



Report on

Which type of rice

(White rice, brown rice,
and germinated brown rice)

**is the best for human
consumption?**

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Professor May
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Ya Ya Wong

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Abstract

This paper will be investigating the best type of rice for human consumption. The three types of rice that will be investigated are white rice, brown rice, and germinated brown rice. The criteria that the research will be focused on are nutritional values of different type of rice and sensory properties of different type of rice. Each criterion was discussed and researched. Information was derived from nutrition profiles and sensory profiles of different type of rice and they were compared. Dietary guidelines from the government were also examined. The overall conclusion that can be made with the information available is that germinated brown rice is the best type of rice for human consumption.

1 Introduction

Rice is one of the most important staple foods in the world. Brown rice is considered a healthier alternative to white rice due to the fiber and nutrients contained in the bran and the germ layer which are removed to produce white rice. In addition, germinated brown rice, an ancient way of preparing rice for cooking in Japan and Korea, has increased in popularity in the United States and is often marketed as a health food. On the other hand, there has been a growing concern among the health conscious individuals regarding arsenic found in rice, particularly brown rice. Arsenic is an element that is known to be carcinogenic. Considering the available information and the variation in public opinion, the investigation will focus on answering the question: Which type of rice (white rice, brown rice, and germinated brown rice) is the best for human consumption?

Sensory Properties¹.

Properties of food including taste, texture, smell, and appearance.

This report will evaluate white rice, brown rice, and germinated brown rice on the following criteria: 1) nutritional values and 2) **sensory properties**¹.

These sensory properties are often measured using two methods: 1) human senses in a controlled environment and 2) instrumental methods to get qualitative measurements, for example, measuring salt content using a salt analyzer.

Researchers in the nutritional and food science field also often perform different food analysis testing to create complete or partial nutrient profiles for further research purposes. **Sensory and nutritional profiles**² of white, brown, and germinated brown rice are compared to see which type of rice is best for human consumption. This report would be valuable to individuals that consume rice in a regular basis.

Sensory and Nutritional Profile².

A sensory profile of a given food product is a peer-reviewed research article that includes one or more of its sensory properties.

A nutritional profile of a given food product is a peer-reviewed research article that includes all or most of its nutrients content.

2 Background Information

2.1 Why do we care about Rice?

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). Therefore both nutritional values and sensory properties of rice directly affect many people.

Figure 1 White, Brown, and Germinated Brown Rice



Source: [Annelicious Food Gallery](http://annieliciousfood.wordpress.com/2012/03/25/review-my-zojirushi-np-hbq10-rice-cooker-part-2-gaba-rice/),
<http://annieliciousfood.wordpress.com/2012/03/25/review-my-zojirushi-np-hbq10-rice-cooker-part-2-gaba-rice/>

2.2 Importance of Rice Selection

Selecting types of rice is important due to its impact on health for consumers. The main three types of rice are **white rice**³, **brown rice**⁴, and **germinated brown rice**⁵.

People generally recognize that brown rice is healthier than white rice. In regions where rice is one of the major staple foods, 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

White Rice³.

Milled Rice that has had its husk, bran, and germ removed (see Figure 2).

Brown Rice⁴.

Unpolished rice with only the husk and bran removed.

Germinated Brown Rice⁵

Brown rice that has been allowed to germinate in order to alter the flavor and texture

brown rice has slowly gained popularity among health conscious consumers (Palasangui et al. 2006).

Despite its elevated content of nutritional values, brown rice consumption remains light for its dark appearance and hard texture. Germination

of brown rice can be used however to improve its 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.

On the other hand, there has been a growing concern among the health conscious individuals regarding **arsenic**⁵ found in brown rice. Arsenic is an element that is known to be carcinogenic. This is mainly due to high arsenic distribution in the rice hull, bran, and germ as shown in Figure 2(Choi et al. 2014). These parts are all removed during white rice processing but only hull and bran are removed when producing brown rice.

Each type of rice has its pros and cons. The following section I will discuss experience and results on the nutritional values, including toxins content, and sensory properties on each type of rice.

Figure 1 Anatomy of Rice



Source: The Celsia Article Data Base, <http://www.celsias.com/article/rice-bran-and-arsenic-unhealthy-health-food/>

Arsenic⁵.

A chemical element with symbol As. It is often used in pesticides and are known to be carcinogenic.

3 Experience and Results

3.1 Nutritional Values on Different Types of Rice

3.1.1 Comparing Nutritional Values of White Rice and Brown Rice

Comparison of nutrient profiles between white rice and brown rice has been done by a lot of researchers. It is well-established that brown rice has higher fiber content (both **soluble**⁶ and **insoluble**⁷) and vitamin B content than in white rice in general.

High fiber content brown rice has been proven to link to multiple health benefits. For example, high fiber content in brown rice sufficiently lowers the **glycemic index**⁸ compare to that of white rice. This contributes to increasing satiety and help prevent over intake of calories (McCrorry et al. 2010). Also, several **epidemiologic studies**⁹ have linked eating food with high glycemic index food such as white rice to an increased risk of type 2 diabetes (Villegas et al. 2007). Insoluble fiber in brown rice has also been found to be linked with lowering blood glucose levels (Seki et al. 2005).

Besides higher fiber content, certain trace elements and B vitamins are also present only in brown rice. These B vitamins were found to protect against diabetes and other metabolic disorders (Metz et al. 2003). In addition, the rice bran oil that is only found in brown rice may lower cholesterol (Rukmini and Raghuram 1991).

Brown rice contains a lot more other nutrients than white rice apart from fiber and vitamins. Most of these health beneficial nutrients are concentrated in the germ and bran which are removed during polishing as shown in Figure 1 (Itani et al. 2002). It seems fairly clear that brown rice is better a choice than white rice in terms of nutritional value.

Soluble Fiber⁶.

Soluble fibers are fibers that are soluble in water. It helps delay emptying of stomachs and helps lower LDL or "bad" blood cholesterol.

Insoluble Fiber⁷.

They pass through the gastrointestinal tract without dissolving in water and help speed up the passage of food and waste through our guts.

Glycemic Index⁸.

a system that ranks foods on a scale from 1 to 100 based on their effect on blood-sugar levels

Epidemiologic Studies⁹.

Studies that aim at finding out patterns, causes, and effects of health and disease conditions in defined populations.

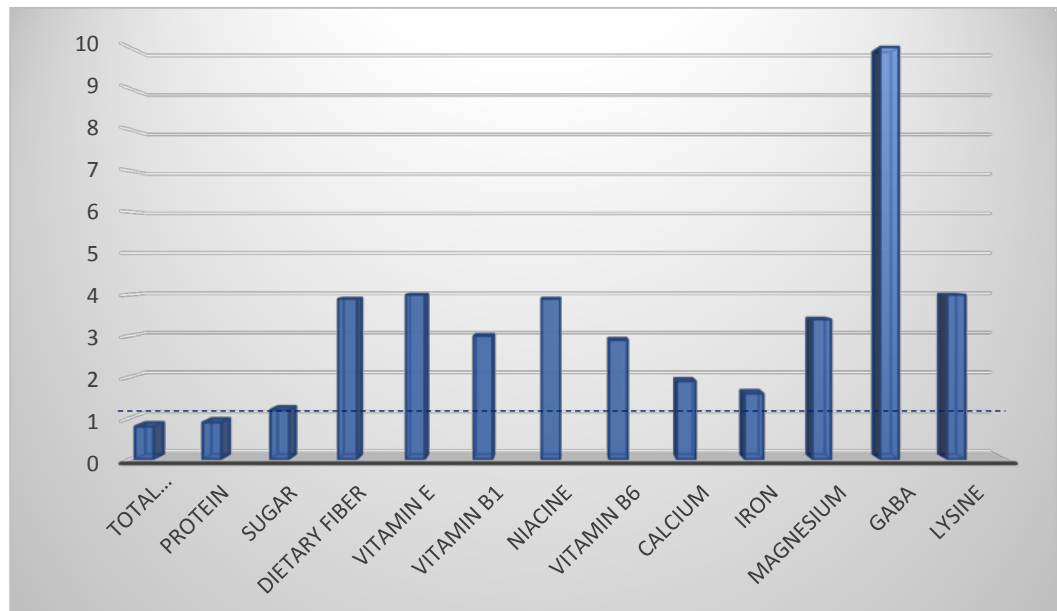
Enzymatic Activity¹⁰.

Enzymes are proteins that acts as a catalyst that speed up biochemical reaction. Enzymatic activity is a measure of how fast and effective a given enzyme works under specific conditions.

3.1.2 Comparing the Nutritional Values of Brown Rice and Germinated Brown Rice

In these recent years, germinated brown rice has been marketed as natural and healthy food product in the States. Indeed, numerous studies have shown that the nutritional profile is altered following germination of cereal grains such as wheat and rice. It is found that **enzymatic activity¹⁰** increase in brown rice through the process of germination (Rozan et al. 1999). This leads to breaking downs of complex organic compounds into simpler and more bioavailable compounds that human being can digest better. During these enzymatic activities in germination, a lot of beneficial nutrients are made available to consumers.

Graph 1 below shows the ratios of nutrient content of germinated brown rice compared with those of white rice. The dotted line represent nutrient content of white rice (y axis = 1) where the blue bars represent each nutrient content ratio



Graph 1 Comparison of Nutritional Content between Germinated Brown Rice And White Rice

Source: Shobana et a. 2010

of germinated brown rice compared with white rice. For example, there are almost twice the amounts of calcium in germinated brown rice compared to that in white rice. Shobana and others found that germinated brown rice has fewer calories and less protein but higher amount of dietary fiber, vitamin E, vitamin B1, Niacin, vitamin B6, calcium, iron, magnesium, GABA, and one of the limiting amino acid in the diet **lysine**¹¹. (Shobana et al. 2010). It is noted that the decrease in protein amount in germinated brown rice is due to increase in enzymatic activity. The breaking down of protein into individual amino acid including lysine happens more rapidly.

The associated health benefits of each of those nutrients are shown in Table 1 below. It is concluded that the enhanced amount of beneficial nutrients found in germinated brown rice makes it the best for human consumption in regards to nutritional value.

Nutrients	Associated Health benefits
Dietary Fiber	Relieving constipation, Preventing colon cancer, and Regulation blood sugar levels
Vitamin E	Antioxidant ¹² , Reducing cholesterol and risk of developing cancer
Vitamin B1	Essential for the breakdown of fat and protein in the body
Niacin	Prevent heart disease in people with high cholesterol
Vitamin B6	Essential in brain development and mood affecting hormones producing
Calcium	Help prevent calcium deficiencies and maintain healthy bones
Iron	Vital in hemoglobin formation, muscle function and brain function.
Magnesium	Preventing heart diseases
GABA	Preventing headaches or depressions aftereffects, Preventing climacteric disorder ¹³ , Activating renal function

Table 1 Associated Health Benefits of Selected Nutrients Contained in Germinated Brown Rice

Source: Shobana et a. 2010

Lysine¹¹.

It is one of the essential amino acid that cannot be made by the body. Amino acid is the basic building block of protein and vital in body functioning. Since it is the most easily lost amino acid of all during food processing in food, it is often the limiting (the most lacking) essential amino acid in the diet.

Antioxidant¹².

Substance that inhibits oxidation (reaction with oxygen)

Climacteric Disorder¹³.

Clinical symptom that women may have during menopausal transition

3.2 Sensory Properties of Different Type of Rice

3.2.1 Sensory Properties of White Rice and Brown Rice

Fair amounts of research have been done on comparing sensory profiles of brown and white rice. Two that are worth noting were focus group studies done in China and India. In Zhang's study, both white and brown rice were in terms of texture, flavor, aroma, and appearance. Brown rice were frequently described as 'poor taste', rough texture', and 'inferior' when compared to white rice (Zhang et al. 2010). In Shobana's research, people rated brown rice and white rice in the criteria shown in table 2 above. It shows that people prefer the 'fluffiness',

<i>Term</i>	<i>Definition</i>
Whiteness	The degree to which the sample is visually pure white
Grain	The degree to which the grains retain the shape and form and the absence of cracked grain indicates high intactness
Fluffiness	Textural property manifested by an expanded and often distorted cellular structure. During cooking of rice, there is expansion in volume, This volume is explained in sensory terms as fluffiness.
Firmness	The force required to compress the cooked grains with molars
Stickiness	The degree to which the sample adheres to the palate
Chewiness	Textural property manifested by the readiness to break down to very small particles. Chewiness is relevant with brown (0% polished) raw and parboiled rice due to the presence of branny layer, needing more chews to masticate the cooked rice before swallowing
Aroma of cooked rice	A general term used to describe the aroma of cooked rice
Starch like	Aroma associated with cooked rice starch
Sweet	Basic taste associated with sucrose solution

Table 2 Lexicon of sensory quality of cooked rice

Source: Shobana et al. 2010

'chewiness', 'stickiness', and 'sweet' that comes with white rice instead of brown rice. He also found that the 'firmness' and high level of 'chewiness' in brown rice were generally not preferred (Shobana et al. 2010). In general people prefer white rice more than brown rice in terms of sensory properties.

3.2.2 Sensory Properties of Germinated Brown Rice

Despite the hard texture and dark appearance of brown rice, germination can be used to improve the texture quality of brown rice. This is because the enzymatic **hydrolysis**¹⁴ of the polymeric materials softens the rice bran and often improves its flavor (Hunt et al.2002). The breaking of starch in rice grains during germination can also led to the increase in small **dextrin**¹⁵ and fermentable sugar (Wijngaard 2006). This change produced a special sweet flavor in germinated brown rice. In addition, Ohtsubo in his research also pointed out that compared with other types of rice, germinated brown rice contain higher amounts of amino acids that carry pleasant tastes such as glutamic acid, alanine, glycine, and alanine during cookings. The first two amino acids that are often related to umami taste while the latter two contribute to a sweet taste. This result indicates that the flavor of brown rice is also improved after germination (Ohtsubo et al. 2005). In summary, the texture of white rice is most preferred while germinated brown rice is the most flavorful.

3.2.3 Arsenic compounds found in brown rice and germinated brown rice

Some individuals hesitate to consume more brown rice or germinated brown rice because of their arsenic content. A number of research articles have shown that rice contains arsenic compounds (Choi et al. 2014, dos Santos et al. 2012, Stone 2008, Jaskson 2012). From 2012 to 2013, the **United States Food and Drugs Administration (FDA)**¹⁶ released the results of approximately 1,300 samples comprise the largest data set available on arsenic in rice and rice

Hydrolysis ¹⁴.

A type of reaction where compound is broken into smaller pieces with water being one of the by-products

Dextrin ¹⁵.

Two or more glucose (a type of sugar found in first) combines to form dextrin. When a thousand or more of them combines they form starch.

FDA ¹⁶.

A federal agency that is responsible for developing and executing regulations on food and drugs

products. They have found the average levels of inorganic arsenic for the various rice and rice products to be from 0.1 to 7.2 micrograms of inorganic arsenic per serving. It has also been discovered that brown rice contains generally 2 to 3 times higher amounts of arsenic concentration than white rice contains. It is because most of the arsenic compounds are found in the bran and hulks which are removed when producing white rice (See Figure 2).

Despite multiple research showing certain amount of arsenic compounds in rice and rice product (Choi et al. 2014, dos Santos et al. 2012, Stone 2008, Jackson 2012), there are no studies yet to show the long-term health effect, if any, these levels of arsenic in rice may have on consumers. Further investigation and long term studies are needed for us to understand risks associated with the consumption of rice and rice products. Together with the **U.S. Department of Agriculture (USDA)**¹⁷ and **Environmental Protection Agency (EPA)**¹⁸, FDA is conducting a risk assessment to help manage any possible risk associated with the consumption of rice and rice products. The draft risk assessment will be made available for public comment within these two years.

It would be valuable for concerned individuals to follow the development of this risk assessment regarding rice arsenic content and future dietary guidelines and make decision according to it. Until further facts to be discovered, it is not worth stop consuming brown rice or germinated brown rice due to the wonderful benefits consumers can get from replacing white rice with them, especially germinated brown rice.

USDA¹⁷.

A federal agency that is responsible for developing and executing regulations on farming, agriculture, and forestry

EPA¹⁸.

A federal agency that is responsible for developing and executing regulations on human health and the environment

4 Conclusion

Despite the arsenic content in germinated brown rice, it is suggested to be the best type of rice for human consumption due to its nutritional values and sensory properties. Further studies are needed to more fully understand the long term effect on human health for consuming arsenic in small level. However, with the knowledge and findings available in the field germinated brown rice is best for human consumption.

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