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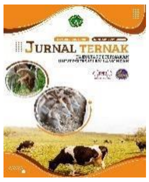

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Determination of Physical and Chemical Quality of Rice Bran in Malang City and Regency, East Java

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ABSTRACT

Rice bran is a by-product of milling grain into rice. Rice bran is an energy source feed ingredient that is used in both poultry and ruminant feed. The availability of rice bran in Indonesia is very abundant, but the quality varies greatly and is prone to counterfeiting. Chemical testing of rice bran quality is less economical for farmers to apply. One simple quality test to estimate the chemical quality of rice bran in the field is to use physical properties (bulk density, tapped density, true density, angel of repose). This research aims to evaluate the physical and chemical quality of rice bran in Malang City and Regency, East Java, and to create a chemical quality estimation model in the form of crude protein and crude fiber of rice bran through regression analysis and correlation of physical test results. The research results show that bulk density, tapped density, true density, and angle of repose in Malang City and Regency are very diverse. The quality of rice bran in Malang City and Regency, East Java varies greatly. Eleven sub-districts do not have quality rice bran. The physical properties of rice bran in the form of bulk density, tapped density, true density, and angel of repose are highest in Klojen District and the lowest in Pakis District. The highest crude protein content in rice bran is in Klojen District, whereas the lowest crude protein content in rice bran is in Pakis District. The correlation between crude protein and crude fiber on bulk density, tapped density, true density, and angle of repose is very close.

Keywords: Rice Bran, Physical Properties, Crude Protein, Crude Fiber, Malang

1. Introduction

Rice bran is a feed ingredient that provides energy for livestock, both poultry and ruminants. Rice bran is a good energy source for poultry with a metabolic energy content of 2800-3200 kcal/kg [1]. Rice bran is a by-product of the rice milling process, namely the epidermis [2]. Rice bran represents 5-12% of the total kernel and consists of the outer layer of the grain consisting of the pericarp, tegmen, and aleurone layer [3] [4]. Rice bran has good nutrient content, namely carbohydrates (34–52%), fat (15–22%), protein (10–16%) and fiber (7–11%) [5]. Apart from that, rice bran contains bioactive compounds

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that have the potential to act as antioxidants [6]. The availability of rice bran is very abundant in Indonesia, namely the average production in 2021 is 54.42 million tons of dry milled grain (GKG) with an average harvest area reaching 10.41 million hectares [7]

One area that has great potential for developing rice bran production is Malang, East Java. The potential rice harvest in Malang Regency in April 2021 is 6441 hectares with an estimated production of 45674 tonnes of milled dry grain and the potential rice harvest in May is 4829 hectares with an estimated production of 34243 tonnes of milled dry grain. The average price of grain in Malang Regency is quite good, namely above the government purchasing price. Where dry grain is harvested Rp. 4600 and ground dry unhulled Rp. 5600 per kilogram [8]. Based on this data, the rice bran production that can be produced can reach 4567 tons. This is in accordance with data from the Central Statistics Agency (2022) which states that the estimated national production of rice bran is around 2500 – 4500 tons [8].

The demand for rice bran continues to increase every year but is not matched by production. A lot of agricultural land has been converted into residential land so the amount of rice production will continue to decline, which has an impact on reducing the amount of rice bran. Adulteration of rice bran is often done to increase its quantity to meet consumer demand. Rice bran adulteration can be done by mixing husks, sawdust, and corn cobs [9]. The impact of adulterated rice bran is an increase in crude fiber levels which can disrupt the digestive tract and cause death in livestock, especially poultry [2] [3].

One effort to detect rice bran adulteration can be made by carrying out physical tests and adulteration tests with phloroglucinol. Rice bran adulteration can be detected by measuring its density. Rice bran adulteration will increase the amount of fiber in rice bran which is characterized by its voluminous properties. Adulteration testing with the phloroglucinol drop test can also be carried out to detect the crude fiber content of rice bran. Apart from detecting adulterated rice bran, physical tests can also be used to estimate the nutrient value of rice bran. Through physical analysis, the nutrient content of feed ingredients can be estimated [12]. Crude fiber has bulk or voluminous properties, while protein has condensed properties because amino acid compounds have a large molecular weight [13]. Based on this background, this research was carried out to evaluate the physical and chemical quality of rice bran in Malang City and Regency, East Java, and create a model for estimating the nutrient content (crude protein and crude fiber) of rice bran through regression analysis and correlation of physical test results.

2. Method

The research was conducted in Malang City and Malang Regency, East Java, Indonesia. Testing of rice bran samples at the Integrated Food Laboratory of the Islamic University of Malang. This research will be carried out for 3 months, namely September – December 2022. Rice bran samples were taken randomly from 11 sub-districts in Malang City and Regency. Rice bran samples were taken at markets and rice bran mills in each sub-district were selected as samples. The samples that have been collected are subjected to physical testing (bulk density, tapped density, true density, angel of repose) and chemical testing, namely protein and crude fiber content tests.

Bulk density (BD) Test

The bulk density test was carried out by weighing 100 g of rice bran and placing the rice bran in a measuring cup with a volume of 250 ml. Observe the volume occupied by the rice bran in the measuring cup. The BD value calculation is carried out using the following formula:

$$Bulk\ density = \frac{\text{Rice Bran Weigh}}{\text{Rice Bran Volume}} x\ 100$$

Tapped density (TD) Test

The tapped density test was carried out by weighing 100 g of rice bran and placing the rice bran in a 250 ml measuring cup. After that, the rice bran is compacted by banging and shaking the measuring cup. TD calculation using the following formula:

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$$Tapped\ density = \frac{\text{Rice Bran Weigh}}{\Delta\ \text{Rice Bran Volume}} x\ 100$$

True density (TrD) Test

The true density test is carried out by weighing 100 g of bran and placing it in a measuring cup containing 200 ml of water. After that, observe changes in the volume of water in the measuring cup. The TrD calculation is carried out using the following formula:

$$True\ Density = \frac{\text{Rice Bran Weigh}}{\Delta\ \text{water Volume}} \text{x } 100$$

Pengukuran *Angel of repose* (AR)

Angel of repose was measured by flowing 100 ml of rice bran into a funnel at a height of 15 cm. Then, measure the diameter and height of the rice bran. The AR value is obtained using the formula:

$$\text{Tg}\ \alpha = \frac{\text{t}}{0.5 \text{ x d}}$$

The angle of repose test is illustrated in the following figure:

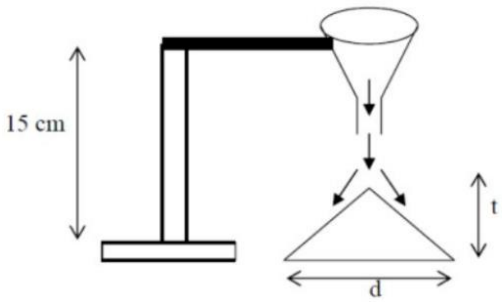

Figure 1. Process of measuring angle of repose

Rice Bran Chemical Quality Testing

Testing the chemical quality of rice bran is carried out using proximate testing to measure the protein and crude fiber content of rice bran. Proximate testing was carried out using the AOAC 2005 method. Crude protein testing was done using the Kjeldahl method and crude fat testing was done using Soxhlet.

Experimental Design and Data Analysis

The experimental design used in this research was a completely randomized design (CRD). The statistical analysis used is analysis of variance (ANOVA), regression and correlation analysis to find the relationship between the physical and chemical quality of rice bran and the regression model. After carrying out the ANOVA test, if significantly different data is found, the Duncan test is carried out.

3. Results and Discussion

3.1 Physical quality of rice bran

Testing the physical quality of rice bran is very important to do. Physical quality testing is a method that is very simple, easy to carry out, does not require large costs for analysis and can describe the quality of bran before it is used as animal feed. Physical tests can also be carried out to estimate the chemical quality of rice bran. The physical quality of rice bran between sub-districts in Malang City and Regency is very significantly different ($P<0.01$). Data on the physical quality of rice bran in Malang City and Regency are presented in Table 1.

Table 1. Data on the physical quality of rice bran in Malang City and Regency

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Location	*Bulk density* (BD) (g/L)	Taped Density (TD) (g/L)	*True density* (TrD) (g/L)	*Angel of repose* (AR) (º)
Klojen	372.62 ± 3.45a	488.27 ± 1.16a	1.74 ±0.01a	62.17 ±0.20a
Karang Ploso	346.89 ± 3.11b	456.58 ± 0.45b	1.67 ±0.02b	61.51 ±0.61a
Blimbing	323.29 ± 4.91c	433.72 ± 2.38c	1.46 ± 0.02c	60.40 ±0.49b
Tumpang	322.44 ± 3.04c	430.95 ± 1.32cd	1.48 ± 0.04c	59.53 ±0.28b
Sukun	321.92 ± 3.43c	428.11 ± 1.34d	1.47 ± 0.02c	56.77 ±1.95c
Lawang	313.67 ± 3.32d	423.06 ± 6.10e	1.19 ± 0.01d	54.44 ±1.19d
Jabung	311.86 ± 3.85e	421.38 ± 1.67e	1.09 ± 0.01e	53.57 ±1.01d
Singosari	291.99 ± 1.19e	412.63 ± 0.24f	1.08 ± 0.02e	50.08 ±0.11e
Kepanjen	284.69 ± 8.19e	410.79 ± 0.97f	1.07 ± 0.02e	49.84 ±0.37ef
Lowok Waru	215.05 ± 7.42f	400.43 ± 3.29g	1.03 ± 0.03f	49.41 ±0.38ef
Pakis	191.59 ± 6.47f	328.83 ± 0.56h	1.00 ± 0.01f	48.84 ±0.19f

The notation shows that the results are very significantly different (P<0.01)

Bulk density

BD measurements are used to determine the volume of storage space for materials of a certain weight. The higher the stack density value, the smaller the storage space required [14]. The lower the BD value indicates the greater the voluminous nature of a feed ingredient. The BD of rice bran between sub-districts in Malang City and Regency was very significantly different (P<0.01). This shows that the physical quality of rice bran in Malang City and Regency is very diverse. This diversity is an indication of counterfeiting in various areas in Malang City and Regency. The highest BD of rice bran was in Klojen District and the lowest was in Pakis District. During the processing process, rice bran in Pakis District is added to a mixture of pandan leaves. The addition of pandan leaves is done so that the resulting bran has a fragrant aroma and covers the rancid smell of the rice bran. The addition of pandan leaves will make the mixture more bulky or voluminous. This addition will also increase the crude fiber value of the bran.

The lowest BD value in this study was 191.59 g/L while the highest was 372.62 g/L. This BD value is lower than the research results of Zhang et al (2012), namely 331.24–380.54 g/L. A low BD value indicates low quality of rice bran [15]. Several factors can influence the quality of rice bran, including foreign body components. According to Ridla et al (2022), adulterating bran with corn cobs can reduce the BD value very significantly (P<0.01), namely from 286.53 g/L to 263.86 g/L [9].

Tapped density

The comparison between the weight of the feed material and the volume of space occupied after compaction will produce a TD value (Jaelani et al. 2016). The BP results in this study were 328.83 – 488.27 g/L. These results are smaller than the results of research by Lavanya et al. (2017) which states that normal BP for rice bran is 500 g/L [17]. This low TD value shows that the physical quality of rice bran in Malang City and Regency is classified as poor.

The research results showed that the BP of rice bran between sub-districts in Malang City and Regency was very significantly different (P<0.01). This difference is caused by various factors. Factors that influence the taped density of rice bran are rice varieties, topology of the rice planting area, type of rice milling machine and adulteration of rice bran with foreign objects such as husks, sawdust, corn cobs and peanut shells [18][19]

The research results showed that the best BP value for rice bran was in Klojen District, namely 488.27 g/L and the lowest was in Pakis District. The high TD value in Klojen District is because the texture of the rice bran in Klojen District in this study is very smooth so it easily occupies space and becomes compacted. Rice bran from Pakis District is very bulky and easily clumps. This happens because of the mixture of pandan leaves and water.*True density*

The TrD measurement principle uses Archimedes' principle. Measuring the density of a material is based on the comparison of the mass or weight of the material with the change in water

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volume after adding a material to it [20]. In this TrD measurement, the characteristics of sinking and floating rice bran will be known. The more crude fiber in rice bran, the more it will float. The nature of crude fiber is voluminous or bulky, so that during the soaking process in water, a lot of it will float and the volume change will be large. The lower the TrD value indicates the more voluminous a material is [9]. TrD measurements can also be used to determine the homogeneity of mixing a feed ingredient, the more homogeneous an ingredient is, the greater the TrD value [20][21[.

Based on research data, the TrD values are very significantly different (P<0.01). The difference in values indicates that the quality of rice bran is very heterogeneous. It is very necessary to select and evaluate rice bran before using it as a feed ingredient. Poor quality rice bran will cause problems with the digestive tract health of livestock, especially poultry. Poultry livestock are very sensitive to high levels of crude fiber in feed ingredients.

Angel of repose

Angel of repose is a physical test method carried out to determine the flow rate of feed ingredients. The flow rate of feed ingredients is related to the molecular weight of the constituent ingredients. According to Nafisah and Nahrowi (2021) that the AR of a material is influenced by the water content of the material, the shape and size of the particles and the compounds that make up the material. In this study, it was found that rice bran between sub-districts in Malang City and Regency was very significantly different (P<0.01) [20].

The real differences in rice bran in Malang City and Regency indicate variations in the quality of rice bran and high levels of rice bran adulteration. Rice bran adulterated with other ingredients that have a high fiber content will produce a low AR value. According to Ridla et al (2021), the addition of higher amounts of corn cobb to rice bran will result in a smaller AR value. The smaller the angle formed, the higher the crude fiber content [9]. The high level of crude fiber in feed ingredients will inhibit the flow rate of feed ingredients.

3.2 Chemical Quality of Rice Bran

Chemical quality is very important in feed raw materials such as rice bran. The chemical quality testing carried out in this research was testing the nutrient content through proximate analysis. Differences in the chemical quality of rice bran were very significant (P<0.01) in each sub-district in Malang City and Regency. Data on the average chemical quality of rice bran in Malang City and Regency are presented in Table 2. According to SNI 3178-2013 concerning Rice Bran Quality Levels, there is no location that produces rice bran with Quality I, namely with a minimum crude protein content of 12% and a maximum crude fiber content. 12%.

Crude protein and crude fiber of rice bran in Malang City and Regency were very significantly different (P<0.01). The best crude rice bran protein is found in Klojen District, namely 11.08% and the lowest crude rice bran protein content is in Pakis District, 7.06%. The higher protein content in rice bran can be caused by the optimal milling process in separating the aleurone part so that it can join the rice bran [22].

The crude fiber of rice bran samples obtained from Pakis District was the highest compared to all treatments. Rice bran samples in Pakis District were added or adulterated with pandan leaves. The addition of pandan leaves is done with the aim of improving the aroma of rice bran but will change the nutrient composition of rice bran. The addition of pandan leaves causes an increase in the crude fiber value and a decrease in the protein value of pandan leaves. View leaves are very low in protein, namely 1.3 mg/100 g and high in fiber, namely 3.5 g/100g [23]. The addition of pandan leaves will increase the crude fiber content of the feed and will also reduce the crude protein content of the feed. Differences in the nutrient content of rice bran are influenced by several factors such as the type of milling machine, grain quality, rice processing process and also rice bran adulteration [9]. A decrease in the quality of feed ingredients can be caused by damage to feed [24] as a result of storage and logistics as well as pollutants for adulteration [25].

Table 2. Average chemical quality of rice bran in Malang City and Regency

Location	Crude Protein (%)	Crude Fiber (%)
Klojen	11.08 ± 0.64a	16.17 ± 0.20e

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Karang Ploso	10.17 ± 0.23b	14.32 ± 0.02a
Blimbing	10.08 ± 0.07b	14.97 ± 0.04b
Tumpang	10.07 ± 0.02b	15.35 ± 0.41c
Sukun	10.03 ± 0.02b	15.53 ± 0.26cd
Lawang	9.16 ± 0.15c	15.70 ± 0.45d
Jabung	9.10 ± 0.13c	16.49 ± 0.02f
Singosari	9.07 ± 0.04c	17.03 ± 0.09g
Kepanjen	8.16 ± 0.12d	17.25 ± 0.18gh
Lowok Waru	7.93 ± 0.08d	17.48 ± 0.29h
Pakis	7.06 ± 0.13e	18.22 ± 0.22i

Notasi menunjukkan hasil yang berbeda sangat nyata (P<0.01)

3.3 Corelation Between Physical and Chemical Quality Of Rice Bran

Estimating the nutrient quality or chemical content of rice bran can be done by physical testing. Table 3 shows that there is a very strong correlation between the physical and chemical properties of rice bran in Malang City and Regency.

Tabel 3 Corelation Between Physical and Chemical Quality Of Rice Bran

	Corelation Coeficient (r^2)	Determination Coeficient (r)	Regresion Models
Crude Protein - *Bulk density*	0.925**	0.855	Y = 41.534x - 85.125
Crude Protein - *Tapped density*	0.902**	0.814	Y = 29.41x + 148.89
Crude Protein - *True density*	0.889**	0.790	Y = 0.2017x - 0.5704
Crude Protein - *Angel of repose*	0.897**	0.805	Y = 3.9227x + 18.804
Crude Fiber - *Bulk density*	-0.775**	0.600	Y = -34.49 x + 859.33
Crude Fiber - *Tapped density*	-0.796**	0.485	Y = -22.509x + 786.6
Crude Fiber - *True density*	-0.783**	0.613	Y = -0.1762x + 4.1575
Crude Fiber - *Angel of repose*	-0.842**	0.709	Y = 2209x – 160.2

** showed very significantly different results (P<0.01)

The quality of nutrients in the form of crude protein and crude fiber in rice bran can be estimated from its physical properties, namely bulk density, tapped density, true density, and angle of repose (Wibowo 2010). This estimation technique is one way to determine the quality of rice bran in the field. Table 3 shows that the correlation between physical properties and different chemical properties is very significant (P<0.01). This is supported by Achmad (2016) who states that the physical properties in the form of angel of repose have a close relationship with crude protein and crude fiber [27]. Based on statistical analysis, the highest correlation is the correlation between crude protein and bulk density (r2 = 0.925), whereas the lowest correlation is between crude fiber and bulk density (r2 = 0.775).

The correlation coefficient (r2) between crude protein and the physical properties of rice bran produces a positive correlation. This explains that the higher the physical properties, the higher the crude protein content of rice bran. On the other hand, a negative correlation value was produced between the relationship between crude fiber and the physical properties of rice bran. The lower the physical properties of rice bran, the higher the crude fiber. The same results were shown in Rosalina's (2014) research, the addition of peanut shell flour to rice bran will cause a decrease in the values of bulk density, tapped density, and angle of repose [28]. The strongest mathematical equation is between crude protein and bulk density (r = 0.855), while the equation that has the lowest coefficient value is between crude fiber and tapped density (r = 0.485).

4. Conclusions

The quality of rice bran in Malang City and Regency, East Java varies greatly. Eleven sub-districts do not have quality rice bran. The physical properties of rice bran in the form of bulk density, tapped density, true density, and angel of repose are highest in Klojen District and the lowest in Pakis District.

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The highest crude protein content in rice bran is in Klojen District, whereas the lowest crude protein content in rice bran is in Pakis District. The correlation between crude protein and crude fiber on bulk density, tapped density, true density, and angle of repose is very close.

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