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Поступила в редакцию 02.06.2025
Поступила после доработки 06.08.2025
Принята к публикации 07.08.2025

https://doi.org/10.53360/2788-7995-2025-3(19)-26

IRSTI: 65.09.05

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THE RESEARCH OF THE QUALITY OF MILLET AND OAT

Abstract: *Currently, there is a growing public demand for whole grains, driven by increasing awareness of their health benefits. Scientific evidence has demonstrated that whole grains possess superior nutritional value compared to highly processed cereal products. Disruptions in gastrointestinal water balance, elevated blood cholesterol levels, and the accumulation of toxins and heavy metals have detrimental effects on the human body and contribute to the onset of various diseases. In contrast, regular consumption of whole grains has been shown to improve blood circulation, support cardiovascular function, and help maintain a balanced intestinal microbiota, thereby promoting overall health.*

Among various cereal grains, millet and oats stand out as particularly suitable for daily gluten-free diets. These grains are especially rich in B-group vitamins and dietary fiber, making them valuable components of a balanced nutritional regimen. In this context, the present study investigates the potential use of whole millet and oat grains as functional ingredients in the formulation of fermented beverages, with particular emphasis on their bioactive compounds and enhanced nutritional profile.

Despite their known health benefits, whole grains also contain phytic acid, which can inhibit the absorption of essential macro- and micronutrients. To mitigate this effect, the grains were soaked in water for six hours – a process shown to effectively reduce phytic acid levels.

Following this treatment, two drying methods were applied: convective drying at 38°C using a Sedona dehydrator, and pan-toasting in a WOK at heat levels 6 to 8. The processed raw materials were subsequently analyzed for their sensory attributes, B-vitamin content, dietary fiber levels, and concentrations of water-soluble antioxidants. The results indicated that the overall nutritional quality of both millet and oat grains was maintained under both drying conditions, with the exception of vitamin B3, which showed a decline in oats subjected to pan-toasting.

Key words: *millet, oats, phytic acid, soaking, fibers, neutralization.*

Introduction

A significant proportion of essential vitamins, minerals, and bioactive compounds beneficial to human health are derived from the consumption of liquid-based food products. Among them, fermented milk beverages are increasingly recognized as functional and health-promoting alternatives. Despite their nutritional advantages, the commercial beverage market remains dominated by sugar-sweetened mineral drinks containing artificial colorants and preservatives. Although fermented beverages are available in retail settings, their variety remains limited. To address this gap, the present study investigates the incorporation of selected grain crops into fermented drinks to enhance their nutritional profile, organoleptic properties, and gastrointestinal benefits.

Kazakhstan is a major producer of grain crops, each possessing distinctive nutritional and functional characteristics. Among the key components, dietary fiber plays a critical role in maintaining water balance, binding metabolic by-products, and eliminating water-soluble toxins from the body.

Furthermore, fiber contributes to the regulation of various physiological and biochemical processes. B-group vitamins have also been shown to support energy metabolism, the functioning of the central nervous system, and cardiovascular regulation. A well-balanced intake of carbohydrates, fats, and proteins remains a fundamental requirement of the human diet. Based on scientific criteria, millet and oats were selected for this study due to their rich content of fiber and B vitamins, as well as their established benefits for digestive health.

Oats and millet are widely utilized as breakfast cereals and porridge bases and, in the case of oats, also serve as raw materials for the production of plant-based milk alternatives. The advantages of these grains are multifaceted. Both crops exhibit strong ecological adaptability. Millet, for example, requires significantly less water compared to other grain crops – approximately 300-400 cubic meters per hectare per irrigation cycle. Oats, due to their resilience, are adaptable to a wide range of environmental conditions. In addition to their agronomic benefits, both grains have been associated with reduced risks of hypercholesterolemia, diabetes, and hypertension. Their high dietary fiber content not only supports energy metabolism but also contributes to gut microbiota regulation, cholesterol reduction, heavy metal detoxification, and exerts a prebiotic effect. Consequently, the integration of these grains into functional food formulations may provide preventive health benefits and reduce the incidence of chronic diseases.

However, like legumes, oilseeds, and nuts, cereal grains inherently contain phytic acid, which comprises 60-80% of their total phosphorus content. Phytic acid ($InsP_6$) is known to inhibit the absorption of essential minerals such as iron, magnesium, zinc, and calcium – elements vital to numerous metabolic functions. Consequently, mineral deficiencies resulting from high phytic acid intake may impair physiological functions and compromise immune competence. To mitigate these effects, neutralization of phytic acid is necessary. By analyzing the physicochemical properties of the grains post-treatment, it becomes possible to evaluate and predict their nutritional quality and functional potential.

The primary objective of this study is to neutralize phytic acid in whole millet and oat grains and to assess their organoleptic characteristics and physicochemical parameters for their application in fermented functional beverages.

Materials and methods

The objects of this study were processed whole grain samples of oats and millet. The investigation into the physicochemical and organoleptic characteristics of these grains was carried out in the scientific laboratory of the Department of Technology of Food and Processing Production at Kazakh Agrotechnical Research University named after by S. Seifullin and the Research laboratory for assessing the quality and safety of food products of the «Almaty Technological University» JSC.

The quality analysis of millet and oat grains was performed using methods specified in regulatory and technical documentation. The experimental procedures were conducted under controlled conditions of 21°C temperature and 64% relative humidity. The primary physicochemical analyses employed during the study included the following:

- Mass fraction of crude fiber, % (according to GOST 31675-2012)
- Water-soluble antioxidants, mg/100 g (according to GOST R 54037-2010)
- Vitamins B1, B2, B6, B5, B3 (according to GOST 31483-2012)
- GOST 28673-2019 «Oats. Technical Specifications»
- GOST 22983-2016 «Millet. Technical Specifications»

Additionally, following water soaking, the millet and oat grains were dried using a Sedona brand convection oven at 38°C and a WOK pan.

Results and discussion

In the scientific laboratory of the Department of Food and Processing Industry Technology of the Kazakh State Agrarian University named after S. Seifullin, dry whole grains of millet and oats were selected (the grains were soaked in filtered water once, the next day another batch was used) and these grains were soaked in filtered water every day. The first day the grains have stayed in filtered water for 10 hours, the second day for 9 hours, the third day for 8 hours, the fourth day for 7 hours, the fifth day for 6 hours and the sixth day for 5 hours. The purpose of soaking these grains in filtered water was to neutralize the phytic acid contained in them. They were also monitored and compared for the absence of foreign tastes and odors, as well as the neutralization of phytic acid over a period of 5 to 10 hours.

Table 1 – Soaking durations of experimental samples of millet and oat grains in water

№ Test Samples	Duration	Millet	Oats
Test Sample № 1	10 hours	There was a strong sour smell, and there were small bubbles on the surface of the water	The smell of fermentation was distinct, and the surface of the water was covered with tiny spherical bubbles
Test Sample № 2	9 hours	A strong smell of fermentation, small bubbles on the surface of the water	There was a faint sour smell, and small spherical bubbles remained on the surface of the water
Test Sample № 3	8 hours	The smell of fermentation remained, the bubbles on the surface of the water became smaller	There was a sour smell, and the water surface had a few small spherical bubbles
Test Sample № 4	7 hours	There was a strange smell, no bubbles were visible.	There was no sour, foreign smell, but there were a few bubbles on the surface of the water
Test Sample № 5	6 hours	There was no foul or foreign odor, the water remained clean.	There was no foul or foreign odor, the water remained clean
Test Sample № 6	5 hours	There was no foul or foreign odor, the water remained clean	There was no foul or foreign odor, the water remained clean

As a result, it was found that when the grain is soaked in water for 5-6 hours on the fifth and sixth day, its organoleptic indicators remain unchanged. This suggests that a 6-hour soaking period may represent the optimal duration for achieving maximal phytic acid reduction while preserving the sensory properties of the grains. Accordingly, following the 6-hour aqueous soaking treatment for phytic acid neutralization, further analyses were conducted to examine the impact of this process on the grains' physicochemical properties.

At first, 300 g of unsoaked oat crop was taken as control sample No. 1. 300 g of samples No. 2 and No. 3 were also taken and soaked in water for 6 hours. 600 ml of filtered water at a temperature of 45-60 ºC was poured into each sample. After the phytic acid was neutralized by soaking and pouring off the remaining excess water, the crops were washed again in filtered water and dried in 2 different ways. The first was in the oven at a temperature of 38 ºC, and the second was placed in a WOK pan and fried. Nothing was poured into the pan and the indicator on low heat was between 6-8. There was no significant change in the weight after drying of the 2 methods (table 2). The same 2 different methods were repeated for millet control samples and samples (shown in the figure 1).

Table 2 – Weight of millet and oat grain samples before and after drying

Samples	**Before pouring water, gr**	**After drying, gr**
Control Oats №1	300	–
Oats № 2	300	281
Oats № 3	300	265
Control Millet № 1	300	–
Millet № 2	300	289
Millet № 3	300	286

Figure 1 – Drying process of whole grain samples of millet and oats

As a result, oat sample No. 2 exhibited a weight difference of 19 grams, while sample No. 3 showed a difference of 35 grams. It was further observed that millet grains absorbed less water than oat grains, with respective differences of 11 grams and 14 grams. Consequently, the final weight of millet and oat grains dried in the oven was greater than that of the samples subjected to pan-frying. Figure 1 presents the process of drying whole grain millet and oat samples in an oven and in a pan.

The organoleptic characteristics of the grains after drying are presented in the following table (table 3).

Table 3 – Organoleptic evaluation of whole grain millet and oat samples after drying

Sample Name	Color	Odor	Taste	Visual Appearance
Test Sample Oats № 1	Light yellow	Fresh, free from mold, mustiness, and off-odors	Pleasant, without bitterness	Predominantly whole, large in size, with a nearly cylindrical or pear-shaped form
Test Sample Oats № 2	Light yellow	Fresh, free from mold, mustiness, and off-odors	Pleasant, without bitterness	Predominantly whole, large in size, with a nearly cylindrical or pear-shaped form
Test Sample Millet № 1	Light brown	Fresh, clean, free from mold, mustiness, and off-odors	Mildly sweet and nutty	Small, oval-round in shape, covered with husks, uniform in form
Test Sample Millet № 2	Light brown	Fresh, clean, free from mold, mustiness, and off-odors	Neutral, nutty	Small, oval-round in shape, covered with husks, uniform in form

The table shows the values of fiber content and water-soluble antioxidants in grains with neutralized phytic acid. It is clear that there were no significant changes in the result. However, while the fiber content of oat grain in the control sample without soaking was close to the result after roasting, the oven-drying method showed a result 1% lower. While the results after roasting were similar to the fiber content of the control sample of millet grain, the fiber content of the oven-dried grain did not change significantly. Along with determining the amount of fiber in millet and oat grains, the amount of water-soluble antioxidants was also studied. The results showed that the quality of the grain was preserved both when roasting and when drying in the oven, as evidenced by the fiber content.

The content of group B vitamins in these samples was additionally determined (shown below). According to the obtained results, there were no significant changes compared to the control sample. However, a significant difference in the content of vitamin B3 was observed in the oat sample No. 3 compared to the control sample. It turns out that vitamin B3 loses its properties when oats are fried (table 4).

Table 4 – Content of mass fraction of fiber and water-soluble antioxidants in experimental and control samples of whole grain oats and millet

Samples	**Mass fraction of fiber**	**Water-soluble antioxidants**
Control Oats № 1	9,65±0,12	0,81±0,0066
Oats № 2	8,64±0,10	0,71±0,0016
Oats № 3	9,11±0,11	0,76±0,0064
Control Millet № 1	4,18±0,04	0,57±0,0050
Millet № 2	3,93±0,04	0,52±0,0015
Millet № 3	3,96±0,05	0,56±0,0076

In addition, it has been established that the process of neutralization of phytic acid by soaking millet and oat grains in water does not affect the quality of these crops (Figure 2).

Therefore, the quality characteristics of millet and oat grains used as functional fillers in the formulation of fermented beverages remained largely stable, even after being subjected to a six-hour water soaking process.

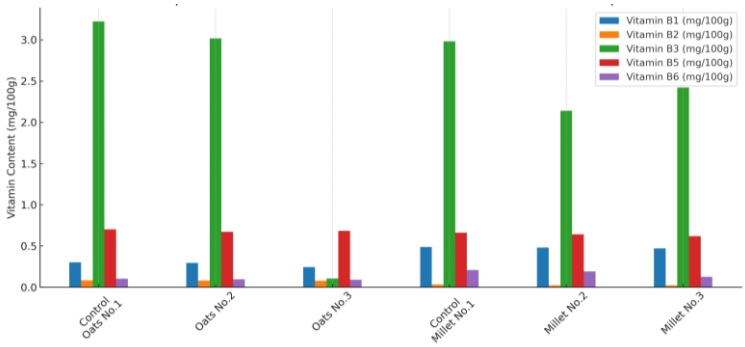

Figure 2 – Comparative vitamin B content in whole grain oat and millet samples

Conclusion

Oats and millet were selected among cereal crops for research as additives to dairy fermented drinks. Determined soaking time and drying methods for the above types of whole grains, as well as their mass after drying. Furthermore, the organoleptic properties of grains subjected to soaking in water were assessed in the context of phytic acid neutralization. Following drying, additional evaluations were conducted to determine their fiber content, levels of water-soluble antioxidants, and B-group vitamins. The findings of the study demonstrated that soaking whole oat and millet grains in water for six hours effectively neutralizes phytic acid without compromising their organoleptic properties or causing a loss of vitamins, macro-, and micronutrients.

Therefore, the integration of processed whole-grain oats and millet, characterized by varying physicochemical properties, into fermented beverages as functional additives has the potential to improve digestibility and overall product quality. Nevertheless, further studies are needed to better understand how phytic acid behaves in cereal grains and how it influences their nutritional and functional properties.

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ТАРЫ ЖӘНЕ СҰЛЫ ДАҚЫЛДАРЫНЫҢ САПАСЫН ЗЕРТТЕУ

Қазіргі таңда халық сұранысы тұтас түрдегі дәнді дақылдарға артып келеді. Бұл астықтың бірнеше рет қайталама өңделген дәнді дақылдарға қарағанда сапасы жоғары болатыны дәлелденген.

Ағзада жиі кездесетін асқазан ішек жолдарында судың тепе теңдігі сақталмай, қандағы холестерин мөлшерінің асқынуы, токсиндер мен ауыр металдардың болуы сияқты мәселелер кері әсерін тигізіп, көптеген ауруларға әкеледі. Ал тұтас түрдегі астықты тұтыну арқылы қан айналымы, жүрек тамыр жүйесінің жұмыстары және тағы маңызды бөлігі ол – ас қорыту жүйесінің микрофлорасын қалыпқа келтірумен денсаулығын нығайтуда оң әсерін беретіні байқалады.

Астық түрлерінің ішіндегі тары және сұлы дәндері күнделікті глютенсіз диетаға арналған дақылдар қатарына кіретінін ескерсек, сондай-ақ құрамында адам ағзасына қажетті В тобының дәрумендері және талшықтар мөлшері жоғары екендігімен ерекшеленеді. Осыған орай, биологиялық белсенді заттардың қосылыстары арқылы құндылығы мен сапасы жоғары болатын тары және сұлы дәндерінің тұтас түрлері ашытылған сусынға толықтырғыш ретінде қосу мақсатында берілген шикізат түрін зерттеу осы жұмыста қарастырылады.

Тұтас түрдегі тары және сұлы дәндері денсаулыққа қатысты мәселелерді шешуде талаптарға сай болғанымен, адам ағзасына қажетті макро, микро элементтердің сіңуіне әсер ететін фитин қышқылы болатыны анықталған. Ол үшін аталған дәндерді суда тұнықтыру әдісі қолданылды, нәтижесінде, фитин қышқылын суда 6 сағат тұнықтыру әдісімен бейтараптандырылды. Одан әрі аталған астықтарды кептірудің 2 жолы (Sedona маркалы конвективті пеште 38ºС температурада және WOK табасында 6-8 дәрежесінде қуырып кептіру) ұсынылды. Кептіруден кейін дайын болған шикізаттың органолептикалық қасиеттері, В тобының дәрумендері, талшықтары және суда ертитін антиоксиданттар мөлшері зерттелді. Нәтижесінде тары және сұлы дәндерінің суда тұнықтырылғанға дейін және одан әрі кептіру жолдарынан кейін де барлық үлгілерінде сапасы сақталды. Тек В3 витамині бойынша сұлы дәнінің қуырылған әдісі бойынша төмен көрсеткіш берді.

Түйін сөздер: *тары, сұлы, фитин қышқылы, суда тұнықтыру, талшықтар, бейтараптандыру*

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ИССЛЕДОВАНИЕ КАЧЕСТВА ПШЕНА И ОВСА

В настоящее время наблюдается рост интереса населения к цельнозерновым культурам. Доказано, что они обладают более высоким качеством по сравнению с неоднократно переработанными зерновыми продуктами.

Нарушение водного баланса в желудочно-кишечном тракте, повышение уровня холестерина в крови, накопление токсинов и тяжёлых металлов — всё это оказывает неблагоприятное воздействие на организм и может привести к развитию различных заболеваний. Потребление цельного зерна, в свою очередь, способствует нормализации кровообращения, улучшению функций сердечно-сосудистой системы, а также восстановлению микрофлоры пищеварительного тракта, оказывая тем самым положительное влияние на общее состояние здоровья.

Среди злаковых культур просо и овёс выделяются как источники, рекомендованные для ежедневного безглютенового питания, отличающиеся высоким содержанием пищевых волокон и витаминов группы В, необходимых для функционирования организма. В связи с этим в данной работе рассматривается возможность использования цельных зёрен проса и овса в качестве функционального компонента в составе ферментированного напитка, с акцентом на их высокую питательную ценность и содержание биологически активных соединений.

Несмотря на соответствие цельных зёрен проса и овса требованиям к продуктам, способствующим укреплению здоровья, установлено, что они содержат фитиновую кислоту, которая может снижать усвоение жизненно важных макро- и микроэлементов в организме. С целью её нейтрализации в работе применялся метод предварительного замачивания зерна в воде в течение 6 часов. Проведённый анализ показал, что данная обработка способствует эффективному

снижению уровня фитиновой кислоты. В дальнейшем были апробированы два метода сушки: конвективная сушка при температуре 38 °С в дегидраторе марки Sedona и обжарка в сковороде WOK на уровне нагрева 6–8. Готовое сырьё было исследовано на предмет органолептических показателей, содержания витаминов группы В, пищевых волокон и водорастворимых антиоксидантов. По результатам анализа установлено, что питательная ценность сырья сохранялась после обеих обработок, за исключением витамина В3, уровень которого был снижен в овсе, прошедшем термическую обработку методом обжаривания.

Ключевые слова: *пшено, овес, фитиновая кислота, замачивание, волокна, нейтрализация*

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Received 05.06.2025
Revised 27.06.2025
Accepted 31.07.2025

https://doi.org/10.53360/2788-7995-2025-3(19)-27

МРНТИ: 65.39.31.

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ӨСІМДІКТЕН ЖӘНЕ ЖАНУАРДАН АЛЫНАТЫН ФУНКЦИОНАЛДЫ БИӨНІМДЕРДІ ЕМДІК-ПРОФИЛАКТИКАЛЫҚ ТАҒАМДА ПАЙДАЛАНУ

Аңдатпа: *Бұл мақалада Қазақстан Республикасының 2021-2025 жылдарға арналған агроөнеркәсіптік кешенін дамыту ұлттық жобасы аясында функционалдық тағам өнімдерін, атап айтқанда йодпен байытылған қайнатылған шұжық өнімдерін жасау және олардың тағамдық құндылығын арттыру мәселесі қарастырылады. Зерттеу барысында өнімдердің химиялық, аминқышқылдық және энергетикалық құрамы сараланып, функционалдық және технологиялық қасиеттері талданды. Эксперимент нәтижелері бірінші нұсқаның ақуыз, кальций және йод мөлшері бойынша басым екенін көрсетті. Сонымен қатар, мақалада функционалдық биоөнімдерді өндіруде*