Characteristics of Brown Rice (*Oryza nivara*) Stored Using Various Packaging with The Addition of Pandanus Powder (*Pandanus amaryllifolius Roxb*.)

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ABSTRACT

Brown rice (Oryza nivara) is known to have a relatively low shelf life when compared to other types of rice. This study aims to determine the physico-chemical characteristics and to determine the best type of packaging for brown rice during storage with the addition of pandan leaf powder. The research method used is an exploratory method with various treatments of brown rice packaging (A: vacuum PE plastic, B: non-vacuum PE plastic, C: PP plastic sack, D: jute sack and E: non-vacuum PP plastic). Pandan leaf powder placed in a tea bag is added to brown rice. A pair of rice lice is also added to brown rice which is stored for one month. Parameters observed were moisture content, ash content, fat content, protein content, carbohydrate content, antioxidant content and grain fracture. The results showed that the best packaging for storing brown rice for one month was vacuum PE plastic packaging (Treatment A) with 10.56 % moisture content, 1.50% ash content, 11.31% fat content, 6.87% protein content, carbohydrate content 69.76%, antioxidant activity 12.37 %, percentage of broken grains 24.31 %.

Keywords: *brown rice, packaging, storage, pandan leaves.*

1. INTRODUCTION

Rice (*Oryza sativa L.*) is a grain type food plant that is used as a source of protein, energy, fiber, minerals and bioactive compounds in several countries [1], [2]. Worldwide, more than 769.9 million tonnes of rice are produced of which 80% is destined for human consumption [3]. Factors such as variety, climatic conditions, pre-harvest processes and technical management affect rice quality. However, the post-harvest process is no less important. Since rice has a growing season, it is necessary to ensure the sustainability and availability of the product for a long period of time [4]. The main post-harvest objectives are to maintain the quality of rice, avoid physical damage and changes in chemical composition, and prevent contamination by insects or fungi [5].

Therefore, the choice of procedures adopted in post-harvest operations such as drying, storage and processing can greatly affect rice quality [6], [7]. To ensure quality and minimize physical and chemical damage to rice, it is imperative to apply modern packaging technology and proper equipment [8].

Rice is a very strategic food commodity because it is the main staple food for most of the Indonesian population. Availability of sufficient food must be supported by a surplus of rice as food reserves. The management of this rice reserve is mandated by the government to the Logistics Affairs Agency (BULOG). Rice that enters Perum BULOG (2012) must meet the standards set by the government through Presidential Instruction No. 3 of 2012. The quality set by this Presidential Instruction is almost the same as grade III rice according to the standards set by BSN through SNI 6128:2008 [9].

Brown rice has a shorter shelf life than white rice. During storage, brown rice will give off a musty smell, because the red skin layer that is not polished contains oil, while in white rice this layer of oil has been lost along with the roasting process so that the shelf life is longer. This is what makes brown rice less attractive to the public, so a better storage process is needed for brown rice [10].

Storage of rice must be done properly to protect rice from weather and pests, prevent or inhibit the decline in quality and nutritional value. To prevent a decrease in

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the quality of rice during storage, one way to do it is by packaging. Packaging protects the product from physical, chemical and biological damage. The purpose of packaging is to avoid damage caused by microbial, physical, chemical, biochemical, water vapor and gas transfer, UV light and temperature changes. Packaging can also extend the shelf life of the product [10].

Warehouse pests are one of the causes of rice damage during storage. To prevent warehouse pests from growing, spraying with fungicides or other preservatives is carried out. Plants that are currently being developed as natural insecticides are plants that produce essential oils. This underlies the use of fragrant pandan leaves as a natural insecticide, which in general is only used as a food coloring and aroma enhancer [11]. This study aims to determine the physicochemical characteristics and to determine the best type of packaging for brown rice during storage with the addition of fragrant pandan leaf powder.

2. MATERIALS AND METHODS

The materials used in this study were fragrant pandan leaves (*Panadanus amaryllifolius*), rice lice (Sitophilus oryzae) obtained in Bidar Alam, Sangir Jujuan District, South Solok Regency and brown rice (*Oryza nivara*) from Kasang, Batang Anai District, Padang Pariaman Regency, West Sumatra. Chemicals used: Selenium mix, H_2SO_4, distilled water, NaOH 40%, H_3BO_3, Tashiro indicator (*methyl red and methylene blue*), 0.1 N HCl, n-hexane, DPPH and methanol.

The tools used in this research are: blender, sieve, digital scale, scissors, tweezers, label paper, oven, gegep, desiccator, porcelain dish, kiln, kjeldhal flask, distillation apparatus, burette, measuring pipette, Erlenmeyer, dropper, glass beaker, soxhlet, electric heater, filter paper, fat flask, spectrophotometer, types of packaging (vacuum plastic, non-vacuum plastic, PP plastic, jute sack, plastic sack) and other glassware.

This research was conducted in an exploratory manner with different types of packaging on rice, namely; A = Vacuum plastic (PE), B = Non-vacuum plastic (PE). C = plastic sack (PP), D = jute sack, E = PP plastic/jar.

The brown rice storage process consists of four stages, namely; 1) preparation of test insects, 2) preparation of test insect feed, 3) manufacture of fragrant pandan powder, 4) packaging and storage of brown rice.

2.1. Preparation of test insects

Rice louse (*Sitophilus oryzae*) is taken from rice that has been damaged by lice.

2.2. Preparation of test insect feed

The test insect feed was 150 grams of brand X rice which had been sorted so that there were no insect pests.

2.3. The process of making fragrant pandan leaf powder [12]

The selected fragrant pandan leaves are cleaned then sliced and dried in the sun to remove the moisture content (<14%) on the leaves, until the leaves are completely dry, i.e. the color of the leaves fades and the leaves feel stiff. After the dry leaves are pureed with a blender, then sieved with a 100 mesh sieve to obtain a homogeneous fragrant pandan leaf powder. The powder is then weighed and placed in a tea bag, so that the pandan powder is located in one place, does not mix directly with the size but gives off a distinctive pandan aroma.

2.4. The process of packaging and storage of brown rice

The fragrant pandan leaf powder that has been prepared in tea bags is then put into each package (vacuum plastic, non-vacuum plastic, plastic sack, jute sack, PP plastic/jar) according to the treatment which already contained 200 grams of brown rice and a pair of lice. rice, then each package is closed and stored for 1 month.

2.5. Observation

Observational parameters in this study consisted of: water content test, ash content test, protein content test, fat content test, carbohydrate content test, antioxidant activity, growth of rice lice and percentage of broken grains.

3. RESULTS AND DISCUSSION

3.1. Water Content

Water content is the amount of water contained in an object such as soil, rocks, agricultural materials, and so on [13]. In this study, the highest water content of brown rice was produced by burlap sack packaging, namely 13.35% and the lowest water content of brown rice was using vacuum plastic packaging, namely 10.56 % with a control ratio of 8.77 %. The average water content of brown rice during storage for 1 month is presented in Table 1.

The difference in the water content of brown rice using packaging is caused by the packaging itself. Vacuum packaging is an airtight packaging of food products that avoids direct contact with air and produces the lowest water vapor in brown rice compared to other packaging, so that the product inside is protected from gas or water exchange from outside during storage [14].

Table 1. Moisture Content of Brown Rice Stored for 1 Month with Various Packaging

Packaging	Water content (%)
Control	8.77
A = Vacuum plastic (PE)	10.56
C = Plastic sack (PP)	11.21
B = Non-vacuum plastic (PE)	11.32
E = Plastic PP	12.93
D = Burlap sack	13.35

Meanwhile, the packaging of the burlap sack occurs in the process of evaporation and absorption of large oxygen from the surrounding environment, causing the water content to increase. These results are in line with research [10], that the increase in the water content of rice is due to rice with bucket containers (control) in direct contact with the air so as to produce the highest water vapor in rice compared to other containers.

3.2. Ash Content

Ash content shows the amount of mineral content in a material [13]. This study showed the ash content in brown rice from the lowest to the highest yield with a control of 1.49%. The average ash content of brown rice during 1 month of storage is presented in Table 2.

Table 2. Ash Content of Brown Rice Stored for 1 Month with Various Packaging

Packaging	Ash Content (%)
Control	1.49
A = Vacuum plastic (PE)	1.50
C = Plastic sack (PP)	1.59
B = Non-vacuum plastic (PE)	1.63
E = Plastic PP	1.67
D = Burlap sack	1.68

This study is not in line with research Pramusita et al., 2019 which states that the increase in ash content is contrary to the water content, the higher the water content the lower the ash content [15]. The highest mineral content was produced by PP plastic packaging and the lowest was produced by vacuum packaging, but the results of ash content from various packages did not differ much. These results are in accordance with the research which states that the results of the analysis of ash content with various packaging are not much different [16]. Other things that affect the ash content are the length of storage, various packaging, and the type of material and method of ashing. During the storage of rice, the mineral content of various packages still showed an increase. This is influenced because the packaging on the material does not damage the mineral content of rice during storage, so that the ash content in brown rice is still high.

3.3. Fat Content

The highest fat content of rice seeds is found in the institutions and aleurone layer that collects in fat granules [17]. This study shows that the results of the fat content of brown rice from the lowest to the highest with a control of 12.41%. The average fat content of brown rice during 1 month storage is presented in Table 3.

Table 3. Fat Content of Brown Rice Stored for 1 Month with Various Packaging

Packaging	Fat Content (%)
Control	12.41
A = Vacuum plastic (PE)	8.40
C = Plastic sack (PP)	11.31
B = Non-vacuum plastic (PE)	16.41
E = Plastic PP	18.22
D = Burlap sack	21.43

The effect of decreasing and increasing fat content during storage is due to the presence of air in the packaging material itself. If air is not present in the packaging material, there will be an inhibition of the oxidation reaction so that the fat content will decrease in vacuum plastic and PP plastic [18]. Meanwhile, the packaging of jute sacks allows the exchange of oxygen resulting in high oxidation of fat content during storage.

3.4. Protein Content

Protein is a food substance that is very important for the body, because in addition to functioning as fuel in the body but also as a building block and regulator. This study shows the results of protein levels from the lowest to the highest. The average protein content of brown rice during storage for 1 month is presented in Table 4.

Table 4. Protein content of brown rice stored for 1 month with various packaging

Packaging	Protein Content (%)
Control	4.62
A = Vacuum plastic (PE)	6.87
C = Plastic sack (PP)	7.27
B = Non-vacuum plastic (PE)	8.43
E = Plastic PP	9.83
D = Burlap sack	11.40

Protein content in brown rice experienced the lowest increase in vacuum plastic, non-vacuum plastic, and PP plastic packaging and the highest increase in burlap sack packaging during storage. This is thought to be due to the influence of temperature on packaging during storage [19]. The relatively high temperature in vacuum, non-vacuum, and PP plastic packaging resulted in a smaller increase in protein, while in open burlap sack packaging, it was possible to exchange temperatures during storage. This is in accordance with the research which states that the damage to foodstuffs such as the nutritional quality of packaged materials includes water content, protein content, starch content and others due to physical processes that are influenced by temperature, water content, and environmental humidity [10].

3.5. Carbohydrate Content

Carbohydrates are natural products that have many important functions in plants and animals. This study shows the levels of carbohydrates produced by various packaging during storage. The highest carbohydrate content during storage was produced by vacuum plastic packaging, namely 69.76% and the lowest was produced by jute sack packaging, namely 52.23%. The average carbohydrate content of brown rice during storage for 1 month is presented in Table 5.

Table 5. Carbohydrate Content of Brown Rice Stored for 1 Month with Various Packaging

Packaging	Carbohydrate Content (%)
D = Burlap sack	52.23
C = Plastic sack (PP)	60.92
B = Non-vacuum plastic (PE)	61.49
E = Plastic PP	69.05
A = Vacuum plastic (PE)	69.76

This is mainly due to the storage temperature. The higher the temperature, the greater the carbohydrate changes that occur. The increase in amylose content during storage was thought to be caused by the hydrolysis of amylose by the amylase enzyme. Hydrolysis of carbohydrates is influenced by the temperature factor. Temperature is a factor that affects starch hydrolysis. The increasing temperature will accelerate the hydrolysis of starch during storage. The highest carbohydrate content of brown rice is produced by vacuum plastic packaging and the lowest is burlap sack packaging, while the factors that affect the carbohydrate content of brown rice are caused by several aspects such as rice quality, storage, and the growth process after planting [20].

3.6. Antioxidant Activity

Antioxidants are chemical compounds that can donate one or more electrons to free radicals, so that these free radicals can be quenched.

This study showed that the antioxidant activity from the lowest to the highest was different in each packaging. The highest yield was obtained in PP plastic packaging, namely 58.93% and the lowest yield was obtained by burlap sack packaging, which was 6.88%. The average antioxidant activity of brown rice during 1 month storage is presented in Table 6.

The antioxidant activity of brown rice in PP plastic packaging is greater than the antioxidant activity of other packaging. The increase in antioxidants is also due to the increase in the main secondary metabolite that functions as an antioxidant in brown rice, namely anthocyanins as a result of the storage process, because if the anthocyanin level is high, the antioxidant activity is also high [21]. Another factor that supports antioxidant activity is that the compounds found in brown rice are able to donate hydrogen atoms to DPPH free radicals and turn them into more stable radicals. The presence of antioxidants can counteract free radical compounds that trigger regenerative diseases in the body [22]. The higher the percentage of antioxidants, the better the ability of an ingredient to inhibit free radicals [23].

Table 6. Red Antioxidant Activity Stored for 1 Month with Various Packaging

Packaging	Antioxidant Activity (%)
D = Burlap sack	6.88
B = Non-vacuum plastic(PE)	8.59
A = Vacuum plastic (PE)	12.37
C = Plastic sack (PP)	44.16
E = Plastic PP	58.93

The burlap sack packaging showed the lowest levels of antioxidants during storage. This decrease is thought to be an antioxidant in red which is oxidized by oxygen during storage of brown rice. This is in accordance with research Fibriyanti, 2012 which states that burlap sack packaging has large pores so that it is possible to be exposed to oxygen [10]. High oxygen pressure, extensive contact with oxygen causes an increase in the initiation and propagation chain of oxidation reactions and decreases antioxidant activity.

3.7. Rice lice growth

Insect contamination is high in jute sack packaging due to the high water content in the packaging. The higher the moisture content of the material, the higher the level of insect development. This is in accordance with research which states that the packaging of burlap sacks is the most contaminated with rice lice, because burlap sacks are in direct contact with air and therefore have a high water content [24]. While in vacuum packaging showed death in rice lice. In airtight packaging (hermetic conditions) and there is no oxygen circulation, the insect's survival will be limited, according to the oxygen threshold limit in the room so that the insects will die. In addition to water content, the availability of oxygen is a factor that affects the growth of insects in burlap sack packaging, thus enabling the growth of warehouse pests.

3.8. Broken Grain

Broken grains are smaller grains of rice, mainly caused by the growth of rice lice. This study showed the results of the broken grain test from the lowest to the highest with a control of 23.40%, the lowest result was indicated by vacuum plastic packaging, namely 24.31%, and the highest yield was produced by jute sack packaging, which was 32.33%. The average broken grain of brown rice during storage for 1 month is presented in Table 7.

Table 7. Broken grains of brown rice stored for 1 month with various packaging

Packaging	Broken Grain (%)
Control	23.40
A = Vacuum plastic (PE)	24.31
C = Plastic sack (PP)	25.08
B = Non-vacuum plastic (PE)	28.56
E = Plastic PP	28.94
D = Burlap sack	32.33

In vacuum plastic packaging has the lowest results on the grain fracture test. The low percentage of broken rice in vacuum packaging is caused by the components and carbohydrates in the seeds becoming more compact, so that the grain becomes strong and does not break easily during storage [25]. Storage time can affect grain fracture in rice, this is due to the growth of rice lice. The growth of rice lice can damage the quality of rice such as broken grains. The growth of rice lice on vacuum plastic packaging showed the lowest yield, so that broken grains on vacuum plastic also showed the lowest yield.

Burlap sack packaging showed the highest grain yield during storage. This is not in accordance with the research which states that the quality of rice during storage is mainly determined by the water content of rice [18]. At high moisture content, rice is relatively soft and will cause it to turn white and break easily, thereby increasing the number of broken grains during storage. While in this study there were only a few packages that matched this statement. Changes in the quality of rice are also caused by the attack of rice lice which causes the rice grains to crack and cause the grains to break. This is in accordance with the research which states that the increase in the percentage of broken grains and groats is also associated with the presence of rice lice [9].

4. CONCLUSIONS AND SUGGESTIONS

The results of this study indicate the characteristics of brown rice during storage using various packaging, namely; water content 10.56 - 13.35%, ash content 1.50 - 1.68%, fat content 8.40-21.43 %, protein content 6.87 - 8.43%, carbohydrate content 52.23 - 69.76 %, antioxidant activity 6.87 - 58.93%, percentage of broken grains 24.31 - 32.33%, growth of rice lice; PE vacuum plastic (dead), PE non-vacuum plastic (not expanded), PP plastic sacks (slightly expanded, PP plastic/jars (slightly expanded), burlap sacks (slightly expanded). The best packaging in brown rice storage in terms of physio-chemical characteristics with the addition of fragrant pandan leaves is vacuum plastic packaging (PE). From the results of the research that has been carried out, the authors suggest that further research be carried out on the storage of brown rice with the addition of other natural insecticides such as lemongrass leaves, papaya leaves, and cinnamon leaves to be used as a comparison against pandan leaves.

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