6.The results of the study will be used in the development of recommendations for the technology of millet cultivation on irrigation in arid conditions of the Aktobe region for specialists, agricultural enterprises and other forms of management.

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ТҮЙІН

Бұл ғылыми мақалада аудандастырылған «Старт» сортымен салыстырғанда әр түрлі пісетін топтардың тары үлгілері мен сорттарын қосымша суаруға бейімділігі туралы зерттеулер нәтижелері келтірілген. Сондай-ақ бұл мақалада қазіргі таңдағы өңірдің басты міндеттері мен тары нысанының зерттеу қажеттілігі көрініс тапқан, себебі бүгінгі таңда топырақ пен климаттың өзгеруіне байланысты бұл салада қызмет ететін зерттеушілерге тарының өнім көлемін көбейту және келешектегі табиғаттың жаңа өзгерістеріне қарсы тұра алатын тарының жаңа түрлерін шығарту мақсатында жаңа зертеу дамыту сондай-ақ өндеу жолдарын таба юілу қажет болып тұр. Сонымен қатар бұл зерртеу жұмысында Ақтөбе облысы бойынша авторлармен жүргізген тәжірибелік күйде есептеулер мен эксперименттердің қорытынды жұмыстары нақтыланып анықталған және ресімделген.

РЕЗЮМЕ

В статье приведены результаты проведенных исследований по отзывчивости на дополнительное орошение образцов и сортов проса различных групп спелости по сравнению с районированным сортом - Старт. Отражены задачи региона, необходимость изучения форм проса на орошении на современном этапе, так как сейчас заметны изменения температурных и почвенных условий, образованы различные хозяйствующие формирования что, заставляет ученых искать новые пути повышения урожайности, качественных показателей сельскохозяйственных культур, в частности проса, которая является ведущей крупяной культурой в Актюбинской области. Выведенные и переданные в ГСИ сорта проса имеют много преимуществ, но они должны также быть гибкими при различных изменениях условий возделывания, в том числе и при орошении. В связи с этим изучение вышеназванного вопроса считаем актуальной и своевременным. Опыты показали положительное влияние полива в засушливых условиях. Заметно увеличение всех показателей (масса 1000 зерен, числа зерен в метелке, а также урожайности всех изучаемых сортов и форм по видам спелости и по сравнению со стандартом и по годам. Выявлены высоко отзывчивые номера и сделаны соответствующие выводы. Результаты исследовании будут использованы при разработке рекомендации по технологии возделывания проса на орошении в засушливых условиях Актюбинской области.

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USE OF OILSEED FLAX WASTE FOR PRODUCTION OF TECHNICAL CELLULOSE

Abstract

This article examines the structure of oilseed flax straw. Oilseed flax is a highly profitable annually renewable technical crop. Given the development directions and environmental preferences of modern society, the need for renewable cellulose-containing resources will increase, and their scope will expand, as evidenced by the experience of many countries. In a study, the chemical composition of oilseed flax straw was examined. The results of the study indicate the possibility of obtaining cellulose directly from oilseed flax straw.

The optimal reaction mixtures and conditions for the process of obtaining cellulose from waste from primary processing of flax straw were selected. The results of the study showed that thick stems are characterized by a lower cellulose content than thin, uniform straw as a whole. In addition, the straws have an increased mass fraction of acid-insoluble lignin, which provides special strength and creates difficulties for grinding. The chemical composition and physicochemical properties of cellulose were also investigated. The analysis results indicate the possibility of processing this type of raw material in order to obtain cellulose suitable for further chemical modifications.

***Keywords**: flax, processing, straw, cellulose.*

Introduction. Waste from the production of oilseed flax, especially flax bonfire, is a valuable raw material for the production of cellulose. Unfortunately, bonfire, as a raw material in papermaking, is used very rarely, it can be said that it is hardly used by pulp mills, despite the scientific facts of its perfect suitability. The reason for this situation can be considered relatively small-scale pulp production from straw of annual plants, which make up only 7% of the total mass of products. Nevertheless, it should be noted that with a certain technology for processing bonfires, it is suitable for further use in the pulp industry.

In the production of pulp in Kazakhstan, one of the main issues is the raw materials. As we know, the raw material for this product is technical wood pulp obtained by pulping softwood and hardwood using the sulfate method [1].

However, our country does not have enough forest plantations and therefore the domestic pulp and paper industry does not have its own raw material base. In view of the above, pulp producers are forced to buy a significant amount of raw materials abroad, which, on the one hand, increases the cost of finished products, and, on the other hand, makes it difficult to transport. This problem can be solved by using the straw of annual plants as a raw material base.

Oilseed flax fiber and bonfire are the most suitable for the production of cellulose and semi-cellulose used in the production of paper and cardboard [2]. Drebentsov F. F. used flax straw and bonfire in his research to produce cellulose. However, the regime for using bonfires to produce fibrous semi-finished products was not thoroughly worked out [3].

Research methods and materials. In view of the above, the laboratory for processing oilseeds of the Astana branch of «Kazakh research Institute of processing and food industry» LLP is conducting research on the possibility of using oilseed flax straw to produce fiber for various purposes, as a product with high added value. The chemical composition of oilseed flax straw was studied.

Objects of research-varieties of oilseed flax: Kostanay amber, Lirina, Kostanay 11, Kazar, oilseed flax straw and bonfire.

Research results. To determine the chemical composition, the raw material was previously crushed with scissors and an average sample was prepared. The mass fraction of extractive substances (extractant – diethyl ether) – the fat-wax fraction (FWF), the mass fraction of acid-insoluble lignin, and the mass fraction of cellulose were determined by the Krushner method [4]. The chemical composition of oilseed flax straw is shown in table 1.

Table 1 – The chemical composition of oilseed flax straw

Name of raw materials	FWF,%	Ash content, %	Lignin, %	Cellulose,%
Kostanay amber	2,40	2,37	22,85	47,29
Lirina	2,48	1,82	23,10	46,90
Kostanay 11	2,36	3,41	21,79	48,85
Kazar	2,12	2,74	21,52	48,03

A comparison of the results presented in table 1 shows that thick straws are characterized by a lower content of cellulose than thin homogeneous straw as a whole. In addition, the stems have an increased value of the mass fraction of acid-soluble lignin, which provides special strength and creates difficulties for crushing.

The obtained results of the chemical composition of oilseed flax straw, namely: the cellulose content in the range from 46,90% to 48,85%; ash content at the level of 1,82-3,41%; acid-insoluble lignin from 21,52% to 23,10% indicate the possibility of obtaining cellulose directly from oilseed flax straw.

Further research was carried out to obtain cellulose from the waste of the primary processing of flax straw. As a source material for the study, we used a bonfire of oilseed flax. The chemical composition of linseed bonfire was studied and cellulose was obtained in the laboratory using the methods of sulphate, peracetic, peroxide and nitric acid pulping. Samples of cellulose were obtained using «efficient» methods. Different fractional composition of the material consists of particles 1-15 mm long, 0,3–1,5 mm thick, with small inclusions of the fibrous part of flax. The mass fractions of the components in the linseed bonfire were determined by standard methods: cellulose – nitrogen-alcohol; lignin-sulfuric acid in the Komarov modification; extracted substances-by sequential extraction with diethyl ether and water in the soxlet apparatus. The results of a comparative analysis of the chemical composition of various types of raw materials are presented in table 2.

Table 2 – Comparative analysis of the chemical composition of various types of raw materials

Components	Mass fraction of components, %		
	Bonfire	Wheat straw	Pine
Lignin	32,8	24,5	28,1
Cellulose	37,5	44,3	52,4
Extracted substances	4,1	3,7	3,4
Ash content	1,8	5,5	0,4

Analysis of the data in table 2 shows that the content of oilseed flax in terms of cellulose and ash has an average reading between the three fibrous materials.

During the experiment, samples of sulphate, peracetic, peroxide and nitric acid technical cellulose from bonfire were obtained using the following modes:

1. Sulphate pulping (in a laboratory reactor). The initial concentration of active alkali in the pulping solution is 55 g/dm^3, the degree of sulfidity is 18%, the liquid module is 4, the temperature is 170°C, the pulping duration is 150 minutes.

2. Peracetic pulping (in a flask with a reverse refrigerator in a water bath). The initial composition of the pulping solution: the mass fraction of «ice» acetic acid-0.65; the mass fraction of perhydrol-0.35; the liquid module-6, the duration of isothermal pulping-90 minutes at a temperature of 92°C.

3. Peroxide pulpling (in a flask with a reverse refrigerator in a water bath). The initial concentration of hydrogen peroxide is 17%; the concentration of the complex catalyst is 0.1 g-mol/dm^3 (H_2SO_4 in the catalyst composition is 0.4). Liquid module – 6, duration of isothermal pulping-105 min. at a temperature of 98°C.

4. Nitric acid pulping (in a flask with a reverse refrigerator in a water bath). The initial concentration of nitric acid is 6%, the liquid modulus is 6, and the duration of isothermal pulping is

150 minutes at a temperature of 96°C. Then the cellulose samples were ground in a centrifugal grinding machine. Thus, semi-finished products from technical cellulose were obtained.

The results of the experiments were subjected to one-factor analysis of variance (the Statgraphics Centurion application package, the Design of Experiments block, and the Single Factor Categorical procedure). The variable factor is the duration of production of cellulose (four discrete levels of variation, indicated by the letters A, B, C, D), and the output parameter is the cellulose yield, which are shown in table 3.

Table 3 – Statistical characteristics of the sample

Pulping methods	Notation	Duration of pulping, min	Cellulose yield, %
		x	*y*
Sulphate	A	150	32,4
Peracetic	B	90	46,2
Peroxide	C	105	45,9
Nitric acid	D	150	41,3
Variance relations *F*			66,03
Significance level *p*			0,0142

The output data show that the relationship between cellulose yield and duration of pulping is characterized by the following equation:

$$y = 62{,}3324 - 0{,}16915x, \qquad (1)$$

Since the p value is less than 0.05, there is a statistically significant relationship between the variables at the 95.0% confidence level, as shown in figure 1.

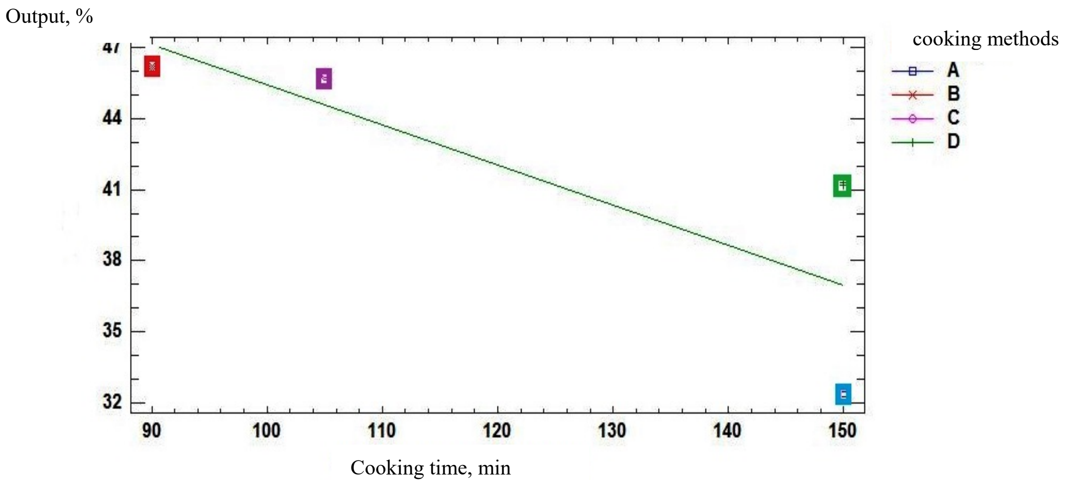

Figure 1 – Confidence intervals of cellulose yield for each of the delignification conditions

Statistics of the dispersion ratio F show that 66.03% of the variability in the yield of cellulose depends on the pulping conditions. At the same time, delignification of bonfire with peracetic acid (modes – levels of factor B) provided a high yield of cellulose of 46.2%, compared with other methods. Thus, peracetic acid was chosen as the optimal reaction mixture for obtaining cellulose from oilseed flax bonfires.

The choice of the peracetic method is due to the fact that it is based on pulping using peracetic acid – $CH_3C(O)OOH$, the components of which are easily decomposed into water, oxygen and acetic acid and are not particularly dangerous to the environment.

Selection of optimal conditions for pulping oilseed flax bonfires with peracetic acid was carried out using two-factor planning under the Statgraphics Centurion program. The most important factors were chosen as variable conditions for peracetic pulping based on the results of preliminary experiments: the duration of the pulping process x_1 (range of variation 80-90 min), the pulping temperature x_2 (range of variation 90-98°C). As the output parameter, the cellulose yield product y was selected, the values of which are shown in table 4.

Table 4 - Influence of peracetic pulping conditions on the yield of cellulose product

Peracetic pulping conditions		Yield of cellulose product,%
t, min	T, °C	
x_1	x_2	y
80	94	45,3
85	94	46,5
80	98	49,5
90	90	50,1
90	98	52,3
80	90	46,0
90	94	49,2
85	98	47,5
85	90	46,8

The dependence of the output parameter on the variable factors of peracetic pulping was approximated by the regression equation:

$$y = 23{,}0607 - 1{,}2x_1 + 0{,}2667x_2, \quad (2)$$

The regression equation adequately reflects the results of the experiment, since the P value for the output of the cellulose product is less than 0.05, there is a statistically significant relationship between y and factors at a confidence level of 95.0%. Figure 2 shows the response intervals that illustrate the dependence of the yield of the cellulose product on the variables of the pulping process.

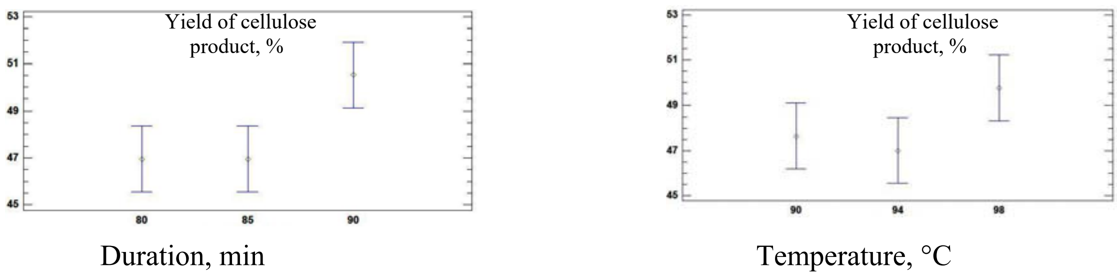

Figure 2 – Dependence of the yield of the cellulose product on the variables of the pulping process

Thus, under the condition t=90 min and T=98 °C, a high yield of the cellulose product is provided.

The study of the chemical composition and physical and chemical properties of cellulose was carried out using standard methods for analyzing products of vegetable raw materials processing: the content of alpha-cellulose was treated with a 17.5% solution of sodium hydroxide (GOST 6840-78), residual lignin-by direct method, ash content-by burning the sample and calcining at a temperature of 575±25°C. the results of the analysis are presented in table 5.

Table 5 - Chemical and physical parameters of the obtained products

Pulping methods	Alpha-cellulose,%	Lignin, %	Ash content, %
Sulphate	83,6	1,15	1,05
Peracetic	93,2	1,17	0,75
Peroxide	91,5	1,26	0,82
Nitric acid	86,8	1,38	0,94

Conclusion. According to the analysis it can be noted that the cellulose obtained peracetic pulping, characterized by thus, the mass fraction of α-cellulose 93,2%, the ash content and mass fraction of residual lignin amount of 0.75% and 1.17 % respectively, which indicates the possibility of processing such raw materials with the aim of obtaining cellulose, suitable for further chemical modifications.

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ТҮЙІН

Бұл мақалада майлы зығыр сабанының құрылымы зерттелген. Майлы зығыр – жоғары тиімділікті жыл сайын қалпына келетін техникалық дақыл. Қазіргі қоғамның даму бағыттары мен экологиялық артықшылықтарын ескере отырып, құрамында целлюлоза бар жаңартылатын ресурстарға қажеттілік артады, ал оларды қолдану аясы кеңейтіледі, бұл туралы көптеген елдердің тәжірибесі куәландырады. Зерттеу барысында майлы зығыр сабанының химиялық құрамы зерттелді. Зерттеу нәтижелері майлы зығыр сабанынан тікелей целлюлоза алу мүмкіндігін көрсетеді.

Зығыр сабанын бастапқы өңдеу қалдықтарынан целлюлоза алу процесін жүргізу шарттары және оңтайлы реакциялық қоспалар іріктелді. Зерттеу нәтижелері бойынша жіңішке біртекті сабанға қарағанда, қалың сабақтардың құрамында Кюршнер бойынша целлюлоза мөлшері аз болатыны анықталды. Сонымен қатар, сабақтарда қышқылмен еритін лигниннің массалық үлесі жоғары мәнге ие, бұл ерекше беріктікті қамтамасыз етеді және ұнтақтау кезінде қиындықтар туғызады. Сонымен қатар целлюлозаның химиялық құрамы мен физикалық-химиялық қасиеттері зерттелді. Талдау нәтижелері одан әрі химиялық модификациялар үшін жарамды целлюлоза алу мақсатында шикізаттың осындай түрін қайта өңдеу мүмкіндігі туралы куәландырады.

РЕЗЮМЕ

В данной статье рассмотрены исследования строения соломы льна масличного. Лен масличный – это высокорентабельная ежегодно возобновляемая техническая культура. Учитывая направления развития и экологические предпочтения современного общества, потребность в возобновляемых целлюлозосодержащих ресурсах будет возрастать, а сфера их применения расширяться, о чем свидетельствует опыт многих стран. В ходе исследования был изучен химический состав соломы льна масличного. Результаты исследования свидетельствуют о возможности получения целлюлозы непосредственно из соломы масличного льна.

Были подобраны оптимальные реакционные смеси и условия проведения процесса получения целлюлозы из отходов первичной переработки льняной соломы. Результаты исследования показали, что толстые стебли характеризуются меньшим содержанием целлюлозы по Кюршнеру, чем тонкая однородная солома в целом. Кроме того, стебли имеют повышенное значение массовой доли кислотонерастворимого лигнина, что обеспечивает особую прочность и создает сложности для измельчения. Также были исследованы химический состав и физико-химические свойства целлюлозы. Результаты анализа свидетельствуют о возможности переработки такого вида сырья с целью получения целлюлозы, пригодной для дальнейших химических модификаций.