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Palatability Level of Dried Rice as an Alternative Feed Ingredient to Subtitute Corn and Rice Bran

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Abstract | Indonesia is among the highest organic waste-generating countries, with an average of 12 × 10^6 t yr^{-1}. After being processed, organic waste is highly potential to contribute to animal farming, and "aking rice" is one such product. After cleaning and rinsing, rice remains are sundried to reach a water content of < 14 %. However, no literature or findings are yet to discover whether "aking rice" is palatable for poultry. Therefore, this study is focused on determining "aking rice" palatability to see its chance to substitute corn and rice bran with an experimental design of three replications employing three treatments of corn (T1), "aking rice" (T2), and rice bran (T3). Broiler chickens aged 35 d with an average body weight of 1 870 g were involved – each treatment unit was of three, making a total of 27 chickens. Data gained from the experiment were run through one-way ANOVA, followed by an LSD test should any differences in the treatments occur. The result showed that consumption on T2 (59.89 g) was higher than on T1 (42.19 g) and T3 (9.22 g). As of feeding duration, T2 (680 s) was also higher than T1 (610 s) and T3 (140 s). Conclusively, "aking rice" has a better palatability rate than corn and rice bran, making it feasible for recommendation as a substitute for the other two base feed materials.

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Introduction

The increase in feed prices especially corn is feared to make chicken farmers in Indonesia damaged. However, several researchers stated that increasing chickens' productivity in Indonesia requires genetic quality improvements in the breeding program. It is also necessary to improve feed conversion efficiency,

which can reduce production costs (Winaya *et al.*, 2023; Suyatno *et al.*, 2023). In contrast, Indonesia is a producer of organic waste that has the potential to be used as feed, but currently, it only pollutes the environment (Setyobudi *et al.*, 2018, 2021b).

With an average waste of 30 × 10^6 t yr^{-1}, 40 % organic, Indonesia is one of the highest waste-generating countries (Hidayat, 2021; Khoiron *et al.*, 2020; Setyobudi *et al.*, 2021a; Tonda *et al.*, 2022). Its government has attempted steps and innovation programs on waste management by issuing Government Regulation No 27/2020 (Asmawati *et al.*, 2021, 2022; Handajani *et al.*, 2021; Rudovica *et al.*, 2021; Setyobudi *et al.*, 2019, 2022; Valdez-Arjona and Ramírez-Mella, 2019). At the same time, researchers have been persevering to find amiable schemes specifically to relegate organic waste. Burlakovs *et al.* (2022), Chia *et al.* (2020), Harsono *et al.* (2016), Setyobudi *et al.* (2018), Soleh *et al.* (2020), Susanto *et al.* (2020a, b) and Wuryantoro *et al.* (2021) have agreed that waste can serve as a source of renewable energy.

Regarding biogas, some of the researchers (Adinurani *et al.*, 2013; Hendroko *et al.*, 2014, 2015; Novianto *et al.*, 2020) suggest employing a two-stage digester to optimize pH in an anaerobic fermentation process. Other researchers advocate turning organic waste into fertilizers with the ability to improve soil nutrients (Anwar *et al.*, 2015; Budiono *et al.*, 2021; Hapsoh *et al.*, 2016; Kadir *et al.*, 2016; Karnchanawong and Nissaikla, 2014; Oliveira *et al.*, 2017). In animal farming, the potential to reuse organic waste as feed is also noted (Kierończyk *et al.*, 2020; Muktiani *et al.*, 2013; Pinotti *et al.*, 2021, Prasetio *et al.*, 2021; Widiyastuti *et al.*, 2015). Vegetable remains are feasible for ruminant cattle (Harsányi *et al.*, 2020; Stamer, 2015), and "aking rice" (dried rice) fits for poultry (Tonda *et al.*, 2022; Zulfikar *et al.*, 2014). Aking rice is made of rice remains, sundried after cleaning, and rinsed to reach a water content of < 14 % (Tonda *et al.*, 2022).

Zulfikar *et al.* (2014) have stated that aking rice can satisfactorily substitute corn, the most common poultry base feed. Approximately 65 % of feed components including corn are imported, making it the highest spending in poultry production cost. When corn is off-season, its price can be so high that the farmers call for alternatives to stabilize their production costs (Alqaisi *et al.*, 2019; Macharia *et al.*, 2020). With a water content of 12.58 %, protein of 8.96 %, crude fat of 0.43 %, and crude fiber of 0.59 %, aking rice has similar nutrient contents to corn and is therefore viable as a substitute (Tonda *et al.*, 2022).

Zulfikar *et al.* (2014) have confirmed the feasibility of aking rice to replace rice bran while the protein and crude fat are similar, aking rice has less crude fiber. Therefore, referring to the recommendation of SNI 8173.1:2015 (SNI: Standar Nasional Indonesia), the maximum limit of 5 % crude fiber content in poultry feed, aking rice, should serve better as base feed.

Processing rice as organic waste into aking rice is a positive endeavor to preserve the environment from degradation due to soil, water, and air pollution (Krumina *et al.*, 2015; Pinotti *et al.*, 2021; Valdez-Arjona and Ramírez-Mella, 2019). Not only does it play a role in cutting down national waste generation, but this scheme also supports animal farming by offering a cheaper alternative to constantly rising feed costs. However, no literature or findings are yet to discover whether "aking rice" is palatable for chickens, and this fact becomes the basis of this study.

Materials and Methods

This research had been authorized by the Ethical Commission on Health Studies of the Faculty of Medicine of the University of Muhammadiyah Malang (No. E.5a./2022/KRPK-UMM/X/2022) and was conducted in Lumajang, a regency in East Java, Indonesia (112°, 53' to 113°, 23' E and 7°, 54' to 8°, 23' S) happens to be a broiler chicken production area in the province, with precipitation of 1 500 mL to 2 500 mL yr^{-1} and temperature of 23 °C to 34 °C. Therefore, turning rice remains into "aking rice" is customary there, which is then given to their poultry or sold.

Materials

Broiler chickens aged 35 d gained from PT. Zakiyah Jaya Mandiri, with an average weight of 1870 g ± 290 g, were employed, 27 chickens in total. All chickens were in good health before treatment. The number of chickens was 27, referring to the range of materials in previous research (Amechi, 2020; Arrozola and Torrey, 2019; Buckley *et al.*, 2015). The ambient temperature and lighting provided are also the same. Before the study, the chickens were fed the same feed for 7 d. The

composition of the feed given before treatment is as follows (Table 1).

Table 1: *Feed composition before treatment.*

No	Ingredient	Composition
1	Poultry ME (kcal kg^{-1})	3 200.00
2	Crude protein (%)	20.00
3	Crude fat (%)	4.75
4	Crude fiber (%)	3.84
5	Calcium (%)	0.90
6	Available phosphorus (%)	0.45
7	Na (%)	0.15
8	Lysin (%)	1.00
9	Metionin (%)	0.38

Figure 1: *Tested feed.*

As per the experimental method, three treatments of corn (T1), aking rice (T2), and rice bran (T3) were prepared (Figure 1). Each treatment was given to a unit of three in three replications. First, treatments were measured and administered simultaneously four times in the morning and two times in the afternoon – for 30 min. The remaining treatments were then measured to find the total consumption of each unit.

Aking rice is processed from leftover rice wasted in markets, restaurants, household waste, etc. Leftover rice is collected, cleaned of other ingredients, and rinsed under running water. Clean food scraps are dried in the sun or baked in an oven until dry with a moisture content < 14 %. Aking rice is processed into flour and ready to be given or formulated into chicken feed.

Feed intake

An approach to discovering the palatability of feeds in chickens is by measuring their consumption in specific periods (Winarso *et al.*, 2018; Wirdateti *et al.*, 2001). Scaled before administered, each treatment of 1000 g was served for 30 min, and the remains were then scaled to record the consumed amounts. The figures were then used to find the feed intake rates by running Equation 1:

Feed intake= Initial feed weight – final feed weight ..(1)

Feeding duration

Another way to determine the palatability of feeds is by measuring the length of time chickens take to eat in each feed administration (Alagawany *et al.*, 2019; Campanile *et al.*, 2011). Once all three chickens in a unit stopped pecking on their feed completely, the finish line of eating was set. Again, a stopwatch was involved in assessing the feeding duration.

Statistical analysis

Data gained from the experiment were tabulated in MS Excel and then ran through a one-way Analysis of Variance (ANOVA) (Damat *et al.*, 2020, 2021; Mandey *et al.*, 2017). Should any differences in the treatments occur, the Least Significant Difference (LSD) test would follow (Tejeda and Kim, 2021; Winaya *et al.*, 2019).

Results and Discussion

Feed intake

Figure 2 shows that T1 rated 59.89 g with a standard deviation of 24.83 g is the highest feed intake average. The relatively clustered ratios are evident in the homogenous spread of data. The standard deviation rates of T1 and T3 are also spread near each of their rates. One-way ANOVA has confirmed significant differences in the three treatments, and LSD has also revealed distinctions in the average feed intakes of T1, T2, and T3.

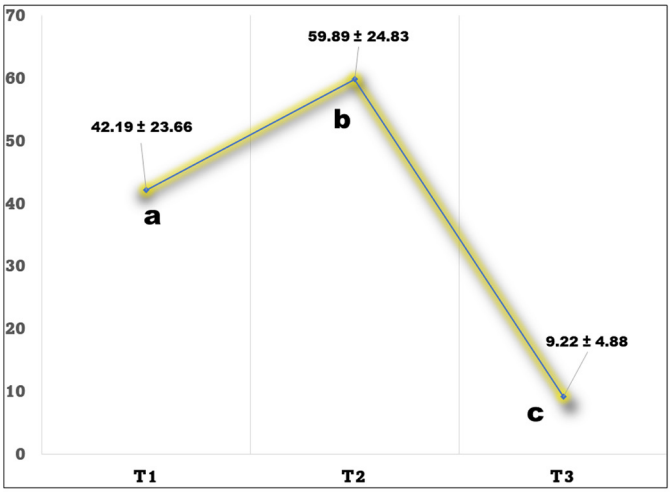

Figure 2: *Feed intake rates (g).*

Chickens are visually attracted to bright colors, particularly when contrasted to the surroundings, such as red and yellow (Mendes *et al.*, 2013; Seifert *et al.*, 2020), which is the reason behind colors used for their feeding and drinking equipment. That corn and "aking rice" are brighter in colors presumably helps to boost their palatability rates. Yet, another factor must make "aking rice" preferable, and its shape is the answer. Feed shapes and forms also determine palatability (Al-Nasrawi, 2016; Karimirad *et al.*, 2020). Chickens favor pellets or grains rather than powder (Attia *et al.*, 2012; Ege *et al.*, 2019) since they are easier to pick with their pointy beaks (Beg *et al.*, 2011; Mingbin *et al.*, 2015).

Additionally, nutrient contents of crude protein, crude fat, and crude fiber in the feed are relevant to its consumption quantity (Campanile *et al.*, 2011; Mingbin *et al.*, 2015) since chickens like nutritious feed better (Bovera *et al.*, 2015; Liu *et al.*, 2011). Therefore, the nutrient contents of the three treatments are compared and drawn in Figure 3.

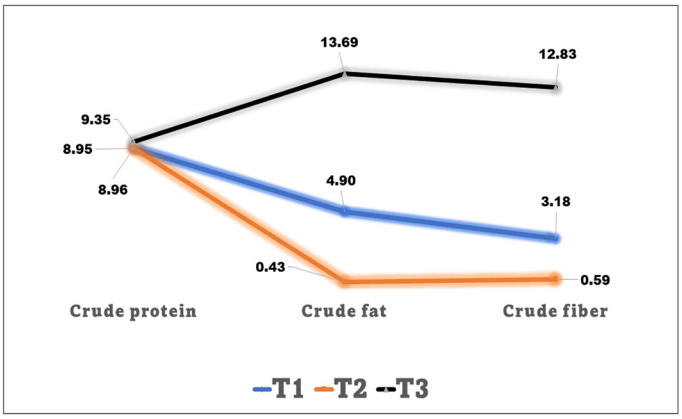

Figure 3: *Contents of crude protein, crude fat, and crude fiber in "aking rice" (%) (Data summarized by Farid et al., 2019; Tonda et al., 2022).*

It indicates that the crude protein contents of all treatments are equal, but crude fat and fiber contents in rice bran are much higher than in corn and aking rice. The result corroborates the finding of Barker and Sell (1994) and Widodo *et al.* (2019, 2021) that chickens only require not more than 5 % of fat in their feed. Furthermore, once they are filled with fat, chickens stop eating even after a small amount.

Feeding duration

As depicted in Figure 4, it is apparent that the highest feeding duration rate goes to T2 at 680 s with a standard deviation of 295 s, while T3 is the lowest at 140 s with a standard deviation of 84 s. One-way ANOVA has corroborated significant differences in the three treatments related to feeding duration, and LSD has also shown distinctions in the feed duration rates of T1, T2, and T3.

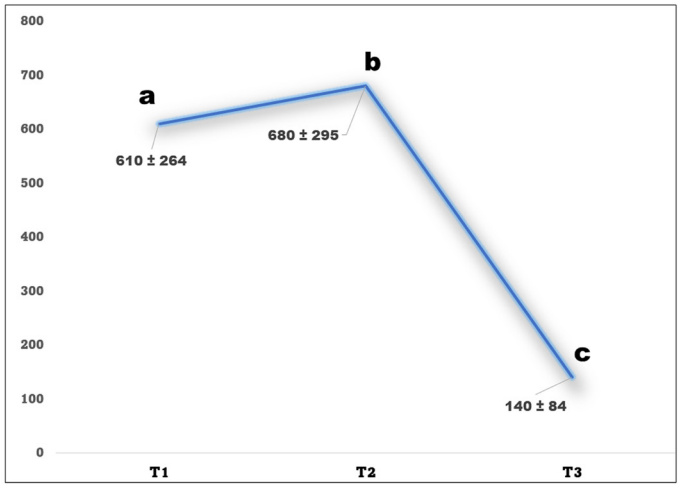

Figure 4: *Feeding duration in second(s).*

Environmental factor affects feeding behavior in chickens. For example, in a high temperatures, chickens tend to eat less to ease their metabolism and, consequently, lower their body temperature (Lara and Rostagno, 2013; Lin *et al.*, 2006) as well as drink more to respond to it (Hassan *et al.*, 2009; Sugito *et al.*, 2020). In this experiment, the temperature was relatively stable at 26 °C and, therefore inconsequential. However, a different duration may occur when feed is administered under heat stress; as discussed by Tonda *et al.* (2023a), chickens in an environmental temperature of > 30 °C showed a better performance index when fed with "aking rice."

Crude fiber also matters in chicken feeding duration (Cerrate *et al.*, 2019; Mandey *et al.*, 2017) since more fiber in feed adds to its bulkiness, making chickens get fulfilled more easily (Jiménez-Moreno *et al.*, 2016; Tejeda and Kim, 2021). Thus, the shorter feeding duration of rice bran is due to its higher crude fiber content than in corn and "aking rice."

Developing "aking rice" as a feed ingredient for broilers can increase productivity because "aking rice" has a higher protein content than corn and rice bran. In addition, "aking rice" also has a lower fat content, so it can reduce the fat in broiler meat (Tonda *et al.*, 2023b).

According to Tonda *et al.* (2022), giving dry rice affects feed costs because the price of dry rice is lower when

compared to substituted feed such as corn. The use of dry rice is essential for breeders because the feed cost is the most significant cost of broiler farming. The lower the feed price, the greater the profit or profit earned. This research shows how vital feed efficiency is in broiler farming.

Processing food waste into feed ingredients can provide several benefits, including First, reducing the amount of food waste: Processing food waste into feed ingredients can help reduce the amount of food waste disposed of and reduce environmental pollution problems caused by food waste. Second, improve the efficiency of feed production: Processing food waste into feed ingredients can help increase the efficiency of feed production because it can reduce dependence on feed ingredients that are expensive and difficult to obtain. Third, increase livestock productivity: By using feed ingredients made from food waste, farmers can increase livestock productivity because the feed ingredients used are cheaper and more readily available. Fourth, reduce production costs: processing food waste into feed ingredients can reduce production costs because the raw materials used are readily available and free of charge. Fifth, it can improve animal health: if the food waste has been appropriately processed and meets the government's quality and safety standards, the feed ingredients can improve animal health. Sixth, this potential will become a new business opportunity for the development of feed ingredients. However, keep in mind that the production of aking rice as a feed ingredient must meet the feed quality and safety standards the government sets.

Conclusions and Recommendations

The highest feed intake and duration rates recorded by "aking rice" are evident in its better palatability than corn and rice bran. It is, therefore, conclusive that "aking rice" is feasible for an alternative energy source. A new prospect in rice waste management and business is open to saving the environment from organic waste and supporting animal farming with a constant supply of alternative quality feed equal to corn.

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Novelty Statement

The data obtained in this study that aking rice has higher palatability than corn and rice bran has never been observed nor published before. In addition to price and nutrient content, palatability is essential in choosing the best feed. Therefore, further product development on aking rice should help the supply of alternative feed while also helping the lessening of organic waste pollution.

Author's Contribution

Rusli Tonda: Conceptualized and designed the study, elaborated the intellectual content, performed literature search, data acquisition, data analysis, manuscript format, manuscript preparation, and manuscript revision

Wahyu Widodo, Lili Zalizar, Damat Damat and David Hermawan: Elaborated on the intellectual content and research supervision and performed the literature search and manuscript review.

Roy Hendroko Setyobudi: Elaborated the intellectual content, performed the literature search, manuscript review and revision, Grammarly check, Turnitin check, and guarantor.

Zane Vincēviča-Gaile, Irum Iqrar, Shazma Anwar and Wirawan Wira: performed the literature search and manuscript review.

All authors have read and approved the final manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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