



## Effect of germination on brown rice and its role in human health promotion: A review

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### Abstract

Brown rice contains more nutritional value than ordinary white rice. In spite of its superior bioactive components, brown rice is rarely consumed as a staple food owing to its dark appearance and hard texture. Brown rice can be germinated to modify its taste and further enhances its nutritional value and health promoting functions. Germinated brown rice (GBR) can be considered as a potential functional food ingredient as it contains more bioactive components, like ferulic acid,  $\gamma$ -oryzanol, and gamma aminobutyric acid (GABA) that has been reported to reveal several physiological benefits. However, there is a need to explore the information about commercial production of GBR and its potential utilization in food products. Value added products with incorporated GBR acquire better nutritional profile, leading to improved consumer acceptability. The aim of this review is to focus nutritional and health-promoting functions of GBR in order to promote its utilization for commercial exploration.

**Keywords:** germinated brown rice (GBR), bioactive components, physiological benefits, function

### 1. Introduction

Rice is most common cereal, serving as a staple food for approximately half of the global population. Brown rice as compared to white rice, have many essential nutrients and bioactive components like ferulic acid,  $\gamma$ -oryzanol, and gamma aminobutyric acid (GABA), which exist mainly in the germ and bran layers (Bahadur, 2003) <sup>[1]</sup>. Thus, brown rice has potential to diminish the prevalence of malnutrition and chronic diseases. However, brown rice is not consumed as table rice due to its poor texture, off-putting bran odour, low digestibility, and the not-easy-to-cook characteristic (Komatsuzaki *et al.*, 2007) <sup>[12]</sup>. Further, brown rice can be germinated to enhance its taste, nutritional value and health promoting functions. The change of staple food from polished rice to germinated brown rice (GBR) has potential to promote healthy life (Hiroshi 2005) <sup>[4]</sup>.

During germination, hydrolytic enzymes are activated and this decomposes starch, non-starch polysaccharides and proteins, which leads to increase in oligosaccharides and amino acids (Manna *et al.* 1995) <sup>[15]</sup>. Proteins and sugars broken down by enzymes produced during the germination process gives a sweet flavor to GBR (Kihara *et al.*, 2007) <sup>[10]</sup>. GBR contains three nutrients as GABA, phytic acid and thiamine that are beneficial to human health. Several types of antioxidant phenolic compounds have also been isolated from brown rice (Tian *et al.*, 2004) <sup>[24]</sup>.

GBR is referred as a functional food as it is good in digestion and absorption, as well as contains nutrients in plenty as compared to ordinary brown rice. It can be utilized in preparation of various food products like bread, porridge, *dhokla* and extruded product for increasing its nutritional profile and health benefits. The objective of this article is to present an overview of the nutritional quality of GBR and its role in human health promotion.

### 2. Effect of germination on nutritional quality of brown rice

The germination of brown rice can be carried out to enhance

its taste, nutritive value and health promoting functions. Brown rice can be germinated by soaking in warm water at 35–40°C for about 10–12 h, draining water and keeping in moist condition for 20–24 h, and during soaking time period, changing the water every 3–4 h to prevent fermentation (which usually produces undesirable odour) and to maintain consistent water temperature. It yields a 0.5–1 mm long sprout from the brown rice grain. During germination of brown rice, the seed reserves are degraded and used for the respiration and synthesis of new cell constituents for the developing embryo, thereby causing significant changes in the biochemical, nutritional and sensory characteristics of grain (Lopez-Amoroso *et al.*, 2006) <sup>[14]</sup>.

Enzymes are activated and high molecular weight polymers broken down into oligosaccharides, amino acids and other bio-functional substances, also improving organoleptic quality mainly due to grain softening, which makes cooking easier (Kim *et al.*, 2004) <sup>[11]</sup>. The bioactive compounds such as gamma-aminobutyric acid (GABA), dietary fibre, ferulic acid, tocotrienols, magnesium, potassium, zinc,  $\gamma$ -oryzanol, lysine, vitamin E, vitamin B<sub>1</sub>, vitamin B<sub>6</sub> and prolyl endopeptidase inhibitor, increases significantly in brown rice after germination. The amount of GABA in GBR was noticed to be ten times more as compared to milled white rice and two times more than that of brown rice. Further, they found that GBR contains less calories and sugar than milled rice.

The content of insoluble phenolic compounds in GBR is significantly higher than white rice. This could be because phenolic compounds are mostly located in the bran layer of rice grains. The increase in insoluble phenolic compounds may be intended to increase the availability of hydrolysable insoluble phenolic compounds during the germination of brown rice (Tian *et al.*, 2004) <sup>[24]</sup>. Antioxidant activity of brown rice is influenced by pretreatments or processing. Therefore, GBR exhibited higher antioxidant activity than that of brown rice or white rice extracts (Ti *et al.*, 2014) <sup>[23]</sup>.

### 3. Health benefits of GBR

Recently, GBR have attracted an increasing number of researchers. The relationship between diet including GBR and prevention of certain diseases has been identified. Moreover, GBR has been reported to exhibit many physiological effects, like anti-hyperlipidemia, anti-hypertension, and reduces the risk of some chronic diseases, such as cancer, diabetes, cardiovascular disease, and Alzheimer's disease. Thus, GBR can be referred as popular health food (Wu *et al.*, 2013)<sup>[26]</sup>.

Saikusa *et al.*, (1994)<sup>[22]</sup> found that GABA increases significantly after germination in brown rice. GABA is known to help protect the brain from harmful amino acids connected to Alzheimer's disease. It's also a powerful neurotransmitter, boosting the central nervous system's ability to support good sleep and reduce stress.

Furthermore, researchers have also reviewed the impact of GBR on the proliferation and apoptosis of cancer cells. GABA, which is abundant in germinated brown rice, was also reported to suppress tumor growth. Tian *et al.*, (2004)<sup>[24]</sup> indicated that GBR could potentially help to decrease mutations and improve human health due to increase in insoluble, but hydrolysable, phenolic compounds during germination. These results further suggest that GBR as a staple food may be beneficial with respect to cancer prevention.

The beneficial effects of GBR on fasting and postprandial blood glucose levels in humans have been investigated by many researchers. The germination of brown rice has shown to improve anti-diabetic potential through various mechanisms such as the reduction of glycemic index, insulin index, hypercholesterolemia and oxidative stress (Imam *et al.*, 2012)<sup>[6]</sup>. The consumption of GBR as a staple food in patients with type 2 diabetes was useful in improving blood glucose and lipid levels. Therefore, GBR is a good food ingredient in preventing diabetes and its associated complications (Hsu *et al.*, 2008)<sup>[5]</sup>.

The GBR has potential for anti-obesity and cholesterol lowering effects. Miura *et al.*, (2006)<sup>[17]</sup> found that GBR suppressed hypercholesterolemia induced by hepatoma growth by means of upregulating cholesterol catabolism. They suggested that GBR is a more efficient functional food that affects high blood cholesterol. Mitsuo and Aya (2004)<sup>[16]</sup> reviewed the effect of GBR diet on the prevention of blood pressure increase in hypertensive rats and patients and suggested that GBR can be used as part of a complementary therapeutic diet for hypertension. The regular intake of GBR is good for health; as it can help to accelerate metabolism of the brain, prevent headache, relieve constipation and prevent colon cancer (Jiamyangyuen and Ooraikul, 2008)<sup>[7]</sup>.

GBR has also been reported to enhance mental health and improve skin conditions (Kawana-Ebizuka *et al.*, 2005)<sup>[9]</sup>. Moreover, GBR may play a nutraceutical role in the prevention of chronic diseases (Osamu *et al.*, 2004)<sup>[19]</sup>. All these health benefits of GBR may be attributed to the combined actions of various components including dietary fibers, vitamins, minerals, and other bioactive compounds such as GABA,  $\gamma$ -oryzanol, phytosterols, polyphenols, tocotrienols, and  $\alpha$ -tocopherol (Lim *et al.*, 2016)<sup>[13]</sup>.

### 4. Potential utilization of GBR in food products

In view of various health benefits, GBR indicates high potential for utilization in food products as abundant source of health-promoting compounds. Watanabe *et al.*, (2004)<sup>[27]</sup>

showed that the substitution of brown rice or germinated brown rice for wheat flour lowered specific volume of bread more than the control bread without brown rice or germinated brown rice with increasing amounts of substitution. The improving effect was for 10 or 20% germinated brown rice than for brown rice. They concluded that GBR would improve the bread quality when substituted for wheat flour.

The development of a new food product from GBR by a twin-screw extruder was investigated by Ohtsubo *et al.*, (2005)<sup>[19]</sup>. Wheat bread prepared with 30% puffed germinated brown rice contained more GABA and free sugars, such as maltose, than ordinary wheat bread. The extruded bread was shown to be sweeter and equivalently palatable as result of the organoleptic test. Kadir *et al.*, (2008)<sup>[8]</sup> prepared instant nutritious germinated brown rice porridge (GBRP) and compared it with white rice porridge (WRP) and commercial porridge (CP). GBRP was found to be more nutritious porridge than WRP and CP. GBRP was higher in unsaturated fatty acids than saturated fatty acids, can be used as healthier option to reduce cardiovascular risks. They revealed a higher potential of GBRP as a healthier option that is abundant in health promoting compounds.

Mounika *et al.*, (2017)<sup>[18]</sup> revealed that GBR flour can be successfully incorporated in nankhatai up to 30% to yield products of enhanced nutritional quality with acceptable sensory attributes. The noodles can be prepared by partially substituting wheat flour with heat-moisture treated (HMT) GBR flour. The mixtures of wheat flour and HMT GBR flour exhibited enhanced pasting properties and improved cooking and textural qualities compared to control wheat noodles (Chung *et al.*, 2011)<sup>[2]</sup>. Hence, development and utilization of such functional foods with GBR will improve the nutritional status of the population and also helps to those suffering from degenerative disease.

### 5. Conclusion

Germinated brown rice (GBR) is considered healthier than white rice, as it is not only rich source of basic nutritional components such as vitamins, minerals, dietary fibers, and essential amino acids, but also contains more bioactive components, like ferulic acid,  $\gamma$ -oryzanol, and gamma aminobutyric acid. It plays vital role in preventing some diseases like obesity, hyperlipemia, hypertension, cancer, diabetes, CVD, and Alzheimer's disease. GBR can potentially utilized in preparation of novel foodstuff for improving nutritional and bio-functional components than ordinary rice products. Thus, GBR has potential to become innovative rice by preserving all nutrients in the rice grain for human consumption in order to create the highest value from rice.

### 6. Future prospects

The health consciousness of consumers makes GBR as dietary food for health improvement. The demand for GBR will be high in the near future, due to its good nutritional and nutraceutical properties. Further, more additional research is essential to develop economical and efficient practices for the production of GBR and discovering possible industrial applications of GBR.

### 7. References

1. Bahadur Hari KC. Useful germinated brown rice. The

- newspaper of Kathmandu 2003 Wednesday, 2009.
2. Chung HJ, Cho A, Lim ST. Effect of heat-moisture treatment for utilization of germinated brown rice in wheat noodle. *LWT*. 2012; 47(2):342-347.
  3. Kayahara H, Tsukahara K, Tatai T. "Flavor, health and nutritional quality of pre-germinated brown rice." in Proceedings of the 10th International Flavor Conference, 2000, 546–551.
  4. Hiroshi C. Attraction of germinated brown rice and contribution to rice consumption expansion. Workshop and Conf on Rice in the World at Stake, 2005, 67–70.
  5. Hsu TF, Kise M, Wang MF. Effects of pre-germinated brown rice on blood glucose and lipid levels in free-living patients with impaired fasting glucose or type 2 diabetes. *Journal of Nutrition Science and Vitaminology*. 2008; 54(2):163–168.
  6. Imam MU, Azmi NH, Bhanger MI, Ismail N, Ismail M. Antidiabetic properties of germinated brown rice: A systematic review. *Evidence-Based Complementary and Alternative Medicine*, 2012, 1–12.
  7. Jiamyangyuen S, Ooraikul B. The physico-chemical, eating and sensorial properties of germinated brown rice. *Journal of Food Agriculture and Environment*. 2008; 6(2):119.
  8. Kadir KKA, Azlan A, Amom Z, Esa NM, Ismail M. Nutritional Composition of Germinated Brown Rice Porridge. *Global science books*. 2008; 2(1):57-60.
  9. Kawana-Ebizuka H, Ihara M, Iton Y, Mizukuchi A, Ohnishi M, Ishiwata K, *et al*. Effects of pre-germinated brown rice diet on skin condition in female university students. *Journal of Japanese diet*. 2005; 16:108-113.
  10. Kihara M, Y Okada T, Iimure K Ito. Accumulation and degradation of two functional constituents. GABA and -glucan, and their varietals differences germinated barley grains. *Breeding Science*. 2007; 57(2):85-89.
  11. Kim SY, Park J, Byun SJ. Method for preparing germinated brown rice having improved texture and cookability without microbial contamination and a germinated brown rice obtained therefore, US Patent 0105921 A1, 2004.
  12. Komatsuzaki N, Tsukahara K, Toyoshima H, Suzuki T, Shimizu N, Kimura T. Effect of soaking and gaseous treatment on GABA content in germinated brown rice. *Journal Food Engineering*. 2007; 78(2):556–560.
  13. Lim SM, Yong MG, Mohtarrudin N, Loh SP. Germinated brown rice ameliorates obesity in high-fat diet induced obese rats. *BMC Complementary and Alternative Medicine*. 2016; 16:140.
  14. Lopez-Amoros ML, Hernandez T, Estrella I. Effect of germination on legume phenolic compounds and their antioxidant activity. *Journal of Food Composition and Analysis*. 2006; 19(4):277–283.
  15. Manna KM, Naing KM., Pe H. Amylase activity of some roots and sprouted cereals and beans. *Food Nutrition Bulletin*. 1995; 16:1–4.
  16. Mitsuo K, Aya M. Pre-germinated brown rice as complementary therapeutic diet for hypertension. *Food Style*. 2004; 8:54–57.
  17. Miura D, Ito Y, Mizukuchi A, Kise M, Aoto H, Yagasaki K. Hypocholesterolemic action of pre-germinated brown rice in hepatomabearing rats. *Life Sciences*. 2006; 79:259–264.
  18. Mounika B, Devi SS, Maheswari KU, Hemalatha V. Storage Stability of Germinated Brown Rice Incorporated Baked Products. *International Journal of Current Microbiology and Applied Sciences*. 2017; 6(12):4051-4055.
  19. Ohtsubo K, Suzuki K, Yasui Y, Kasumi T. Bio-functional components in the processed pre-germinated brown rice by a twin- screw extruder. *J Food Compos Anal*. 2005; 18:303–316.
  20. Osamu K, Tooru N, Masanori F, Kazuo T. High alcohol sake production tests with use of roasted germinated brown rice. *Nippon Jozo Kyokaiishi*. 2004; 99:474–480.
  21. Patil SB, Khan MK. Germinated brown rice as a value-added rice product: Review. *Journal of Food Science and Technology*. 2011; 48(6):661-667.
  22. Saikusa T, Horino T, Mori Y. Accumulation of  $\gamma$ -aminobutyric acid (GABA) in the rice germ during water soaking. *Bioscience, Biotechnology and Biochemistry*. 1994; 58(12):2291–2292.
  23. Ti H, Zhang R, Zhang M, Li Q, Wei Z, Zhang Y, *et al*. Dynamic changes in the free and bound phenolic compounds and antioxidant activity of brown rice at different germination stages. *Food Chemistry*. 2014; 161:337–344.
  24. Tian S, Nakamura K, Kayahara H. Analysis of phenolic compounds in white rice, brown rice, and germinated brown rice. *Journal of agricultural and food chemistry*. 2004; 52(15):4808-4813.
  25. Tian S, Nakamura K, Kayahara H. Analysis of phenolic compounds in white rice, brown rice, and germinated brown rice. *Journal of Agricultural and Food Chemistry*. 2004; 52:4808–4813.
  26. Wu F, Chen H, Yang N, Wang J, Duan X, Jin Z, *et al*. Effect of germination time on physicochemical properties of brown rice flour and starch from different rice cultivars. *Journal Cereal Science*. 2013; 58(2):263–271.
  27. Watanabe M, Maeda T, Tsukahara K, Kayahara H, Morita N. Application of Pregerminated Brown Rice for Breadmaking. *Cereal Chemistry*. 2004; 81(4):450-455.