

ISSN 2518-1629 (Online),
ISSN 2224-5308 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ
Өсімдіктердің биологиясы және биотехнологиясы институтының

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Института биологии и биотехнологии растений

NEWS

OF THE NATIONAL ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN
of the Institute of Plant Biology and Biotechnology

**БИОЛОГИЯ ЖӘНЕ МЕДИЦИНА
СЕРИЯСЫ**



СЕРИЯ

БИОЛОГИЧЕСКАЯ И МЕДИЦИНСКАЯ



SERIES

OF BIOLOGICAL AND MEDICAL

1 (325)

**ҚАҢТАР – АҚПАН 2018 ж.
ЯНВАРЬ – ФЕВРАЛЬ 2018 г.
JANUARY – FEBRUARY 2018**

**1963 ЖЫЛДЫҢ ҚАҢТАР АЙЫНАН ШЫҒА БАСТАҒАН
ИЗДАЕТСЯ С ЯНВАРЯ 1963 ГОДА
PUBLISHED SINCE JANUARY 1963**

**ЖЫЛЫНА 6 РЕТ ШЫҒАДЫ
ВЫХОДИТ 6 РАЗ В ГОД
PUBLISHED 6 TIMES A YEAR**

**АЛМАТЫ, ҚР ҰҒА
АЛМАТЫ, НАН РК
ALMATY, NAS RK**

Б а с р е д а к т о р

ҚР ҰҒА академигі, м. ғ. д., проф. **Ж. А. Арзықұлов**

Абжанов Архат проф. (Бостон, АҚШ),
Абелев С.К., проф. (Мәскеу, Ресей),
Айтқожина Н.А., проф., академик (Қазақстан)
Акшулаков С.К., проф., академик (Қазақстан)
Алшынбаев М.К., проф., академик (Қазақстан)
Бәтпенев Н.Д., проф., корр.-мүшесі (Қазақстан)
Березин В.Э., проф., корр.-мүшесі (Қазақстан)
Берсімбаев Р.И., проф., академик (Қазақстан)
Беркінбаев С.Ф., проф., (Қазақстан)
Бисенбаев А.К., проф., академик (Қазақстан)
Бишимбаева Н.Қ., проф., академик (Қазақстан)
Ботабекова Т.К., проф., корр.-мүшесі (Қазақстан)
Bosch Ernesto prof. (Spain)
Жансүгірова Л.Б., б.ғ.к., проф. (Қазақстан)
Ellenbogen Adrian prof. (Tel-Aviv, Israel),
Жамбакин Қ.Ж., проф., академик (Қазақстан), бас ред. орынбасары
Заядан Б.К., проф., корр.-мүшесі (Қазақстан)
Ishchenko Alexander prof. (Villejuif, France)
Исаева Р.Б., проф., (Қазақстан)
Қайдарова Д.Р., проф., академик (Қазақстан)
Кохметова А.М., проф., корр.-мүшесі (Қазақстан)
Күзденбаева Р.С., проф., академик (Қазақстан)
Локшин В.Н., проф., корр.-мүшесі (Қазақстан)
Лось Д.А., prof. (Мәскеу, Ресей)
Lunenfeld Bruno prof. (Израиль)
Макашев Е.К., проф., корр.-мүшесі (Қазақстан)
Муминов Т.А., проф., академик (Қазақстан)
Огарь Н.П., проф., корр.-мүшесі (Қазақстан)
Омаров Р.Т., б.ғ.к., проф., (Қазақстан)
Продеус А.П. проф. (Ресей)
Purton Saul prof. (London, UK)
Рахыпбеков Т.К., проф., корр.-мүшесі (Қазақстан)
Сапарбаев Мұрат проф. (Париж, Франция)
Сарбасов Дос проф. (Хьюстон, АҚШ)
Тұрысбеков Е.К., б.ғ.к., асс.проф. (Қазақстан)
Шарманов А.Т., проф. (АҚШ)

«ҚР ҰҒА Хабарлары. Биология және медициналық сериясы».

ISSN 2518-1629 (Online),

ISSN 2224-5308 (Print)

Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.)

Қазақстан республикасының Мәдениет пен ақпарат министрлігінің Ақпарат және мұрағат комитетінде
01.06.2006 ж. берілген №5546-Ж мерзімдік басылым тіркеуіне қойылу туралы куәлік

Мерзімділігі: жылына 6 рет.

Тиражы: 300 дана.

Редакцияның мекенжайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., 220, тел.: 272-13-19, 272-13-18,
www.nauka-nanrk.kz/biological-medical.kz

© Қазақстан Республикасының Ұлттық ғылым академиясы, 2018

Типографияның мекенжайы: «Аруна» ЖК, Алматы қ., Муратбаева көш., 75.

Г л а в н ы й р е д а к т о р

академик НАН РК, д.м.н., проф. **Ж. А. Арзыкулов**

Абжанов Архат проф. (Бостон, США),
Абелев С.К. проф. (Москва, Россия),
Айтхожина Н.А. проф., академик (Казахстан)
Акшулаков С.К. проф., академик (Казахстан)
Алчинбаев М.К. проф., академик (Казахстан)
Батпенов Н.Д. проф. член-корр.НАН РК (Казахстан)
Березин В.Э., проф., чл.-корр. (Казахстан)
Берсимбаев Р.И., проф., академик (Казахстан)
Беркинбаев С.Ф. проф. (Казахстан)
Бисенбаев А.К. проф., академик (Казахстан)
Бишимбаева Н.К. проф., академик (Казахстан)
Ботабекова Т.К. проф., чл.-корр. (Казахстан)
Bosch Ernesto prof. (Spain)
Джансугурова Л. Б. к.б.н., проф. (Казахстан)
Ellenbogen Adrian prof. (Tel-Aviv, Israel),
Жамбакин К.Ж. проф., академик (Казахстан), зам. гл. ред.
Заядан Б.К. проф., чл.-корр. (Казахстан)
Ishchenko Alexander, prof. (Villejuif, France)
Исаева Р.Б. проф. (Казахстан)
Кайдарова Д.Р. проф., академик (Казахстан)
Кохметова А.М. проф., чл.-корр. (Казахстан)
Кузденбаева Р.С. проф., академик (Казахстан)
Локшин В.Н., проф., чл.-корр. (Казахстан)
Лось Д.А. prof. (Москва, Россия)
Lunenfeld Bruno prof. (Израиль)
Макашев Е.К. проф., чл.-корр. (Казахстан)
Муминов Т.А. проф., академик (Казахстан)
Огарь Н.П. проф., чл.-корр. (Казахстан)
Омаров Р.Т. к.б.н., проф. (Казахстан)
Продеус А.П. проф. (Россия)
Purton Saul prof. (London, UK)
Рахыпбеков Т.К. проф., чл.-корр. (Казахстан)
Сапарбаев Мурат проф. (Париж, Франция)
Сарбасов Дос проф. (Хьюстон, США)
Турьсыбеков Е. К., к.б.н., асс.проф. (Казахстан)
Шарманов А.Т. проф. (США)

«Известия НАН РК. Серия биологическая и медицинская».

ISSN 2518-1629 (Online),

ISSN 2224-5308 (Print)

Собственник: РОО «Национальная академия наук Республики Казахстан» (г. Алматы)

Свидетельство о постановке на учет периодического печатного издания в Комитете информации и архивов
Министерства культуры и информации Республики Казахстан №5546-Ж, выданное 01.06.2006 г.

Периодичность: 6 раз в год

Тираж: 300 экземпляров

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, ком. 219, 220, тел. 272-13-19, 272-13-18,
www:nauka-nanrk.kz / biological-medical.kz

© Национальная академия наук Республики Казахстан, 2018

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75

Editor in chief

Zh.A. Arzykulov, academician of NAS RK, Dr. med., prof.

Abzhanov Arkhat, prof. (Boston, USA),
Abelev S.K., prof. (Moscow, Russia),
Aitkhozhina N.A., prof., academician (Kazakhstan)
Akshulakov S.K., prof., academician (Kazakhstan)
Alchinbayev M.K., prof., academician (Kazakhstan)
Batpenov N.D., prof., corr. member (Kazakhstan)
Berezin V.Ye., prof., corr. member. (Kazakhstan)
Bersimbayev R.I., prof., academician (Kazakhstan)
Berkinbaev S.F., prof. (Kazakhstan)
Bisenbayev A.K., prof., academician (Kazakhstan)
Bishimbayeva N.K., prof., academician (Kazakhstan)
Botabekova T.K., prof., corr. member. (Kazakhstan)
Bosch Ernesto, prof. (Spain)
Dzhansugurova L.B., Cand. biol., prof. (Kazakhstan)
Ellenbogen Adrian, prof. (Tel-Aviv, Israel),
Zhambakin K.Zh., prof., academician (Kazakhstan), deputy editor-in-chief
Ishchenko Alexander, prof. (Villejuif, France)
Isayeva R.B., prof. (Kazakhstan)
Kaydarova D.R., prof., academician (Kazakhstan)
Kokhmetova A., prof., corr. member (Kazakhstan)
Kuzdenbayeva R.S., prof., academician (Kazakhstan)
Lokshin V.N., prof., corr. member (Kazakhstan)
Los D.A., prof. (Moscow, Russia)
Lunenfeld Bruno, prof. (Israel)
Makashev E.K., prof., corr. member (Kazakhstan)
Muminov T.A., prof., academician (Kazakhstan)
Ogar N.P., prof., corr. member (Kazakhstan)
Omarov R.T., Cand. biol., prof. (Kazakhstan)
Prodeus A.P., prof. (Russia)
Purton Saul, prof. (London, UK)
Rakhypbekov T.K., prof., corr. member. (Kazakhstan)
Saparbayev Murat, prof. (Paris, France)
Sarbassov Dos, prof. (Houston, USA)
Turysbekov E.K., cand. biol., assoc. prof. (Kazakhstan)
Sharmanov A.T., prof. (USA)

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of biology and medicine.

ISSN 2518-1629 (Online),

ISSN 2224-5308 (Print)

Owner: RPA "National Academy of Sciences of the Republic of Kazakhstan" (Almaty)

The certificate of registration of a periodic printed publication in the Committee of information and archives of the Ministry of culture and information of the Republic of Kazakhstan N 5546-Ж, issued 01.06.2006

Periodicity: 6 times a year

Circulation: 300 copies

Editorial address: 28, Shevchenko str., of. 219, 220, Almaty, 050010, tel. 272-13-19, 272-13-18,
<http://nauka-nanrk.kz/> / biological-medical.kz

© National Academy of Sciences of the Republic of Kazakhstan, 2018

Address of printing house: ST "Aruna", 75, Muratbayev str, Almaty

NEWS

OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN

SERIES OF BIOLOGICAL AND MEDICAL

ISSN 2224-5308

Volume 1, Number 325 (2018), 51 – 57

UDC 664.162.116

B. Sh. Kedelbaev¹, K. M. Lakhanova², Zh. B. Makhatov¹¹M. Auezov South Kazakhstan State University, Shymkent, Kazakhstan,²Yassawi International Kazakh-Turkish University, Turkestan, Kazakhstan.E-mail: *kulzada.lakhanova@iktu.kz* *kulzada56@mail.ru***STUDY OF THE PROCESS OF SORBITOL PRODUCTION
FROM WHEAT STRAW**

Abstract. The article presents the results of the study of the enzymatic combined (hybrid) hydrolysis-hydrogenation process for the production of sorbitol. This article describes the results of the pre-treatment and enzymatic hydrolysis of wheat straw, as well as the synthesis of sorbitol in order to increase the yield of valuable products needed for industry. Pretreatment of straw was carried out in the temperature range 190-250°C with a variation in the concentration of sulfuric acid from 0.6 to 2.5% by weight. The optimum temperature and duration of hydrolysis of straw with sulfuric acid were 160°C - 170°C and 30-80 minutes, respectively. In all straw hydrolysis experiments, the best results were achieved with a sulfuric acid concentration of 1.6% by weight and an experimental temperature of 150-160°C. Studies of the processes of enzymatic hydrolysis of straw have been carried out. Since the paper is practically pure cellulose, then, with the same kinetic parameters of the fermentolysis processes, the amount of formed sugars in the case of fermentolysis of straw would be 1.49 times less than when using paper. The resulting purified glucose hydrolyzate was subjected to hydrogenation in the presence of a nickel-aluminum-iron-chromium catalyst. The catalyst of the alloy with 7.0% chromium exhibits the greatest activity, the yield of sorbitol at which at 100°C and 6MPa for 60 minutes of hydrogenation is 50.5%, and the rate of hydrogenation of glucose is 1.46 times higher than for skeleton nickel without an additive. It is shown that with increasing hydrogen pressure from 2 to 12 MPa and 40-120°C, the rate of hydrogenation of glucose on titanium-promoted nickel-aluminum-iron catalysts increases.

Key words: wheat straw, sorbitol, cellulose, catalyst, enzymatic hydrolysis, biomass.

The growing interest in the use of plant biomass, rich in polysaccharides, determines the search for optimal methods for its processing. The main criterion in waste processing is their cost, volume, availability and localization, as well as chemical composition and technological properties. The processing of renewable plant materials in industrial-important substances is of great practical interest.

Cellulose-containing raw materials in the country are available in almost unlimited quantities in the form of wood, straw, solid household waste, etc. However, its effective conversion into biologically digestible sugars is a complex task, over which scientific collectives all over the world work. In this case, the possibilities of using directly microorganisms, complexes of cellulolytic enzymes, chemical hydrolyzing agents for the effective conversion of non-food raw materials into digestible sugars are explored.

According to the statistic data, wheat and cotton are the leaders in crop yields in the Republic of Kazakhstan. Gross harvest of wheat in 2011 amounted to 22.7 million tons, while in the fields of agricultural enterprises an average of 11.1 million tons of wheat straw was formed, only 10 percent of which is used for feeding livestock and as litter to animals, the rest of it is plowed up into the ground and burned in the fields. Thus, cereal straw is a large-capacity, affordable and promising secondary resource of agricultural production in the Republic of Kazakhstan. One of the cheapest and available types of cellulose-containing raw materials for large-tonnage production of energy carriers, in particular fuel alcohol, is straw. This is a huge potential raw material base. Finally, the existing agricultural infrastructure

makes it possible to solve the problem of delivering straw for processing, provided that the processing enterprise is located near the elevator [1].

Given the low degree of effective use of straw cereals at present, the main attention is paid to the problem of saccharification of this type of secondary raw materials. The plant cell wall has a high resistance to degradation. Fungi and bacteria that use cellulose as a source of carbon have developed a complex set of enzymes that hydrolyse cellulose, releasing glucose monomers. Enzymatic hydrolysis is a promising method of processing plant biomass. However, during the enzymatic hydrolysis of ligno-cellulosic materials in their native form, the yield of sugars reaches less than 20% of the theoretically possible yield. Overcoming the physico-chemical barriers that hamper the availability of cellulose for enzymes is an important issue, the solution of which is directly related to the search for low-cost pre-treatment methods for raw materials. The effectiveness of this process determines the yield of the target product in the process of enzymatic hydrolysis of cellulose and the economic feasibility of the entire technology as a whole. Despite the relatively high catalytic activity of sulfuric, hydrochloric and phosphoric acids, their use in the hydrolysis of lignocellulose is still not economically effective, since they have a strong corrosive activity, their cost is high, and the neutralization of their excess in hydrolyzates is associated with costs and environmental stress. Perspective is the use of sulfuric acid, which allows to reduce the consumption of hydrolyzing agent due to its recovery. In this regard, the determination of optimal pre-treatment regimes using sulfuric acid, as well as the study of the effect of its conditions on the efficiency of enzymatic hydrolysis of wheat straw, is an urgent task. The development of complex processing of wheat straw will not only improve the ecological situation, but also will provide raw materials and additional products for the industry.

The development of complex processing of carbohydrate-containing plant raw materials and waste will allow not only to improve the ecological situation, but also to obtain raw materials and additional products for the chemical industry and biotechnological productions. Thus, the processing of renewable carbohydrate-containing plant material and waste into industrially important chemicals is of great practical interest

Of particular interest is the search for catalytic technologies of a one-stage, combined (hybrid) process for obtaining valuable substances directly from this raw material, excluding the technological stages of separation and purification of intermediates. One-stage organization of the process makes it possible to obtain from the plant polysaccharide by the hydrolysis-hydrogenation reaction of compounds such as xylitol and sorbitol. Intensive research is being carried out in this direction in the world. A wide range of catalytic systems for the hydrolytic transformations of a renewable polysaccharide are proposed, for example, catalytic systems based on carbon, oxides, zeolites, ion exchange resins. Various technological schemes for the implementation of such processes have been developed, various variations of the methods for similar processing of polysaccharides of carbohydrate-containing plant material and waste are proposed.

However, the literature data published so far on the use of various catalytic systems in the conversion of these polysaccharides often contradict each other, and the catalysts proposed exhibit little activity or stability. It should be noted that most researchers have studied exclusively the hydrolysis of polysaccharides into glucose, and the number of works devoted to the possibility of obtaining, for example, from wheat straw of xylitol and sorbitol as a result of combined (hybrid) process processes is extremely small. Although, these compounds are substances that are highly demanded in many modern branches of the chemical, food, perfume, medical, and other industries. In particular, sorbitol and xylitol are widely used in the production of surfactants, synthetic resins, varnishes, drying oil, vitamin C, food products, etc.

To date, a fairly large number of experimental data on the hydrolysis of cellulose to glucose has been obtained, but information on single-stage hybrid processes for the production of sorbitol and xylitol is not enough, and the results described in the literature often do not agree with each other.

Analysis of the literature [2-11] on the topic of the work showed that in the field under study there are a number of unresolved problems, the search for solutions of which seems useful for the creation of effective catalytic technologies for the conversion of carbohydrate-containing plant material and waste into valuable chemicals.

In [12], a method is proposed that pertains to genetic engineering and can be used in the microbiological industry. Arabid producing yeasts or fungi transform the DNA encoding the D-xylose-forming D-arabitol dehydrogenase and DNA encoding xylitol dehydrogenase. Then, transformed yeast or fungi under conditions that ensure the synthesis of xylitol. Xylitol is removed. Yeast is selected from *Lygosaccharomycesrouxii*, *Candidapolymorpha*, *Torulopsiscandida*, *Pichiafarinosa*, *Torulasporahansenii*. Mushrooms are selected from *Dendryphiellasalina* and *Schizophyllumcommune*. The method makes it possible to convert readily available sources of carbon, such as D-glucose to xylitol.

In [13], cellulose and hemicellulose in biomass are first decrystallized first with concentrated sulfuric acid and subjected to the first hydrolysis, resulting in a hydrolyzate saturated with sugar and acid. After that, the silicon oxides contained in the biomass are removed and sent to the processing. Then, the remaining solid residues are subjected to repeated decrystallization and re-hydrolysis. The resulting sugar solution is thereafter subjected to fermentation, using for this purpose microorganisms, preferably yeast and bacteria, providing fermentation of both hexoses and pentoses simultaneously. The method makes it possible to obtain sugars from biomass containing cellulose and hemicellulose, which is economically efficient and does not pollute the environment.

In [14] describes a process for pretreating a cellulose-containing feedstock for enzymatic hydrolysis, which involves preparing a feed slurry and treating it with an acid solution. A solution of nitric acid with a concentration of 2,8-6,5% is used as the acid solution. The solution is heated to a temperature of 98-100 °C and held for 1-5 hours. The product obtained is filtered, washed. And as a cellulose-containing raw material use miscanthus or fruit shells of cereals. The acid solution worked out after one cycle is strengthened with concentrated nitric acid to a solution concentration of 2,8-6,5% and repeatedly used again. The solution spent 18-25 cycles is neutralized with ammonia to obtain a solution of ammonium nitrate for use as a fertilizer.

A method related to the microbiological as well as the food industry and which can be used in the disposal of waste containing cellulose is described in [15]. The method involves pretreating cellulose-containing raw materials from which barley or rice grains are used, or cotton linters, or wheat straw to break down the crystal structure and increase its specific surface area. This treatment is carried out by extrusion. The obtained extrudate is subjected to enzymatic hydrolysis with enzymatic preparations of Asp. mix B 2000 or B1mix or celloviridine G20x at a mass ratio of the enzyme: extrudate 1-3: 1-9, respectively. The proposed method is non-waste, environmentally friendly and inexpensive, characterized by a high degree of bioconversion of raw materials with a significant reduction in the time required for its implementation.

A method was developed [16] comprising the step of hydrolyzing a cellulose-containing biomass to obtain an aqueous sugar solution. The resulting aqueous sugar solution is then filtered through a nanofiltration membrane and/or a reverse osmosis membrane. The purified sugar solution is collected from the inlet side and the fermentation inhibiting substances are removed from the filtrate side. These fermentation inhibiting substances are one or more compounds from organic acids, furan compounds and phenolic compounds. The invention makes it possible to obtain a sugar syrup purified from the fermentation-inhibiting compounds in a simple manner and to increase the efficiency of the fermentation of various chemical products.

Silveira et al [17] compared the activity of 6 strains of *Zymomonasmobilis* with respect to D-sorbitol and gluconic acid.

The strain of *Zymomonasmobilis* ATSS-29191 compared to others showed relatively good growth and high yield of products. For this strain, the effect of the initial concentration of substrates on the yield of D-sorbitol and gluconic acid in the batch process was investigated [18]. The equimolar concentrations of glucose and fructose ranged from 100 to 750 g / l. Increase in productivity occurred at an increase in the initial concentration of the substrate to 650 g / l. At 750 g / l, a drop in productivity was observed.

It was also found that with an initial concentration of 100 g / L, glucose and fructose were equally converted to sorbitol and gluconic acid, especially during the initial reaction period. However, after 20 minutes there was a shift in the metabolism of sugars, characterized by: an increase in glucose consumption, a strong decrease in fructose intake, a decrease in the yield of sorbitol, and a decrease in the concentration of gluconic acid. An increase in the concentration of substrates to 600 g / l led to an almost complete conversion of sugars to sorbitol and gluconic acid.

This article describes the results of the pre-treatment and enzymatic hydrolysis of wheat straw, as well as the synthesis of sorbitol in order to increase the yield of valuable products needed for industry. To develop the processing technology, wheat straw was formed, formed as waste in the agricultural sector of the Republic of Kazakhstan. Previously investigated plant raw materials were crushed and sorted. The individual monosaccharides in the hydrolysates were analyzed by paper chromatography using Filtrak FN-3, 11 and 14 in butanol-acetic acid-water solvents (4: 1: 5). The substances were detected by spraying first with a first developer of K₂SO₄, then a mixture of benzidine, acetone and hydrochloric acid in a ratio of 10: 2: 1. Alloys were prepared in the high-frequency melting furnace of the brand according to the technology developed by us. A calculated amount of aluminum was placed in a quartz crucible and gradually heated to 100-110⁰C, then the calculated amount of nickel, iron and titanium was introduced. As a result of the exothermic reaction, the temperature of the melt rose to 170-180⁰C, which was mixed for 3-5 minutes by an induction field. In graphite molds, the alloy was cooled in air and ground to 0.25 mm grains. Activation of the alloys was carried out by leaching with 10 aqueous solution of caustic sodium, taken in a volume of 40 cm³ per 1 g of alloy in a boiling water bath for 1 hour, after which the catalyst was washed from alkali with water until neutral reaction with phenolphthalein. The catalysts thus obtained were used for the hydrogenation of glucose. For the rapid identification of the optimum catalyst and the study of kinetic regularities, the experiments were initially carried out in a modified batch reactor. The device is equipped with a hermetic drive with a power of 0,6 kW, the speed of rotation of the stirrer is 2800 rpm, which allows to remove the diffusion complications of the reaction.

Pretreatment of straw was carried out in the temperature range 190-250⁰C with a variation in the concentration of sulfuric acid from 0.6 to 2.5% by weight. Increasing the temperature to a greater extent, compared with the increase in the concentration of acid, contributed to a reduction in the processing time required to achieve the maximum yield of reducing substances (RS). more than decomposition of monosaccharides. The yield of monosaccharides therefore increases with the reaction temperature. The influence of the concentration of sulfuric acid at temperatures below 150 ° C is noticeable, but with increasing temperature to 160 ° C it disappears.

The optimum temperature and duration of hydrolysis of straw with sulfuric acid were 160⁰C - 170⁰C and 30-80 minutes, respectively. As the concentration of sulfuric acid increases, the rate of decomposition of sugars increases. The optimum concentration of sulfuric acid is 1.77% by weight. Pretreatment of straw with a variation of the hydromodule from 1: 3 to 1: 5 was carried out under conditions of 1.6% by weight. sulfuric acid and at a temperature of 150 ° C. The highest yield of RS was achieved with the hydromodule 1: 3.5, 1: 5 and 1: 5.8 and amounted to 26.8%, 27.0% and 29.2% respectively. The monosaccharide composition of the hydrolysates was mainly represented by glucose, the concentration of which reached 25 g / l in the hydrolysates.

Thus, the treatment of straw is 1.35% by weight. sulphurous acid at a temperature of 150⁰C, a hydromodule of 1:3 for 60 min allows to obtain hydrolysates with a concentration of reducing substances up to 7.6%, which will promote their further use in the microbiological industry. When using the hydromodule 1: 4.5, the maximum concentration of reducing substances in the hydrolyzate is reached at a temperature of 160⁰C, sulfuric acid concentration of 1.6% by weight. The yield of reducing substances was 25.57% of the absolutely dry substance. In all straw hydrolysis experiments, the best results were achieved with a sulfuric acid concentration of 1.6% by weight and an experimental temperature of 150-160⁰C.

Studies of the processes of enzymatic hydrolysis of straw

Model experiments for the study of enzyme kinetics were carried out using paper and cotton wool as the source of cellulose. In the experimental processes of fermentolysis, wheat straw that was pre-ground, screened and dried to constant value in a drying cabinet at a temperature of 120⁰C for 2 hours was used, which was pre-soaked in an autoclave at an excess pressure of 0.05-0.1 MPa for 0.5 - 1 hour.

The processes of fermentolysis were carried out while maintaining active acidity in the range of 4.9-5.0 units. pH and temperature of 49⁰C. The duration of fermentolysis was 7-10 hours.

Studies of the kinetics and stoichiometry of the reactions of enzymatic hydrolysis of disperse solid-phase vegetable substrates were carried out in a laboratory fermentolizer with automated pH control and thermostating.

The results of the experiment are given in Table 1.

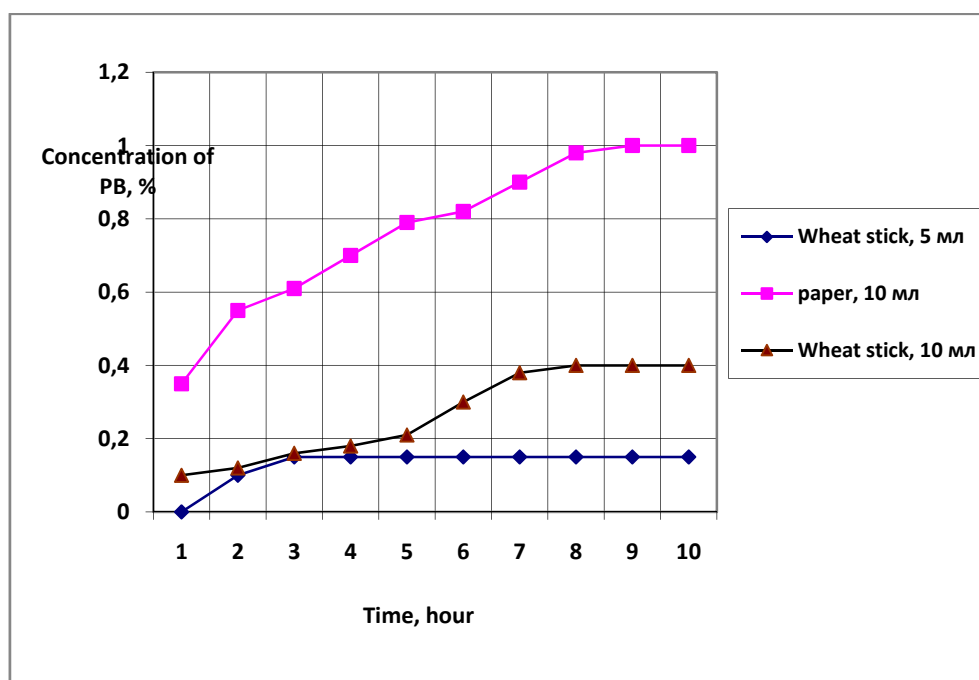
Table 1 – Results of fermentolysis of the wheat sticks in the fermenter

Process number	Number of enzymes, units activity	The maximum concentration of RS, %	Output RS, %
1	62-75.8	0.43	4.3
2	62-75.8	0.46	4.6
3	6.2-17.6	0.46	4.6
4	31-37.9	0.48	4.8
5	62-75.8	0.32	3.2
6	1.6-1.9	0.26	2.6
7	3.0-3.8	0.26	2.6
8	4.6-5.7	0.22	2.2

In order to reduce the error and verify the action of the enzyme on single-component substrates, a series of experiments were carried out on the fermentolysis of comminuted, de-impregnated paper into a 6-liter fermentolizer.

It is easy to verify that the dependence of the final concentration of RS (hence, the average rate of fermentolysis) on the average value of the enzyme activity is linear, which theoretically follows from the Michaelis-Menten model.

The results of comparative processes of fermentolysis of straw and paper are shown in Figure.



Variation in the concentration of RS in the processes of fermentolysis of paper and wheat straw

Since the paper is practically pure cellulose, then, with the same kinetic parameters of the fermentolysis processes, the amount of formed sugars in the case of fermentolysis of straw would be 1.49 times less than when using paper. However, in reality, the structure of the straw is characterized by a higher packing density of fibers and the presence of other interfering components, which leads to a slowing of the rate of the fermentolysis process by a factor of 2.5.

The resulting purified glucose hydrolyzate was subjected to hydrogenation in the presence of a nickel-aluminum-iron-chromium catalyst. From Table 2 it can be seen that the nickel catalysts under investigation, under the conditions studied by us, show high activity and stability with respect to sorbitol, the rate of formation of the latter varies with the number of doping metals in the initial alloys. The catalyst

Table 2 – The effect of the amount of added titanium additive on the activity of the nickel-aluminum-iron catalyst, (PN2 = 6MPa, Top-1000C)

Additive, %	t op., °C	Sorbitol yield (%) in time (min)					W*10 ⁴
		0	10	20	40	60	
0	100	14.4	18.6	23.4	31.4	38.1	10.9
1.0	100	14.5	18.3	24.5	31.3	38.5	11.3
3.0	100	16.3	22.5	27.8	37.0	43.7	12.8
5.0	100	17.9	24.2	28.7	40.5	48.3	14.1
7.0	100	18.7	25.3	32.1	41.4	50.5	15.9
10.0	100	15.3	23.0	29.7	34.1	49.3	14.8

of the alloy with 7.0% chromium exhibits the greatest activity, the yield of sorbitol at which at 100°C and 6MPa for 60 minutes of hydrogenation is 50.5%, and the rate of hydrogenation of glucose is 1.46 times higher than for skeleton nickel without an additive.

It is shown that with increasing hydrogen pressure from 2 to 12 MPa and 40-120°C, the rate of hydrogenation of glucose on titanium-promoted nickel-aluminum-iron catalysts increases. However, the hydrogen pressure limit values have not been established. The "seeming" tendency of the reaction rate to is due to the lack of a hydrogenated compound on the surface of the catalyst, as indicated by the fractional order of the reaction for glucose. The order for hydrogen depends both on the temperature of the experiment and on the pressure of hydrogen. Experiments on the influence of the concentration of glucose and hydrogen show that the reaction order for the hydrogenated substance varies from zero to fractional, and in hydrogen, fractional.

REFERENCES

- [1] Makhatov Zh.B., Kedelbaev B.Sh., Lakhanova K.M. Prospects of use of enzymatic treatment of wheat straw for glucose production: IV International Conference «Industrial Technologies and Engineering» // ICITE – 2017. October 26-27/2017. P. 115-121.
- [2] Huber G.W., Iborra S., Conrria A. Synthesis of transportation fuels from biomass: Chemistry, catalysts, and engineering // Chem. Rev. 2006. Vol. 106. P. 4044-4098.
- [3] Yang P., Kobayashi H., Fukuoka A. Recent Developments in the Catalytic Conversion of Cellulose into Valuable Chemicals // Chin. J. Catal. 2011. Vol. 32.
- [4] Xingguang Zhang, Lee J. Durndell, Mark A. Isaacs, Christopher M. A. Parlett, Adam F. Lee, and Karen Wilson Platinum-catalyzed aqueous-phase hydrogenation of D-glucose to sorbitol // Catalysis. 2016. P. 7409-7417.
- [5] Onda A., Ochi T., Yanagisawa K. Selective hydrolysis of cellulose into glucose over solid acid catalysts // Green Chem. 2008. Vol. 10. P. 1033-1037.
- [6] Fukuoka A., Dhepe P. L. Catalytic Conversion of Cellulose into Sugar Alcohols. // Angew. Chem. 2006. Vol. 118. P. 5285-5287.
- [7] Palkovits R., Tajvidi K., Procelewska J., Ruppert A. Efficient conversion of cellulose to sugar alcohols combining acid and hydrogenation catalysts // From Abstracts of Papers, 241st ACS National Meeting & Exposition, Anaheim, CA, United States, March 27-31, 2011, CELL-240.
- [8] Palkovits R., Tajvidi K., Procelewska J., Rinaldi R. and Ruppert A. Hydrogenolysis of cellulose combining mineral acids and hydrogenation catalysts // Green Chem. 2010. Vol. 12. P. 972-978.
- [9] Palkovits R., Tajvidi K., Ruppert A. M. and Procelewska J. Heteropoly acids as efficient acid catalysts in the one-step conversion of cellulose to sugar alcohols. Chem. Commun. 2011. Vol. 47. P. 576-578.
- [10] Tao F., Song H., Chou L. Catalytic conversion of cellulose to chemicals in ionic liquid // Carbohydrate Research. 2011. Vol. 346. Issue 1.
- [11] Tian J., Wang J., Zhao S., Jiang C., Zhang X. and Wang X. Hydrolysis of cellulose by the heteropoly acid H₅PW₁₀O₄₀ / Cellulose. 2010. Vol. 17. P. 587-594.
- [12] Jianrong Li, Helena S. M. P. Soares, Jacob A. Moulijn and Michiel Makkee. Simultaneous hydrolysis and hydrogenation of cellobiose to sorbitol in molten salt hydrate media. Catalysis Science & Technology // This journal is c The Royal Society of Chemistry 2013 Catal. Sci. Technol. 2013, 3, 1565-1572.
- [13] Ning Yan, Chen Zhao, Chen Luo, Paul J. Dyson, Haichao Liu, and Yuan Kou One-Step Conversion of Cellobiose to C6-Alcohols Using a Ruthenium Nanocluster Catalyst. C O M M U N I C A T I O N S J. AM. CHEM. SOC. 9 Vol. 128, N 27. 2006. 8715 Published on Web 06/20/2006.
- [14] Joung Woo Han, Hyunjoon Lee, Joung Woo Han, Hyunjoon Lee. Direct conversion of cellulose into sorbitol using dual-functionalized catalysts in neutral aqueous solution // Catalysis Communications 19 (2012) 115-118.
- [15] Jianrong Li, Helena S. M. P. Soares, Jacob A. Moulijn and Michiel Makkee. Simultaneous hydrolysis and hydrogenation of cellobiose to sorbitol in molten salt hydrate media. Catalysis Science & Technology // This journal is c The Royal Society of Chemistry 2013 Catal. Sci. Technol., 2013, 3, 1565-1572.

[16] Trofimov N.N., Babkin V.A. Study of the acid hydrolysis of the polysaccharides of larch wood for obtaining crystalline glucose chemistry of vegetable raw materials. 2009. N 3. P. 31-37.

[17] Outlaw S.A., Bazarnova N.G., Kushnir E.Y. Microcrystalline cellulase: structure, properties and applications (review) // Chemistry of vegetable raw materials. 2013. N 3. P. 33-41.

[18] Ardizzone S., Dioguardi F.S., Mussini T., Mussini P.R., Rondinini S., Vercelli B., Vertova A. Microcrystalline cellulose powders: structure, surface features and water sorption capability // Cellulose. 1999. Vol. 6, N 1. P. 57-69.

Б. Ш. Кедельбаев¹, К. М. Лаханова², Ж. Б. Махатов¹

¹М. Әуезов атындағы Оңтүстік Қазақстан мемлекеттік университеті, Шымкент, Қазақстан;

²Х. А. Ясауи атындағы Халықаралық қазақ-түрік университеті, Түркістан, Қазақстан

БИДАЙ САБАНЫНАН СОРБИТТИ АЛУ ҮДЕРІСІН ЗЕРТТЕУ

Аннотация. Мақалада сорбитті алу мақсатында гидролиз – сутектендірудің ферментативті аралас (гибридті) процестерін зерттеудің нәтижелері көрсетілген. Дәл осы мақалада өндіріске қажетті бағалы өнімдердің шығымын жоғарылату мақсатында сорбит синтезін сонымен қатар бидай сабанының ферментативті гидролизін және қайта өңдеудің зерттеу нәтижелері көрсетілген. Сабанды қайта өңдеуді температурасы 190-250°C диапазонында күкірт қышқылы концентрациясының масс. 0,6 бастап 2,5 % түрлендіріп жүргізілді. Сабанды күкірт қышқылында гидролиздеудің оңтайлы температурасы және ұзақтығы 160–170°C және 30–80 минутты құрады. Сабанды гидролиздеудің барлық тәжірибелеріндегі ең жақсы нәтиже күкірт қышқылының концентрациясы масс 1,6% және температурасы 150–160°C кезінде жетті. Сабанды ферментативті гидролиздеу процестеріне зерттеулер жүргізілді. Қағаз тәжірибе жүзінде қаншалықты таза целлюлоза болып табылады, онда ферментализ процесінің кинетикалық параметрлері бірдей кезінде, сабан ферментализі жағдайында түзілетін қантмөлшері қағазды қолданғанға қарағанда 1,49 есе аз. Алынған тазаланған глюкоза гидролизаты никель-алюминий-темір-хромдық катализатордың қатысуымен сутектендірілді. 7,0% хром құймасынан жасалған катализатор сорбиттің шығуына үлкен белсенділік көрсетеді, 100°C және 6МПа, 60 минут кезіндегі сутектендіру 50,5%, ал глюкозаны сутектендіру жылдамдығы 1,46 есе жоғары қоспасыз қаңқалы никельге қарағанда. Көрсетілді, сутектің қысымының өсуі 2-ден 12 МПа дейін және 40-120°C глюкозаны сутектендіру жылдамдығы монтаждалған титан никель-алюминий-темір катализаторында үлкейеді.

Түйін сөздер: бидай сабаны, сорбит, целлюлоза, катализатор, ферментативті гидролиз, биомасса.

Б. Ш. Кедельбаев¹, К. М. Лаханова², Ж. Б. Махатов¹

Южно-Казахстанский государственный университет, Шымкент, Казахстан,

²Международный казахско-турецкий университет им. Х. А. Ясауи, Туркестан, Казахстан

ИССЛЕДОВАНИЕ ПРОЦЕССА ПОЛУЧЕНИЯ СОРБИТА ИЗ ПШЕНИЧНОЙ СОЛОМЫ

Аннотация. В статье приведены результаты по изучению ферментативного совмещенного (гибридного) процесса гидролиз-гидрирование с целью получения сорбита. В настоящей статье изложены результаты исследования предобработки и ферментативного гидролиза пшеничной соломы, а также процесс синтеза сорбита с целью повышения выхода ценных продуктов, необходимых для промышленности. Предобработку соломы проводили в диапазоне температур 190–250°C при варьировании концентрации сернистой кислоты от 0,6 до 2,5 % масс. Оптимальная температура и продолжительность гидролиза соломы сернистой кислотой составили соответственно 160–170°C и 30–80 минут. Во всех экспериментах гидролиза соломы наилучшие результаты достигнуты при концентрации сернистой кислоты 1,6 % масс и температуре опыта 150-160°C. Проведены исследования процессов ферментативного гидролиза соломы. Поскольку бумага является практически чистой целлюлозой, то, при одинаковых кинетических параметрах процессов ферментализа, количество образовавшихся сахаров в случае ферментализа соломы было бы в 1,49 раза меньше, чем при использовании бумаги. Полученный очищенный глюкозный гидролизат подвергали гидрированию в присутствии никель-алюминий-железо-хромового катализатора. Катализатор из сплава с 7,0% хрома проявляет наибольшую активность, выход сорбита на котором при 100°C и 6 МПа на 60 минуте гидрирования составляет 50,5%, а скорость гидрирования глюкозы в 1,46 раза выше, чем на скелетном никеле без добавки. Показано, что с ростом давления водорода от 2 до 12 МПа и 40–120°C скорость гидрирования глюкозы на промотированных титаном никель-алюминий-железо катализаторах увеличивается.

Ключевые слова: солома пшеницы, сорбит, целлюлоза, катализатор, ферментативный гидролиз, биомасса.

Сведения об авторах:

Кедельбаев Бахытжан Шильмирзаевич – доктор технических наук, профессор, Южно-Казахстанский Государственный университет им. М. Ауэзова, Высшая школа «Химическая инженерия и Биотехнология», кафедра «Биотехнология»;

Лаханова Кулзада Мергенбаевна – доктор сельскохозяйственных наук, профессор, Международный казахско-турецкий университет им. Х. А. Ясауи, кафедра «Морфологии и физиологии человека»;

Махатов Жаксылык Бауманович – докторант, Южно-Казахстанский Государственный университет им. М. Ауэзова, Высшая школа «Химическая инженерия и Биотехнология», кафедра «Биотехнология»

Publication Ethics and Publication Malpractice in the journals of the National Academy of Sciences of the Republic of Kazakhstan

For information on Ethics in publishing and Ethical guidelines for journal publication see <http://www.elsevier.com/publishingethics> and <http://www.elsevier.com/journal-authors/ethics>.

Submission of an article to the National Academy of Sciences of the Republic of Kazakhstan implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see <http://www.elsevier.com/postingpolicy>), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The National Academy of Sciences of the Republic of Kazakhstan follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics.org/files/u2/New_Code.pdf). To verify originality, your article may be checked by the Cross Check originality detection service <http://www.elsevier.com/editors/plagdetect>.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the National Academy of Sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of Sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации в журнале смотреть на сайте:

www.nauka-nanrk.kz

ISSN 2518-1629 (Online), ISSN 2224-5308 (Print)

<http://www.biological-medical.kz/index.php/ru/>

Редактор *М. С. Ахметова, Т. М. Апендиев, Д. С. Аленов*
Верстка на компьютере *Д. Н. Калкабековой*

Подписано в печать 07.02.2018.

Формат 60x881/8. Бумага офсетная. Печать – ризограф.

9,4 п.л. Тираж 300. Заказ 1.