of function of Laplace in a critical point by a formula (2):

$$\Phi(W_{кр}) = \frac{1-\alpha}{2} = \frac{1-0,05}{2} = \frac{0,95}{2} = 0,475$$

After that, from the table of values of function of Laplace find that $W_{кр} \approx 1.96$.

For all above-mentioned physicomechanical characteristics of two forms of hemp absolute values of criterion W_c which are presented in Tables 1-3 were calculated and analysed.

Absolute values of criterion W_c on an indicator diameter of stalks of grades of Ermakovsky local and USO-31 are presented in Table 1.

Table 1 Absolute values of criterion W_c according to selective data of diameter of stalks of the studied hemp grades

Grade and sexual types of hemp	Ermakovsky local fimble	Ermakovsky local female	USO-31[1]	USO-31[2]	USO-31[3]	USO-31[4]
Ermakovsky local fimble	0.000					
Ermakovsky local female	82.976	0.000		symmetric.		
USO-31[1]	100.073	23.953	0.000			
USO-31[2]	65.568	8.246	9.828	0.000		
USO-31[3]	76.175	11.524	8.692	1.808	0.000	
USO-31[4]	80.671	17.889	2.115	7.097	5.767	0.000

Note: 1 - monoecious female hemp; 2 - monoecious feminized fimble; 3 - feminized fimble; 4 - monoecious maskulinizirovanny female hemp.

Analyzing values of criterion W_c presented in the table according to selective data of an indicator diameter of stalks, it is possible to draw a conclusion that all values of criterion W_c on an indicator diameter of stalks considerably exceed values of criterion $W_{кр}$, i.e $|W_c| > W_{кр}$. It gives the grounds to claim that on an indicator diameter of stalks the studied grades of hemp differ considerably. An exception is feminized fimble and monoecious feminized fimble USO-31 grades which on an indicator diameter of stalks practically do not differ. These are sexual types of monoecious not narcotic hemp therefore, really, on an indicator diameter of stalks they also should not differ considerably. For monoecious hemp of different sexual types of technology of processing should not differ. Absolute values of criterion W_c on an indicator the maintenance of a bass in stalks of hemp of grades of Ermakovsky local and USO-31 are presented in Table 2. From Table 2 it is visible that all values of criterion W_c considerably exceed values of criterion $W_{кр}$, i.e $|W_c| > W_{кр}$. Thus, on an indicator the maintenance of a bass in stalks the studied grades of hemp differ considerably.

Thus, the criteria characteristics given above - diameter of stalks of straw of hemp and the maintenance of a bass in them - further it is necessary to use for adjustment of parameters and the modes of machining of stalks trusts of not narcotic monoecious hemp in comparison with the modes and parameters of this process for dioecious hemp.

Absolute values of criterion W_c on an indicator an exit of long fiber from trusts of hemp of grades of Ermakovsky local and USO-31 are presented in Table 3.

Analyzing of Table 3, it is possible to draw a conclusion that all values of criterion W_c much more exceed values of criterion $W_{кр}$, i.e $|W_c| > W_{кр}$. Thus, on an indicator an exit of long fiber from trusts the studied grades of hemp differ considerably.

Table 2 Absolute values of criterion W_c according to selective data of an indicator the maintenance of a bass in stalks of the studied hemp grades

Grade and sexual types of hemp	Ermakovsky local fimble	Ermakovsky local female	USO-31[1]	USO-31[2]	USO-31[3]	USO-31[4]
Ermakovsky local fimble	0.000					
Ermakovsky local female	10.340	0.000		symmetrically		
USO-31[1]	25.500	67.882	0.000			
USO-31[2]	19.558	62.191	14.767	0.000		
USO-31[3]	12.738	26.679	8.370	2.025	0.000	
USO-31[4]	3.478	9.588	10.184	6.663	4.950	0.000

Table 3 Absolute values of criterion W_c on selective given vent an indicator of long fiber from trusts of the studied hemp grades

Grade and sexual types of hemp	Ermakovsky local fimble	Ermakovsky local female	USO-31[1]	USO-31[2]	USO-31[3]	USO-31[4]
Ermakovsky local fimble	0.000					
Ermakovsky local female	41.800	0.000		symmetric		
USO-31[1]	43.412	104.355	0.000			
USO-31[2]	34.059	87.057	7.913	0.000		
USO-31[3]	32.271	86.461	10.787	2.530	0.000	
USO-31[4]	31.921	111.734	22.804	11.068	8.165	0.000

Table 4 Absolute values of criterion W_c according to selective data of explosive loading of fiber studied hemp grades

Grade and sexual types of hemp	Ermakovsky local fimble	Ermakovsky local female	USO-31[1]	USO-31[2]	USO-31[3]	USO-31[4]
Ermakovsky local fimble	0.000					
Ermakovsky local female	24.343	0.000		symmetric		
USO-31[1]	58.316	21.922	0.000			
USO-31[2]	49.115	12.456	21.974	0.000		
USO-31[3]	62.879	24.318	3.508	31.623	0.000	
USO-31[4]	38.694	11.617	8.528	2.657	10.733	0.000

Table 5 Absolute values of criterion W_c according to selective data of linear density of fiber studied hemp grades

Grade and sexual types of hemp	Ermakovsky local fimble	Ermakovsky local female	USO-31[1]	USO-31[2]	USO-31[3]	USO-31[4]
Ermakovsky local fimble	0.000					
Ermakovsky local female	41.158	0.000		symmetric		
USO-31[1]	190.671	113.399	0.000			
USO-31[2]	239.473	121.342	14.261	0.000		
USO-31[3]	200.798	110.068	14.078	1.754	0.000	
USO-31[4]	156.183	96.000	7.593	3.178	4.093	0.000

Absolute values of criterion W_c on an indicator explosive loading of fiber and monoecious hemp of the studied grades are presented by a two-blast furnace in Table 4. From Table 4 it is visible that all values of criterion W_c considerably exceed values of criterion $W_{кр}$, i.e $|W_c| > W_{кр}$. Thus, on an indicator explosive loading of fiber the studied grades of hemp differ considerably.

Absolute values of criterion W_c on an indicator the linear density of fiber of the studied grades of hemp are presented in Table 5. Analyzing of Table 5, it is possible to draw a conclusion that practically all values of criterion W_c much more exceed values of criterion $W_{кр}$, i.e $|W_c| > W_{кр}$. Therefore on an indicator the linear density of fiber the studied grades of hemp differ considerably.

Exception is feminized fimble and monoecious feminized fimble USO-31 grades which on an indicator the linear density of fiber differ slightly.

Thus, according to the theory of mathematical statistics physicomechanical characteristics of two forms of hemp which differ considerably were defined. Treat them: diameter of stalks of straw, the maintenance of a bass in stalks, an exit of long fiber from trusts, explosive loading and linear density of fiber. Considering the revealed criteria characteristics of stalks of straw of not narcotic monoecious hemp it is necessary to develop innovative technologies of preparation trusts and its machining for the purpose of receiving the fiber suitable for use in different industries that will promote increase in the production of a hemp produktion, improvement of its quality, improving competitiveness of goods from not narcotic hemp and entry of Ukraine into the world market.

4 RESULTS

Modern market conditions demand new approaches to development of technologies which have to consider the forecast concerning demand for a concrete type of a hemp produktion. The directions of use of hemp change that, in turn, causes requirement of change of technologies of cultivation, cleaning and processing. Besides, modern technologies have to be energy saving and most mechanized.

Effective primary processing of stalks of hemp is impossible without development of innovative technologies and providing the hemp processing enterprises with new, more highly productive effective processing equipment which use will promote improvement of quality, expansion of the range and reduction of prime cost of fiber. In modern conditions new scientific approach to development of technologies is necessary for preprocessing of stalks of not narcotic monoecious hemp.

The presented calculations on the basis of methods of mathematical statistics give the chance to define criteria characteristics of stalks of straw of not narcotic grades of hemp – diameter of stalks and the maintenance of a bass in stalks according to which it is necessary to carry out adjustment of parameters and the modes of technological processes of receiving trusts and machining of hempy raw materials. Criteria characteristics of fibers - explosive loading and linear density - it is offered to use for determination of functional purpose of fibers after machining trusts.

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