Potential Utilization

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Potential Utilization of Dried Rice Leftover of Household Organic Waste for Poultry Functional Feed

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Abstract

Indonesia produced 30 × 10^6 t of waste in 2021; 40 % was organic and 276 × 10^3 t leftover rice. Meanwhile, broiler chicken farmers have been struggling with high feed costs to continue their production. Processing leftover rice into "aking-rice" is environmentally friendly, and it also provides alternative feed for chickens. "Aking-rice" is a type of resistant starch because it has undergone a gelatinization process that works as a synthesis of short-chain fatty acids that positively improve the function of the digestive tract because it increases the villi in the small intestine. This study analyzed the potential of "aking-rice" in broiler chicken productivity. The experimental method was a completely randomized design with three treatments, five replications and 12 chickens in each unit. The treatments are T0 (100 % basal feed), T1 (80 % basal feed + 20 % "aking-rice" spread on top of the basal feed), and T2 (80 % basal feed + 20 % "aking-rice" mix). Statistical analysis used ANOVA, and continued with LSD with observed variables, *i.e.* Feed Intake (FI), Average Daily Gain (ADG), Feed Conversion Ratio (FCR), and Performance Index (PI). The results showed that the highest FI values were T0 (99.02), T1 (97.45), and T2 (96.58). The highest ADG was T1 (40.40) then T0 (37.07) and the lowest was T2 (36.40). T1 has the lowest FCR (2.42) compared to T0 (2.68), T2 (2.66). The lowest FCR is T1 (2.42), then T2 (2.66) and the highest is T0 (2.68). The third variable was not significantly different, but the PI results showed a significant difference with the highest PI value T1 (433.84), while T0 (374.81) and T2 (372.67) were not different. Economic analysis also shows that the highest cost T0 (118 475) is significantly different from T1 (110 541) and T2 (109 558). The highest profit is shown by T1 (2 102) then T2 (1 063) and T0 (507). In conclusion, the use of "aking-rice" can increase the performance index with a higher ADG value and a lower FCR so that the costs are smaller and the profit is greater.

Keywords: Aking-rice, Alternatif feed, Environmentally friendly, Farmer income, Feed cost, Feed substitution, Resistant starch, Waste to feed.

1. Introduction

Based on the data released by the Ministry of Environment and Forestry, Indonesia produced 30 × 10^6 of waste in 2021 – 40 % was organic, and 40 % of aforementioned organic waste was domestic garbage mostly out of food remains (Setiawan, 2021; Setyobudi *et al*., 2021a; SISPN, 2022). Anriany *et al*. (2013) stated that the amount of remaining rice in Indonesia per capita per year is an average of 1 000 g. Therefore, if Indonesia's population is 276 × 10^6, the remaining rice per year is 276

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× 10^3 t. Even Hidayat (2021) explains that food waste in Indonesia is 112 ×10^6 per year.

Realizing the urgency of handling waste properly, researchers have been studying various attempts on the matter (Halim *et. al*., 2019; Monice and Perinov, 2017; Setyobudi *et al*., 2019, 2022) in accordance with government regulations PP No. 27/2020 on waste management (RI, 2020) and supportive towards waste management program for renewable energy (Abdullah *et al*., 2020; Ibrahim, 2022; Misna, 2018; Setyobudi *et al*., 2021b, 2022). In particular, Hendroko *et al*. (2013) and Adinurani *et al*. (2017) suggested a two-stage digester for biogas with organic waste feedstocks related to the low pH in the initial process (hydrolysis and acidogenesis process).

Reusing domestic waste for feed is beneficial to not only cut down organic waste, but also reduce feed cost in farming. About 65 % of the current feed cost goes to imported materials (Emiria, 2022; Kemenperin, 2019; Nasution and Kisihandi, 2021), while feed prices tend to hike from year to year (Midaada, 2022; Romdhon, 2022; Suprobo, 2021; Susanto, 2022; Tumion *et al*., 2017). A staple food in Indonesia, rice contributes a considerably large amount of domestic waste on daily basis; processing it into *nasi aking* (sun-dried waste rice) should solve part of the problems. Once rinsed in clean water, rice leftovers are sundried to reduce the water content up to 14 % before further treatment for poultry feed.

"Aking rice" is characterized as resistant starch (Arshad *et al*., 2018; Fuentes-Zaragoza *et al*., 2010; Rozali *et al*., 2018) which is uncommon in other feed materials. Since it is unhydrolyzed and indigestible (Suloi, 2019), it goes to the colon and nourishes apathogenic bacteria when administered in warm temperature (Arshad *et al*., 2018; Fuentes-Zaragoza *et al*., 2010; Setiarto *et al*., 2015). Quite popular among duck (*Anas platyrhynchos domesticus* Linnaeus, 1758), swan (*Cygnus cygnus* Linnaeus, 1758), and local chicken (*Gallus gallus domesticus* Linnaeus, 1758) farmers (Nugraha *et al*., 2012; Prasetyo *et al*., 2018; Saty *et al*., 2014; Yendy *et al*., 2014), "aking-rice" and its feasibility in poultry industry has been scientifically studied. Roboth (2015) recorded up to 40 % involvement of "aking-rice" in feed for super chicken. Yendy *et al*. (2014) found that using 10 % "aking-rice" and citric acid additive in feed for local male duck was significantly effective ($P < 0.05$) on calcium and phosphor retentions, but not ($P > 0.05$) on feed, calcium, and phosphor consumption rates nor on weight. Maghfiroh *et al*. (2012) stated that utilizing 20 % "aking-rice" and lime additive brought insignificant differences on feed consumption rates, protein digestibility, nitrogen retention, and weight. Khusna (2009) even noted that either feed consisting of 60 % "aking-rice" or 100 % "aking-rice" to substitute corn was viable.

Broiler chicken meat is vastly consumed in Indonesia, and its increase in production goes along with consumption growth rate annually (Pradita *et al*., 2015; Widodo *et al*., 2019; Yemima, 2014). Since the feed that entails this commodity reaches 70 % of total production cost (Anggitasari *et al*., 2016; Widodo, 2009; Yendy *et al*., 2014), a hike in feed price will reduce the farmer's income (Bessei, 2006; Hartono, 2005; Lara and Rostagno, 2013; Ranjan *et al*., 2019; Tumion *et al*., 2017). However, "aking-rice" is rarely found in broiler chicken farms despite its benefits. One study by Zulfikar and Sania (2014) concluded that broiler chicken feed containing 10 % "aking-rice" was inconsequential towards foot color, meat cholesterol percentage, and breast meat deposition percentage.

The short list of studies on "aking-rice" for broiler chicken feed calls for more discussions. Until this report was written, no research on an effective "aking-rice" feeding method to boost broiler chicken productivity in warm temperature had been conducted.

2. Materials and Methods

Authorized by the Ethical Commission on Health Studies of the Faculty of Medicine of University of Muhammadiyah Malang (E.5.a/222/KEPK-UMM/X/2022), this research was conducted in 2022 in PT. Zakiyah Jaya Mandiri, a broiler chicken farm in Lumajang, East Java, Indonesia (112°-53' to 113°-23' E and 7°-54 to 8-23' S), at an average temperature of 33 °C.

2.1. Materials

Day old chicks (DOC) were of platinum PT. Multibreeder Adirama Indonesia Tbk., adlibitum feed with Wonokoyo BR1 (Indonesia product) at the starter age (1 d to 21 d), transferred to a battery cage at 14 d old for adaptation, and treated at 21 d old.

The experiment was held in dry season at day temperature of between 28 °C and 33 °C – lightbulbs of 100 Watt were utilized to keep the temperature at 30 °C to 33 °C. Amount of 15 units of battery cages were arranged, and each was occupied by 12 chickens.

"Aking-rice" used as much as 20 % for treatment T1 and T2. The nutrients contained in "aking-rice" are based on the results of a proximate analysis from the nutrition laboratory of the University of Muhammadiyah Malang; water content 12.58 %; dry matter 87.42 %; ash content 0.83 %; crude protein 8.96 %; crude fat 0.43 %; and crude fiber 0.59 %.

2.2. Methods

Corresponding to experimental method of completely randomized design, five replications were performed to make 15 tests, and each test comprised 12 chickens. Three treatments were prepared: T0 (100 % basal feed), T1 (20 % "aking-rice" spread a top 80 % basal feed), and T2 (20 % "aking-rice" evenly mixed with 80 % basal feed). The formula of each treatment is detailed in the following Table 1 on the basis of recommendations SNI 8173.1:2015.

Table 1. Feed formula in treatments

No	Ingredient	T0	T1	T2
1	Corn (%)	69.43	48.91	48.91
2	Wheat pollard (%)	5.31	2.66	2.66
3	Corn gluten meal (CGM) (%)	12.60	12.49	12.49
4	Distillers dried grains with solubles (%)	3.00	5.00	5.00
5	"Aking-rice" (%)	0.00	20.00	20.00
6	Meat bone meal (%)	7.23	8.04	8.04
7	Palm oil (%)	0.20	1.00	1.00
8	L-Lysine HCL (%)	0.96	0.88	0.88
9	Calcium carbonat ($CaCO_3$) (%)	0.65	0.58	0.58
10	Salt (%)	0.17	0.21	0.21
11	DL Methionine (%)	0.15	0.13	0.13
12	Dicalsium phospat (%)	0.30	0.10	0.10
Calculated analyses				
13	Poultry ME (kcal kg^{-1})	3 200.00	3 200.00	3 200.00
14	Crude protein (%)	20.00	20.00	20.00
15	Crude fat (%)	4.75	4.75	4.75
16	Crude fiber (%)	3.84	3.84	3.84
17	Calcium (%)	0.90	0.90	0.90
18	Available phosphorus (%)	0.45	0.45	0.45
19	Na (%)	0.15	0.15	0.15
20	Lysin (%)	1.00	1.00	1.00
21	Metionin (%)	0.38	0.38	0.38

Feed was measured before administered between 10 AM and 4 PM at an average temperature of 32 °C, and any leftovers were scaled in the following day.

The rates of feed intake (FI), average daily gain (ADG), and feed conversion ratio (FCR) were calculated in order to analyze the effect of "aking-rice" in broiler chicken's performance index and its prospect to prosper its farmers via income analysis.

FI refers to the total amount of feed consumption during the 14 d of treatment (Fijana *et al*., Hasan *et al*., 2013; 2012; Liu *et al*., 2020), calculated as per Equation (1):

$$FI = \text{Total feed consumption} / \text{Day of treatment} \quad (1)$$

The weights of all chickens were measured at the beginning (21 d old) and the end (35 d old) of the research. Deducting chicken weights when the experiment started from when it concluded should give ADG (Astuti and Jaiman, 2019; Awad *et al*., 2009; Hoan *et al*., 2021) in accordance with Equation (2):

$$ADG = \text{Final body weight} - \text{First body weight} \quad (2)$$

FCR should reveal the broiler chicken productivity during treatment (Hoan *et al*., 2021; Khalifa *et al*., 2014; Rusli, 2012; Sugito, 2016; Umam *et al*., 2015), determined through Equation (3):

$$FCR = \text{Daily feed consumption} / \text{Daily weight gain} \quad (3)$$

Recorded data was then evaluated for its average and standard deviation, then run for analysis of variance (ANOVA) (Adli and Sjofjan, 2018; Kartikaningrum, 2018; Saty, 2014). Should a significant effect be detected, Least Student Differences (LSD) test would follow (Abdulbaqi *et al*., 2018; Adinurani, 2016, 2022; Alwi *et al*., 2019).

2.3. Performance Index (PI)

PI represents how well the treatment meets its goal. In this experiment, percentage of live chickens, body weight, average harvest age, and FCR are the defining factors (Anggitasari and Sjofjan, 2016; Azis *et al*., 2011; Herlina *et al*., 2016; Nuryati, 2019; Rusli, 2012) run through Equation (4):

$$PI = \frac{\text{Live chicken (\%)} \times \text{Average weight (kg)}}{\text{FCR} \times \text{Average age} \times 100\ \%} \quad (4)$$

2.4. Income Analysis

Gain/loss analysis is an approach to estimate a farmer's income (Solehah and Halimatus, 2016; Suwarta *et al*., 2012; Tuite *et al*., 1987), so Equation (5) was run to verify whether "aking-rice" is beneficial for farmers:

$$\text{Gain/loss} = \text{Output} - \text{input} \quad (5)$$

3. Results and Discussion

3.1. Performance index (PI)

The outcome of consuming "aking-rice" towards FI, ADG, and FCR of broiler chicken is presented in Figure 1. The result of PI analysis is also displayed.

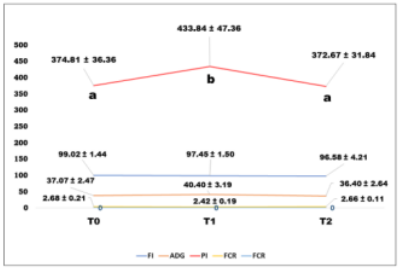

Figure 1. FI, ADG, FCR, and PI of broiler chicken fed with "aking-rice"

Figure 1. Illustrates that the highest FI rate is of P0 (99.02), followed by P1 (97.45) and P2 (96.58). Although only slightly different, the best ADG goes to P1 even with lower intake. P1 also recorded the lowest FCR rate (2.42) compared to P0 (2.68) and P2 (2.66). "Aking-rice" in P1 treatment has performed significantly better ($P < 0.05$) – in other words, "aking-rice" sprinkled on top of the feed is advantageous in enhancing PI when administered at a high temperature.

A bigger ADG rate and a smaller FCR one are keys to a higher PI value (Khalifa, 2014; Syukma, 2016; Umam *et al*., 2015; Yendy, 2014;), and their differences rely on nutrient absorption in broiler feed (Kusnadi, 2006; Nugraha *et al*, 2012; Roboth, 2015). Despite lacking on FI distinctions, P1 proves through its highest ADG rate that the nutrients in it have been better absorbed than in the other two treatments, which is appropriate to a statement by Marinus *et al*. (2020) and Suprayogi (2021) that the more nutrients a chicken absorbed, the heavier it will be (Widodo *et al*. 2019). Factors that may induce low nutrient absorption are low quality feed (Hakim *et al*., 2019; Latif and Sulaksana, 2014; Mansyur and Tangko, 2008; Widiyaningrum and Utami, 2014) or poor digestion as an effect of stress or illness (Setiarto *et al*., 2015; Sugito, 2016; Zalizar, 2010). Since the feed was of good quality and the materials were healthy, it is apparent that the low nutrient absorptions in P0 and P2 were due to stress – heat stress, to be specific (Dayyani and Bakhtiari, 2013; Khalifa, 2014; Kusnadi, 2007; Li *et al*., 2015; Mohammed *et al*., 2021; Tamzil, 2014).

The presence of resistant starch (RS) in "aking-rice" is deduced to be the reason of high IP. RS is not only indigestible but also unhydrolyzed, preventing it from getting absorbed in the small intestine (Setiarto *et al*., 2015; Suloi, 2019) and, consequently, reducing the organ's metabolic burden (Carvalho *et al*., 2020; Lin *et al*., 2006; Setiarto *et al*., 2015; Tamzil, 2014). Sprinkling "aking-rice" on feed ensures its higher consumption, which means more RS intake, since chickens eat more of it on the top layer contrasted to one mixed in the feed. As a result, chickens feel satiated longer and are able to relax despite the heat, enable them to eat normally and maintain stable weight gain. Besides, RS boosts the number of villi in ileum (Damat *et al*. 2020; Fuentes-Zaragoza *et al*., 2011; Lotfi *et al*., 2019; Santos *et al*., 2019; Suprayogi *et al*., 2021) and maximizes microbial functions there, which is essential in increasing chicken's performance (Astuti *et al*., 2015; Marinus *et al*., 2020; Mohammed *et al*., 2019; Wahyudi, 2008) – organic acids produced in the intestine should ease any heat stress syndromes, particularly in sensitive organs like jejunum (Awad *et al*., 2009; Santos *et al*., 2019; Sun *et al*., 2005; Suprayogi *et al*., 2021). Fast and feed cutdown – two techniques commonly applied to fight heat stress – are against broiler chicken's instincts to eat more in order to increase productivity by gaining weight (Astuti *et al*., 2015; Raji *et al*., 2017), adding more stress to the chickens and cost them their ADG (Azis *et al*., 2011; Khalifa, 2014).

RS also improves the digestive system (Astuti *et al*., 2015; Rozali *et al*., 2018) by nourishing the growth of good bacteria in the colon (Arshad *et al*., 2018; Damat *et al*. 2021a, 2021b; Setiarto *et al*., 2015). The good bacteria then produce bacterial acid that enhances insulin production in the pancreas which is essential in metabolism (Banjarnahor and Tangko, 2013; Lee *et al*., 2010; Marinus *et al*., 2020) as well as supporting the forming of short-chain fatty acid (butirat) (Damat *et al*. 2013; Rozali *et al*., 2018; Salim *et al*., 2013; Yendy, 2014) and the suppression of ammonia (Supartini and Darmawan, 2016; Suloi, 2019). Additionally, RS is able to accelerate the recovery process from diarrhea in broiler chicken by reducing the growth of vibrio cholera (Sulistiyanto *et al*., 2019; Suloi, 2019).

3.2. Income analysis

The potential of "aking-rice" in improving the welfare of broiler chicken farmers was analyzed by comparing feed cost (input) and harvest (output) and calculating profit-and-loss. Figure 2 and Figure 3 below signify the results.

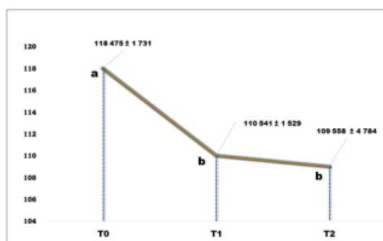

Figure 2. Feed cost (input) of broiler chicken

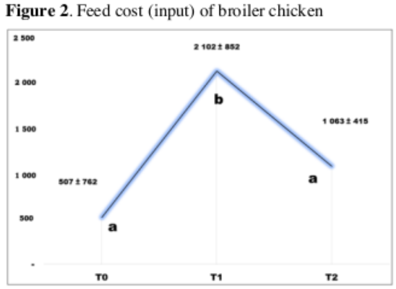

Figure 3. Profit-and-loss of broiler chicken

P1 was quite effective towards both input and profit-and-loss, while P2 was significantly effective towards input but less significant towards profit-and-loss. None of the treatments gave effect towards output, which means that although the harvest remains the same, involving 20 % "aking-rice" in broiler chicken feed should help in cutting down feed cost, thus increasing the farmer's profit.

Feed cost reduction is made possible since "aking-rice" is cheaper than corn, the broiler chicken basal feed. Since the highest production cost in broiler farming goes to feed (Astuti *et al*., 2019; Solehah and Halimatus, 2016; Suwarta *et al*., 2012) – covering 60 % (Anggitasari and Sjofjan, 2016; Widodo, 2009; Yafi, 2021) even 70 % to 80 % (Ariyadi and Anggraini, 2010; Astuti *et al*., 2015; Yendy, 2014) – lower feed cost should give higher revenue (Hartono, 2005; Hendayana and Wally, 2008; Iyai *et al*., 2020; Jaelani *et al*., 2013; Prasasta, 2018; Solehah, 2016). This study asserts the importance of "aking-rice" for feed efficiency to flourish broiler farming.

4. Conclusion and Suggestion

The use of "aking-rice" can improve the digestive tract so as to increase the performance index with a higher ADG value and lower FCR so that the cost is smaller and the profit is greater.

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