THE POTENTIAL OF POLLARD AND RICE BRAN WITH FRACTIONATION PROCESS AS RAW MATERIALS FOR HIGH FIBER PROCESSED FOOD

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ABSTRACT

Rice bran and pollard are by-products of the rice and wheat milling process. These two ingredients are generally not used as the main raw material for food products and are diverted as feed ingredients due to their low nutritional content. The nutrient content that is still present in pollard and rice bran, especially fiber and anti-nutrients, is very useful for people with diabetes and obesity. The aim of this study was to analyze the effect of fractionation on nutrient content and to separate the components of pollard and rice bran using a gravity and molecular weight approach. The experimental design used was CRD (Completely Random Design) Factorial $2 \times 3 \times 3$ for physical test data. Factor A is the material, namely pollard and rice bran, factor B is the position of the fraction, namely top, middle and bottom. Data analysis was performed by analysis of variance (ANOVA) and the significant one will be further analyzed using Duncan's test. The chemical property values were analyzed descriptively. The results showed that the value of bulk density (g l^{-1}), compacted bulk density (g l^{-1}), specific gravity (kg l^{-1}), angle of purpose (º) of pollard and rice bran were significantly different (P<0.05) on all three fractions. The highest physical parameters for pollard were at the bottom fraction with the value 386.47 g g l^{-1}, 537.28 g l^{-1}, 1.42 kg l^{-1}, ST 46.98º. The highest physical parameters for rice bran were at the upper fraction with the value of 394.09 g l^{-1}, 526.33 g l^{-1}, 1.50 kg l^{-1}, 46.01º. Crude fiber content (%) of pollard and rice bran were the upper fractions 6.77 and 21.69, middle fractions 8.19 and 34.70, lower fractions 5.52 and 32.76. Fractionation technology can separate food ingredients based on chemical components, especially crude fiber. The physical properties of pollard and rice bran after fractionation generally improved in quality. The fraction that has the best physical and chemical quality is the lower fraction for pollard and the upper fraction for rice bran. The middle fraction has the highest crude fiber content, so it has the potential to be a raw material for making high fiber processed food.

Keywords: Processed food, fractionation, molecular weight, pollard, rice bran

INTRODUCTION

Indonesia's rice production in 2017 has reached 81.38 million tons of dry milled grain with a harvested area of 15.79 million hectares (BPS 2018). The milling process produces by-products in the form of broken rice, husks and bran. The use of rice bran as raw material for food products is very rare because of the high fiber content and anti-nutrient components. The protein content of milled rice bran is 11.01% and carbohydrates 53.29% (Hadipernata *et al*, 2012).

Another agricultural by-product that is rarely used as the main raw material for food products is an energy source in the form of a pollard. Crude protein in pollard 17.98%

(Nadhifah *et al*. 2012), crude fiber 8.81% (Arditya 2010) and carbohydrate levels rice is generally 78% (Hernawan & Meylani, 2016). The characteristics of pollard are almost the same as rice bran. The quality of rice bran depends on the proportion of its constituent components, namely pure bran, husks and rice grains. Sukria and Krisnan (2009) added that the factors that can affect differences in the chemical composition of rice bran are agronomic factors (fertilization, soil), rice varieties and the milling process. A better milling process will produce pure rice bran with a higher protein content because protein is more important in the aleurone portion which will be wasted along with rice bran during milling, especially in the grinding process erodes the bran layer (Patiwiri 2006). One of the efforts that can be made to increase the percentage of pollard and rice bran use as raw materials for food products is the application of fractionation processing technology. Fractionation aims to identify and separate components in materials that have different nutritional content and molecular weights. Rice bran and pollard that have gone through the fractionation process may be used as raw materials for high-fiber processed food. All this time, bran only used as animal feed because there are not many people who know the benefits of both for health i.e. biscuit, food bar (Made and Andi 2010). Biscuits are snacks that are consumed as a hunger delay and are easy to obtain and are a type of snack that has a long shelf life (Caleja *et al*. 2017; Klunklin and Savage 2018). Biscuits are made from flour, butter and sugar, making this food less fiber and protein (Park *et al*. 2015). The development of people's lifestyles who are starting to realize a healthy lifestyle has resulted in an increasing demand for highly nutritious foods. These conditions create opportunities to make biscuit products rich in protein so that they can become functional foods. Functional food is a food ingredient that has a healthful effect and reduces the incidence of disease in the body (Siró *et al*. 2008; Lordan *et al*. 2011).

Problems in using bran in food products is its low stability, due to hydrolytic rancidity and oxidative rancidity. This study aims to analyze the effect of fractionation with a molecular weight approach on the physical (bulk density, compacted bulk density, specific gravity, angle of purposes) and chemical (moisture content, crude protein, crude fiber) properties of pollard and rice bran which have potential as raw materials high fiber processed food.

MATERIALS AND METHODS

The materials used in this study were pollard and rice bran obtained from a poultry shop in the Parung area, Bogor, and chemicals required for proximate analysis.

Pollard and rice bran were sieved using a 20 mesh sieve to uniform particle size and separated between the materials that passed the sieve and those that did not. Proximate analysis for chemical component in the form of water content, crude protein and crude fiber using the AOAC 2005 method.

Particle size

The particle size of pollard and rice bran can be determined with the help of a vibrator ball mill consisting of several sieves. The filters are arranged vertically from the coarsest to the finest (4, 8, 16, 30, 50, 100, and 200 mess). Each sample weighed as much as 250 grams and poured on the top filter, then the ball mill vibrator was vibrated for 10 minutes. The weight of each material that did not pass in each shaker was recorded to calculate the average diameter of the material (ASAE 1983). Modulus of Fineness (MF) or the level of fineness is a measurement of the coarseness or fineness of certain aggregates calculated using the formula:

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$$MF = \frac{\sum(\% \, material \, left \, on \, each \, mesh \; \times \, Agreement \, Number)}{100}$$

Furthermore, the materials were categorized based on the MF value with the provisions of 4.1 x 7.0 coarse category, 2.9 x < 4.1 medium category, < 2.9 category. The average particle size (D) was calculated using the formula (Henderson and Perry 1976):

$$D = 0.0041 \; x \; 2^{MF} \; x \; 2.54 \, cm \; x \; 10 \, mm$$

Pollard and Rice Bran Fractionation

The glass column is in the form of a beam with a length of 15 cm, a width of 15 cm and a height of 150 cm with a faucet to drain 20 cm of water from the bottom of the column. The glass column is filled with 25 liters of water and then inserted a 60 mesh sieve in the form of a beam with a length of 13.5 cm, a width of 13.5 cm and a height of 25 cm to a depth of 130 cm. Pollard and 1.25 kg of rice bran were put together in a glass column and stirred so that the material did not agglomerate. The material is allowed to settle for 3 hours in a sieve. After 3 hours, the material that floats on the surface of the water is taken and separated. The water in the column is removed, the filter is removed and drained for 45 minutes. The filter containing the drained sediment is opened on a predetermined side slowly in a vertical position. The height of the precipitate formed was measured using a ruler. The fraction whose height has been measured is then divided into 3 parts, namely the top 1/3, middle 1/3 and bottom 1/3. The three fractions were separated and placed in separate containers. The material that has been separated based on the fraction is put in an oven at 60°C for 48 hours.

Specific Gravity (SG)

Specific gravity is the ratio of the weight of a material to its volume. Specific gravity is measured using the principle of Archimedes' Law. Calculation of specific gravity is carried out using units modified from g ml^{-1} to kg l^{-1} (Syamsu *et al.* 2015)

$$SG \, (kg \, L^{-1}) = \frac{Weight \, of \, Feed \, Ingredients \, (kg)}{Aquades \, Volume \, Change \, (l)}$$
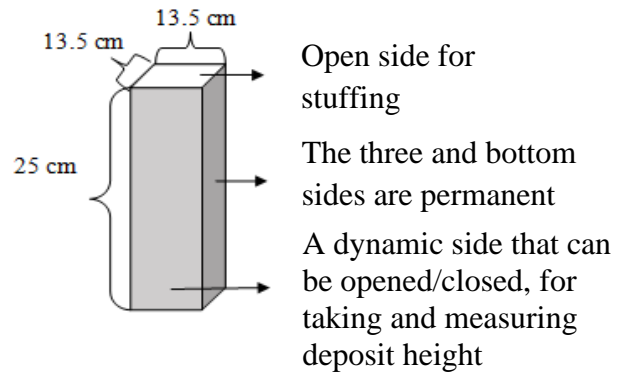

Figure 1. A sieve with a mesh size of 60 as a place for the material to settle

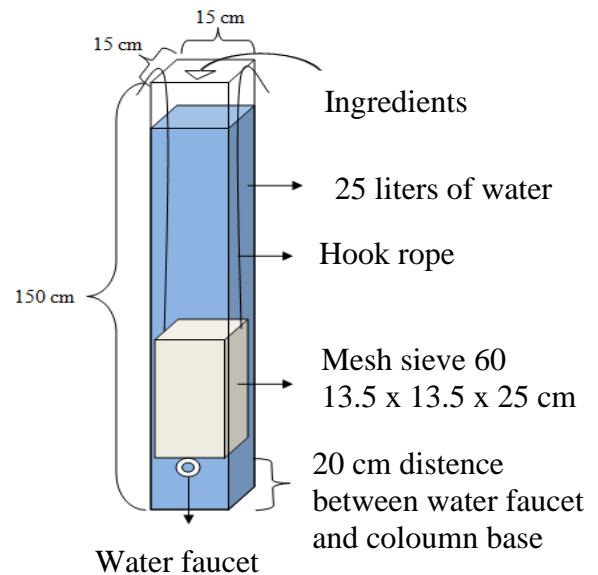

Figure 2. Glass column and fractination equipment.

Bulk Density (BD)

Bulk density is the ratio between the weight of the material and the volume of space it occupies. The value of bulk density is inversely proportional to the water content and foreign particles in the material (Fasina

and Sokhansanj 1993). Samples weighing 60 grams were poured into a 250 ml measuring cup with the help of a plastic funnel. Then measure the height of the sample in the measuring cup by looking at the volume of the measuring cup (Syamsu *et al*. 2015). The bulk density is calculated by the formula:

$$BD\ (g\ L^{-1}) = \frac{Weight\ of\ material\ (g)}{Volume\ of\ space\ of\ material\ (L)}$$

Compacted Bulk Density (CBD)

The compacted bulk density is the ratio of the weight of the material to the volume of space it occupies after the compaction process is carried out. The value of compacted bulk density is influenced by the particle size and moisture content of the material. The compacted bulk density was measured by the same method as the bulk density, but the volume of the sample was measured after the compaction process by shaking the measuring cup until the volume was constant. The compacted bulk density is calculated by the formula (Syamsu *et al.* 2015)

$$CBD\ (g\ L^{-1}) = \frac{Weight\ of\ material\ (g)}{Volume\ of\ material\ space\ after\ compaction\ (L)}$$

Angle of Purpose (AP)

The angle of purpose is the angle formed between the plane and the slope of the pile of material when poured from a certain height onto a flat plane. The angle of purpose indicates the material flow rate. The angle of purpose was measured by dropping the sample from a certain height using a funnel until the sample fell on a flat surface with a white manila cardboard. The diameter of the sample was measured by the flat part formed (Syamsu *et al*. 2015). The value of the angle of purpose is measured by the height (t) of the pile and the diameter of the base (d), then calculated by the formula:
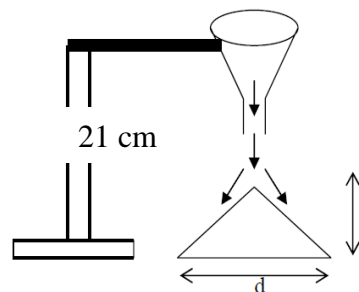
$$AP\ (tg\ \alpha) = \frac{2t}{d}$$

Figure 3. Angle of purpose measurement Method

Experimental Design and Data Analysis

The experimental design used was CRD (Completely Random Design) Factorial $2 \times 3 \times 3$ for physical test data. Factor A being pollard and rice bran and factor B being the position of the fraction (1/3 top, 1/3 middle, 1/3 bottom) and 3 replications.

The physical properties data obtained were analyzed using variance (ANOVA), if there was a significant difference, the data would be further tested with Duncan's test. Chemical test data in the form of moisture content, crude protein and crude fiber obtained were analyzed descriptively.

RESULTS AND DISCUSSION
Physical Properties of Pollard and Rice Bran

Evaluation of physical properties is one method of testing the quality of raw materials which is very important in formulating formulas, determining the quality and efficiency of the production process including processing, storing, and packaging food products in an industry. A physical evaluation is generally carried out in the first stage because this method is simple and applicable or does not require complicated chemicals and equipment. Some important physical properties, namely specific gravity, bulk density, compacted bulk density and angle of purpose. The data in Table 1 and Table 2 show that different materials will have different physical and

chemical properties. Raw materials cannot be compared with one another due to different chemical or nutrient components and physical characteristics.

Table 1. Physical properties of pollard

Pollard	BD (g L^{-1})	CBD (g L^{-1})	SG (kg L^{-1})	AP (^{o})
Before Fractionation	320.86 ± 1.06	433.51 ± 2.42	1.29	42.32 ± 0.13
After Fractionation				
Upper Fraction	350.67 ± 3.05b	520.01 ± 2.62b	1.28 ± 0.02b	44.35 ± 0.95b
Middle Fraction	338.39 ± 4.78c	493.83 ± 9.87c	1.12 ± 0.02c	41.81 ± 0.76c
Lower Fraction	386.47 ± 1.71a	537.28 ± 4.39a	1.42 ± 0.04a	46.98 ± 0.54a

Different letters in the same column indicate significant differences (P<0.05), BD: bulk density; CBD: compacted bulk density; SG: specific gravity; AP: angle of purpose.

Table 2. Physical properties of rice bran

Dedak padi	BD (g L^{-1})	CBD (g L^{-1})	SG (kg L^{-1})	AP (^{o})
Before Fractionation	352.95 ± 0.70	509.34 ± 0.71	1.29	40.53 ± 0.08
After Fractionation				
Upper Fraction	394.09 ± 4.75a	526.33 ± 1.60a	1.50 ± 0.00a	46.01 ± 0.51a
Middle Fraction	281.03 ± 5.05c	484.15 ± 3.37c	1.25 ± 0.00c	39.80 ± 0.29c
Lower Fraction	355.62 ± 1.99b	503.41 ± 1.76b	1.36 ± 0.00b	41.36 ± 0.28b
Rice Brand[1]	340.52	525.40	1.21	41.60
Rice Brand[2]	319.19	367.06	1.1	31.99
Rice Brand[3]	270 – 362.5	425 – 557.5	1.01 – 1.11	43.87 – 45.47
Rice Brand[4]	238.7 – 273.65	300.01 – 345.47	1.15 – 1.29	34.11– 42.92

Different letters in the same column indicate significant differences (P<0.05), [1]: Anita 2014, [2]: Maulana 2007, [3]: Irawan 2006, [4]: Aryono 2008, BD: bulk density; CBD: compacted bulk density; SG: specific gravity; AP: angle of purpose.

The values of BD, SG and AP pollard (Table 1) were higher than those of Irawan (2006) which were 293.75 g l^{-1}, 1.11 kg l^{-1} and 41.15^o. However, the value of pollard CBD before and after fractionation was lower than 443.75 g l^{-1}. The difference in the physical value of pollard and rice bran from the research results with the literature is caused by several factors, one of which is the difference in nutrient content. Problems that are often encountered in the milling process is separation bran tightly bound to the endosperm so that the help of mechanical forces and treatment the heat applied can cause endosperm rupture of various sizes. Endosperm damage during the process milling can provide yield low head rice, reduction of milling degree, as well as a decrease in nutritional components which exceeds the desired limit (Slamet and Aziz 2011).

The physical properties of rice bran before and after fractionation have different values from the literature. This is because the sources of rice bran used are not the same. Patiwiri (2006) stated that the diversity of rice bran is caused by rice varieties, milling or processing during grain drying. This can cause the quality of the obtained bran to vary (Tris *et al*. 2007). The rice milling process needs to be considered because the different settings and use of the machine will produce various qualities of rice bran. Sukria and Rantan (2009) added that the difference in the rice milling process has more influence on the quality of the bran compared to rice

varieties. White rice grain (Setra Ramos) has water content of 11.46%, brown rice grain (Inpari 24) has a moisture content of 11.05%, and unhulled rice Black (Cempo Ireng) contains a water content of 11.44%. The moisture content of the grain has met the standard level safe water for grain storage. Quality and the shelf life of grain is affected by the moisture content of the grain. The water content can affect the quality of milled rice generated. Damage to grain chemically, biochemically, and microbiology triggered by high water content (Aryunis 2012). Rice quality is influenced by the degree of milling. The high degree of milling will reduce the quality of rice because of the low level of milled rice produced and the percentage of broken rice produced. This quality has an influence on the level of public acceptance and purchasing power of rice. The high degree of grinding can affect the content the main nutrients of rice such as the digestibility of starch correlated with the fiber content of rice. Rice color will be brighter (white) with a higher degree of grinding high because of the color pigment in the outer layer of rice red and black rice wasted in large quantities (Aryunis 2012). Mechanical milling can reduce the content of vitamins B1, B2, B3, and B6 on brown rice (Indrasari 2011).

Table 3. Chemical properties (%DM)

	DM (%)		CF (%)		CP (%)	
	Pollard	Rice Bran	Pollard	Rice Bran	Pollard	Rice Bran
Before Fractionation	86.91	89.48	8.50	29.14	19.40	11.64
After Fractionation						
Upper Fraction	92.42	92.75	7.33	21.55	16.69	12.60
Middle Fraction	94.23	93.25	8.69	33.98	19.49	7.70
Lower Fraction	91.79	93.24	6.01	33.85	21.03	8.20

DM: dry matter; CF: crude fiber; CP: crude protein.

Bulk Density

The bulk densities of pollard before fractionation were 320.86 g l^{-1} and after fractionation 338.39 g l^{-1} until 386.47 g l^{-1}. The density value of the heap of rice bran before fractionation was 352.95 g l^{-1} and after fractionation was 281.03 to 394.09 g l^{-1}. The increase in KT after fractionation was due to different particle sizes. The particle sizes of pollard and rice bran before fractionation were 0.84 mm and 0.48 mm. The particle sizes of pollard and rice bran after fractionation were 0.67 mm and 0.32 mm, respectively. The value of the particle size of the material influences the value of the bulk density and the compacted bulk density (Damayanti *et al*. 2017). The particle size of the material after fractionation is smaller than before fractionation. According to Krisnan (2008), a material with a smaller particle size means that the volume of space it occupies will be smaller so that the CBD becomes larger. The material flow rate will increase with increasing BD values (Krisnan 2008).

The value of bulk density and rice bran quality can vary if there are foreign objects in the components of rice bran (Patiwiri 2006). A low BD value will require a larger space to store the material. In addition, the existing air voids will also increase the speed of material being contaminated by fungi if in the storage process less attention is paid to controlling water content, temperature and humidity. The air cavities present in materials that have an ether extract content will be able to increase the oxidation process so that the material will go rancid quickly, shorten the shelf life of the

material and decrease the quality of the material.

Further test results showed that there was a significant difference (P<0.05) in pollard and rice bran after fractionation. The difference is due to the separation of materials based on nutrient content (Table 3). The higher the crude fiber content, the lower of BD value. Ansor (2015) revealed that the BD is directly proportional to the protein content and inversely proportional to the crude fiber content.

Table 4. Correlation between physical properties of pollard after fractionation

Physical properties	BD	CBD	SG	AP
BD	1	0.900[**]	0.930[**]	0.917[**]
CBD		1	0.945[**]	0.960[**]
SG			1	0.939[**]
AP				1

BD: bulk density; CBD: compacted bulk density; SG: specific gravity; AP: angle of purpose, [**] : different (P<0.01).

Compacted Bulk Density

The compacted bulk density values for the pollard and rice bran before fractionation were 433.51 g l^{-1} and 509.34 g l^{-1}. up to 526.33 g l^{-1}. The increase in the value of the compacted bulk density is also due to the particle size. Smaller particle sizes when shaken or compressed will be better able to fill the space and easy to solidify so that the required volume will be less by materials with fine particles accompanied by shaking or shaking. According to Daud *et al*. (2013) the smaller the particle size of the wafer constituent material, the wafer density value will increase and vice versa.

The middle and lower fractions of rice bran after fractionation showed the presence of a mixture of husks. A husk which has a high crude fiber content has a low cohesive force so that the bonding power between particles is low which causes the given shock to not be able to suppress the material to become denser so that it will reduce the value of the CBD. The CBD value of pollard and rice bran after fractionation was significantly different (P<0.05) in each fraction. This is due to differences in nutrient content (Tables 3 and 4). The compacted bulk density value has a negative correlation with crude fiber and a positive correlation with crude protein (Ansor 2015).

Specific Gravity

The specific gravity values of pollard and rice bran before fractionation were 1.29 kg l^{-1} and after fractionation were 1.12 kg l^{-1} to 1.42 kg l^{-1} and 1.25 to 1.50 g l^{-1}. Bulk density based on fraction showed a significant difference (P<0.05). The difference is due to differences in the chemical or nutrient content of the ingredients in each fraction, especially crude fiber and crude protein (Tables 3 and 4). According to Ansor (2015), specific gravity has a positive correlation with crude protein and a negative correlation with crude fiber. This is also related to the greater protein molecular weight compared to crude fiber. According to Cecep *et al*. (2015) the lower the value of the specific gravity of rice bran, the higher the husk content is suspected. According to Khalil (1999a), specific gravity affects the homogeneity of particle distribution and stability in a mixture of processed food products. In the food industry such as biscuits, specific gravity also greatly determines the level of accuracy in the automatic dosing process such as the packaging process and the process of removing materials from the silo to be mixed.

Angle of Purpose

The purpose angle values of pollard and rice bran before fractionation were

42.32º and 40.53º. The AP of pollard is higher than that of rice bran because the crude fiber content of rice bran is 29.14% higher and pollard crude fiber is 8.50%. The AP of pollard and rice bran after fractionation were 41.81º to 46.98º and 39.80º to 46.01º. Duncan's further test results showed a significant difference (P<0.05) in the stack angle parameter of each fraction. Differences in crude fiber and crude protein content of rice bran resulted in changes in the value of the AP. The AP has a negative correlation with crude fiber content and a positive correlation with crude protein (Ansor 2015). The AP indicates the characteristics of the material when it moves freely. The higher the value of the stack angle, the less free the particles to move (Khalil 2006). The value of the AP will increase with the increase in the moisture content of the material (Baryeh 2002). According to Fasina and Sokhansanj (1993), there are several AP based on the shape of the material. Liquid material has a stack angle of 0°, very easy to flow 20-30°, easy to flow 30-38°, medium/medium 38º-45°, difficult to flow 45º-55° and very difficult to flow >55°. The angle of purpose affects the flow rate of a material, namely when transporting and unloading using a tractor or conveyor.

Table 5. Correlation between physical properties of rice bran after fractionation

Physical properties	BD	CBD	SG	AP
BD	1	0.957**	0.970**	0.881**
CBD		1	0.989**	0.962**
SG			1	0.967**
AP				1

BD: bulk density; CBD: compacted bulk density; SG: specific gravity; AP: angle of purpose, **: different (P<0.01).

Chemical Properties of Pollard and Rice Bran

The crude fiber content of pollard before fractionation used was 8.5% and after fractionation was 6.01% to 8.69% (Table 3). The crude fiber content of pollard according to Arditya (2010) is 5 to 8.81%. This is due to the different molecular weights between pollard particles so that the particles will separate and have different falling or settling times. The crude protein content of pollard before fractionation was 19.40% higher than that of wheat bran protein according to Balderok *et al*. (2000) which is about 16%.

The crude fiber content of rice bran before fractionation is 29.14% crude fiber content. The crude fiber value of research bran is high compared to crude fiber, according to Rasyaf (2004) which is 26.8% and according to Hana (2015) which is 8.69%-13.06%. The main carbohydrates in rice bran is hemicellulose (8.7-11.4%), cellulose (9-12.8%), starch (5-15%) and β-glucan (1%). The rice bran used in this study did not fall into the criteria for rice bran according to the crude fiber content of SNI (2001) with a maximum of 11% (quality I), 14% (quality II) and 16% (quality III) and was included in rice bran. quality I according to SNI (2001) with a minimum crude protein content of 11% (quality I), 10% (quality II), 8% (quality III). The crude protein content of rice bran research is 11.64% lower than the crude protein of rice bran according to Sukria and Krisnan (2009) which is around 12.7%-13.5%, higher than crude protein according to Ansor (2015) which is 9.32%-10.175 and falls into the protein range rice bran research results by Hana (2015) which is around 11.16%-13.90%. Grain milling affects the nutritional content of rice and rice bran.

The variety is one of the factors that determine the quality of the bran because the protein and crude fiber content is determined by the diversity of the physical and chemical properties of the grain, mainly due to genetic

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factors carried by rice varieties and the environment. If the soil fertility is in accordance with the rice growing media, it will produce good bran production and nutrient quality (Ishaq *et al*. 2001). The content and crudeness of pollard and rice bran after fractionation have differences in each fraction. The falling time of the particles is determined by the molecular weight and chemical properties of the material, one of which is the level of polarity, which causes the separation of particles with different nutrient content. High polymers including plastics, rubber and fibers have a molecular weight of 104-106 (Sari 2018). Pollard crude fiber and rice bran in the middle fraction were 8.69% and 33.98% higher than the lower fraction, namely 6.01% and 33.85%, respectively. It was found that there were many husk components mixed into the middle fraction which caused the high crude fiber content. The high crude fiber content is caused by the silica and lignin contained in the husks (Telew *et al*. 2013). According to research Adibrata (2001), husk contains 40% cellulose and 30% lignin. Lignin has a low molecular weight resulting in a longer fall time. This causes the crude fiber content of the middle fraction to be higher than the lower fraction because the falling time of the particles in the middle fraction is longer than the lower fraction.

The decrease in crude fiber content will be accompanied by an increase in crude protein. The results are based on the nutrient distribution scheme according to proximate analysis, if there is an increase in the value or percentage of protein content, there will be a decrease in the content of the extract without nitrogen which will then result in a decrease in the percentage of crude fiber (McDonald *et al*. 1995). The crude protein content of pollard from the upper, middle and lower fractions increased respectively, namely 16.69%, 19.49% and 21.03%. This is because the value of the molecular weight of the material that has a higher protein content will decrease or settle more quickly. Saade and Siti (2009) showed that the higher the protein content in fish feed, the higher the sinking speed due to the high protein molecular weight, which is around 5000 to one million (Poedjiadi 1994). In addition, pollard contains more non-polar amino acids such as glycine and leucine, and is deficient in several polar amino acids such as lysine. Amino acids that are non-polar when put into water will not form bonds between amino acids and H_2O so that materials with high amino acids or proteins will settle more quickly. The solubility of materials with non-polar amino acids also cannot be affected by their solubility in water because they are hydrophobic. The molecular weights of the amino acids glycine and leucine were 75.07 and 131.18 g mol^{-1}, and the molecular weights of lysine were 182.65 (Mutia *et al*. 2014). Although the molecular weight of lysine is large, lysine has a bond with water so that the solubility of the material will occur which can reduce the weight of the material. This causes materials with polar amino acid content to decrease longer.

The results of rice bran fractionation had the highest protein content in the upper fraction and decreased in the next fraction, namely 12.60%, 7.70% and 8.20%. Based on the physical observation of the fractionated bran, the upper fraction found a white fine powder which is a fraction of rice. This causes the protein content of the fraction of rice bran to have a high protein content. This decrease was also due to an increase in crude fiber content in the middle and lower fractions. In addition, the solubility of the material in water also affects the protein content of rice bran. Rice bran has a limiting amino acid or is deficient in the amino acid methionine (Suprayogi *et al*. 2009). The amino acid methionine is nonpolar or hydrophobic with a molecular weight of 149.21 g mol^{-1} (Mutia *et al*. 2014). This

causes other polar amino acids in rice bran to form hydrogen bonds so that it will slow down the downtime and the precipitation of rice bran which contains higher protein. Dias *et al*. (2011) explained that rice bran contains hydrophilic gluten. Materials that contain protein and are dissolved in a liquid will certainly have a viscosity value. The viscosity of a protein solution depends on the type of protein, molecular shape, concentration and temperature of the solution (Soedarmo and Sediaoetama 1987). This causes the crude protein content in the upper fraction to be higher than the middle and lower fractions.

Correlation between Pollard and Rice Bran Physical Properties

The value of physical properties is important to know because it will affect the logistics and production processes in the industry. Aspects of the physical properties of materials that are important to know to optimize the production process are bulk density, compacted bulk density, specific gravity and angle of purpose. These four aspects have a relationship with each other in the production process. The magnitude of the correlation value produced between the two materials is influenced by the physical characteristics produced so that different materials will produce different correlation values. Table 4 shows the correlation values between the physical properties of the pollard resulting from the fractionation.

The correlation results of all physical parameters were significantly different (P<0.01) and had a positive correlation with other physical parameters. This shows that the higher the value of a certain parameter, the other physical parameters will also increase. This value will change if there is a change in the component or chemical content in the material and the particle size of the material is not uniform. The pollard resulting from the fractionation has a particle size of

0.67 ± 0.09 mm. Each material has different physical and chemical characteristics so that it will produce different correlation values. The correlation between the physical properties of fractionated rice bran is shown in Table 5. Rice bran which has almost the same characteristics as pollard also showed significantly different results (P<0.01) on all parameters and positively correlated between physical parameters.

The correlation value of bulk density with all physical test parameters shows a positive correlation and a very significant value. This shows that the higher the bulk density value, the higher the compacted bulk density, specific gravity and angle of purpose will be. All parameters of the physical properties of the fractionated rice bran that have very significant different correlation values are also due to the particle size of the rice bran in the upper, middle and lower fractions being the same, namely 0.32±0.03 mm.

Specific density has a very significant effect on bulk density, compacted bulk density, and angle of purpose. The higher the specific gravity, the higher the bulk density, compacted bulk density, and angle of purpose. The increase in SG will affect the increase in the value of BD, CBD and AP (Mujnisa 2007). The higher the bulk density, the higher the compacted bulk density (Khalil 1999a) and the angle of purpose, because the measurement method used is almost the same as the CBD, only different in the compaction process. The CBD has a very significant effect on the angle of purpose. The higher the BD, the higher the resulting AP (Khalil 1999b).

Rice bran and pollard have the potential to be processed into edible oil by a stabilization process (Hasnelly *et al.* 2020). On rice bran rich in nutrients that are beneficial for human health. Inside the bran can found dietary fiber, fatty acids do not

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saturated, sterols, proteins and minerals (Made and Andi 2010).

CONCLUSION AND SUGGESTIONS
Conclusion

The physical properties of pollard and fractionated rice bran generally improved in quality. The fraction that has the best physical and chemical quality is the lower fraction for pollard and the upper fraction for rice bran. The middle fraction has the highest crude fiber content, so it has the potential to be a raw material for making high fiber processed food.

Suggestion

Further research is needed to use more by-products from various agricultural commodities and their diversity in several regions in Indonesia due to fluctuations in the quality of rice bran caused by differences in rice bran varieties and soil conditions and a more complete proximate analysis is needed. The fractionation method is applied on an industrial scale with dry fractionation and testing of the resulting fractionated material for making biscuits in patients with degenerative diseases.

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