Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 2, Issue 3, March, 2026
Website: usajournals.org

ANALYSIS OF THE PROPERTIES OF GRAIN INDUSTRY WASTE AND THE SCIENTIFIC AND TECHNOLOGICAL BASIS FOR THEIR PROCESSING

G. K. Tukhtamishova
Gulistan State University
gtoxtamishova@gmail.com

D. X. Xaydarova
Gulistan State University
durdonaxaydarova762@gmail.com

Abstract
This article analyzes the composition, quantity, and biotechnological processing potential of waste generated during grain processing. The research was conducted under the conditions of Xovos Don Mahsulotlari JSC, where it was determined that a significant amount of waste is produced as a result of grain processing. The compositional analysis of the waste showed that although bran constitutes the major portion, the most important fraction for bioethanol production is grain waste consisting of fine grain particles and broken grains. This fraction accounts for approximately 3.5% of the total mass. Based on calculations, it was substantiated that a certain amount of ethanol can be obtained under practical conditions, considering the starch content of these wastes.The research results indicate that the differential analysis of grain waste and its targeted use in bioconversion processes play an important role in increasing production efficiency.

Keywords: Grain waste, grain by-products, bioethanol, starch, bioconversion, fermentation, processing, grain industry, ethyl alcohol, technological analysis

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 2, Issue 3, March, 2026
Website: usajournals.org

Introduction

Ensuring food security and the rational use of resources are becoming increasingly important worldwide. In particular, the grain processing industry, while producing large volumes of products, is also one of the sectors that generates significant amounts of secondary raw material waste. The composition of this waste and the level of its utilization have a direct impact on production efficiency.

Waste generated during grain processing consists of various fractions, not all of which have equal technological value. In particular, bran has a fibrous structure and contains very low amounts of starch; therefore, its importance in bioethanol production is limited. In contrast, fine grain particles, broken grains, and certain impurities contain significant amounts of starch, making them promising raw materials for bioconversion processes.

Practical observations and calculations indicate that approximately 3–4% of the total mass in the grain processing process consists of waste fractions rich in starch. Despite appearing relatively small, this proportion represents a significant volume at the industrial scale and provides an opportunity to achieve additional economic efficiency through their processing.

From a research perspective, a detailed analysis of the composition of grain waste particularly the separation of starch-containing fractions and the development of their biotechnological processing methods constitutes an important scientific and practical task. The main objective of this study is to determine the compositional characteristics of grain waste, evaluate the proportion of starch-rich fractions, and substantiate the possibilities of their effective use in bioethanol production.

Literature Review

The efficient utilization of grain industry waste has become one of the key areas of scientific research in recent years. In particular, the study of the composition of by-products generated during grain processing and their conversion into high value-added products has been widely addressed by many researchers.

According to scientific sources, waste generated during grain grinding and sieving processes consists of various fractions, and their technological value depends on their compositional characteristics. Studies show that bran mainly

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 2, Issue 3, March, 2026
Website: usajournals.org

consists of cellulose and hemicellulose, with a relatively low starch content. Therefore, it is primarily used as animal feed.

However, a number of scientific studies have identified fine grain particles, broken grains, and starch-rich mixtures as promising raw materials for bioethanol production. These fractions contain relatively high levels of starch and undergo efficient bioconversion during the fermentation process. Experimental studies conducted by researchers have demonstrated that the production of ethyl alcohol from such waste can be highly efficient.

Literature Review (continued)

In modern scientific literature, the concept of integrated processing of grain waste is widely discussed. According to this approach, separating waste into fractions based on their composition and processing each fraction using specific technologies is considered the most effective strategy. In particular, it is emphasized that directing starch-rich waste to enzymatic hydrolysis followed by alcoholic fermentation can significantly increase the efficiency of bioethanol production.

Some studies indicate that the total volume of grain waste may reach approximately 20–30%; however, the proportion of fractions suitable for bioethanol production is much smaller, accounting for about 3–5%. This highlights the necessity of detailed analysis and targeted separation of waste fractions.

At the same time, scientific sources have extensively explored the use of enzymes in bioethanol production from grain waste, optimization of process parameters, and the implementation of energy-efficient technologies. These approaches not only improve processing efficiency but also contribute to environmental sustainability.

The analysis of the above-mentioned studies demonstrates that the separation and biotechnological processing of grain waste especially starch-rich fractions represent an important direction in the modern food and biofuel industries.

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 2, Issue 3, March, 2026
Website: usajournals.org

Research Methodology

The research was developed based on practical observations conducted at Xovos Don Mahsulotlari JSC, as well as an analysis of the technological indicators of production processes. All stages of grain processing at the enterprise raw material reception, cleaning, grinding, and fractionation were comprehensively studied.

The findings revealed that the total amount of grain delivered to the enterprise was 438,600 kg. During the technological processing, the grain mass was separated into its constituent components, and along with the main product, a significant amount of secondary raw material grain waste was generated. This phenomenon is a natural outcome of the grain processing process and serves as an important indicator for evaluating technological efficiency and resource utilization.

According to the obtained experimental data, the total amount of waste was 118,158 kg, which corresponds to 26.9% of the total raw material. This waste is characterized by structural heterogeneity. Although the major portion consists of bran rich in fibrous components, fractions with high technological value such as fine grain particles, broken grains, and starch-rich mixtures are of particular scientific interest.

Further detailed analysis showed that after the removal of the bran fraction, the remaining grain waste amounted to 15,526 kg. This corresponds to approximately 3.5% of the total grain mass and is considered a valuable raw material for biotechnological processes due to its starch content. These fractions are characterized by their ability to ensure a high conversion rate during enzymatic hydrolysis and subsequent alcoholic fermentation processes.The results of the data analysis are presented in Figure 1.

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 2, Issue 3, March, 2026
Website: usajournals.org

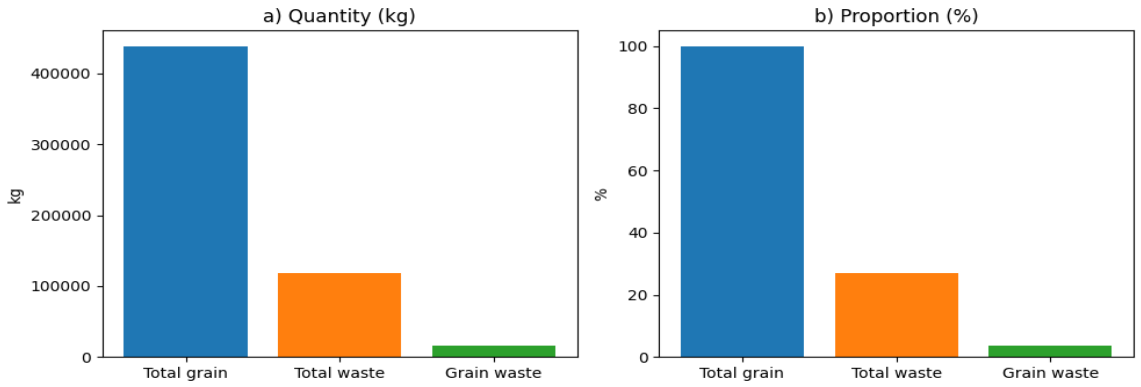

Figure 1. Quantitative and Percentage Distribution of Products and Waste Generated During Grain Processing

The results obtained under production conditions demonstrate the necessity of evaluating grain waste based on a differential approach. In other words, instead of considering all waste as having the same technological value, it is important to classify it according to its compositional characteristics and direct it toward targeted applications. In particular, the separation of starch-rich waste fractions and their utilization in biotechnological processing can significantly increase production efficiency.

The practical results obtained at Xovos Don Mahsulotlari JSC highlight the need for a detailed analysis of waste generated during grain processing and its reassessment as a valuable resource. This approach not only helps reduce waste volumes but also expands the possibilities for producing value-added products, particularly bioethanol.

Figure 2. Separation Process of Grain Waste Under Laboratory Conditions

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 2, Issue 3, March, 2026
Website: usajournals.org

Conclusion

As a result of the conducted research, the quantity and composition of waste generated during grain processing were thoroughly analyzed. It was found that 26.9% of the total raw material consists of various types of waste. However, the technological value of this waste varies significantly depending on its composition.

The analysis showed that the major portion of the waste is bran, which is not suitable for bioethanol production due to its low starch content. In contrast, the grain waste fraction consisting of fine particles and broken grains is considered technologically valuable. According to calculations, this fraction accounts for 3.5% of the total grain mass, amounting to 15,526 kg.

Assuming that grain waste contains an average of 60–65% starch, the theoretical amount of ethanol that can be obtained is as follows:

15,526 kg × 0.60 ≈ 9,315 kg of starch

Considering that, on average, 1 kg of starch yields 0.56 kg of ethanol:

approximately 9,315 × 0.56 ≈ 5,216 kg of ethanol can be produced

Despite representing a relatively small proportion, grain waste constitutes an important additional raw material resource at the industrial scale.

In general, the deep processing of grain waste for bioethanol production contributes to increasing production efficiency, creating additional sources of income, and ensuring the rational use of resources.

References

1.Mussatto S.I., Dragone G., Guimarães P.M.R. et al. Technological trends, global market, and challenges of bio-ethanol production. Biotechnology Advances, 2010, 28(6), 817–830.

2.Balat M., Balat H. Recent trends in global production and utilization of bio-ethanol fuel. Applied Energy, 2009, 86(11), 2273–2282.

3.Zabed H., Sahu J.N., Suely A. et al. Bioethanol production from renewable sources: Current perspectives and technological progress. Renewable and Sustainable Energy Reviews, 2017, 71, 475–501.

4.Demirbas A. Bioethanol from cellulosic materials: A renewable motor fuel from biomass. Energy Sources, 2005, 27(4), 327–337.

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 2, Issue 3, March, 2026
Website: usajournals.org

5.Pandey A., Soccol C.R., Nigam P., Soccol V.T. Biotechnological potential of agro-industrial residues. Bioresource Technology, 2000, 74(1), 69–80.
6.Kim S., Dale B.E. Global potential bioethanol production from wasted crops and crop residues. Biomass and Bioenergy, 2004, 26(4), 361–375.
7.Taherzadeh M.J., Karimi K. Pretreatment of lignocellulosic wastes to improve ethanol and biogas production: A review. International Journal of Molecular Sciences, 2008, 9(9), 1621–1651.