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Nutritional Content of Brown Rice and White Rice from Organic Rice of Mentik Susu Varieties with Parboiled Method

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ABSTRACT: Parboiled rice is rice produced from milled dry grain (MDG) that has received cleaning, soaking, steaming, drying, and milling treatments. It is very rare that the parboiling process is done on brown rice or white rice. In this study, the parboiling process was carried out on MDG, brown rice, and white rice from the organic rice of Mentik Susu variety. The study consisted of six treatments, unparboiled brown rice, parboiled brown rice, brown rice from parboiled MDG, white rice, parboiled white rice, and white rice from parboiled MDG. The results showed that the parboiling process had an effect on content of carbohydrates, protein, fat, crude fiber, ash, starch, and amylose but had no effect on the water content. The parboiling process affects brown rice more than white rice. The parboiling process increases carbohydrate and starch content but decreases protein, crude fiber, and ash content of brown rice. The parboiling process increases carbohydrates but reduces crude fiber in brown rice from MDG. The parboiling process reduces protein and ash content of white rice.

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KEYWORDS: milled dry grain, brown rice, white rice, praboiled, Mentik Susu, organic

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1. INTRODUCTION

Cereals are grains from the grass family (gramines). One that is quite well known is rice (*Oryza sativa*). Paddy with several stages of the process will produce rice. After paddy is harvested, it will get rice grains, or dry harvested grain (DHG), which are separated from straw with a moisture content ranging from 18 to 25% (Nurwidah et al., 2021). DHG is dried to a moisture content of 14%, and milled dry grain (MDG) is obtained (Lestari and Kurniawan, 2021)**.** The MDG is ground or pounded to separate the unhusked rice husk (chaff) to obtain brown rice. The process of refining (grinding or mashing) brown rice will produce white rice or polished rice. In addition, there is also parboiled rice, i.e. rice produced from MDG, which gets cleaning, soaking, steaming, drying, and milling treatment (Fadhallah et al., 2016; Hasbullah and Riskia, 2013).

Rice is the staple food of the Indonesian population. As much as 90% of Indonesia's population consumes rice and it is 4th largest country after China (29.97%), India (20.48%), and Bangladesh (7.21%) in domestic consumption of rice in the world, with an average of 35.59 million metric tons (7.11%) in the 2018–2022 period. The average consumption of rice by Indonesian households during the 2010–2021 period was 1.87 kg per capita per week, equivalent to 97.66 kg per capita per year (Kementan RI, 2022)**.**

In general, rice contains carbohydrates, protein, fat, vitamins (thiamin, riboflavin, and niacin), and minerals (calcium, phosphorus, iron, sodium, potassium, copper, and zinc) in different levels depending on the type of rice (Kemenkes RI, 2017)**.** The biggest constituent of rice carbohydrates is starch (85–90%) and a small portion of pentosan (2.0–2.5%), sugar (0.6–1.4%), and fiber (cellulose and hemicellulose). Mentik Susu is one of the local rice varieties with white rice characteristics and looks like milk. It is often called "the Japanese rice" because it tastes fluffier (soft and delicious) and is sticky, but not like sticky rice.

Rice can be obtained from organic rice cultivation through agricultural intensification that is free from the use of chemicals. Organic rice cultivation supports sustainable agriculture (Putra, 2021), which is very important for Indonesian agriculture. Organic rice is the second organic product most frequently purchased by consumers (David and Ardiansyah, 2017). The demand for organic rice is increasing, and this is proportional to the conversion of organic land from 144ha in 2007 to 53,974ha in 2018 (AOI, 2019). According to Nirmagustina and Handayani, 2019), organic rice has better added value than rice obtained from conventional cultivation.

Brown rice and white rice are two types of rice that have different physical and chemical characteristics. In addition, the characteristics of parboiled rice are also different from those of the others. The parboiling process is generally done on MDG, not brown or white rice. Therefore, in this study, the parboiling process of brown rice and white rice will be carried out. The parboiling process of Mentik Susu varieties with organic cultivation has also never been rigidized. The aim of the study was to determine the nutritional content (carbohydrates, protein, fat, starch, amylose, water, and ash) of Mentik Susu organic rice by treatment, i.e. origin (rice and MDG), type of rice (brown rice and white rice), and method (not parboiled and parboiled).

2. MATERIAL AND METHODS

Material and Equipment

The material used is dry milled grain (MDG) of the Mentik Susu varieties with organic cultivation obtained from Candipuro Village, Sidomulyo Subdistric, South Lampung Regency, Lampung Province, Indonesia. The chemicals used for chemical analysis were aquadest, H2SO4 (Merck), Cu2SO4 (Merck), Na2SO4 (Merck), NaOH (Merck), HCl (Merck), n-hexane (Merck), ethanol (Merck), I2 (Merck), pp indicator (Merck), and starch indicator (Merck).

The equipments used are a drying oven (Jouan EV 280), an autoclave (Autoclave GEA LCD LS50HD), a rice grinder (rice huller mini type AGR-RM40). The equipments used for chemical analysis were an analytical balance (Ohaus Model PA224), a K-Lab Optizen Alpha UV-VIS Spectrophotometer, and glassware.

Research Method

The research was conducted experimentally. The research design used was a complete randomized block design with three replications. The treatments applied were brown rice, parboiled brown rice, brown rice from parboiled MDG, and white rice, parboiled white rice, and white rice from parboiled MDG.

Procedure

1. Brown rice and white rice

The process of making brown rice and white rice is: 1) Milling MDG to get brown rice; 2) polishing brown rice to get white rice

2. Parboiled brown rice and parboiled white rice

The process of making parboiled-brown rice and parboiled-white rice is 1) soaking brown rice and white rice at 80^{o}C for 10 minutes, 2) cooling at 4^{o}C for 1 hour, and 3) drying.

3. Brown rice and white rice from parboiled MDG

The processes for making brown rice and white rice from parboiled MDG are: 1) soaking the MDG in the oven at 60^{o}C for 4 hours; 2) steaming the MDG with an autoclave at 105^{o}C for 20 minutes; 3) drying the parboiled MDG; 5) milling the parboiled MDG to produce brown rice from parboiled and polished MDG to get white rice from parboiled MDG.

Testing

Tests were carried out on nutritional content based on AOAC (2005), including water content (oven-thermogravimetry), ash (furnace-thermogravimetry), fat (Soxhlet extraction), protein (micro kjeldahl), crude fiber (acid-base hydrolysis-gravimetry), carbohydrates (by different methods), starch (anthrone reagent method), and amylose (iodine-binding).

Data Analysis

The test results were processed by analysis of variance (ANOVA) to determine the effect of treatment on the parameters tested. If there is a significant effect, the DMRT (Duncan Multiple Range Test) is used to find out the difference between the treatments.

3. RESULT AND DISCUSSION

Physical Characteristic of Rice

The physical characteristics (color) of organic rice of the Mentik Susu variety with various treatments, namely origin (rice and GKG), type of rice (brown rice and white rice), and method (not parboiled and not parboiled), can be seen in Figure 1.

Gambar 1. Brown rice and white rice (unpraboiled, parboiled, Parboiled-MDG

Brown rice (unparboiled, parboiled, or parboiled MDG) has a darker color than white rice (unparboiled, parboiled, or parboiled MDG). This is because brown rice in general still contains, which coats the endosperm. Brown rice is brownish-white (dull). Meanwhile, white rice is brown rice that has been treated with polishing to remove the aleurone so that it is white in color.

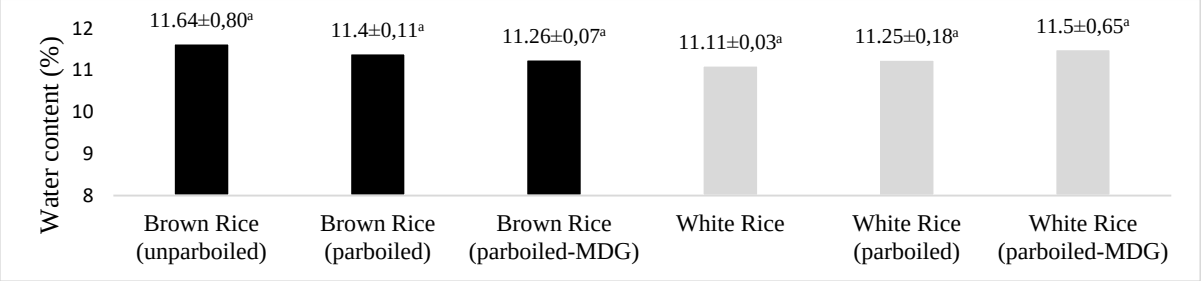
Brown rice and white rice (unparboiled and parboiled) have the same color. The parboiling process does not change the color of either brown rice or white rice. However, according to Pal et al. (2018) the parboiling process reduces the whiteness of the rice. Brown rice and white rice (parboiled MDG) have a darker color. Several factors can cause this, including the parboiling process in MDG, which causes the infiltration of the grain skin color into the rice. More aleuron layers containing protein and the amino acid lysine are attached to the endosperm. A non-enzymatic browning reaction occurs, namely the reaction between reducing sugars and amine groups due to high temperatures, which forms brown melanoidin pigments (Croquennec, 2016)**.**

Nutritional Content of Rice

Origin (rice and MDG), type of rice (brown rice and white rice), and method (unparboiled and parboiled) had an effect on carbohydrates, protein, fat, crude fiber, ash, and starch but had no effect on water content or starch content on the organic rice of the Mentik Susu variety at a significant level of 5%. The nutritional content of rice is influenced by variety, environment, and processing methods (Abdul-Hamid et al., 2007). Hasnelly et al. (2020) convey that polishing affects the quality of rice, namely its nutritional content. According to Nurdjannah et al. (2019), the parboiling process causes a change in the composition of the rice.

Water Content

Water content of rice ranges from 11.11 to 11.64% (Figure 2). Brown rice (unparboiled, parboiled, or parboiled MDG) and white rice (unparboiled, parboiled, or parboiled MDG) undergo the same drying process. Munarko et al. (2020) reported that the moisture content of brown rice varieties (Inpari 42, Inpari 43, Situ Bagendit, IPB3 S, Inpari 17, and Inpar) ranges from 11% to 12%. Based on SNI 6128:2015 (BSN, 2015), the maximum moisture content of rice is 14%. The moisture content of food ingredients greatly affects their shelf life. Moisture content that exceeds 14% can be a medium for the growth of microorganisms that can damage stored food. According to Kasaai (2014), water makes an important contribution to the quality, taste, and shelf life of food.

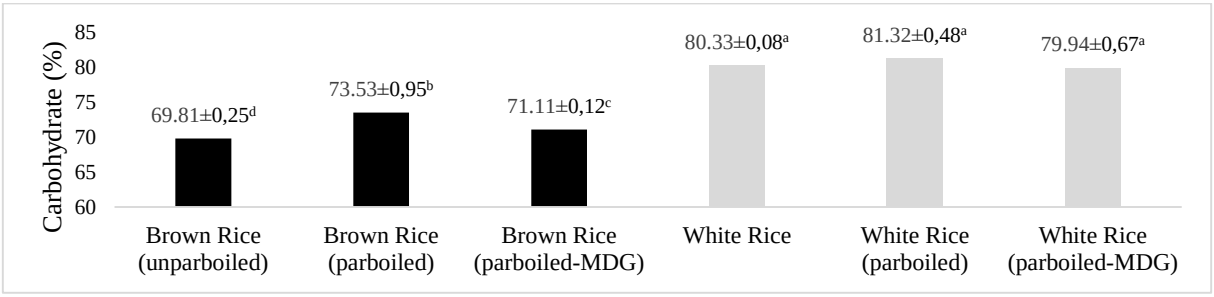


Mean±SE (n=3). Value with different superscripts are significatnly different (p<0.05) by Duncan Test

Gambar 2. Water content of brown rice and white rice (unparboiled, parboiled, parboiled MDG)

Carbohydrate content

Rice is a source of carbohydrates, especially starch in the form of amylose and amylopectin. The type of rice (brown rice or white rice) has an effect on rice carbohydrates. White rice (not parboiled, parboiled, or parboiled MDG) has higher carbohydrates, namely 79.94%–81.32%, than white rice (unparboiled, parboiled, or parboiled MDG), namely 69.81%–73.53% (Figure 3). Brown rice is rice that still has aleurone, while white rice is rice that does not have aleurone. The nutritional content contained in aleurone, such as protein, fat, vitamins, minerals, and fiber, it is lost during the refining process (USDA, 2020). This causes an increase in carbohydrates in white rice. Brown rice has the lowest protein content and total dietary fiber among cereals and the highest starch and carbohydrate content.



Mean±SE (n=3). Value with different superscripts are significatnly different (p<0.05) by Duncan Test

Gambar 3. Carbohydrate of brown rice and white rice (unparboiled, parboiled, parboiled MDG)

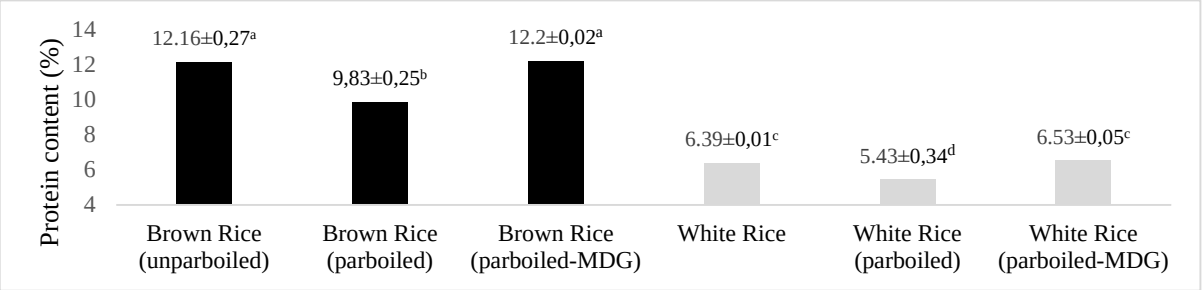
The parboiling process has an effect of increasing the carbohydrates level in brown rice but has no effect on white rice. Brown rice (parboiled and parboiled MDG) had higher carbohydrates, namely 73.53 and 71.11%, compared to unparboiled brown rice, namely 69.81%. The process of parboiling brown rice is thought to dissolve other nutritional components so that the carbohydrates become higher than brown rice (unparboiled). The parboiling process of brown rice (parboiled MDG) will attach other nutritional components so that it is higher than brown rice (unparboiled) but lower than brown rice (parboiled).

According to Susilo et al. (2013), the carbohydrates of brown rice, white rice, and parboiled white rice from Ciherang variety rice were 84.03%, 88.78%, and 88.76%, respectively. Nurdjannah et al. (2019) reveal that the carbohydrates of white rice (parboiled MDG) of the Inpari 24 variety are 79.20%. Based on Febriandi et al. (2017), the carbohydrates of brown rice and white rice of the Mayang Pandan variety are 84.87% and 89.42%, respectively. According to Munarko et al. (2020), the protein of brown rice varieties (Inpari 42, Inpari 43, Situ Bagendit, IPB3 S, Inpari 17, and Inpar) ranges from 84% to 89%. Based on this, organic rice of the Mentik Susu variety generally has fewer carbohydrates than other types of rice.

Protein content

Protein is the second-largest nutritional component in rice after carbohydrates, but according to Juliano (2016), rice has the lowest protein content among other cereals. Rice protein consists of four fractions, namely albumin, globulin, glutelin, and prolamin (Shih, 2003). The type of rice (brown rice or white rice) has an effect on rice protein. Brown rice (unparboiled, parboiled, or parboiled MDG) has a higher protein content than white rice (unparboiled, parboiled, or parboiled MDG) (Figure 4). The protein content of brown rice (unparboiled, parboiled, or parboiled MDG) ranged from 9.83 to 12.2%, while that of white rice (unparboiled, parboiled, or parboiled MDG) ranged from 5.43 to 6.53%.

Brown rice contains more protein than white rice. Brown rice consists of bran (6-7%), endosperm (80%), and embryo (2–3%) (Chen, 1998). The polishing process to produce white rice removes 15% of the protein, especially the protein in the bran. Kawakatsu (2019) states that the average rice protein is 7%. According to the USDA (2020), brown rice protein ranges from 7.1 to 8.3%, and white rice ranges from 6.3 to 7.1%.



Mean±SE (n=3). Value with different superscripts are significatnly different (p<0.05) by Duncan Test

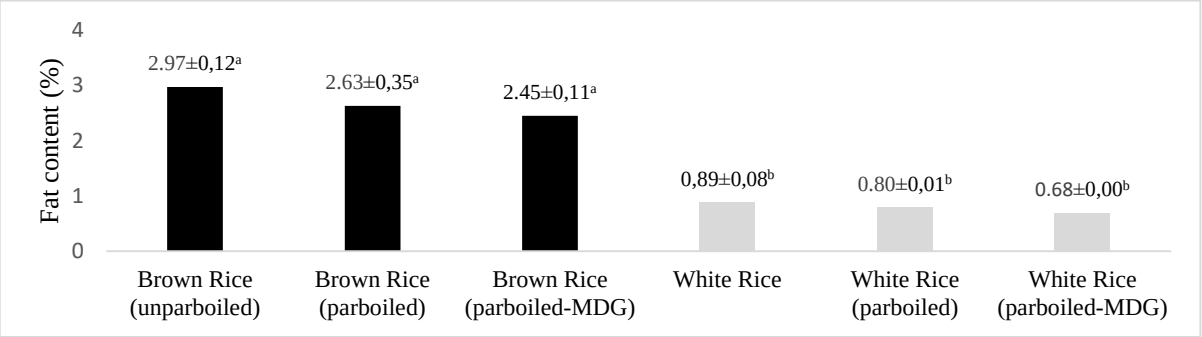
Gambar 4. Protein of brown rice and white rice (unparboiled, parboiled, or parboiled MDG)

Brown rice and white rice (parboiled) have a lower protein content than brown rice and white rice (unparboiled). Meanwhile, brown rice and white rice (parboiled MDG) have almost the same protein content as brown rice and white rice (unparboiled). This shows that parboiling reduces the protein content of brown rice and white rice.

The proteins of brown rice, white rice, and parboiled white rice from Ciherang variety rice were 10.43%, 9.76%, and 8.96%, respectively (Susilo et al., 2013). The protein content of white rice (parboiled-MDG) of the Inpari 24 variety is 9.91% (Nurdjannah et al., 2018). The protein content of brown rice and white rice of the Mayang Pandan variety is 9.84% and 8.97%, respectively (Febriandi et al., 2018). The protein content of brown rice varieties (Inpari 42, Inpari 43, Situ Bagendit, IPB3 S, Inpari 17, and Inpar) ranges from 7% to 11% (Munarko et al., 2020)**.** Based on this, brown rice (unparboiled or parboiled MDG) from organic rice of the Mentik Susu variety has a higher protein content than other types of rice.

Fat content

Fat is the fourth most abundant nutritional component after carbohydrates, protein, and fiber (Juliano, 2019). The type of rice (brown rice or white rice) has an effect on rice fat. Brown rice (unparboiled, parboiled, or parboiled MDG) has higher fat, namely 2.97%–2.45%, than white rice (unparboiled, parboiled, or parboiled MDG), namely 0.68%–0.8% (Figure 5). Brown rice contains fat, especially in the aleurone. Rice contains essential fatty acids, especially oleic and linolenic fatty acids (Juliano, 2016).



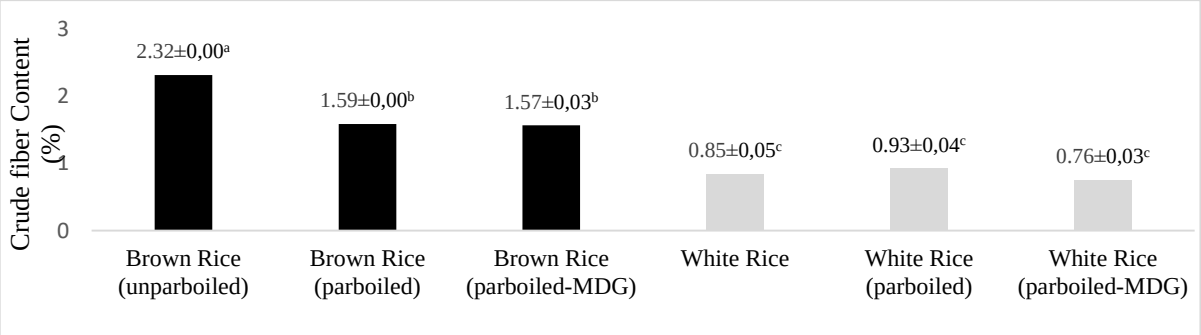
Mean±SE (n=3). Value with different superscripts are significatnly different (p<0.05) by Duncan Test

Gambar 5. Fat of brown rice and white rice (unparboiled, parboiled, or parboiled MDG)

The parboiling process has no effect on the fat content. According to Susilo et al. (2013), the fat content of brown rice, white rice, and parboiled white rice from Ciherang variety rice is 4.42%, 0.89%, and 1.59%, respectively. Nurdjannah et al. (2019) convey that the fat content of white rice (parboiled MDG) of the Inpari 24 variety is 1.14%. Based on Febriandi et al. (2017), the fat content of brown rice and white rice of the Mayang Pandan variety is 3.69% and 1.99%, respectively. According to Munarko et al. (2020), the fat of brown rice varieties (Inpari 42, Inpari 43, Situ Bagendit, IPB3 S, Inpari 17, and Inpar) ranges from 2% to 3%, with the main fatty acids in the form of unsaturated fatty acids ranging from 77.30 to 77.72 mg/100 g. Based on this, brown rice and white rice from organic rice of the Mentik Susu variety have almost the same fat content as other types of rice.

Crude Fiber content

The type of rice (brown rice or white rice) affects the crude fiber of rice. Brown rice (unparboiled, parboiled, or parboiled from MDG) has higher crude fiber, which is 1.57%–2.32% higher than white rice (unparboiled, parboiled, or parboiled MDG), i.e. 0.76%–0.93% (Figure 6). Crude fiber in rice is mainly found in the aleurone layer, which is still abundant in brown rice (Upadhyay and Karn, 2018). The high crude fiber is an advantage for brown rice compared to white rice (Saleh et al., 2019; Ravichanthiran et al., 2018; Tetelepta and Picauly, 2017). High crude fiber in brown rice can be an indication that the rice has a low glycemic index (Febriandi et al., 2018; Rosli et al.,2016).



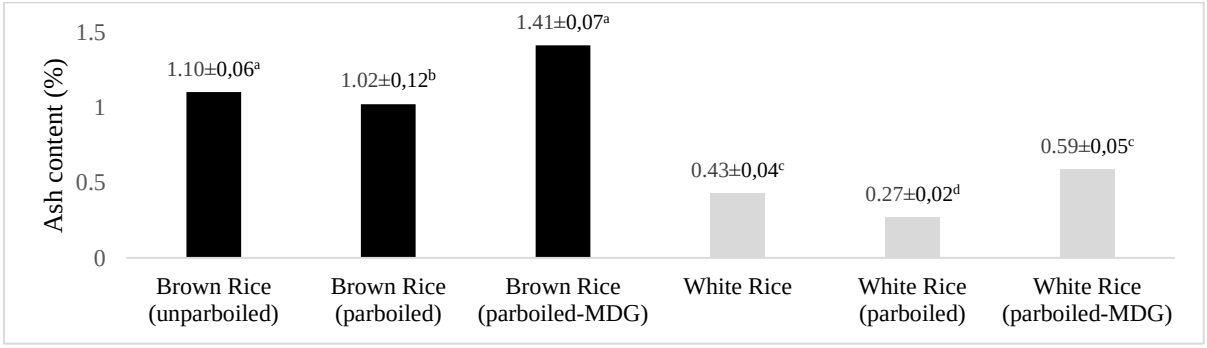
Mean±SE (n=3). Value with different superscripts are significatnly different (p<0.05) by Duncan Test

Gambar 6. Crude fiber content of brown rice and white rice (unparboiled, parboiled, or parboiled MDG)

The parboiling process has an effect on the crude fiber content of brown rice but has no effect on white rice. It reduces the crude fiber of brown rice and MPD brown rice. Brown rice (not parboiled) has a higher crude fiber content, which is 2.32%, than brown rice (parboiled and GKG parboiled), namely 1.59% and 1.57%. Based on this, it is suspected that the coarse fiber of brown rice, which is mostly found in the aleurone when it gets heat treatment, will experience decomposition.

Ash content

The type of rice (brown rice or white rice) affects the ash content of rice. Brown rice (unparboiled, parboiled, or parboiled MDG) has a higher ash content ranging from 1.02% to 1.41% than white rice (unparboiled, parboiled, or parboiled MDG), which ranges from 0.27% to 0.59%.



Mean±SE (n=3). Value with different superscripts are significatnly different (p<0.05) by Duncan Test

Gambar 7. Ash content of brown rice and white rice (unparboiled, parboiled, parboiled MDG)

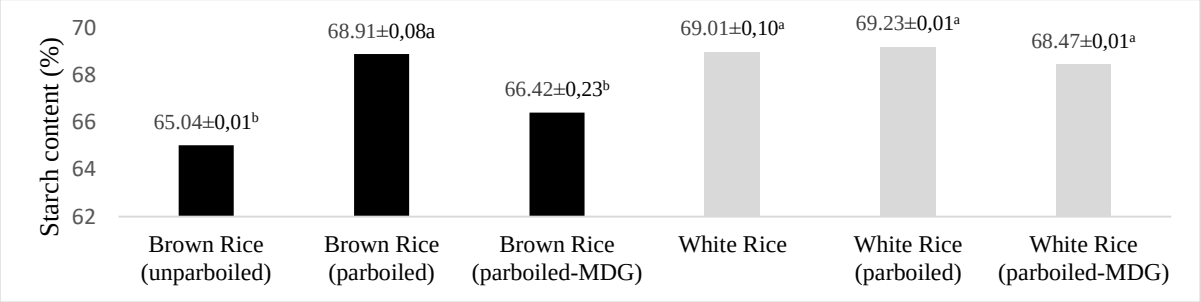
The parboiling process affects the ash content of the rice (brown rice, white rice, brown rice from MDG, white rice, and white rice from MDG). The parboiling process of brown and white rice reduces the ash content. The ash content of brown rice and white rice (parboiled MDG) has a higher ash content than brown rice and white rice (parboiled)

According to Susilo et al. (2013), the ash content of brown rice, white rice, and white rice (parboiled) from Ciherang variety rice was 1.12%, 0.57%, and 0.69%, respectively. Nurdjannah et al. (2019) states that the ash content of white rice (parboiled MDG) of the Inpari 24 variety is 0.89%. Based on Febriandi et al. (2017) the ash content of brown rice and white rice of the Mayang Pandan variety was 1.61% and 0.90%, respectively. According to Munarko et al. (2020), the ash content of brown rice varieties (Inpari 42,

Inpari 43, Situ Bagendit, IPB3 S, Inpari 17, and Inpar) ranges from 1.29% to 1.44%. Based on this, brown rice from the organic rice variety Mentik Susu has almost the same ash content, but white rice has a lower ash content than other types of rice.

Starch content

Starch is the most abundant component in rice—about 90% of white rice. Starch is mainly composed of amylose and amylopketin, and the amylose content is a determinant of the quality of rice. Amylose and amylopectin contribute to the physicochemical and functional properties of rice starch (Kawakatsu et al., 2019). The type of rice (brown rice and white rice) affects the starch content of rice. Brown rice (unparboiled, parboiled MDG) has a lower starch content than white rice (unparboiled, parboiled MDG) (Figure 4). The starch content of brown rice (unparboiled, parboiled, or parboiled MDG) ranged from 65.04 to 68.91%, while that of white rice (unparboiled, parboiled, or parboiled MDG) ranged from 68.47% to 69.23%.



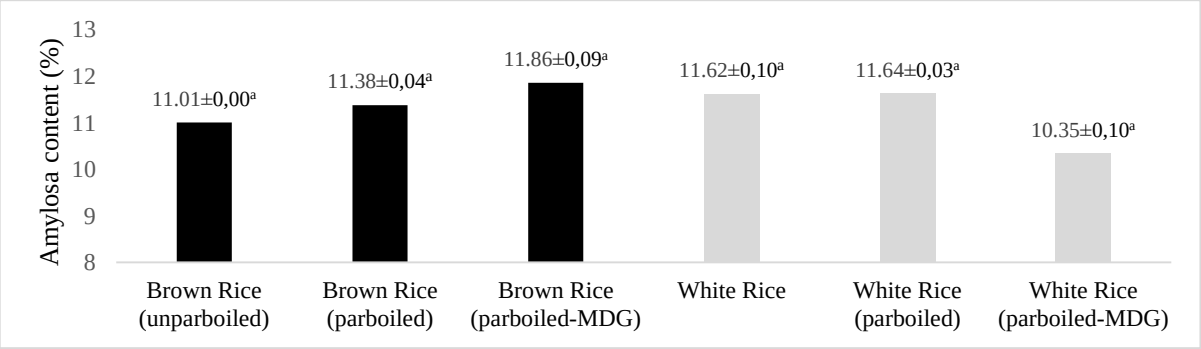
Mean±SE (n=3). Value with different superscripts are significatnly different (p<0.05) by Duncan Test

Gambar 8. Starch content of brown rice and white rice (unparboiled, parboiled, or parboiled MDG)

The parboiling process affects the starch content of brown rice. The parboiling process increases the starch content of brown rice. The starch content of brown (parboiled) rice is higher than brown rice (parboiled, or parboiled MDG) and the same as white rice (unparboiled, parboiled, or parboiled MDG). Huang et al. (2021) demonstrated that parboiling and MW drying processes increased RS and TDF contents

Amylose content

The type of rice (brown rice or white rice) had no effect on the amylose content of rice. The amylose content of brown rice (unparboiled, parboiled, or parboiled MDG) ranged from 11.01% to 11.86%, and that of white rice (unparboiled, parboiled, or parboiled MDG) ranged from 10.35% to 11.64%.



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Gambar 9. Amylose content of brown rice and white rice (unparboiled, parboiled, or parboiled MDG)

According to Susilo et al. (2013), the amylose content of brown rice, white rice, and white rice (parboiled) from Ciherang variety rice was 38.00%, 30.29%, and 33.53%, respectively. Based on Febriandi et al. (2017), the amylose content of brown rice and white rice of the Mayang Pandan variety was 30.31% and 36.38%, respectively. Based on this, brown rice and white rice from Mentik Susu organic rice varieties have lower amylose levels than other types of rice. Badi (2013) states that rice with an amylose content of 10–20% is categorized as low amylose rice, while rice with an amylose content of 25%–35% is categorized as high amylose rice.

CONCLUSION

Brown rice and white rice (parboiled MDG) have a darker color. Brown rice and white rice (unparboiled and parboiled) have the same color. The parboiling process has more effect on brown rice than white rice. The parboiling process increases the carbohydrates in brown rice and brown rice (parboiled MDG). The parboiling process reduces the protein of brown rice and white rice, but the protein of brown rice and white rice (unparboiled) is the same as brown rice and white rice (parboiled MDG). The parboiling process has no effect on the fat content of both brown rice and white rice, but brown rice has a higher fat content than white rice. The parboiling process reduces the crude fiber of brown rice (from MDG), but white rice has the same crude fiber. The parboiling process reduces the ash of brown rice and white rice, but the ash of brown rice and white rice (unparboiled) is the same as that of brown rice and white rice (from MDG). The parboiling process increases the starch of brown rice, but the starch of brown rice (unparboiled) is the same as that of brown rice (parboiled MDG).

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