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Quality improvement of post-harvest red rice through grain germination

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Abstract. Red rice is generally consumed without the polishing process, but only milled into brown rice. The results of rice milling are only wasted and used as animal feed, even though there are many nutrients inside that exceed the rice itself. With grain germination technology, it is expected that the nutrients in the husk can be absorbed into the red rice and improving its quality. This research was conducted to determine the effect of temperature and humidity on the immersion and germination of red rice grain and the best treatment to produce germinated red rice. The method of this research was carried out by soaking the grain in the water and then proceed with germination with varied temperature and humidity. The duration of grain soaking was 48 hours then incubated in a gunny sack with 20 °C, 30 °C, and uncontrolled temperature and humidity of 70%, 80%, 90%, and uncontrolled humidity until the grain germinates along 1 cm sprout. The research observed the effect of temperature and humidity on the length of germination. In addition, differences in the quality of rice produced were also observed by comparing the results and the quality standard requirements of rice produced. The results show that, as temperature and humidity increased, the germination time will be shorter. The fastest germination was resulted from a temperature treatment of 30 °C with 90% humidity and the control or without temperature and humidity treatment. Germination with 30°C temperature and 90% humidity, is the best treatment.

1. Introduction

Brown rice is the rice that has been separated from outer skin (husk) which is the most part of the grain weight that is 16-28% compared to the aleuron layer (4-6%), the epidermis (1-2%), and bodies (2-3 %) [1]. After milling process, the husk and all it layers are often wasted and used as animal feed despite the fact that the nutritional content of grain consists of protein 6.7-8.3%, fat 2.1-2.7%, fiber 8.4-12.1%, ash 3.4-6.0%, starch 62.1% and sugar 1.4%, the bran layer in the grain contains lots of vitamin B1, besides that the bran also contains protein, fat, vitamins B2 and niacin. Grain soaking can increase the nutritional value of rice produced [2]. Grain incubation and germination are also increasing the nutritional value of the rice [3]. In the process of grain soaking, it is expected that nutrients from the husk will be absorbed into the rice. The germination process will increase the nutritional content of the grains, and also increase antioxidant activity in rice [4]. Germination is a sign of an early seed life. When seeds germinated, many nutritional compositions are prepared for shoot growth [5-7]. Germinated rice contains more nutrients compared to ground rice ie, 10 times γ -



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aminobutyric acid, and about 4 times the dietary fiber, vitamin E, niacin and lysine, and about 3 times the vitamin B1, B2 and magnesium compared to ungerminated brown rice [8].

2. Materials and methods

2.1. Materials

Materials used were fresh harvested red rice grain (Sidrap local variety) purchased from a farmer at Compong, Sidenreng Rappang, South Sulawesi, Indonesia, gunny sack, basin, moisture meter, and germinator.

2.2. Methods

The research was carried out by soaking the grain with 1:2 (w/v) ratio of water for 48 hours followed by germination in the germinator set at a temperature of 20 °C and 30 °C each with humidity of 70%, 80%, and 90%. One seed lot was germinated in uncontrolled temperature and humidity. Germination was carried out until the rice seeds germinate along 1 cm. Germinated red rice grain was dried until 14% water content and milled.

2.2.1. *Weight loss (yield) analysis.* The measurement of rice weight loss (yield) was calculated based on the ratio of the rice produced, to the initial weight of used rice.

2.2.2. *Quality requirements determination.* 100 g of grounded rice separated manually to get head rice, broken rice, and groats. Separated rice for each category then weighed.

2.2.3 *Statistical analysis.* Statistical analysis was designed by using a randomized block design with two replications. Data obtained were analyzed by using SPSS ver.23 and continued with Duncan test if it is significantly different.

3. Results and discussion

Table 1 shows the results of germination time in each treatment until reaching 1 cm sprout length. The fastest germination time occurred at 30 °C temperature with 90% humidity along with uncontrolled temperature and humidity.

Table 1. Germination time each sample

Germination Treatment T (°C), RH(%)	t (hours)
20, 70	76
20, 80	76
20, 90	70
30, 70	60
30, 80	56
30, 90	48
Uncontrolled	48

Rice yield from germination in each treatment compared with red rice without germination treatment in the analysis of yield and quality of rice.

3.1. The effect of temperature and humidity on germination time.

Figure 1 shows the relationship between temperature and humidity to the germination time. Samples

with temperature treatment of 30 °C with 90% humidity and uncontrolled temperature and humidity treatment experienced the fastest time of 48 hours, while samples with a temperature treatment of 20 °C with 70% humidity and a temperature of 20 °C with 80% humidity were the samples with the longest germination time (76 hours). Air, water temperature, and humidity greatly influence the quality and yield of soybean germination. Low temperatures cause a negative effect at the beginning of germination which affects the length and thickness of the sprouts [9]

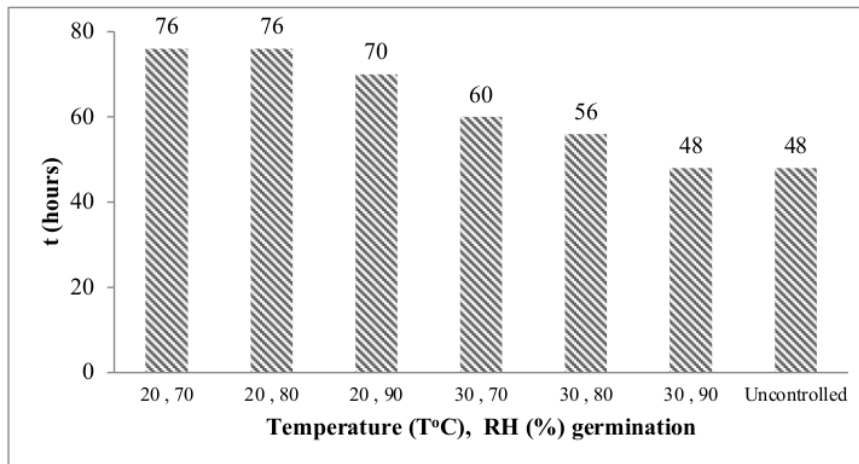


Figure 1. Relationship between temperature and humidity to the germination time

3.2. The effect of temperature and humidity on weight loss (yield)

Figure 2 shows the relationship between germination treatments and red rice yield content. The highest yield was produced by red rice without germination treatment (92%). The highest yield in the germination treatment was produced by uncontrolled temperature and humidity (71%), while the lowest yield of 53%, produced by germination at a temperature of 20 °C and 70% humidity. Decreased milling yield caused by the germination process, the longer the germination time will damage the rice cells so that the rice will break and be damaged when milled. In addition, the longer the soaking time, the more water absorbed into the rice cells will affect the quality of rice after the milling process [10].

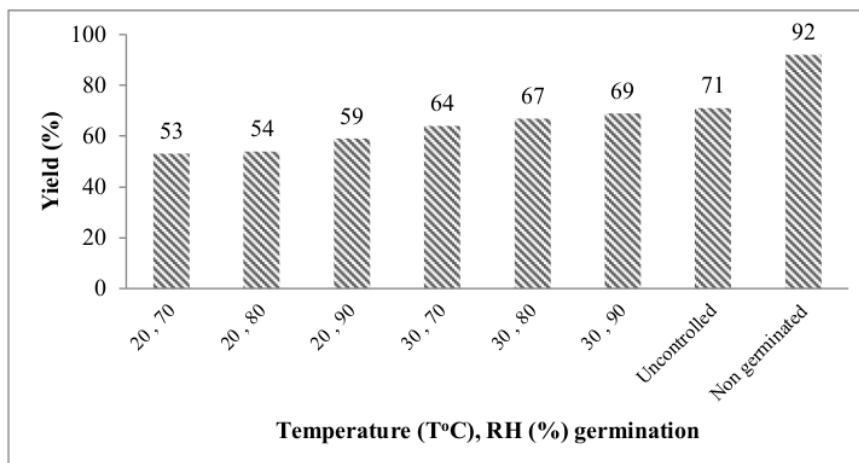


Figure 2. Relationship between yield percentage with temperature and humidity germination

3.3. The effect of temperature and humidity on the quality requirements

The percentage of red rice quality components as shown in figure 3 shows that the lower temperature and humidity, the lower the percentage of head rice compared to the non-germinated treatment. This is because, the longer the germination time, will damage the rice cells so that the rice will break and be damaged when milled. In addition, the time of soaking the grain also affects the quality of rice after the milling process caused by the water absorbed into the rice cells. The low quality of the milled rice is influenced by several things like the damaged condition of the milled rice, the geometric shape of the rice, the level of hardness, grain quality indicated by high water content, and the degree of rice purity (physical contamination of the rice to be ground) that has been cracked in it [11].

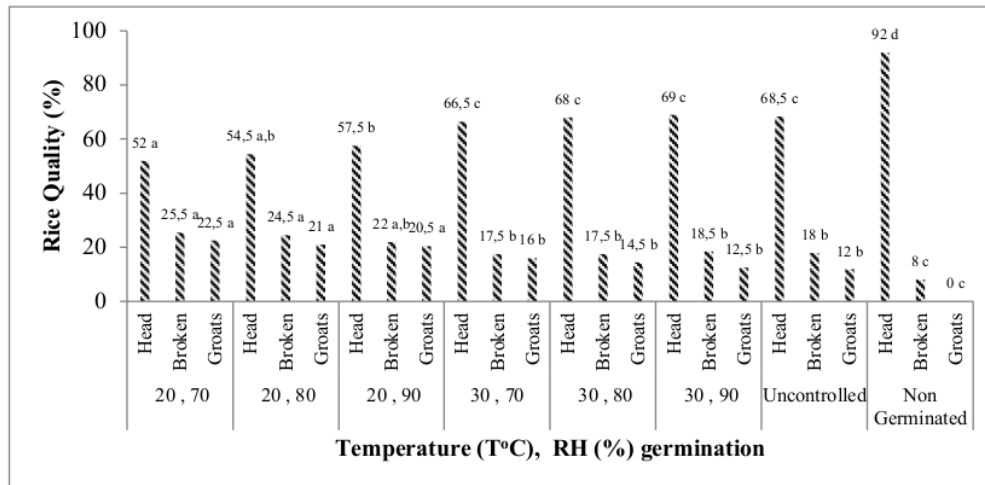


Figure 3. Relationship between germination treatments with rice quality.

Based on statistical analysis of variance, the percentage of quality in head rice, broken rice, and groats showed a significant difference at the 1% level, so it was continued with the Duncan test which showed that the percentage of head rice, broken rice, and groats without germination treatment was significantly different from each germination temperature and humidity treatment.

4. Conclusions

As temperature and humidity increase, the germination time will be shorter. The earliest germination resulted from the treatment of 30 °C temperature and 90% humidity along with uncontrolled temperature and humidity treatment. The highest yield of germinated red rice is produced from uncontrolled temperature and humidity treatment. Germination with 30 °C temperature and 90% humidity is the best.

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