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Д.В. Сокольский атындағы
«Жанармай, катализ және электрохимия институты» АҚ

ХАБАРЛАРЫ

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
АО «Институт топлива, катализа и
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RESEARCH OF MALTING PROPERTIES OF KAZAKHSTAN TRITIKALE GRAIN VARIETIES FOR USE IN THE BEVERAGE INDUSTRY

Abstract. Today the beverage industry occupies an important place in the processing industry of the Republic of Kazakhstan and is one of the most attractive investment sectors of the economy.

However, this industry is still not provided in sufficient quantities with its own, domestic high-quality raw materials - rye and / or barley malt. For example, fermented malt is used as a source of colors and aromas. It is the main raw material in the preparation of kvass, kvass wort concentrate and kvass bread, the rate of application of this type of malt is from 40 to 60%, depending on the method of production of this type of product.

The processing of cereals with a high protein content (above 12%) and a low starch content and extractiveness is economically disadvantageous, and undesirable from a quality point of view.

The most important directions in solving this problem should be recognized as the improvement and development of new resource-saving technologies of malt using non-traditional types of raw materials.

Currently, the use of triticale grain in the fermentation industry in the production of malt and the further replacement of traditional types of malt for the preparation of alcohol, beer, kvass is promising. In recent years, new varieties of triticale have been obtained in the Republic of Kazakhstan, which are distinguished by high technological properties, which are included in the State Register.

In this regard, it is obvious that the performance of work related to theoretical and experimental research aimed at the development of new technological modes of preparation of malt from triticale is one of the urgent tasks, the decision of which, to create an assortment of drinks. The purpose of the research work is to study the malting properties of Kazakhstani varieties of triticale grain.

Key words: Malt, barley, triticale, fermentation industry, kvass, kvass wort concentrate, ethyl alcohol, extract, variety, germination ability.

Introduction. Along with traditional types of cereals, in the production of malt, cereals such as triticale, amaranth, sorghum, buckwheat, oats, etc. are used, which until recently were mainly used for fodder purposes [1-5]. Among the listed alternative crops, triticale should be noted as the most promising type of grain raw material [6-7].

Triticale (lat. Triticosecale, from lat. "Triticum" - wheat and lat. "Secale" - rye) is a new botanical species created by man. By combining the chromosome complexes of two different botanical genera - wheat and rye, man was able to synthesize a new agricultural crop for the first time in the history of agriculture. Triticale attracts special attention for a number of important indicators, such as yield, winter hardiness, nutritional value of the product, etc. The artificially created cereal that did not exist before in nature - triticale - is a crop that does not have intermediate properties between rye and wheat, which has its own characteristics [8].

Triticale is superior to rye and barley in total extract, enzymatic activity and protein dissolution. These indicators suggest its use as a raw material for the production of malt [9].

In recent years, new varieties of triticale have been obtained in the Republic of Kazakhstan, which are distinguished by high technological properties, which are included in the State Register [10-12].

In this regard, it is obvious that the implementation of work related to the improvement of the theoretical and experimental research aimed at the development of new technological modes for the preparation of triticale malt is one of the urgent tasks, the decision of which will create an assortment of quality.

Materials and methods. The object of the study was triticale grains of the varieties: Aziada, Balausa 8, Kozha, Orda, Taza and barley malt of the Tekeli variety, corresponding to GOST 29294-2014.

Kazakhstan varieties of triticale grain (Figure 1) have been experimentally developed and submitted for research by the Kazakh Research Institute of Agriculture and Crop Production LLP (Almaty region, Kazakhstan).

Figure 1 - Photos of the studied varieties of triticale grain

Experimental studies to study the quality indicators of triticale grain were carried out at the Educational and Scientific Center for the Production of Fermentation Products at the Department of Technology of Bread Products and Processing Industries of the Technopark of the Almaty Technological University.

The results of the study. The experiments were carried out in three - four times repetition, analogous determinations for each sample in three repetitions. Only those results were discussed that were reproducible in each experiment.

Determination of organoleptic and some physicochemical parameters (absolute weight, natural weight, vitreousness, filminess, water sensitivity, extractivity, mass fraction of moisture) of the initial grain raw material was carried out in accordance with the standard methods adopted in the technochemical control of malting production [13].

The determination of the germination energy was carried out according to GOST 10968-88. The suitability of grain for malting is determined by its ability to germinate. The grain is germinated in a glass funnel, at the end of which a rubber tube with a clip is put on. The number of germinated grains is determined by the formula (1)

$$x = 100 * A / B, \quad (1)$$

where, A - the number of grains germinated in the sample, where B -the number of grains in the sample (500 pcs.)

The determination of the germination ability was carried out according to the EBC method. Count 100 whole grains. Soak in a prepared 5% solution of Tetrazolium solution for 24 hours. After 24 hours, the number of red-colored grains is counted and expressed as a percentage (Figure 2).

Grain samples, after 24 hours of soaking in solution — Longitudinal section of grain

Figure 2 - Determination of germination ability grains of triticale grade "Balausa 8"

The determination of fat content was carried out according to the EBC method 6.10. The fat content of the triticale grain is determined by extraction with ethyl sulfate in a Soxhlet apparatus. The method is based on the property of vegetable fats to dissolve in ethyl sulfate. By subjecting the raw material

to be extracted with ethyl sulfate ether, the fat is transferred into an ether solution, from which ether is then distilled off [14].

The ash content was determined according to the EBC method. Ash content - expressed as a percentage, the amount of minerals remaining after the complete combustion of organic matter in the sample. The essence of the method lies in the combustion of a sample of ground grain, followed by a quantitative determination of the incombustible residue [15].

Determination of the content of protein substances in grain was carried out according to the EBC 3.31 method (Kjeldahl method) using the Kjeldahl apparatus. An important technological indicator in the production of malt is the protein content, which more containing in the grain make more difficultits to germinate. The essence of the method lies in the mineralization of organic matter with sulfuric acid in the presence of a catalyst with the formation of ammonium sulfate, destruction of ammonium sulfate with alkali with the release of ammonia, stripping ammonia with water vapor into a solution of sulfuric or boric acids, followed by titration [16].

Determination of starch content in grain was carried out onspectrophotometer at 510 nm, according to ICC standard No. 168, using a Total starch Assay procedure from Megazyme Kit. The method is based on determining the concentration of optical active sugars formed as a result of acid hydrolysis of starch [17]. Determination of β-glucan in grain was carried out by spectrophotometric method at wavelength 510 nm, according to ICC standard No. 166.

To assess the quality and suitability of Kazakhstan varieties of triticale grain, the physicochemical indicators of 5 varieties (Aziada, Balausa 8, Kozha, Orda, Taza) were studied, which are presented in table 1.

Results and discussion. The most common variety of barley, Tekeli, grown in Kazakhstan for malt production, served as a control.

Table 1 - Qualitative indicators of various grades of triticale and barley grains, zoned in the Republic of Kazakhstan

Indicators	Triticale					Tekeli barley
	Aziada	Balausa 8	Kozha	Orda	Taza	
The nature of the grain, g/l (n=3)	665±0.85	683±0.46	710±0.53	716±0.45	707±0.54	725±0.94
Absolute weight of 1000 grains, g (n=3)	38.95±0.2	45.3±0.32	46.8±0.18	47.09±0.3	46.8±0.37	46.9±0.24
Moisture content, % (n=3)	12±0.18	11.8±0.23	12.7±0.52	13±0.32	11.7±0.36	12.2±0.22
Protein content, % CB (n=3)	12.8±0.71	10.6±0.07	12.3±0.53	12.9±0.61	13.2±0.27	11.3±0.47
Starch content, % CB (n=3)	68.65±5.2	70.73±5.4	65.43±3.3	61.13±4.7	64.62±5.1	69.48±3.8
Extractivity, in% for DM (n=3)	79±0.15	81±0.21	76±0.17	75±0.09	75±0.22	80±0.28
Germination energy, % (n=3)	91±0.11	99±0.13	86±0.17	85±0.09	92±0.25	98±0.08
Germination ability, % (n=3)	91±0.07	99±0.13	86±0.12	85±0.21	92±0.25	98±0.18
Water sensitivity, % (n=3)	3±0.51	2±0.37	5±0.22	6±0.26	3±0.35	3±0.41
Glassiness,% (n = 3)	56±0.03	44±0.19	61±0.20	60±0.32	58±0.33	42±0.09
Filminess,% (n = 3)	8.48±0.12	7.62±0.13	9.36±0.08	10.1±0.18	11.2±0.24	8.12±0.26
Ash content, % (n=3)	1.62±0.13	2.02±0.03	1.72±0.12	1.88±0.26	1.71±0.07	1.51±0.06
Fats, % (n=3)	1.53±0.06	1.2±0.01	1.70±0.03	1.88±0.08	1.64±0.07	1.27±0.09
B glucan content, in% for DM(n=3)	0.83±0.18	0.7±0.05	0.9±0.03	0.9±0.07	0.8±0.23	0.76±0.14

According to Table 1, the quality indicators: nature and absolute weight, as well as the content of the mass fraction of moisture, starch, extract, ash, fat and β glucan of all samples are normal, however, for the production of malt, a wider range of indicators should be considered.

Empirical dependencies more revealingly characterize the relationship between the extract and quality indicators: the mass fraction of starch and the absolute mass of triticale, which were determined according to the methods adopted in the malting industry (Figure 3, 4).

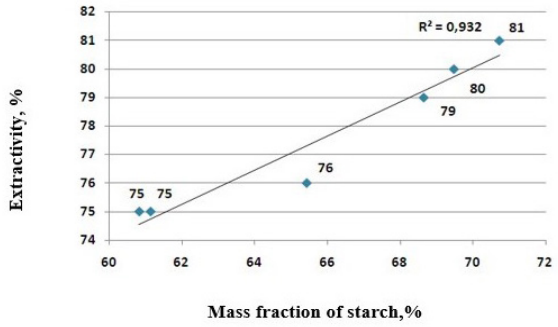

Figure 3 - Relationship between extractivity and starch content

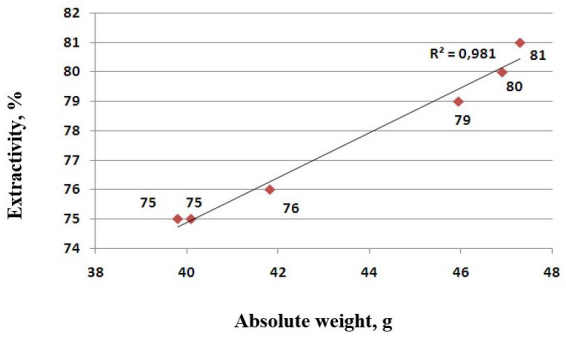

Figure 4 - Relationship between extractivity and absolute weight

Obtained empirical dependencies:

$E = 0.597ms + 38.22$ (2)

where E is the content of extractives,%; ms - mass fraction of starch,%.

$E = 0.759ma + 44.50$ (3)

where ma is the absolute weight of triticale grain, g.

The experimental dependences are described by a linear equation with a sufficiently high degree of approximation reliability (R_2 = 0.932 and R_2 = 0.981). High extractiveness of grain is one of the main indicators of the quality of barley used in malting, the main part of which is contained in starch [18].

Conclusion. As follows from Table 1, the triticale variety Balausa 8 surpasses not only the grain of barley of the Tekeliysky variety, but also the triticale varieties Aziada, Ozha, Orda and Taza with a high starch content (by 1.7%, 3%, 7.5%, 13.5 % and 8.7%), high extractability (by 1.3%, 2.5%, 6.2%, 7.5% and 7.5%), energy and germination ability (by 1.1%, 8 , 1%, 13.1%, 14.1% and 7%). The content of ash, fats, β glucan and moisture content in all studied samples is normal.

It should be noted that variety Balausa 8, in contrast to other studied varieties, meets the requirements of GOST 29294-2014 in terms of the main technological quality indicators such as: protein content, water sensitivity, glassiness and filminess. High water sensitivity characterizes a decrease in the ability to germinate even with a slight excess of water and requires strict adherence to a special soaking technology. High graininess of grain, negatively affects its extract. High vitreous grains tend to contain higher amounts of protein, making them difficult to process and yielding lower quality malt [19-21].

Triticale varieties Asiada and Taza have higher energy and germination ability compared to varieties Kozha and Orda, however, in terms of filminess, glassiness and protein areunsuitable for preparation of malt.

Triticale varieties Kozha and Orda are distinguished by their high nature and absolute weight of grain, but due to the high protein content (an increase in protein content by 1% leads to a decrease in extractability by 0.8%) [22-23], fat and glassiness, as well as more low energy and germination ability are unsuitable for malt production.

Thus, on the basis of the studies carried out on the physicochemical indicators of quality and biochemical characteristics of Kazakhstan varieties of triticale grain, the variety "Balausa 8" was selected as the most suitable for obtaining malt, characterized by high extractability (81% on DM), low protein content (10.6%), high values of energy and germination ability (99%), which has the best technological indicators corresponding to the requirements of GOST 29294-2014.

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СУСЫНДАР ИНДУСТРИЯСЫНДА ҚОЛДАНЫЛАТЫН ТРИТИКАЛЕ ДӘНДЕРІНІҢ ҚАЗАҚСТАНДЫҚ СҰРЫПТАРЫНЫҢ УЫТТАНУ ҚАСИЕТТЕРІН ЗЕРТТЕУ

Аннотация: Бүгінгі таңда сусындар өнеркәсібі Қазақстан Республикасының өңдеу өнеркәсібінде маңызды орын алады және экономиканың ең тартымды инвестициялық секторларының бірі болып табылады.

Алайда, бұл сала әлі күнге дейін өзіндік, отандық жоғары сапалы шикізатпен - қара бидай немесе арпа уытымен жеткілікті мөлшерде қамтамасыз етілмеген. Мысалы, ферменттелген уыт өнімнің түстілігі мен хош иістерінің көзі ретінде қолданылады. Бұл квас, квас сусыны концентратын және квас нандарын дайындаудағы негізгі шикізат болып табылады, уыттың осы түрін қолдану өнімнің түрін өндіру әдісіне байланысты 40-тан 60% -ға дейін құрайды.

Құрамында ақуыз мөлшері көп (12% -дан жоғары) және құрамында крахмал және экстрактивтілік мөлшері төмен дәнді дақылдарды өңдеу экономикалық тұрғыдан тиімсіз және сапа жағынан айтарлықтай төмен.

Бұл мәселені шешудің маңызды бағыттары дәстүрлі емес шикізат түрлерін қолданатын және ресурстарды үнемдейтін уыт технологияларын жетілдіру және дамыту деп тану керек.

Қазіргі уақытта тритикале дәнін ферменттеу және оны уыт өндірісінде қолдану алкоголь, сыра, квас дайындау үшін уыттың дәстүрлі түрлерін одан әрі алмастыру перспективалы болып табылады. Соңғы жылдары Қазақстан Республикасында мемлекеттік тізіміне енгізілген тритикаленің жоғары технологиялық қасиеттерімен ерекшеленетін жаңа сорттары алынды.

Осыған байланысты, тритикале уытын дайындаудың жаңа технологиялық режимдерін әзірлеуге бағытталған теориялық және эксперименттік зерттеулермен байланысты жұмыстарды жүзеге асыру - шешілетін сусындардың түрлерін құру кезек күттірмейтін міндеттердің бірі екені анық. Зерттеу жұмысының мақсаты - тритикале дәндерінің Қазақстандық сорттарының уыттану қасиеттерін зерттеу.

Түйін сөздер: уыт, арпа, тритикале, ашыту өнеркәсібі, квас, квас сусласының концентраты, этил спирті, сығынды, сорт, өсу қабілеттілігі.

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ИССЛЕДОВАНИЕ СОЛОДОВЕННЫХ СВОЙСТВ КАЗАХСТАНСКИХ СОРТОВ ЗЕРНА ТРИТИКАЛЕ ДЛЯ ИСПОЛЬЗОВАНИЯ В ИНДУСТРИИ НАПИТКОВ

Аннотация: На сегодня индустрия напитков занимает важное место в перерабатывающей промышленности Республики Казахстан и является одним из инвестиционно привлекательных секторов экономики.

Однако, данная отрасль до сих пор не обеспечена в достаточном количестве собственным, отечественным качественным сырьем – ржаным и/или ячменным солодом. К примеру, ферментированный солод используется в качестве источника красящих и ароматических веществ. Является основным сырьем при приготовлении кваса, концентрата квасного сусла и квасных хлебцев, норма внесения данного вида солода составляет от 40 до 60 %, в зависимости от способа производства данного вида продукта.

Переработка зерновых с высоким содержанием белка (выше 12%) и низким содержанием крахмала и экстрактивностью с экономической точки зрения невыгодна, а с точки зрения качества нежелательна.

Важнейшими направлениями в решении этой задачи следует признать совершенствование и разработку новых ресурсосберегающих технологий солода с использованием нетрадиционных видов сырья.

В настоящее время перспективным является использование зерна тритикале в бродильной промышленности при производстве солода и дальнейшей замены традиционных видов солодов для приготовления спирта, пива, кваса.В последние годы в Республике Казахстан получены новые сорта тритикале, отличающиеся высокими технологическими свойствами, которые включены в Государственный реестр.

В связи с этим, очевидно, что проведение работ, касающихся теоретических и экспериментальных исследований, направленных на разработку новых технологических режимов приготовления солода из тритикале является одной из актуальных задач, решение которой, позволит создать

ресурсосберегающую технологию и расширить ассортимент напитков. Целью исследовательской работы является изучение солодовенных свойств казахстанских сортов зерна тритикале.

Ключевые слова: солод, ячмень, тритикале, бродильная промышленность, квас, концентрат кваского сусла, этиловый спирт, экстракт, сорт, способность прорастания

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DEVELOPMENT OF THE CONDITIONS FOR STORING THALLIUM AMALGAM

Abstract. It has been established that lNH_2SO_4 solution and distilled water can be used as a protective medium for a long-term storage (30-40 days) of thallium amalgam of eutectic composition (8.6 mas.%), without sliming of its surface and an insignificant change of its concentration. An inverse dependence between the decomposition reaction rate and the ratio of the solution volume per unit of the contact surface (V:S), which corresponds to the height of the liquid layer (h) above the amalgam, is observed. At h ~ 2.5 cm and higher, the reaction rate becomes stabilized. The value of metal loss during its storage for 10-15 days does not exceed 0.5-1.0 mas.% of the initial thallium content in the amalgam.

It has been shown that the rate of dissolution of thallium from amalgam is rather low, and in sulfuric acid solution it is only slightly higher than that in water with all S:V ratios. A similar picture is observed upon thallium amalgam decomposition in the same media in an open vessel; the difference consists only in a higher K value (Table 4). Thus, with S:V = 1:2.5, in an open vessel K in lNH_2SO_4 makes up 10,5.1011 mol/cm2.sec, and in H_2O – 7.3.1011 mol/cm2.sec, whereas in a closed vessel K in lNH_2SO_4 makes up 1,9.1011 mol/cm_2. sec, and in H_2O – 1.5.1011 mol/cm2.sec.

For 40 days of thallium amalgam (8.54 mas.%) storage in 1NH_2SO_4 the loss of thallium has been 1.3 mas.%, and in the distilled water - 1 mas.%. The quantity of the dissolved metal increases in proportion to the experiment duration, which is characteristic for a zero-order reaction, and this dependence is observed for all S:V ratios from 1:1 to 1:7.

Besides, a possibility to use some saturated hydrocarbons, wherein no sliming of thallium amalgam occurs, as a protective wash liquid has been shown.

Key words: thallium amalgam, chemical preparation, storage, decomposition, sulfuric acid, water, wash liquid.

Introduction. Thallium is a very important metal in both theoretical and practical terms, combining the properties of both alkali and heavy (Pb, Ag, Au) metals. It is highly soluble in mercury, which is very important for amalgam hydrometallurgy (at 293 K - 43 mas.%), and for solving other technical problems.

The development of structures and technologies for manufacturing mercury-thallium thermometers, hermetic contacts, contactrons and thermal contactrons is complicated by the fact that there are no reliable data on thallium amalgam permanency in water solutions, methods of controlling the content of metal in amalgam and methods of processing the amalgam wastes, formed in the process of filling the stocks.

The literature data on thallium amalgam permanency in various media are rather limited. The basic data, related mainly to the behavior of amalgam in the water solutions, have been obtained upon the development of a technology for thallium production by the methods of amalgam hydrometallurgy [1-6]. It has been found that in some cases amalgam sliming occurs. This is facilitated by the presence in the solution of the substances - emulsifiers, which are not sulfur-containing compounds or metal oxides, formed due to oxidation, for example, by air oxygen. Small droplets of amalgam are enveloped with these substances or particles, which form stable adsorption salts on the surface, which contributes to the fragmentation of thallium amalgam [2].

The work practice with thallium amalgam shows that sliming occurs when amalgam is in the air, due

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