The Effect of Grain Germination to Improve Rice Quality

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Abstract. The stages of post-harvest processing have a very large influence on the yield and quality of rice produced. At the time of grinding grain, the high nutritional content in husks and bran are often wasted and used as animal feed. Through the process of germination of grain, the nutrient content in husks and bran can be used to increase the nutritional content of rice. The purpose of this study was to determine the effect of grain immersion and germination on the quality of rice produced. The method of this research was germinating grains by variation of soaking and incubation time. The duration of grain soaking, 12, 18, and 24 hours and incubation time period, 18, 24, and 30 hours. The parameters of this research, including ash content, protein, thiamin, and mineral content such as Fe and Mg. The data of this research was processed and tested by complete randomized design with one factorial. The result showed, ash and protein content of rice was a significantly different at 5% level on each treatment. For other parameters, thiamin was significantly different at 1% level on each treatment. The best treatment during the germinating grains process towards the quality of rice was soaking at 12 hours and incubation time 30 hours with length of grain sprout was 1 cm.

1. Introduction

Indonesia is an agricultural country where agriculture is a field that has very good prospects for people income. One of the high yields of agriculture in Indonesia is rice, and rice is a source of Indonesian people's daily calorie intake. The post-harvest processing stage has a very large influence on the yield and quality of rice produced. Grain consists of 20% rice husk, 8% bran, 70% endosperm and 2% germ [1]. Rice bran consist just 8-10% of total weight, however contribute most of some nutrients such as macronutrients (carbohydrate (25.91%-47.14%), protein (13.6-19.5%), fat (19.4-30.45%), ash (7.7-11.1%), dietary fibre (20-23.5g/100 g), soluble fibre (1.9-2.1 g/100g)); micronutrients such as vitamins i.e. niacin (30-37mg/100g), pyridoxine (3.4-4.2 mg/100g), thiamine (2.2-2.4 mg/100g) and riboflavin (0.25-0.30 mg/100g). Rich in minerals i.e. phosphorus (1710-1830 mg/100g), potassium (1170-1350 mg/100g), magnesium (823-952 mg/100g) [2]; contain phytochemicals (phenolic acids, flavonoids, anthocyanins and steroidal compounds) [3]. The amount of nutrient content is lost due to post-harvest handling, for example during grain grinding, nutrient content in the rice husk and bran is wasted and causes a decrease its nutrient. A method to maintain the nutrient content is needed. The grain germination process is one of methods to increase the nutrient content of the rice. Germination is a

sign of an early seed life, during germination, many nutritional compositions are prepared for growth [4], dormant enzymes activate and increase the nutrients, and antioxidant activity will also increase [5]. Rice germ contains most alfa-tocopherol and gamma-tocopherol [6]. The production of germinating rice has been done [7]. However, in this research the germination of the grain will be carried out so that it can be known the effect on the quality of rice produced.

2. Materials and Methods

2.1 Material
The fresh harvested grain (Ciherang variety) was purchased from farmer at Sidrap, South Sulawesi, Indonesia. Chemical reagents for analysis were purchased from chemical market in Makassar, South Sulawesi, Indonesia.

2.2 Methods
This research divided into two steps: to get the desired average grain length from 9 treatments, and will be used to second step for chemical analysis.

2.2.1 Sample Preparation. Fresh harvested grain was taken from field and brought to laboratory for dried until reached 14% of water content. Then grain soaked in the water with a ratio of water and grain is 1: 2 (w/v), as long as 12, 18 and 24 hours. Each sample was then germinated in sacks for 18, 24 and 32 hours at room temperature. Germinated grain then dried until reached 14% water content and milled.

*2.2.2 Determination of Protein***.** Protein was determined by using Kjeldahl method. Protein was expressed as the percentage of total protein [8].

2.2.3 Determination of Ash. Ash content was analyzed by using dry method. Ash content was expressed as the percentage of ash [8].

*2.2.4 Determination of Thiamine***.** Thiamine was analyzed by using HPLC method. The sample was weighed as much as 1 gram and stored in a 25 mL tube. Then add 5 mL of 0.1 M H_2SO_4 and stir it. In addition heated at 100^{o}C for 30 minutes and stirred every 10 minutes. Cool and mix it with CH_3COONa 2 M as much as 1.4 mL and 2 mL papain 0.1%. The solution was then mixed with distilled water and filtered with Whatman filter paper number 42 then with a 0.45 μm membrane. Injected into HPLC with column C18, λ = 254 nm, flow rate 0.7 mL / minute, and phloroglucinol solvent (FG) ratio of 80:20 [8].

*2.2.5 Determination of Fe***.** Iron was analyzed by using the Atomic Absorption Specthrophotometer (AAS). 5 g of sample was dry with a temperature 450 and 550^{0}C for 6 hours to become ash. Each sample then added with 10 mL HCl 10 M and heated in a hot plate until the ash dissolves. The dissolved ash was diluted with 0.1 M HNO_3 until reached 100 mL. Furthermore, each sample and iron standard (2 ppm; 4 ppm; 6 ppm; and 8 ppm) solutions were read on the atomic spectrophotometer at a wavelength of 285nm [8].

*2.2.6 Determination of Mg***.** Magnesium measured by using the Atomic Absorption Specthrophotometer (AAS). 5 g of sample was dry with a temperature 450 and 550^{0}C for 6 hours to become ash. Each sample then added with 10 mL HCl 10 M and heated in a hot plate until the ash dissolves. The dissolved ash was diluted with 0.1 M HNO_3 until reached 100 mL. Furthermore, each sample and magnesium standard (0.25 ppm; 0.5 ppm; 2 ppm; 4 ppm and 8 ppm) solutions were read on the atomic spectrophotometer at a wavelength of 766 nm [8].

2.3 Statistical analysis

The experimental was designed by using standard deviation and factorial randomized complete random (RAL) with two replications and the data was analysed by using SPSS ver. 22, if the data is significantly different then proceed with the duncan test.

3. Results and Discussion

Table 1 shows the results of the nine treatments of grain.

Table 1. Average length of grain sprouts from 9 treatments

No.	Immersion Time (h) : Germination Time (h)	Grain Germination	Average Grain Length (cm)
1	12 :18	None	None
2	12 : 24	Half	0.7 (±0.47)
3	12 : 30	All	1.0 (±0.10)
4	18 : 18	All	1.3 (±0.57)
5	18 : 24	All	1.5 (±0.10)
6	18 : 30	All	1.7 (±0.17)
7	24 : 18	All	1.8 (±0.10)
8	24 : 24	All	2.0 (±0.05)
9	24 : 30	All	2.4 (±0.15)

For nine treatments, we take 3 treatments that can represent the sample that are immersion time (h): germination time (h) (12:30; 18:24; 24:24). Samples will be used in the second treatment, it can be seen in figure. 1

12:30 *18:24* *24:24*

Figure 1. Examples of length of grain sprouts in each sample (immersion time (h): germination time (h))

3.1 Protein Content

Figure 2 shows the relationship between length of grain sprouts and rice protein content, grain with 0; 1; 1.5; and 2 cm length of sprouts have protein content of 5.62%, 6.22%, 5.53% and 5.74% respectively. Grain with 1 cm length of sprouts has the highest protein content and the lowest is grain with 1.5 cm length of sprouts. When soaking 12 hours water-soluble protein (albumin) will diffuse into the rice tissue. However, soaking for 18 hours can cause water-soluble proteins (albumin) that have diffused maximally into the rice tissue to come out, so that the protein content decreases. The 24-hour immersion treatment with 24-hour germination causes the water-soluble protein re-enter to the rice tissue, so that the protein content in this treatment increases. This is consistent with the statement of Paiva *et al*. [9], which states that an increase in protein content of rice is caused by the transfer of bran layer protein into endosperm of rice during immersion. Germination also has an effect on protein levels. The germination process will increase the protein content because the formation of essential amino acids. In addition, the protein during germination can increase due to the activation of the germination enzymes that are proteins. Lipase and amylase will degrade fats and carbohydrates during the germination process. This is consistent with the statement of Lopez and Escobedo [10], that

germination can increase protein content. Increased protein content during the germination process is caused due to the formation of essential amino acids that are constituents of proteins needed for the growth process of sprouts.

Based on statistical analysis of variance showed that treatment of long grain sprouts significantly affected the protein content at the level of 5%. And based on Duncan's test, it was found that rice with 1 cm sprout length differ from other treatments.

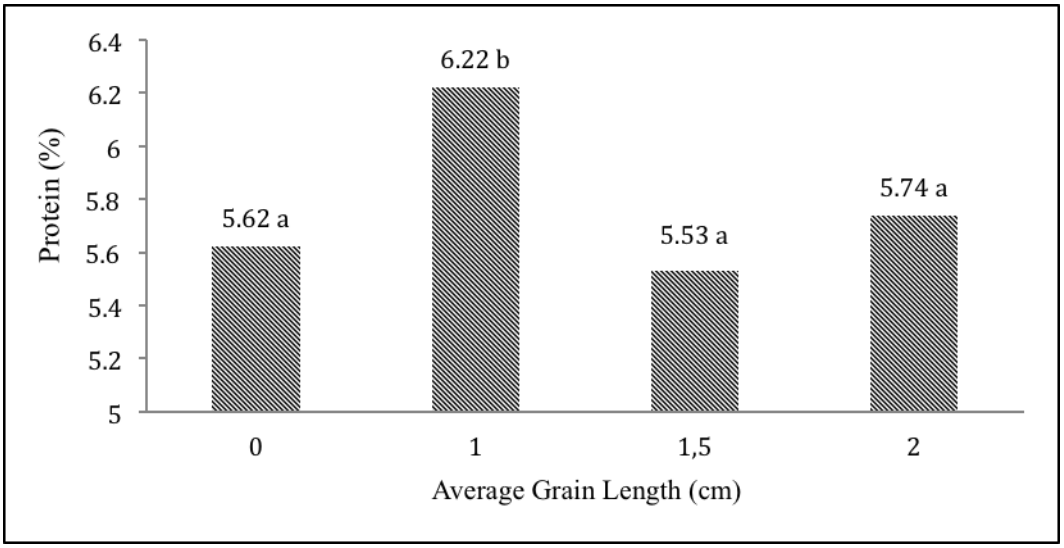

Figure 2. Relationship between length of grain sprouts and rice protein content

3.2 Thiamine Content

Figure 3 shows thiamine content for all treatments increased after soaking and germinating process. Grain with 0; 1; 1.5 and 2 cm sprout length had thiamine content 9.7; 11.4; 11.5 and 9.7 mg/kg, respectively. Based on statistical analysis of variance showed that treatment of long grain sprouts significantly affected the thiamine content at the level of 1%. And based on Duncan's test, it was found that rice with 1 and 1.5 cm sprout length were differ from control and rice with 2 cm sprout length.

The immersion and germination process treatments can increase thiamin levels in rice. During soaking, water soluble component in bran layer such as thiamine adsorbed into the endosperm of rice. The bran layer is a layer of rice that contains lots of protein, fat, vitamins, and minerals [11]. In addition, germination process will activate germination enzymes that will form compounds including thiamin. The germination process will activate the thiamin diphosphotransferase that will activate thiamin into thiamin diphosphate.

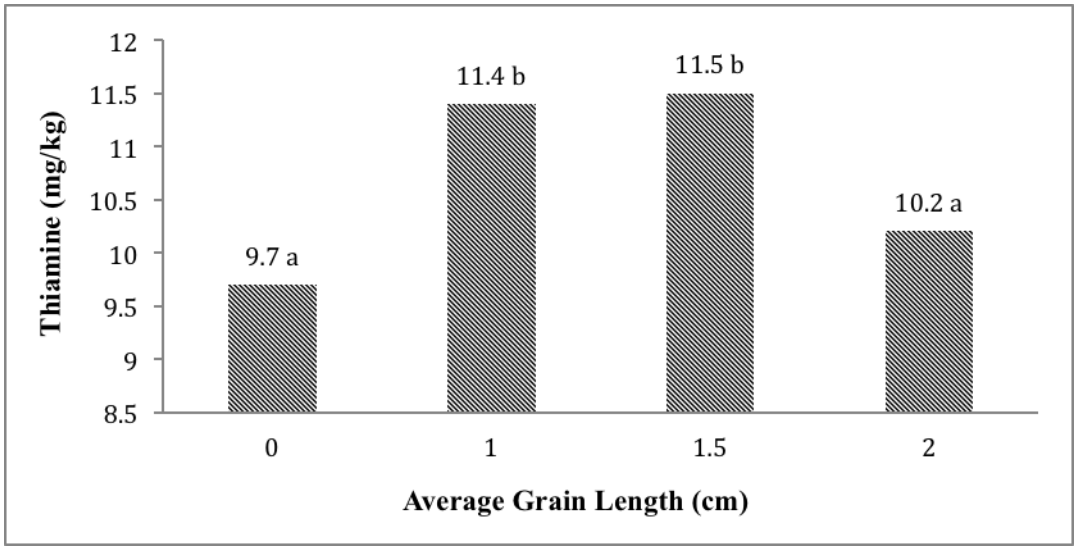

Figure 3. Relationship between length of grain sprouts and thiamine content

3.3 Ash Content

Figure 4 shows ash content for all treatments. Ash content from high to low is 2; 1.5; 1 and 0 cm length sprouts with a value of 0.61%; 0.58%; 0.52% and 0.4%, respectively. The result indicate that the longer the sprout grain, the higher the ash content.

The results of statistical analysis of variance showed that the ash content in the treatment of long grain sprouts significantly affected at the level of 5%, so the duncan test was carried out. The results showed that the ash content in the treatment without germination was not different from the treatment of 1 cm sprouts. However, it is different from the treatment of 1.5 cm sprouts and the treatment of 2 cm sprouts.

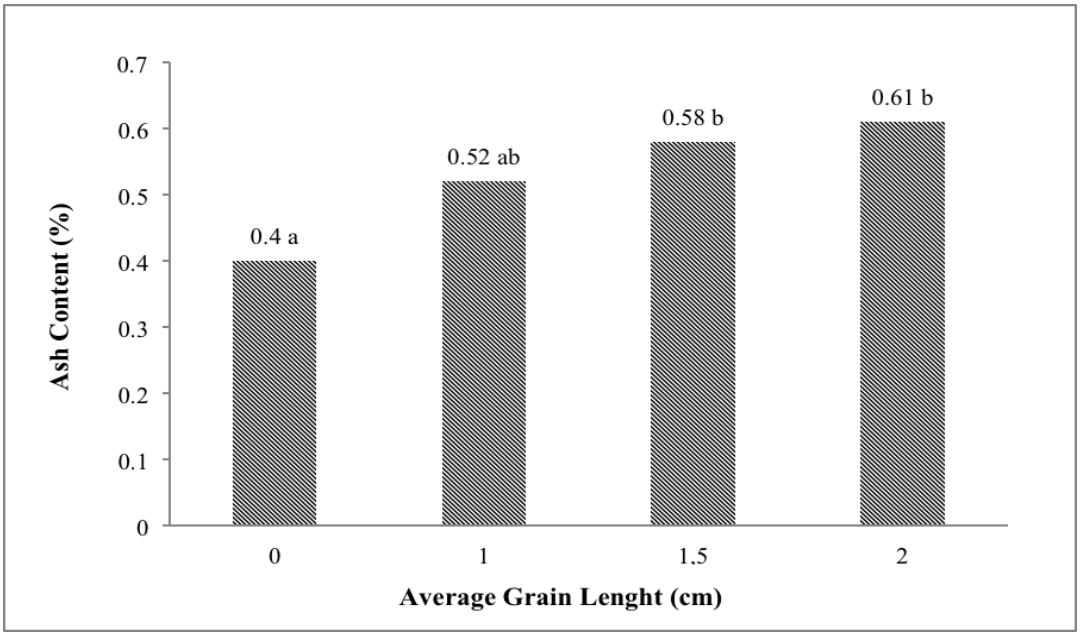

Figure 4. Relationship between length of grain sprouts and ash content

Ash levels Increased due to the germination of grain will activate enzymes in grain. Some enzymes will be active, for example an enzyme used for growing sprouts. The enzyme will free the bonds between minerals and proteins, so that the availability of minerals during germination will increase. This is in accordance with Mamoudou *et al*. [12], which states that enzymes at the time of germination will free the bonds between minerals, protein, and other compounds so that nutrient availability such as mineral content will experience an increase.

3.4 Fe Content

Figure 5 shows Fe content of grain sprouts. Grain without treatment (0 cm grain length) has the highest Fe content that is 0.458 mg/g and followed by 1 and 1.5 cm of grain length that is 0.428 and 0.341 mg/g. The result indicate the longer the sprouts or the longer the immersion and germination the less the Fe content. In other side, grain with a length of 2 cm sprouts has increased Fe content from 0.341 to 0.344 mg/g after 24 hours of soaking and germination. This is because soluble Fe in the water is re-absorbed to the endosperm of rice. This is in accordance with Suprapto [13], which states that immersion can cause mineral solubility so that minerals in food can be reduced.

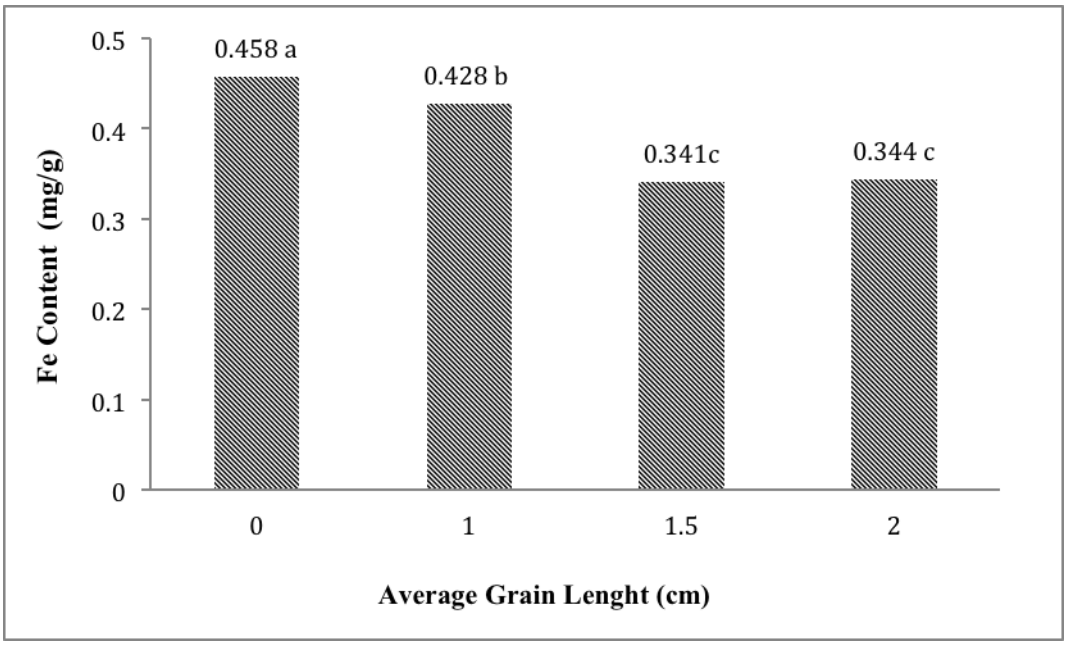

Figure 5. Relationship between length of grain sprouts and Fe content

Based on statistical analysis of variance showed that the Fe content in the long treatment of grain sprouts significantly affected at the level of 1%. And based on Duncan test, Fe content in 0 cm grain length is differ from Fe content in 1; 1.5 and 2 cm grain length.

3.5 Mg Content

Figure 6 shows magnesium content of grain sprouts. Grain without treatment (0 cm grain length) has the highest Mg content that is 44.4 mg/g and followed by 1;1.5; 2 cm of grain length that is 37.0; 30.2 and 28.3 mg/g. The result indicate the longer the sprouts or the longer the immersion and germination the less the Mg content. Magnesium levels for all treatments decreased compared to controls. The longer the immersion and germination, the magnesium level decreases. This is caused by the dissolution of magnesium that is one of the minerals that are soluble in water [13].

Based on statistical analysis of variance showed that the Mg content in the long treatment of grain sprouts significantly affected at the level of 1%. And based on Duncan test, Mg content is different for all treatments.

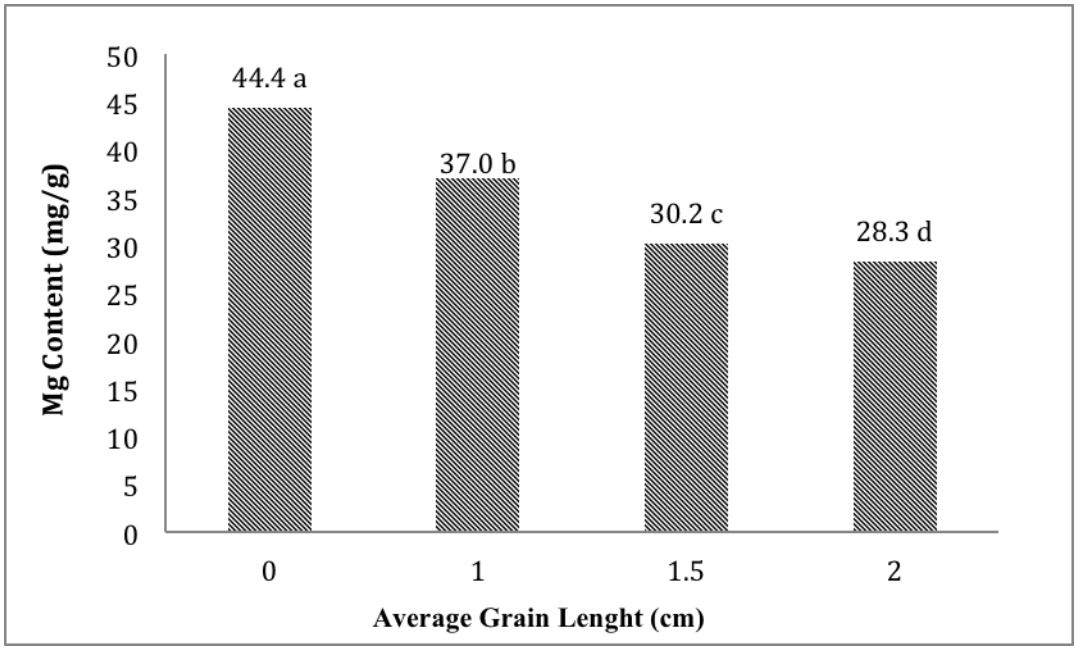

Figure 6. Relationship between length of grain sprouts and Mg content

4. Conclusions

The grain from Ciherang variety has been soaked and germinated in some treatments. The duration of soaking and germination affects the length of the grain sprouts, the longer time of soaking and germination of the grain, the longer sprouts will be produced. The best treatment during the germinating grains process towards the quality of rice was soaking at 12 hours and germination time 30 hours with length of grain sprout was 1 cm.

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