Proceedings of ICBioMed 2025 Symposium: AI for Healthcare: Advanced Medical Data Analytics and Smart Rehabilitation
DOI: 10.54254/2753-8818/2025.AU28318

The Nutritional Composition of Brown Rice and Rice Bran: Potential and Challenges for Public Health Applications

Tingrui Li

Chinese Hong Kong English School, Zhongshan, China
82631745@qq.com

Abstract. The growing concern over nutrition-related chronic diseases in the past has highlighted the necessity of developing more sustainable dietary strategies. Nowadays, brown rice and rice bran are attracting considerable attention from the academic community because of their plentiful nutritional value. Meanwhile, Rice bran is a by-product of rice milling. It is rich in dietary fiber, which is a key biomedical feature for regulating glucose metabolism in pre-diabetic populations. This study systematically employs literature review and cases to clarify the nutritional composition of brown rice and rice bran, further exploring their application in public health-oriented dietary balance promotion.

Keywords: Brown rice, Rice bran, Public health, Chronic Disease Prevention

1. Introduction

People tend to eat polished rice in their daily lives because it is believed that during rice milling, polished rice contains a higher proportion of nutrients, such as rice protein, lipid,. This is why the majority of rice sold in the market is polished. However, researches suggests that white rice can significantly increase the incidence of Type 2 diabetes. Analytical studies have shown that for Asians who consume three liang (approximately 150 grams) of white rice per meal daily, the incidence of diabetes can increase by 11% [1]. When comparing those who eat the most white rice with those who eat the least, the risk of diabetes can increase by 55% [1]. Brown rice has more fiber, magnesium, and vitamins than white rice and also has a lower glycemic index. It is essential to explore the importance of brown rice and rice bran. Currently, Brown rice and rice bran are applied in many aspects. Brown rice, is used in food to help people lose weight and is often preferred over white rice as a main food for diabetic patients to manage their sugar intake. Rice bran is widely used as a baking ingredients ingredient in products like bread and puffed foods. Rice bran is widely used as a raw material for health care products due to its cholesterol-reducing and excretion-promoting effects. However, there is a lack of evidence to support its use.

Therefore, this paper aims to systematically review the relevant research, combined with relevant data and cases, to explore the nutritional components of brown rice and rice bran and their applications in clinical dietary interventions. Moreover, it further investigates the mainstream development technologies of brown rice and rice bran. This paper provides theoretical guidance for sustainable rice processing.

© 2025 The Authors. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/).

DOI: 10.54254/2753-8818/2025.AU28318

2. Literature review

There are numerous studies on rice bran and brown rice at present. For example, according to research, the starch content in brown rice is lower than that in rice bran and white rice. Compared with rice processed once, the starch content increases gradually in rice processed twice. In addition, as a food with a high sugar content, rice contains a large amount of amylose and amylopectin. However, the polyphenolic compounds contained in brown rice can have a certain impact on the digestibility of starch, reducing the rate of starch digestion and thereby lowering the glycemic index [1].

Secondly, as studied by Yuan et al., germinated brown rice was ground into rice bran and then mixed with water and dilute hydrochloric acid to produce PGBR-DF [2]. DF can adsorb bile acids and reduce the solubility of cholesterol and triglyceride digestion products, thereby slowing down the absorption of cholesterol in the human body and promoting the oxidative decomposition of cholesterol in the liver, thus achieving the effect of lowering cholesterol. With the increasing attention to physical health and nutritional needs, numerous studies have been conducted to improve brown rice application technologies and investigate its functional components, aiming to refine the texture of brown rice and optimize the release of its nutritional components [2]. However, scholars still face many obstacles, and there are speicific gaps in the extraction purity of the nutritional components of rice bran and brown rice, as well as in their storage and promotion [3].

3. Research on rice bran and brown rice

3.1. Basic structure

3.1.1. Brown rice

The biological structure of brown rice includes several key components. The outermost layer is the husk, a protective covering that is removed prior to consumption. Beneath the husk lies the pericarp, followed by the aleurone layer, a nutrient-dense layer located just inside the seed coat and adjacent to the endosperm, rich in proteins, lipids, vitamins, and minerals. The endosperm forms the bulk of the grain, consisting mainly of starch and proteins. At the base of the grain is the germ, which holds essential oils, vitamins, and minerals. These layers contribute to brown rice's nutritional value and functionality.

3.1.2. Rice bran

Rice bran is primarily composed of the pericarp, seed coat, embryo, and aleurone layer. The pericarp and seed coat are rich in lignin and cellulose, which serve to protect the embryo and endosperm. This layered structure makes rice bran a major source of bioactive compounds, including dietary fiber, unsaturated fatty acids, vitamin E, γ-oryzanol, and phenolic compounds [4].

3.2. Chemical composition and functional components

3.2.1. Chemical composition

Brown rice is a rich source of various nutrients, starting with carbohydrates, primarily in the form of starch. Not only does this starch is for gut health. Meanwhile, but the carbohydrates as a whole also provide sustained energy and support to provide essential amino acids.

DOI: 10.54254/2753-8818/2025.AU28318

Brown rice contains a variety of proteins, including albumin, globulin, prolamin, and glutelin. These proteins provide essential amino acids, which play a key role in muscle growth, tissue repair, and general health maintenance.

Additionally, brown rice is an excellent source of dietary fiber, mainly consisting of cellulose, hemicellulose, and lignin. This fiber is categorized into soluble dietary fiber (SDF) and insoluble dietary fiber (IDF) [3]. Insoluble dietary fiber (IDF) increases fecal bulk, promotes intestinal motility, and helps prevent constipation. Soluble dietary fiber (SDF) can slow down the absorption of sugars, stabilize blood glucose levels, and is beneficial for diabetes management.

Brown rice further contains vitamins (e.g., B vitamins and vitamin E) as well as minerals(e.g., magnesium, phosphorus, and selenium). as well as phytonutrients, including antioxidants that offer health benefits.

3.2.2. Functional components/ nutritional value and health impacts

Public attention to the comprehensive utilization of rice bran has grown significantly, owing to its exceptional nutritional value and rich contains a variety of functional components such as unsaturated fatty acids, tocopherols, and γ-oryzanol.

First, rice bran is abundant in unsaturated fatty acids. Linoleic acid, for eaxmple, is an essential fatty acid that should be obtained through intake. These unsaturated fatty acids can lowver cholesterol levels and prevent cardiovascular diseases. Second, tocopherol (fat-soluble vitamin) exhibits strong antioxidant capacity, protecting cells and unsaturated fatty acids from oxidative damage. γ-Oryzanol, another key component, exerts mutiple: regulating blood lipids, scavenging free antioxidant, improving endocrine, and anti-aging.

In addition to rice bran, brown rice dietary also delivers notable health benefits. Its insoluble IDF increases fecal bulk and promotes regular bowel regularity, thereby reducing the risk of constipation. Meanwhile, SDF slows the absorption of sugars, leading to a more gradual rise in blood glucose levels, which is beneficial for managing diabetes. Rice bran also contains a variety of phenolic compounds, including ferulic acid, p-coumaric acid, and vanillic acid. These compounds have antioxidant, anti-inflammatory, and antimicrobial properties, which can help prevent chronic diseases and improve overall health.

3.3. Processing and utilization technologies

Currently, germination technology and high-pressure homogenization are the main techniques used for rice bran and brown rice. Germination technology is an advanced technique designded to maximize the nutritional value of brown rice. It is applied to brown rice before milling, allowing its germ to absorb water and swell, triggering germ growth and transforming it into a more nutritious-dense form. Essentially, it is an industrial technique that, under certain industrial conditions, activates various enzymes it contains, such as amylase and phytase, protease, and then converts their bound forms into free, bioavailable states [3].

High-pressure homogenization uses a homogenizer to mix the pulp and liquid of brown rice together, thereby improving the fineness and uniformity of the food, preventing the liquid separation of the food, enhancing the color and taste, and increasing the activity of dietary fiber in brown rice to promote intestinal peristalsis and digestion [3].

DOI: 10.54254/2753-8818/2025.AU28318

4. The multi-field application value of brown rice and rice bran

4.1. Medical application

The rice bran oil made from rice bran has the effect of protecting the heart. Studies have showed that an oil-based rather than fiber-based diet can effectively lower cholesterol levels [4]. Other scholars from a biomedical research center in the United States also have proposed and proved that rice bran and rice bran oil can effectively help prevent cardiovascular diseases. They recruited male and female subjects with high cholesterol and added an appropriate amount of rice bran oil to their diets. The results showed a significant decrease in their cholesterol levels. The results showed a significant reduction in the subjects' cholesterol levels. In addition, when rice bran oil was used as a substitute for cooking oil for middle-aged and elderly people, and their cholesterol levels also gradually decreased [4]. Therefore, many patients with high blood lipids or cardiovascular diseases now often use brown rice and add an appropriate amount of rice bran to their diet.

Meanwhile, Rice bran uses as pharmaceutical component extraction. It contains several bioactive compounds with medicinal value, such as ferulic acid and sterols. Ferulic acid possesses anti-inflammatory, antioxidant, and antiplatelet aggregation properties,making it applicable in the treatment of cardiovascular and inflammatory diseases [5]. Sterols, can regulate the human endocrine system and have potential anticancer and immune-modulating effects [5]. These compounds can be extracted and purified from rice bran for pharmaceutical use [6].

Rice bran contains water-soluble polysaccharide compounds with anti-tumor properties (mainly pentoses and hexoses). In the mouse experiments, 1 million fibroblasts and cancer cells each were treated at a concentration of 0.9 mg/mL. The results showed that the normal cells had a 100% survival rate, while the cancer cells were inactivated by 50%. Moreover, the mice's immune systems were enhanced, showing better effects than conventional anti-cancer drugs and demonstrating good anti-cancer potential. These experiments indicated that the utilization of rice bran and brown rice can be even more effective than some traditional anti-cancer drugs [7].

4.2. Agricultural applications: fertilizers and soil improvement

Rice bran is rich in nutrients and contains about 11 metal elements such as magnesium, potassium, and iron [1]. It is a high-quality organic fertilizer, the nitrogen, phosphorus, and potassium in which can improve soil structure and increase soil fertility. Rice bran can effectively improve the soil's permeability and aeration. Therefore, rice bran is also widely used in agriculture as a raw material for organic fertilizers. What'more, it wildly employed for soil improvement. Rice bran can be used to amend acidic soils and saline-alkali lands. The organic acids and alkaline substances in rice bran can neutralize the soil's acidity, improving its physical and chemical properties.

4.3. Food and health applications

The key factor that enables rice bran to be used in health products is the decomposition of its main component, protein, into rice bran protein using certain techniques. Experiments have shown that the content of stabilized rice bran protein in rice bran is more than twice that of stabilized rice protein [7]. Its protein digestibility is as high as 90%. Importantly, rice bran protein has low allergenicity, which greatly increases its applicable population [7]. For diabetic patients, clinical guidelines suggest replacing 50–100 grams of white rice with brown rice per meal. Relevant experiments have proven that, in addition to lowering glycated hemoglobin (HbA1c) levels, this

DOI: 10.54254/2753-8818/2025.AU28318

substitution does not increase gastrointestinal side effects. Moreover, rice bran protein has extremely low allergenicity and is significantly lower than that of soy and milk proteins [7]. This makes it a safe and hypoallergenic dietary alternative for pediatric patients with cow's milk protein allergy (CMPA). According to relevant experiments, infant formulas based on rice bran protein can alleviate allergic symptoms, effectively compensate for the nutritional gaps caused by the avoidance of allergens, and maintain the "dietary balance" required for growth.

5. Discussion

5.1. Challenges

Data indicates that, according to research, brown rice is classified as a medium glycemic index (GI) food, while white rice has a GI of approximately 73, making it a high GI food. Brown rice is digested and absorbed at a relatively slower rate, which allows for a more gradual release of glucose, helping to maintain stable blood sugar levels and thereby reducing the risk of developing type 2 diabetes.

Brown rice and rice bran not only contain better nutritional components and lower GI values to improve public health, but also by maximizing the reduction of processing energy consumption and reducing environmental pollution, they contribute to economic development through a diversified product portfolio [8]. The efficient utilization of brown rice and rice bran can become a "low-cost pathway" for developing countries to achieve SDG3.

However, there are still many challenges in the process of application and promotion. First, with the improvement of rice processing and milling precision, the loss of protein, fat, and minerals in rice has been exacerbated, which can easily lead to nutrition-related diseases such as iron-deficiency anemia [2]. Although brown rice and rice bran can reduce this risk to some extent, how to reduce nutritional loss while ensuring taste and quality remains a challenge.Second, brown rice has problems such as difficulty in chewing and longer cooking time. Due to poor taste, it limits consumers' acceptance and willingness to consume addition, The endogenous phytase in the germ and bran layers of brown rice can be activated under certain conditions, which can also degrade the phytic acid in brown rice. However, this technology is still under exploration. Further research is needed on how to achieve a rapid hydrolysis rate of phytic acid and the activation conditions under specific circumstances.

The promotion of brown rice and rice bran faces challenges. Limited by consumption habits and gaps in public awareness, due to the low awareness of their nutritional advantages, people still prefer refined rice. The second is the barrier to practical implementation. Because of its rough texture, which leads to low acceptance, and the lack of product forms suitable for different groups of people, these two major problems directly affect the realization of the target for whole grain intake.

5.2. Future directions

In the future, the utilization of rice bran and brown rice needs to be advanced from multiple dimensions in a coordinated manner. First, governments and relevant departments should strengthen publicity and conduct nutritional education to enhance the public's awareness of brown rice and rice bran and promote the popularization of healthy dietary culture. Second, food enterprises should be encouraged to develop and improve products. For example, soft brown rice can be developed to shorten cooking time and improve texture. In addition, rice bran breakfast cereals and energy bars that are convenient to carry should be developed.

DOI: 10.54254/2753-8818/2025.AU28318

Meanwhile, low-allergenic formula milk powder and functional health foods based on rice bran protein can be produced for infant group. Third, it is necessary to continuously develop hydrolysis techniques to improve the texture of brown rice and reduce the loss of nutritional components. By improving extraction techniques, it is accessible to facilitate large-scale promotion. Finally, against the backdrop of global malnutrition and the high incidence of chronic diseases, the promotion of brown rice and rice bran can serve as an important tool. By learning from the successful experiences of countries and achieving international cooperation to share scientific research results and promotion experience and contribute to the realization of the United Nations Sustainable Development Goals.

6. Conclusion

This paper systematically investigates the chemical composition, nutritional value, and extraction methods of brown rice and rice bran, as well as their applications in the fields of medicine, agriculture, and food. The research results show that brown rice and rice bran play a positive role in improving blood lipid levels and stabilizing blood sugar. They also have certain advantages in the prevention of cardiovascular diseases and anti-tumor research. However, the study further points out that there are a series of problems in the utilization of brown rice and rice bran. For example, the current extraction processes are limited, and their taste is relatively less acceptable. Although the market is gradually expanding, further promotion and publicity are still urgently needed, and thus continuous efforts should be made to to expand further and develop the rice market.

The study mainly summarises based on existing research, with a lack of empirical experimental verification and quantitative analysis, The accuracy and generalizability of the conclusions still need further verification. In the future, more relevant experimental verifications can be carried out to verify the long-term effects of brown rice and rice bran in the prevention of chronic diseases, and to enhance the scientific nature and universality of the research conclusions.

References

[1] Shi, Y., Zou, J., Zheng, W., & Zhang, H. (2010). Distribution analysis of major nutritional components and mineral elements in rice. Journal of Nanchang University (Engineering & Technology Edition), 32(4), 390–393, 408.
[2] Yuan, L. J., Fu, X. J., Li, Z. H., & Lin, Q. L. (2016). Preparation of dietary fiber from germinated brown rice and its hypolipidemic activity [Chinese]. Cereals & Oils, 29(5), 51–53.
[3] Xia, Q., Wang, L., Xu, C., Mei, J., & Li, Y. (2017). Effects of germination and high hydrostatic pressure processing on mineral elements, amino acids and antioxidants in vitro bioaccessibility, as well as starch digestibility in brown rice (Oryza sativa L.). Food Chemistry, 214, 533-542.
[4] Geng, Z.(2005). Dietary intake of rice bran oil-rich foods reduces cholesterol levels. Foreign Medical Information, (7), 28.
[5] Jin, Z., & Xu, X. (2013). Rice bran processing technology and the development of health foods. Liangshi Jiagong, 38(1), 29–32.
[6] Singh, S., Sharma, H., & Singh, B. (2022). Rice bran: Composition, functionality, and emerging applications. Comprehensive Reviews in Food Science and Food Safety, 21(3), 2230-2255.
[7] Shi, S. (2013). Rice processing and marketing characteristics observed from the 2012 Hunan Agricultural Expo. Liangshi Jiagong, 38(1), 32–34, 37.
[8] Gu, H.(2001). Composition and development application of rice bran. Zhongguo Daomi, 5, 36–38.