Report on

How does Germination of Brown Rice Cause Increase in Nutritional Value?

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By
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1. Objectives

White rice is the most important staple food in many Asian and South American Countries. Its production has grown steadily in recent years, expecting to achieve a world production of 512 million tons by 2016. (OECD-FAO Agricultural Outlook 2012) In these regions, white rice consumption has been connected with a growing incidence of chronic diseases such as type-2 diabetes (Hu et al. 2012). It could contribute to the fact that consumption of brown rice has gained popularity among health conscious consumers (Palasangui et al. 2006). Despite its elevated content of bioactive components and nutritional values, brown rice consumption remains light for its dark appearance and hard texture. Germination of brown rice can be used to improve brown rice’s taste and further enhance its nutritional value and health function (Lee et al., 2007). Germination is method of preparing rice for years in Korea and Japan areas. It is done by soaking washed brown rice in warm water for 1 to 2 days for altering its flavor and texture. Numerous studies have shown that the nutritional and chemical profile is altered following germination of cereal grains such as wheat, rice, barley, oats, and rye (Price 1988, Prodanov et al. 1997, Rozan et al. 1999, Rozan et al. 2000). Germination can improve the texture of brown rice and enables the nutrients of the grains to be more easily digested and absorbed (Jiamyangyuen 2008, Wu 2013).

It has also been recently shown that germinated brown rice (GBR) exerts chemopreventive and immunomodulatory activity (Wang et al. 2012), suppresses inflammatory responses (Park et al. 2013), inhibits adipogenesis (Ho et al. 2013), and attenuates hydrogen peroxide-induced oxidative stress (Azmi et al. 2013). However, there are not very many studies done on how germination cause it. The objective of this research proposal is to evaluate the studies that have been done on how germination causes an increase in nutritional values in GBR and to provide a proposal for future
2. Literature review

2.1 Experiences and Methods

2.1.1 Preparation of GBR

Most of the material and methods from related research are similar. They mainly washed the brown rice and soaked it in water at around 15 °C - 30°C for 1 - 3 days in the darkness. In most cases, water was changed every 24 hours. After the germination process, the seed was separated into parts and dried.

2.1.2 Analysis of crude protein, lipids, carbohydrates, and fiber

For analysis of crude protein and lipids, the standard method of AOAC (1990) were often used. For crude protein, researchers mainly used either the Kjeldahl method (AOAC, 950.09) or the crude protein method (AOAC 984.13). For analyzing free sugars HPLC were often used. Fatty acids in the sample extract were trans-esterified to methyl esters (FAMEs) using a base-catalyzed trans-esterification followed by a Borontrifluoride-catalysed esterification according to AOCS (1998, Official methods). Then fatty acid methyl esters were identified using gas chromatograph. Free sugars were often analysed using HPLC (Kim et al. 2012). Crude fiber was determined in the sample using the standard methods of analysis of the AOAC (AOAC 1984).

2.1.3 Analysis of GABA and γ-oryzanol

There are several different way of analysis GABA. However basic principles are similar. Mainly γ-Aminobutyric acid (GABA) content was extracted according to methods such as that in Oh et al. 2003 which was adding the mixture of organic solution to the pulverised grains. The aqueous solution layer containing GABA was obtained through centrifugation and then the supernatant was
freeze dried. GABA was measured by a spectrophotometric assay at 340 nm (Zhang & Brown 1997, Kim et al. 2012). Rice bran is a rich source of steryl ferulate esters, commonly referred to as oryzanols (Xu and Godber, 1999). γ-Oryzanol, which is ubiquitous as a component in primary plant cell walls, offers some benefits, such as hypolipidemic (Guardiola et al. 1996, Rong et al. 1997) and antioxidant properties (Xu et al. 2001). γ-Oryzanol was analysed using HPLC with a UV detector around 325-350 nm. (Kim et al. 2012)

2.2 Results and Discussion

2.2.1 Effect of soaking and germination on dietary fiber

It was found that the total dietary fiber content, though depends on brown rice variety and harvesting conditions, has a slight increase during germination process of brown rice. The highest increase for both soluble and insoluble fiber was observed after germination which is soaking for more than 2 days (Lin et al. 2011).

2.2.2 Effect of soaking and germination on protein and carbohydrates

In general, germination did not cause relevant changes in protein content. The levels of most amino acids increased significantly during germination. Veluppillai and others observed that the free amino acid content increased significantly from 1.96 to 3.69 mg/g on a dry matter basis during brown rice germination for up to 5 days. (Veluppillai et al. 2009). However it has also been reported that rice loses protein during the soaking process (Albarracín et al. 2013). The degree of the changes seen in starch depends on different germination conditions, such as temperature, humidity, culturing media, steeping (soaking) and the length of germination (Koehler et al. 2007). Islam and other found the total free sugar content of brown rice increased 2.0 folds as compared to the unterminated sample (Islam et al. 2012).
2.2.3 Effect of soaking and germination on lipids

Reports on the effect of germination on the changes in lipids in brown rice are relatively scarce. Choi and others investigated the effect of germination on the changes in the fatty acids of the brown rice “Keunnun,” which has a large embryo, and “Ilpumbyeo,” which has a normal embryo. Oleic acid, the most abundant fatty acid in both types of rice, decreased in content throughout germination, whereas palmitic and linoleic acid contents increased (Choi et al., 2009). Their results are somewhat contradictory to the results of Shu and others who observed that the concentrations of oleic, palmitic, and palmitoleic acids increased in the initial stage of germination but decreased rapidly after 72 hours. Further studies are required to clarify the various aspects of lipid metabolism during brown rice germination (Shu et al. 2008).

2.2.4 Effect of soaking and germination on GABA and γ-oryzanol

This was found that GABA levels increased significantly when brown rice was soaked in water at 40 °C for 8 - 24 h (Saikusa et al. 1994). The concentration of γ-oryzanol being higher in the outer layers. Butsat and Siriamornpun reported that the concentration of γ-oryzanol varied among all rice fractions (Butsat et al. 2010). Ng and others found on their research that the application of the germination process was able to enhanced γ-oryzanol content (Ng et al. 2013).

2.3 Discussion on how soaking and germination causes these results

During germination, some molecules are degraded for the respiration and synthesis of new cell constituents, which causes significant changes in the biochemical, nutritional and sensory characteristics of cereals. On one hand, enzymes are activated to hydrolyse carbohydrates and proteins, which makes these nutrients more easily digestible by the human body (Komatsuzaki et al. 2007, Palmiano et al. 1973). This account for the increase in free sugar as well (Islam et al. 2012) As soon as rice is hydrated during soaking, the metabolic activity of dry seed increases. It has been proven that processing techniques such as soaking and germination, when applied to seeds, would allow phytates
hydrolysis. This improves enzyme activity present in the seed (Egli et al. 2003). In different parts of the rice grain, complex biochemical changes occur during germination. A study was made of the changes in activity of enzymes involved in the breakdown of stored phytin, lipid, and hemicellulose in the aleurone layer of rice seed during the 1st week of germination in the light (Palmiano et al. 1973). Phytase activity increased within the 1st day of germination. That could account of the decreased protein content and increased amino acid content as consequence of proteases activation (Veluppillai et al. 2009). There were also an increase in activity of most other enzymes -phosphomonoesterase, phosphodiesterase, esterase, lipase, peroxidase, catalase, β-glucosidase, and α- and β-galactosidase – closely followed the increase in free amino acid content (Palmiano et al. 1973).

The breaking down the large molecular substances to small molecular compounds can also generate bioactive components. Among the many bioactive phytochemicals in brown rice, γ-oryzanol is rarely found in common crops and vegetables (Miller et al. 2006, Yoshie et al. 2009), whereas GABA is present in most plant tissues, especially in germinated seeds (Li et al. 2010)

Additionally, germination improves the texture quality of brown rice because the enzymatic hydrolysis of the polymeric materials softens the rice bran and often improves its flavor (Hunt et al. 2002). The degradation of starch in rice grains during germination can also led to the increase in small dextrin and fermentable sugar (Ohtsubo 2005, Wijngaard 2005). This change produced a special sweet flavor in germinated brown rice.

In conclusion, this review has concluded that germination process was able to improve brown rice nutritional values as demonstrated by enhanced fiber, vitamins, GABA, γ-Oryzanol and so forth. It is due to the increase in activity of a lot of different kind of enzymes present in the rice grain. This causes complex biochemical changes which often involves the breakdown of compound, thus the increase of bioactive compound.
3. Experimental Design and Analysis

From the studies and data that have been reviewed, we know a lot about the difference between the composition of regular brown rice and germinated brown rice as well as the biochemistry and philological mechanisms behind it. It is suggested that the next step would be to further understand the food microbial aspect of germinated brown rice as well as the environmental factors in order to create a safe and functional food product both domestically and commercially.

A t-test would be used to determine the differences of the compositions of germinated brown rice made from different environmental factors, such as temperature of water, soaking time etc. The standard method of AOAC could be sued to analyze the amount of crude protein, lipids, carbohydrates, and fiber. Method from Zhang and others could be used for GABA analysis (Zhang & Brown 1997). For γ-Oryzanol analysis HPLC with UV detector method could be used according to Kim’s study (Kim et al. 2012).
Reference


