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Efficiency of Protein Use and Performance of Broiler Chickens Fed Corncob Fermented with EM4 (*Effective Microorganisms 4*)

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ABSTRACT. This study aimed to evaluate the use of fermented corncob flour as a substitute for rice bran in broiler chicken rations and its effects on protein efficiency ratio and broiler performance. Conducted at the Farm and Laboratory of the Faculty of Animal Science, University of Jambi, the study tested four treatments on 200 broiler chicks using a Completely Randomized Design (CRD) with five replications. The treatments included 0%, 4%, 8%, and 12% fermented corncob flour as a substitute for rice bran. Key variables observed were feed intake, body weight gain, feed conversion ratio, and protein efficiency ratio. Results indicated that the inclusion of fermented corncob flour significantly ($P<0.05$) improved feed intake, protein intake, protein efficiency ratio, and feed conversion ratio, with no significant impact ($P>0.05$) on body weight gain up to a 12% inclusion level. The optimal feed conversion was observed at the 8% substitution level. In conclusion, corncob flour fermented with EM4 can replace up to 12% of rice bran in broiler rations without negatively affecting performance, providing a viable alternative for poultry feed formulation.

Keywords: broiler, corn cobs, EM4, fermentation, protein use efficiency

INTRODUCTION

One of the primary challenges in broiler chicken farming is the high cost of feed, which constitutes 60–70% of total production expenses. Therefore, reducing feed costs while maintaining nutritional adequacy is crucial for the sustainability of poultry farming. Feed ingredients should be cost-effective, readily available, and non-competitive with human food sources. Varianti et al. (2017) and Wijayanti et al. (2024) suggest that using locally available agricultural byproducts, such as rice bran and corncobs, can help reduce feed costs.

Rice bran is commonly used in poultry feed due to its availability, affordability, and moderate nutritional value (Mila and Sudarma, 2021). It contains 82–90% dry matter, with 13.43–14.75% crude protein, 8.72–21.16% crude fiber, and 1.514–2.612 kcal/kg of metabolizable energy (Langu & Sudarma, 2022; Suryani and Luthfi, 2022). Variations in its nutritional composition result from differences in rice milling processes, with some bran containing husk residues (Mila & Sudarma, 2021). However, Karunia et al. (2022) reported that rice bran quality in Jambi is inconsistent, with low protein content (5.42–6.84%), high crude fiber (24.79–30.80%), and possible adulteration. This necessitates finding alternative feed ingredients, such as corncobs.

Corncobs are agricultural byproducts with low nutritional value, which has led to their limited utilization and frequent disposal as waste. Their natural decomposition process is relatively slow. Nutritionally, corncobs contain 4.64% crude protein, more than 10% lignin, and high levels of cellulose, making them suboptimal for direct use as animal feed. Hernaman et al. (2017) reported that corncobs contain 5.88% lignin and 32.03% crude fiber, further restricting their digestibility. To enhance their nutritional value, fermentation using *Effective Microorganisms 4* (EM4) is necessary.

According to Kastalani et al. (2020), the quality and digestibility of corncobs can be improved through EM4 fermentation, making them a viable feed ingredient. EM4 is a liquid microbial culture containing cellulase-producing microorganisms capable of hydrolyzing cellulose in corncobs, thereby softening the material (Molo et al., 2023). Additionally, EM4 contains *Lactobacillus spp*., which produce protease enzymes that help degrade proteins, increasing their bioavailability (Haryasakti et al., 2019). This process is expected to enhance protein utilization efficiency, measured through the protein efficiency ratio.

Based on these considerations, this study was conducted to assess feed utilization efficiency by evaluating the protein efficiency ratio and the performance of broiler chickens fed EM4-fermented corncobs as a substitute for rice bran.

MATERIALS AND METHODS

This study was conducted at the Livestock and Forage Cultivation Laboratory and the Basic and Integrated Laboratory of the Faculty of Animal Science, University of Jambi. The research utilized

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200 day-old broiler chicks (Platinum Strain CP 707) obtained from PT. Charoen Pokphand Indonesia Tbk. The broilers were housed for five weeks in colony cages measuring 100×100×50 cm³, with each cage containing 10 birds. The cages were equipped with feeders, drinkers, and heating lamps that also served as lighting.

The experimental diet included corncobs fermented with Effective Microorganisms 4 (EM4) as a substitute for rice bran, with replacement levels of up to 12%. The study followed a completely randomized design (CRD) with four dietary treatments and five replicates. Ethical supervision was conducted in accordance with the guidelines of the Livestock Ethics Commission, Faculty of Animal Science, University of Jambi.

Corn Cob Fermentation EM4 Fermentation

The fermentation of corncobs was carried out following the method described by Nurhayati et al. (2022). The ingredients included corncobs, sugar, EM4, and water. The preparation process is illustrated in Figure 1. First, corncobs were ground into fine particles. Simultaneously, sugar and EM4 were dissolved in clean water at a ratio of 100 mL of water, 0.6 g of sugar, and 0.6 mL of EM4. This solution was prepared for every 1 kg of corncob flour.

The corncob flour was gradually mixed with the sugar-EM4 solution while stirring until evenly distributed. The mixture was then placed in a semi-aerobic environment and fermented for three days, with daily stirring. After three days, the fermented corncobs were ready for use in feed formulations. The nutrient composition of both raw and fermented corncobs was analyzed before application.

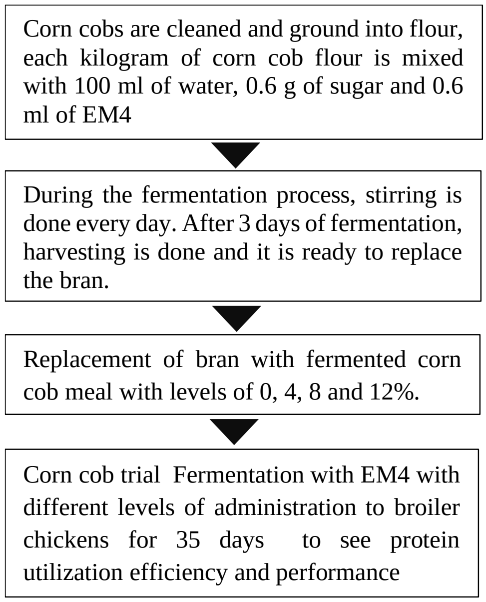

Figure 1. Flow chart of the corn cob fermentation process using Effective Microorganisms 4 Nurhayati et al. (2022)

Treatment Ration

The treatment ration consisted of concentrate, corn, bran, and fermented corn cobs, as detailed in Table 1, with the nutrient composition of each ingredient presented in Table 2, and the nutrient content of the treatment rations provided in Table 3.

Table 1. Composition of ingredients used in the treatment ration

Feed Ingredients	P0	P1	P2	P3
Concentrate (%)	35	35	35	35
Corn (%)	53	53	53	53
Bran (%)	12	8	4	0
Fermented Corn Cob (%)	0	4	8	12
Amounts	100	100	100	100

Note: P0= ration contains 12% bran and 0% fermented corn cob, P1= ration contains 8% bran and 4% fermented corn cob, P2= ration contains 4% bran and 8% fermented corn cob, and P3= ration contains 0% bran and 12% fermented corn cob

Table 2. Content of food substances concentrate, corn, bran, corn cob and fermented corn cob

Nutrients Content	Concentrate*	Corn	Bran	Corn Cob	Fermented Corn Cob
Dry Matter (%)	88,00	86,30	89,37	90,00	84,85
Ash (%)	15,00	5,30	11,64	3,52	5,71
Crude Protein (%)	36,50	8,30	8,90	7,93	3,31
Crude Fat (%)	3,00	2,20	4,20	4,72	2,70
Crude Fat (%)	8,00	4,10	13,21	23,20	31,81
NNFE (%)	25,50	66,40	51,42	48,50	41,32
ME (kkal/kg)	2800,00	2840,55	2200,00	2573,75	1956,05

Note: Results of Basic and Integrated Laboratory Analysis, Jambi University (2023) *Produced by PT.CPI,Tbk, NNFE= Non Nitrogen Free Extract, ME= Metabolic Energy

Table 3. Content of feed substances in the treatment rations

Treatments	Nutrients Content (% DM)						ME (Kcal/kg)
	DM	CP	CF	C Fat	Ash	NNFE	
P0	87.26	18.24	6.56	2.72	9.46	50.29	2749.49
P1	87.08	18.02	7.30	2.66	9.22	49.88	2739.73
P2	86.90	17.80	8.05	2.60	8.98	49.48	2729.98
P3	86.72	17.57	8.79	2.54	8.74	49.08	2720.22

Note: P0= ration contains 12% bran and 0% fermented corn cob, P1= ration contains 8% bran and 4% fermented corn cob, P2= ration contains 4% bran and 8% fermented corn cob, and P3= ration contains 0% bran and 12% fermented corn cob, DM= Dry Matter, CP= Crude Protein, CF= Crude Fiber, C Fat= Crude Fat, NNFE= Non Nitrogen Free Extract, ME= Metabolic Energy

The variables observed in this study included ration consumption, weight gain, ration conversion, and protein utilization efficiency. Ration conversion was calculated by dividing total ration consumption by weight gain, while protein utilization efficiency was determined by comparing weight gain to protein consumption.

The research data were statistically analyzed using analysis of variance (ANOVA) following a completely randomized design (CRD) with four treatments and five replications. When a significant difference was found among treatments, further analysis was conducted using Duncan's multiple range test (DMRT) (Steel et al., 1997) to determine differences between treatment means.

RESULTS AND DISCUSSION

The effect of the treatment, specifically the replacement of bran with fermented corn cobs up to 12% in the ration, on the observed variables ration consumption, protein consumption, weight gain, protein utilization efficiency, and ration conversion is presented in Table 4.

Ration Consumption

The results of the variance analysis indicate that the use of corn cobs fermented with EM4 as a substitute for bran in the ration has a significant effect (P<0.05) on increasing ration consumption (Table 4). The inclusion of EM4-fermented corn cobs in the ration up to a level of 12% significantly increases ration consumption. This is because the increased use of EM4-fermented corn cobs lowers the energy content in the ration (Table 3), leading to greater feed intake by the livestock. Additionally, the fermentation process softens the ration, enhancing its palatability.

This aligns with the principle that feed consumption is influenced by palatability, which is determined by factors such as smell, taste, texture, and color, all of which are affected by the physical and chemical properties of the feed material. Furthermore, Rianza et al. (2019) stated that fermentation introduces beneficial physical and chemical changes, including improvements in aroma, taste, and texture, as well as the breakdown of complex compounds into simpler forms. Similarly, Nurhayati et al. (2016) reported that the inclusion of feed ingredients fermented with bacteria such as *Lactobacillus sp.* at levels up to 15% in the ration can enhance feed intake.

The EM4 material used in this study was produced by PT. Songgolangit Persada and contains *Lactobacillus casei*, *Saccharomyces cerevisiae*, and *Rhodopseudomonas palustris*, which have been shown to improve feed quality after 36 hours of fermentation (Nurhayati et al., 2022). The average broiler chicken ration consumption in this study ranged from 52.32 to 73.91 g/bird/day (Table 4). This result is lower than findings from previous studies (Ali et al., 2019; Berliana et al., 2020; Ibrahim et al., 2015), which reported broiler ration consumption ranging from 85.93 to 97.55 g/bird/day (Ali et al., 2019), 71.62–78.84 g/bird/day (Ibrahim et al., 2015), and 72.33–74.90 g/bird/day (Berliana et al., 2020). According to Wahju (2015), variations in ration consumption are influenced by factors such as the age, quality, quantity, and palatability of the feed.

Protein Consumption

The results of the variance analysis indicate that the use of EM4-fermented corn cobs as a substitute for bran in the ration has a significant effect (P<0.05) on increasing protein consumption (Table 4). This demonstrates that replacing bran with EM4-fermented corn cobs at levels up to 12% significantly enhances protein consumption. This finding is consistent with the observed increase in feed intake as the proportion of fermented corn cobs in the ration increases.

Feed intake is influenced by nutrient content and the body's metabolic processes. Although the protein content in the treatment ration decreases with the increased use of fermented corn cobs (Tables 1 and 3), the protein consumed is effectively metabolized by the livestock, aided by the microbial activity in EM4. Efficient metabolism enhances appetite and overall feed consumption. The fermentation process with EM4 improves feed quality, particularly protein availability, as the microbes in EM4 produce protease enzymes that degrade protein, as reported by Haryasakti et al. (2019). This aligns with Rianza et al. (2019), who stated that fermentation introduces beneficial physical and chemical changes, including the reduction of anti-nutritional compounds.

The average broiler chicken protein consumption in this study ranged from 8.29 to 11.69 g/bird/day. This is consistent with findings by Varianti et al. (2017), who reported an average protein consumption of 7.65 to 11.30 g/bird/day. However, this result is lower than those of Nurhayati et al. (2019), who found that broiler chicken protein consumption ranged from 19.04 to 19.27 g/bird/day. Similarly, Berliana and Azis (2016) reported broiler feed protein consumption of 7.02 g/bird/day, which increased to 8.06 g/bird/day by five weeks of age. Ibrahim et al. (2016) found that broiler protein consumption in the initial phase ranged from 6.94 to 8.03 g/bird/day, while in the final phase, it ranged from 6.55 to 7.87 g/bird/day. Wardaya et al. (2015) stated that protein consumption is directly related to protein digestibility, where lower protein intake corresponds to lower protein digestibility.

Table 4. Average ration consumption, protein consumption, weight gain, protein use efficiency and broiler chicken ration conversion during the study (Average±SD)

Variable	Treatments			
	P0	P1	P2	P3
Feed Consumption (g/head/day)	61.84^{b}±3.10	62.77^{b}±7.87	52.32^{c}±4.52	73.91^{a}±4.20
Protein Consumption (g/head/day)	9.84^{b}±0.49	9.97^{b}±1.25	8.29^{c}±0.72	11.69^{a}±0.66
Weight Gain (g/head/day)	23.86±2.60	25.05±4.27	24.61±1.82	20.56±1.89
Efficiency of Protein Use	2.42^{b}±0.33	2.51^{b}±0.52	2.97^{a}±0.45	1.76^{c}±0.19
Rations Conversion	2.59^{b}±0.13	2.51^{b}±0.32	2.13^{c}±0.23	3.59^{a}±0.19

Note: Different lowercase superscripts on the same line indicate a significant difference (P<0.05), P0= ration contains 12% bran and 0% fermented corn cob, P1= ration contains 8% bran and 4% fermented corn cob, P2= ration contains 4% bran and 8% fermented corn cob, and P3= ration contains 0% bran and 12% fermented corn cob

Weight Gain

The results of the variance analysis indicate that the use of EM4-fermented corn cobs as a substitute for bran in the ration has no significant effect (P>0.05) on the weight gain of broiler chickens (Table 4). However, there is a tendency for weight gain to decrease when fermented corn cobs replace more than 4% of the bran in the ration. This decrease is attributed to a reduction in essential nutrients such as crude protein, an increase in crude fiber, and a decline in metabolic energy as the proportion of EM4-fermented corn cobs increases up to 12%.

Higher crude fiber levels can hinder nutrient digestibility, particularly protein, which is essential for growth and weight gain. Additionally, excessive crude fiber may cause the excretion of easily digestible nutrients through feces, preventing chickens from fully utilizing the consumed protein. Nurhayati et al. (2019) reported that a high crude fiber content in the ration inhibits nutrient absorption, reducing the efficiency of nutrient utilization since a significant portion is lost through excreta, leading to low protein digestibility. Furthermore, an increase in crude fiber raises intestinal fluid viscosity, disrupting nutrient absorption and consequently reducing growth rates. This aligns with the findings of Varastegani and Dahlan (2014), who stated that the crude fiber content in feed significantly affects livestock performance and growth.

The average weight gain of broiler chickens in this study ranged from 20.56 to 25.05 g/bird/day (Table 4). This result is lower than the findings of Nurhayati et al. (2019), who reported broiler chicken weight gains of 43.64–50.18 g/bird/day. This difference is likely due to the high crude fiber content in the feed, which negatively impacts feed consumption, nutrient digestibility, and overall weight gain. Ali et al. (2019) similarly stated that an increase in crude fiber content in the ration leads to reduced feed consumption, which directly lowers protein intake and protein digestibility, ultimately contributing to lower weight gain.

Efficiency of Protein Use

The results of the variance analysis indicate that the use of EM4-fermented corn cobs as a substitute for bran in the ration has a significant effect (P<0.05) on protein utilization efficiency (Table 4). The highest protein utilization efficiency was observed at the 8% substitution level, with a value of 2.97, which was significantly higher than other treatments. Conversely, at the 12%

substitution level, protein utilization efficiency decreased to 1.76, the lowest among all treatments.

This finding suggests that at the 8% substitution level, the nutrient balance in the ration was more optimal compared to other treatments, leading to efficient protein utilization despite relatively lower ration and protein consumption. This efficiency contributed to higher weight gain. On the other hand, at the 12% substitution level, although both ration consumption and protein intake were high, protein utilization efficiency was lower, leading to reduced weight gain. This is likely due to the high crude fiber content (8.79%) and low metabolizable energy (2720.22 kcal/kg) at this level, which negatively affected protein efficiency. Fanani et al. (2014) stated that broiler chickens struggle to digest excessive crude fiber, which leads to decreased nutrient utilization efficiency.

The average protein utilization efficiency in this study ranged from 1.76 to 2.97 (Table 4). These results align with the findings of Nurhayati et al. (2019), who reported a protein efficiency ratio ranging from 2.28 to 2.61, and Sari et al. (2014), who found values ranging from 1.88 to 2.57. Furthermore, protein utilization efficiency can be evaluated based on weight gain, protein consumption, and the protein efficiency ratio.

Feed Conversion

The results of the variance analysis show that the use of EM4-fermented corn cobs as a substitute for bran in the ration significantly affects the feed conversion rate of broiler chickens ($P<0.05$) (Table 4). Based on the Duncan test, the average feed conversion rate of broiler chickens shows that treatment P3 (3.59) provides a higher feed conversion rate compared to P0 (2.59), P1 (2.51), and P2 (2.13). The best treatment in terms of feed conversion was P2 (2.51), indicating that the 8% fermented corn cobs substitution was the most efficient in utilizing the consumed ration for weight gain. However, increasing the percentage of EM4-fermented corn cobs to 12% resulted in higher crude fiber content in the ration, which, despite increasing ration consumption, led to reduced weight gain. This finding aligns with the research of Berliana et al. (2021), Berliana et al. (2022), and Nurhayati et al. (2016), who stated that feed conversion is a critical measure of livestock productivity. Feed conversion is defined as the ratio of feed consumption to weight gain over a specific period, and a lower feed conversion rate indicates higher feed efficiency, while a higher ratio reflects lower feed efficiency.

The average feed conversion ratio in this study ranged from 2.13 to 3.59 (Table 4), which is lower than the results reported by Ali et al. (2019), where the feed conversion ratio ranged from 3.36 to 7.47. Berliana et al. (2022) found that the feed conversion ratio ranged from 1.61 to 1.66 for broiler chickens. Feed conversion can serve as an indicator of production efficiency: the lower the feed conversion ratio, the more efficient the feed use, as less feed is required to increase body weight.

CONCLUSION

Based on the results and discussion, it can be concluded that corn cob flour fermented with EM4 can replace rice bran up to 12% in the ration without negatively affecting protein utilization efficiency and broiler performance.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest regarding the presentation of this manuscript.

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