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# Application of the Analysis Model for Estimating the Nutrient Content of Feed Ingredient: A Case Study of Rice Bran

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**ABSTRACT.** In rural areas, farmers face a significant challenge due to the lack of access to chemical analysis for feed ingredients. Therefore, there is a need for a new approximate analysis model that is lightweight and easy to apply. This study aimed to address this issue by utilizing bulk and tapped density analysis to estimate the composition of rice bran samples collected from 30 rural rice mill factories across 3 districts in Indonesia. The study used a correlation formula between bulk density values and tapped density values to estimate the crude protein and crude fiber contents of the samples. The study's results revealed significant variations ($p<0.05$) in the quality of rice bran due to various factors. Crude protein content significantly differed ($p<0.05$) across districts, with Bogor and Bandung having the highest values and Cirebon the lowest. Tapped density measurements generally yielded higher crude protein content values. Similarly, there were variations ($p<0.05$) in crude fiber content across districts and locations, with Cirebon having the highest values and Bogor the lowest. Tapped density measurements generally resulted in higher crude fiber content values, but there were significant variations observed in different districts and locations. The rice bran from the Bogor region showed indications of being of higher quality, with higher crude protein and lower crude fiber content compared to the other two regions.

Keywords: Density, correlation, crude fiber, crude protein, estimation

## INTRODUCTION

In rural areas, the lack of access to chemical analysis for feed ingredients poses a significant challenge for farmers. The only commonly used method relies on physical characteristics like texture, color, and odor, which are highly subjective and dependent on the farmer's experience (Nugroho et al., 2022). Consequently, there is a pressing need for a new approximate analysis model that is lightweight and easy to apply in rural settings. One method that has been reported to be easy to apply is by weighing physical properties such as bulk and tapped density. The values of bulk density (BD) and tapped density (TD) were reported to have a high correlation with the chemical composition of rice bran. such as crude protein and crude fiber contents (Ridla et al., 2022). Therefore, without the need for chemical analysis, by weighing BD and TD, the crude protein and crude fiber contents of rice bran can be estimated.

The development of an approximate analysis model that is easy to apply and does not require chemical analysis is crucial in rural areas where resources may be limited. This approach can help farmers to produce and use feed ingredients with proven nutritional value, which can lead to improved livestock productivity and better profits. Moreover, this model can be developed for use with other feed ingredients and can be used by farmers to make informed decisions about their farming practices.

The objective of this experiment was to demonstrate the use of the correlation formula developed by Ridla et al. (2023a) between the BD and TD values and the crude protein and crude fiber contents of rice bran samples obtained from 30 selected rural rice mill factories in the Bogor, Bandung, and Cirebon districts of Indonesia. These three areas were chosen as representative locations with medium (Bogor), high (Bandung), and low (Cirebon) elevations above sea level, which also correspond to medium, cool, and hot temperature zones, respectively.

## MATERIALS AND METHODS

### Sample preparation

The rice bran samples were collected from 30 selected rural rice mill factories located in Bogor, Bandung, and Cirebon Districts, West Java Province, Indonesia. Four replicates of rice bran samples were taken from each rural mill factory at different times, with each replicate consisting of 1-2 kg of rice bran. The collection process recorded all types of machines and systems used in milling, as well as the varieties of rice that were grown.

### Bulk and Tapped Density Analysis Methods.

The measurement of bulk density and tapped density was conducted by pouring 100 g of the sample into a 250 ml measuring glass to determine the volume of space occupied before (Bulk) and after (Tapped) the sample was tapped for 10 minutes. The bulk density (BD) was calculated as the mass of the material (g) divided by the volume of space occupied (L). The tapped density (TD) was determined by dividing the mass of the material (g) by the final volume after compaction (L). The estimation of crude protein and crude fiber composition was calculated using the regression equation of bulk density and tapped density (Table 1) against crude protein and crude fiber, based on previous Ridla et al. (2023a) research.

Table 1. Regression equation formula of bulk density and tapped density against crude protein and crude fiber.

| Correlation | Equation formula |
|---|---|
| Bulk density against crude protein | y = 0.026x + 2.9676 |
| Tapped density against crude protein | y = 0.0235x - 0.0496 |
| Bulk density against crude fiber | y = -0.0642x + 31.514 |
| Tapped density against crude fiber | y = -0.0576x + 38.861 |

### Statistical Analysis

Collected rice bran samples from Bogor, Bandung, and Cirebon Districts (each consisting of 10 rural rice mill factories, with each factory serving as a treatment group and replicated four times). Each District sample was calculated separately, for the analysis of physical parameters, including bulk density, tapped density, estimated crude protein, and estimated crude fiber. A Completely Randomized Design (CRD) was used for the analysis of variance (ANOVA), and if significant differences were found, further analysis was conducted using Duncan's test.

## RESULTS AND DISCUSSION

### Machine types and rice varieties

Table 2 presents a comprehensive overview of the different brands of rice milling machines utilized in rice mill factories for the purpose of husking and polishing. These brands include Dai Ichi, Echo, Agrindo, Yanmar, Iseki, Crown, and Dongfeng. The machines can be categorized into two types based on their completeness: the simple type and the complete type. The complete type is typically found in larger rice mills and includes a rice cleaning machine, a rice husker, a rice separator, a rice whitener (polisher), a shifter, a grader, and other machines. Elevators are used to facilitate the transfer of materials from one machine to another. On the other hand, smaller and simpler rice mills, known as "one-pass" rice mills, perform three basic processes using gravity in a top-to-bottom approach: husking, bran separation, and polishing (Hasbullah and Dewi, 2009; Patiwiri, 2006).

Aside from the rice milling machine factor, the quality of rice bran is also influenced by the rice variety. Common rice varieties found in 30 rural areas of rice mill factories in the Bandung, Bogor, and Cirebon districts include Ciherang, Mentik wangi, Pandan wangi, IR64, Sticky rice, Mekongga, Jembar, Midun, Sidomuncul, Hawara Garut, Masdas, and Malaya. Different rice varieties have varying shapes and sizes of milled dry grains, which may affect the efficiency of the milling process and the quality of the resulting rice bran. Several studies have shown that the physical and chemical properties of rice bran vary depending on the rice variety (Ilias et al., 2020; Akbarillah et al., 2007; Sartika and Ramdhani, 2018).

Table 2. Combination of husker and polisher machine types in each rice mil and the rice varieties used selected rural rice mill factories

| Machine types and brand | | | Rice Varieties |
|---|---|---|---|
| Husker | Polisher | Polishing (times) | |
| Bogor District | | | |
| Lm24, Iseki, and Yanmar | Dai Ichi n70 | 2 - 3 | Ciherang, Inpari, IR64, Pandan wangi, and Mentik wangi |
| Bandung District | | | |
| Iseki, Agrindo, Lm24, and Yanmar | Dai Ichi n50 and Agrindo | 1 - 2 | Ciherang, Inpari, IR64, Pandanwangi, Mekongga, Jembar, Midun, Sidomuncul, Hawara Garut, and Masdas |
| Cirebon District | | | |
| Dai Ichi, Agrindo, Crown, and Yanmar | Dai Ichi n50, Echo, and Crown | 1 - 2 | Ciherang, Mentik wangi, Pandan wangi, IR64, Sticky rice, and Malaya |

**Bulk density and Tapped density.**

Based on Table 3, the bulk density (BD) and tapped density (TD) of rice bran samples obtained from 10 rural rice mill factories in Bogor District, found that the highest BD value of 377.62 ± 12.79 g $L^{-1}$ was obtained from Situ Daun2, while the lowest BD value of 305.98 ± 15.86 g $L^{-1}$ was obtained from Purwasari. The mean BD value was 321.94 ± 22.84 g $L^{-1}$. In terms of TD, the highest value of 537.28 ± 46.71 g $L^{-1}$ was obtained from Situ Daun2, while the lowest value of 440.77 ± 1.49 g $L^{-1}$ was obtained from Purwasari. The mean TD value was 445.04 ± 13.92 g $L^{-1}$. These results indicate that there is a significant variation ($p<0.05$) in the BD and TD values among the rice bran samples obtained from different rice mill factories in Bogor District.

The data from the 10 rural rice mill factories in Bandung District (Tale 3), it was found that the mean bulk density (BD) of the rice bran samples significantly ranged ($p<0.05$) from

305.98 to 377.62 $gL^{-1}$, with a standard deviation ranging from 5.03-19.26 $gL^{-1}$. The mean tapped density (TD) of the rice bran samples significantly ranged ($p<0.05$) from 440.77 to 537.28 $gL^{-1}$, with a standard deviation ranging from 11.59 to 22.88 g/L. Among the 10 rural rice mill factories, the rice bran samples from Situ Daun2 were found to contain the highest BD and TD values, which were 377.62 ± 12.79 $gL^{-1}$ and 537.28 ± 46.71 $gL^{-1}$, respectively. On the other hand, the rice bran samples from Purwasari contained the lowest BD and TD values, which were 305.98 ± 15.86 $gL^{-1}$ and 440.77 ± 1.49 $gL^{-1}$ L, respectively.

The collected data from the Cirebon district (Table 3) shows a wide range of values for BD and TD. The mean values for BD significantly ranged ($p<0.05$) from 179.86 to 307.71 $gL^{-1}$, with a standard deviation ranging from 1.11 to 12.45 gL-1. The mean values for TD significantly ranged ($p<0.05$) from 279.22 to 472.84 $gL^{-1}$, with a standard deviation ranging from 0.46 to 25.46 $gL^{-1}$. The highest BD value was observed in Kudu Keras (307.71±1.41 $gL^{-1}$), while the lowest was found in Suranenggala (179.86±2.87 $gL^{-1}$). Similarly, the highest TD value was found in Kudu Keras (472.84±11.92 $gL^{-1}$), while the lowest was observed in Suranenggala (279.22±9.29 $gL^{-1}$).

Table 2. Combination of husker and polisher machine types in each rice mil and the rice varieties used selected rural rice mill factories

| Machine types and brand | | | Rice Varieties |
|---|---|---|---|
| Husker | Polisher | Polishing (times) | |
| Bogor District | | | |
| Lm24, Iseki, and Yanmar | Dai Ichi n70 | 2 - 3 | Ciherang, Inpari, IR64, Pandan wangi, and Mentik wangi |
| Bandung District | | | |
| Iseki, Agrindo, Lm24, and Yanmar | Dai Ichi n50 and Agrindo | 1 - 2 | Ciherang, Inpari, IR64, Pandanwangi, Mekongga, Jembar, Midun, Sidomuncul, Hawara Garut, and Masdas |
| Cirebon District | | | |
| Dai Ichi, Agrindo, Crown, and Yanmar | Dai Ichi n50, Echo, and Crown | 1 - 2 | Ciherang, Mentik wangi, Pandan wangi, IR64, Sticky rice, and Malaya |

The results of the study indicated a significant variation ($p < 0.05$) in the quality of rice bran obtained from different districts based on the values of bulk density (BD) and tapped density (TD). This finding is consistent with previous research, where variations in BD and TD values of rice bran have been reported. For example, Sairam et al. (2012) reported BD values ranging from 340-470 g L-1 for defatted rice bran, while Lavanya et al. (2017) found BD values of 340 g L-1 for defatted rice bran and 500 g L-1 for raw rice bran. Additionally, Ling *et al.* (2018) reported TD values ranging from 364-528 g L-1.

Hamalinda et al., (2022) observed significant differences in the BD and TD values of rice bran obtained from 10 rice mills factories in Katala Hamu Lingu District, East Sumba Province. The BD values ranged from 381.39 to 386.04 while the TD values ranged from 512.36 to 527.29. The average BD was 383.72 and the average TD was 519.83. Factors contributing to the variation in BD and TD values include the type of rice mill machine used (Kalpanadevi et al., 2018), rice varieties (Ilias et al., 2020), forging process (Ridla et al., 2022), storage time (Marbun et al., 2018), and packaging (Ridla et al., 2023b), among others. These findings suggest that the quality of rice bran can vary significantly depending on many factors, and therefore, it is crucial to consider the BD and TD values when evaluating the quality of rice bran.

**Estimation of crude protein and crude fiber.**

The estimation of crude protein and crude fiber values based on bulk density and tapped density correlation could provide valuable information about the nutrient content of ingredient feed samples. Table 4 presents the estimation of crude protein content (%) based on density correlation in three different districts in Indonesia, namely Bogor, Bandung, and Cirebon, using feed samples. The table shows that the crude protein content significantly varied ($p<0.05$) across the districts and the locations within the districts. In Bogor, the crude protein content ranged from 10.93 ± 0.41% to 12.79 ± 0.33%, while in Bandung, it ranged from 9.77 ± 0.30% to 11.62 ± 0.74%, and in Cirebon, it ranged from 7.643 ± 0.07% to 10.967 ± 0.04%. The crude protein content estimation based on tapped density measurements generally yielded higher values than those based on bulk density measurements.

Table 4. Estimation of crude protein values based on density correlation (%DM)

| Rural rice mill factory | Crude protein (% DM) | | |
|---|---|---|---|
| | Bulk density-based | Tapped density-based | Average |
| Bogor District | | | |
| Ciderum | 11.32 ± 0.09$^{bc}$ | 10.42 ± 0.04$^{b}$ | 10.87 ± 0.45$^{b}$ |
| Sinarsari | 11.12 ± 0.27$^{c}$ | 10.39 ± 0.02$^{b}$ | 10.76 ± 0.40$^{b}$ |
| Cimande | 11.54 ± 0.02$^{b}$ | 10.43 ± 0.01$^{b}$ | 10.98 ± 0.06$^{b}$ |
| Purwasari | 10.93 ± 0.41$^{c}$ | 10.31 ± 0.04$^{b}$ | 10.62 ± 0.36$^{b}$ |
| Situ Daun1 | 11.04 ± 0.09$^{c}$ | 10.39 ± 0.06$^{b}$ | 10.72 ± 0.15$^{b}$ |
| Situ Daun2 | 12.79 ± 0.33$^{a}$ | 12.58 ± 1.10$^{a}$ | 12.68 ± 0.11$^{a}$ |
| Ciapus | 11.33 ± 0.08$^{bc}$ | 10.43 ± 0.04$^{b}$ | 10.88 ± 0.45$^{b}$ |
| Pancawati1 | 10.99 ± 0.00$^{c}$ | 10.36 ± 0.03$^{b}$ | 10.68 ± 0.02$^{b}$ |
| Cinagara | 11.59 ± 0.00$^{b}$ | 10.46 ± 0.02$^{b}$ | 11.03 ± 0.07$^{ab}$ |
| Pancawati2 | 11.31 ± 0.04$^{bc}$ | 10.41 ± 0.03$^{b}$ | 10.86 ± 0.46$^{b}$ |
| Bandung District | | | |
| Tangsimekar | 10.94 ± 0.25$^{bc}$ | 10.68 ± 0.24$^{bc}$ | 10.81 ± 0.18$^{ab}$ |
| Mekarpawitan | 10.60 ± 0.65$^{b}$ | 10.20 ± 0.96$^{b}$ | 10.40 ± 0.29$^{ab}$ |
| Cipedes | 10.67 ± 0.31$^{b}$ | 10.30 ± 0.39$^{b}$ | 10.48 ± 0.14$^{ab}$ |
| Cipaku | 10.57 ± 0.42$^{b}$ | 10.14 ± 0.48$^{b}$ | 10.35 ± 0.18$^{ab}$ |
| Karangtunggal | 11.17 ± 0.13$^{bc}$ | 10.69 ± 0.24$^{bc}$ | 10.93 ± 0.24$^{ab}$ |
| Drawati | 9.77 ± 0.30$^{a}$ | 9.01 ± 0.29$^{a}$ | 8.89 ± 0.38$^{a}$ |
| Sukamanah | 11.62 ± 0.74$^{c}$ | 11.49 ± 1.08$^{c}$ | 11.05 ± 0.64$^{b}$ |
| Sindangsari | 10.63 ± 0.51$^{b}$ | 10.26 ± 0.64$^{b}$ | 10.44 ± 0.20$^{ab}$ |
| Cigentur | 10.76 ± 0.35$^{b}$ | 10.28 ± 0.57$^{b}$ | 10.52 ± 0.24$^{ab}$ |
| Loa | 10.32 ± 0.51$^{ab}$ | 9.84 ± 0.80a$^{b}$ | 10.08 ± 0.35$^{ab}$ |
| Cirebon District | | | |
| Kudu Keras | 10.967 ± 0.04$^{h}$ | 11.062 ± 0.28$^{h}$ | 10.99 ± 0.12$^{h}$ |
| Sutawinangun | 10.480 ± 0.10$^{g}$ | 10.426 ± 0.08$^{g}$ | 10.45 ± 0.09$^{g}$ |
| Pekiringan | 10.088 ± 0.07$^{f}$ | 9.818 ± 0.23$^{f}$ | 9.95 ± 0.13$^{f}$ |
| Pangenan | 9.898 ± 0.03$^{f}$ | 9.360 ± 0.01$^{e}$ | 9.63 ± 0.02$^{f}$ |

| | | | |
|---|---|---|---|
| Kali Wolu | 9.593 ± 0.32$^{e}$ | 9.239 ± 0.18$^{e}$ | 9.42 ± 0.25$^{e}$ |
| Tuk | 9.541 ± 0.18$^{e}$ | 8.784 ± 0.60$^{d}$ | 9.17 ± 0.39$^{e}$ |
| Wot Gali | 9.242 ± 0.11$^{d}$ | 8.233 ± 0.19$^{c}$ | 8.74 ± 0.15$_{d}$ |
| Bondet | 8.754 ± 0.04$^{c}$ | 8.089 ± 0.01b$^{c}$ | 8.42 ± 0.02$_{c}$ |
| Kertawinangun | 8.305 ± 0.03$^{b}$ | 7.812 ± 0.01$^{b}$ | 8.06 ± 0.02$^{b}$ |
| Suranenggala | 7.643 ± 0.07$^{a}$ | 6.512 ± 0.22$^{a}$ | 7.085 ± 0.16$^{a}$ |

$^{abcdefg}$ *Means in the same column and district without a common letter are different at p<0.05*

On the other hand, Table 5 shows the estimation of crude fiber content (%) based on bulk density and tapped density correlation in the same three districts in Indonesia, using rice bran samples. The table shows that the crude fiber content also varied across the districts and the locations within the districts. In Bogor, the average crude fiber content ranged from 7.27 ± 0.82% to 12.67 ± 1.21%, while in Bandung, it ranged from 10.15 ± 1.82% to 14.73 ± 0.74%, and in Cirebon, it ranged from 11.626 ± 0.69% to 22.778 ± 0.53%. Similar to the estimation of crude protein content, the estimation of crude fiber content based on tapped density measurements generally yielded higher values than those based on bulk density measurements.

Saunders (1985) reported that rice bran has a highly nutritious chemical composition, including 12-17% crude protein (CP) and 6-14% crude fiber (CF). However, Hamalinda et al. (2022) observed significant differences in the CP and CF values of rice bran obtained from 10 rice mills factories in Katala Hamu Lingu District, East Sumba Province. CP values ranged from 9.94 to 12.45 with an average of 11.19, while CF ranged from 14.56 to 16.357% with an average of 15.45%. The diversity in protein content and crude fiber content of rice bran is influenced by various factors, including the proportion of its components such as pure bran, rice husk, and rice grains (Astawan and Febrinda, 2010; Budijanto and Sitanggang, 2011). Lavanya et al. (2017) noted that these proportions may result from the main rice milling process, particularly the threshing, setting, condition, and capacity of the machine. McDonald *et al.* (1995) pointed out that an increase in protein content leads to a decrease in non-nitrogenous extract, resulting in a decrease in crude fiber percentage, based on the ingredient substance distribution scheme from the proximate analysis.

This study estimated the chemical composition of rice bran and found that the correlation between the physical properties of rice bran and its chemical composition can serve as a preliminary step in determining the nutrient content of rice bran. This information can aid traders and consumers in determining the value of rice bran during buying and selling transactions, as well as intermediaries, farmers, and feed quality supervisors in the rural field.

Table 5. Estimation of crude fiber values based on density correlation

| Rural rice mill factory | Crude fiber (% DM) | | |
|---|---|---|---|
| | Bulk density-based | Tapped density-based | Average |
| Bogor District | | | |
| Ciderum | 10.88 ± 0.21$^{ab}$ | 13.21 ± 0.10$^{a}$ | 12.04 ± 1.21$^{a}$ |
| Sinarsari | 11.39 ± 0.65$^{a}$ | 13.27 ± 0.05$^{a}$ | 12.33 ± 0.44$^{a}$ |
| Cimande | 10.36 ± 0.06$^{b}$ | 13.18 ± 0.03$^{a}$ | 11.77 ± 1.41$^{a}$ |
| Purwasari | 11.87 ± 1.02$^{a}$ | 13.47 ± 0.09$^{a}$ | 12.67 ± 1.21$^{a}$ |
| Situ Daun1 | 11.59 ± 0.23$^{a}$ | 13.27 ± 0.14$^{a}$ | 12.43 ± 1.09$^{a}$ |
| Situ Daun2 | 7.27 ± 0.82$^{c}$ | 7.91 ± 2.69$^{b}$ | 7.59 ± 0.62$^{b}$ |
| Ciapus | 10.87 ± 0.19$^{ab}$ | 13.18 ± 0.09$^{a}$ | 12.03 ± 1.18$^{a}$ |
| Pancawati1 | 11.70 ± 0.02$^{a}$ | 13.36 ± 0.08$^{a}$ | 12.53 ± 0.33$^{a}$ |
| Cinagara | 10.23 ± 0.02$^{b}$ | 13.10 ± 0.05$^{a}$ | 11.67 ± 1.44$^{a}$ |

| | | | |
|---|---|---|---|
| Pancawati2 | 10.92 ± 0.09$^{ab}$ | 13.23 ± 0.06$^{a}$ | 12.08 ± 1.15$^{a}$ |
| Bandung District | | | |
| Tangsimekar | 11.83 ± 0.62$^{ab}$ | 12.55 ± 0.59$^{ab}$ | 12.19 ± 0.39$^{bc}$ |
| Mekarpawitan | 12.67 ± 1.60$^{b}$ | 13.75 ± 2.36$^{b}$ | 13.21 ± 0.93$^{b}$ |
| Cipedes | 12.50 ± 0.78$^{b}$ | 13.50 ± 0.97$^{b}$ | 13.00 ± 0.83$^{b}$ |
| Cipaku | 12.75 ± 1.05$^{b}$ | 13.88 ± 1.18$^{b}$ | 13.32 ± 0.67$^{b}$ |
| Karangtunggal | 11.27 ± 0.32$^{ab}$ | 12.53 ± 0.58$^{ab}$ | 11.90 ± 0.93$^{c}$ |
| Drawati | 14.73 ± 0.74$^{c}$ | 16.65 ± 0.72$^{c}$ | 15.69 ± 0.96$^{a}$ |
| Sukamanah | 10.15 ± 1.82$^{a}$ | 10.57 ± 2.64$^{a}$ | 10.36 ± 0.99 |
| Sindangsari | 12.60 ± 1.26$^{b}$ | 13.60 ± 1.57$^{b}$ | 13.10 ± 0.69$^{b}$ |
| Cigentur | 12.26 ± 0.86$^{b}$ | 13.55 ± 1.40$^{b}$ | 12.91 ± 0.95$^{b}$ |
| Loa | 13.36 ± 1.24$^{bc}$ | 14.63 ± 1.95$^{bc}$ | 13.99 ± 0.72a$^{b}$ |
| Cirebon District | | | |
| Kudu Keras | 11.759±0.09$^{a}$ | 11.626±0.69$^{a}$ | 11.692±0.39$^{a}$ |
| Sutawinangun | 12.962±0.25$^{b}$ | 13.184±0.19$^{b}$ | 13.073±0.22$^{b}$ |
| Pekiringan | 13.930±0.17$^{c}$ | 14.676±0.56$^{c}$ | 14.303±0.38$^{c}$ |
| Pangenan | 14.400±0.08$^{c}$ | 15.798±0.03$^{d}$ | 15.099±0.67$^{d}$ |
| Kali Wolu | 15.154±0.08$^{d}$ | 16.093±0.44$^{d}$ | 15.624±0.68$^{d}$ |
| Tuk | 15.282±0.45$^{d}$ | 17.298±1.47$^{e}$ | 16.290±0.93$^{e}$ |
| Wot Gali | 16.020±0.26$^{e}$ | 18.561±0.47$^{f}$ | 17.291±1.05$^{f}$ |
| Bondet | 17.224±0.11$^{f}$ | 18.913±0.03f$^{g}$ | 18.569±0.22$^{fg}$ |
| Kertawinangun | 18.334±0.07$^{g}$ | 19.591±0.03$^{g}$ | 18.963±0.23$^{g}$ |
| Suranenggala | 19.967±0.18$^{h}$ | 22.778±0.53$^{h}$ | 21.873±1.40$^{h}$ |

$^{abdefgh}$ *Means in the same column and district without a common letter are different at p<0.05*

## CONCLUSION

This study showed that bulk and tapped density measurements can predict the nutritional content of rice bran, providing a cost-effective alternative for analyzing its composition. This approach can be useful for farmers in rural areas who lack access to chemical analysis and can also be applied to other feed ingredients. The rice bran from the Bogor region showed indications of being of higher quality, with higher crude protein and lower crude fiber content compared to the other two regions. However, further laboratory testing might be required to confirm the estimated results, and additional information from relevant parties should be obtained to ensure that pure rice bran is being used.

## CONFLICT OF INTEREST

The authors of this manuscript declare that they have no financial, personal, or other conflicts of interest with any person or organization related to the material discussed in the manuscript.

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