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Rice bean meal and turmeric rhizome powder and their potential as growth supplements in broiler chicken diet

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Abstract

This study explores the potential of local rice bean meal as a sustainable, reasonably priced protein source and turmeric rhizome powder as an alternative source of antibiotics, evaluating their effects on the growth performance and economic benefits of broiler chickens. Conducted in Santa Fe, Cebu, Philippines, from August 22 to September 18, 2024, a completely randomized design (CRD) was used to assess their efficacy as growth supplements in broiler starter chicken diets. Ninety broiler chicks were allocated into three groups: Treatment 0 (control group receiving just commercial feeds), Treatment 1 (35% rice bean meal and 7.5 g/kg turmeric powder), and Treatment 2 (45% rice bean meal and 7.5 g/kg turmeric powder). Data were analyzed using ANOVA, F-test, and Least Significant Difference at 5% and 1% significance levels. The findings revealed that sand-roasted rice bean meal and turmeric rhizome powder improved growth performance, with average final weight and weight gain comparable to pure commercial feeds. Despite lower costs for Treatment 0, Treatment 1 demonstrated superior feed efficiency and profitability, making it the best option. No significant differences in growth characteristics were observed. The research shows that incorporating turmeric rhizome powder and rice bean meal into broiler chicken feed can enhance feed efficiency. Future studies should investigate processing techniques, variations in dosage, and comprehensive research to promote sustainable feeding practices for farmers.

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Introduction

Broiler meat production in developing countries is growing due to its affordability, versatility, and perceived health benefits. Broiler chickens are currently the most advanced livestock industry in the Philippines. Customers also switched from pork to chicken due to the shortage and increased pig prices caused by the African swine fever outbreak (Acosta, 2022). However, despite this status, the Philippine broiler industry faces challenges due to the high costs of feeds and a need for alternative sources of protein supplements and antibiotics.

To answer this, locally grown forages and grain legumes are used as animal feed, which offer ecological benefits (Martens *et al.*, 2012).

One of these legumes is rice bean, a tropical legume that is underutilized but high in nutrients (Katoch, 2013). It is cultivated by tribals in India's Eastern and North-Eastern regions, consumed as a pulse mixed with rice, and cooked as vegetables (Saika *et al.*, 1999). It is also common in the Philippines, particularly in the rural areas in Cebu province. Only a few have revealed the potential of rice beans as alternative protein sources. In addition, these studies sadly have not usually been realized amidst the challenges faced by small-scale farmers.

When commercial feed costs start to soar, they suffer the most. On the other hand, turmeric rhizome can be used as an alternative to antibiotics in poultry production in commercial broiler chickens (Aderemi and Alabi, 2023). Turmeric protects and reduces stress and the harmful effects of inflammation while promoting growth in broiler chickens (Khodadadi *et al.*, 2021).

One of the 17 world Sustainable Development Goals created by United Nations members in 2015 was SDG 12, which urges people to consume and produce responsibly, ensuring sustainable consumption and production processes. This study investigated the potential of rice bean meal as an alternative protein source and turmeric rhizome powder as an alternative antibiotic source for poultry diets. Rice beans are high in protein, making them a potential alternative feedstuff. Anti-inflammatory, antioxidant, and antimicrobial capabilities were also found in turmeric rhizomes, which may benefit broilers' health and performance (Memarzia *et al.*, 2021). Through this approach, redirecting food in daily operations will lower feed-related expenditures for poultry farmers and support local agriculture. Thus, the study evaluated the impact on the production parameters such as the average final weight, weight gain, feed intake, and feed conversion ratio (FCR) to determine their optimal inclusion rates in the diet and economic profitability. The study also aimed to fill knowledge gaps on the combined use of rice bean meal and turmeric in poultry diets, filling knowledge gaps and providing a foundation for future research. The research will contribute to more sustainable and efficient poultry production practices and guide poultry farmers, supporting economical and sustainable methods of producing chicken.

Materials and methods

Study design

This study employed a Completely Randomized Design (CRD) to evaluate the effects of rice bean and turmeric supplementation on broiler starter chickens' growth performance and economic profitability. A total of ninety (90) day-old chicks were used as experimental animals. These experimental birds were randomly assigned to three (3) treatments and replicated three (3) times with ten (10) birds per replication, totalling ninety (90) heads of broilers. The experimental treatments were Treatment 0, which served as the control group and were fed commercial broiler feeds; Treatment 1, where birds were fed 35% rice bean meal and 7.5 g of turmeric rhizome powder; and Treatment 2, where birds were fed 45% rice bean meal and 7.5 g of turmeric rhizome powder.

Study area

The study was conducted in Sitio Matiamban, Barangay Okoy, Santa Fe, Cebu, Philippines, from August 22 through September 18, 2024. All

Procedures used in the study followed the Good Animal Husbandry Practices in the Philippines. Cleaned and disinfected cages that measured one (1) square foot per chick with good ventilation and proper heat conversion were constructed a month before the arrival of the experimental birds. The cages were built of bamboo slats, tie wire, empty bags, plastic screens, hammers, nails, a crosscut saw, and a bolo. The study used three battery-type rearing cages measuring 3 meters in length, 0.8 meters in height, and 0.9 meters in width. Each deck was divided into three compartments, accommodating ten (10) birds. The cages were made of bamboo slats to provide air passage for proper ventilation. Feeding and watering troughs were placed inside the rearing cages.

Rearing management

A hundred one-day-old broiler chicks were acquired from a local Agrivet store. The experiment used ninety (90) birds, with the remaining ten (10) heads as a reserve. When the chicks arrived, they were given fresh, clean water with commercial electrolytes. The day-old chicks were given multivitamins for seven days.

The brooding cages were thoroughly cleaned and disinfected before the stocks arrived. Four (4) 25-watt lamps were put at the four corners of the brooding room, and the feeding and watering troughs were disinfected. To defend against pathogenic microorganisms, disinfectants were placed at the brooding room's entry. After two weeks of brooding, the birds were moved and randomly allocated to each treatment. The draw lots method randomly assigned the birds to the various treatments.

Preparation of the experimental diets

Rice bean seeds were sand roasted for approximately 10 minutes to obtain 80 to 85% dry matter (DM), then grounded using a mechanical corn miller. Fresh turmeric rhizomes were washed entirely to remove all soil remains, boiled for approximately 40 minutes, and then sun-dried for 7 days. Then, using a mechanical food processor, it was processed into a powder. Mixing SRRBM with commercial feeds was based on each treatment. Treatment 0 (Control), 1000 grams of pure commercial feeds; Treatment 1, 650 grams of commercial feed added with 350 grams SRRBM + 7.5 g/kg turmeric powder; and Treatment 2, 550 grams of commercial feed added with 450 grams SRRBM + 7.5 g/kg turmeric powder. Mixing the different levels of sand-roasted rice bean meal and turmeric with the commercial feeds was done using a plastic jar, shaking it, and incorporating the feed ingredients well inside.

Feeds and feeding management

The type of feed given depended on the age of the birds. Commercial chick booster mash was fed from one to fourteen days old, followed by broiler starter crumble from fifteen to thirty days old. The supplementation started on the 14th day of the chicks, after a gradual transition feeding of three days. The experimental diets and clean drinking water were provided ad libitum every day.

One group served as a control and was fed a pure commercial diet, while the other groups received different levels of supplemented rice bean and turmeric rhizome powder. Birds in treatment zero (0) fed with 1000 grams of pure commercial feeds (control), while birds in treatment one (1) fed with 650 grams of commercial feed + 350 grams SRRBM + 7.5 g/kg TRP, and Treatment two (2), 550 grams of commercial feed + 450 grams SRRBM + 7.5 g/kg TRP.

The experimental birds were fed twice daily, six (6) in the morning and five (5) in the afternoon. The feeding schedule was followed until the end of the research. Every day, the amount of food supplied and denied was carefully recorded. Throughout the trial, health care and sanitation management were implemented to prevent illness transmission.

Data gathered

Growth performance

The initial weights of the birds were recorded at the start of the feeding trial right after the fourteen (14) days

brooding period. In contrast, the final weight was determined after the 14th day of the feeding trial, and experimental birds were fasted for 12 hours before weighing. Body weight (BW) was measured weekly to monitor weight gain. The feed intake of broilers was recorded by offering a weighed quantity of feed and weighing feed refused daily. The average weight gain per treatment was determined by subtracting the average initial weight from the average final weight of birds per treatment. The average feed consumption was determined by multiplying the average feed consumed by the number of birds per treatment and the number of days the feed consumed, then dividing by the total number of birds per treatment. The feed conversion ratio (FCR) was calculated by getting the percentage of the feed consumed over the broiler's final body weight gain. A digital weighing scale with a maximum capacity of three (3) kg and a division of 0.1 g was used to measure weight parameters.

Average final weight (g/bird)
This was obtained by dividing the weight of birds at harvest from the total number of birds per treatment.

Average final weight = (Total final weight of broiler chicken)/(The total number of broilers per treatment)

Average weight gain
The average weight gain per treatment was determined by subtracting the average initial weight from the average final weight of birds per treatment.

Average Weight Gain = Average final weight - Average initial weight

Average feed consumption
The average feed consumption was determined by multiplying the average feed consumed by the number of birds per treatment and by the number of days the feed consumed, then dividing by the total number of birds per treatment.

Average feed consumption = (Feed Consumption per treatment ×No. of days)/ (Total no. of sample birds per treatment)

Average feed conversion efficiency
The average feed conversion efficiency was determined after gathering data on feed consumption. It was obtained by dividing weight gain by total feed consumption.

Feed conversion efficiency = Average feed consumed/*Average weight gained*

Return on investment
It is a ratio that compares the gain or loss to the cost of an investment to determine its profitability. It assists in determining the possible return on investments made in stocks or company endeavors. ROI can be computed using a particular formula and typically displayed as a percentage (Beattie, 2024).

ROI=(GI/PC)×100

Where,
GI = Gross income
PC = Production cost

Results and discussion
Please see Table 1 summary on the initial weight, final weight, weight gain, feed consumed, and feed conversion efficiency.

Average final weight
After the production period, the final weight of birds was obtained by dividing the weight of birds at harvest by the total number of birds per treatment. Table 1 shows the average final weight of broilers fed with pure commercial feeds supplemented with different rice bean and turmeric levels. Findings revealed that Treatment 1 had the highest mean weight (1121.21 g), followed by Treatment 2 (1073.54 g), with the least at Treatment 0 (1031.91 g). However, statistical analysis showed no significant differences among treatment means ($F = 2.49$, $p = 0.1631$). This suggests that the treatments have a comparable effect with pure commercial feeding on the average final weight of birds.

Table 1. Summary on the initial weight, final weight, weight gain, feed consumed, and feed conversion efficiency

Treatment	Average initial weight (Kg)	Average final weight (Kg)	Average weight gain (Kg)	Average feed consumed (Kg)	FCE
A	0.28	1.03	0.76	1.20 [b]	1.59 [b]
B	0.28	1.12	0.84	1.37 [a]	1.63 [ab]
C	0.30	1.07	0.77	1.34 [a]	1.73 [a]
F-Test	-	ns	ns	**	*
CV (%)		4.56	5.84	3.67	3.17

A=Treatment 0 (1000 grams of pure commercial feed, control), B=Treatment 1 (650 grams commercial feed + 350 grams sand roasted ground rice bean meal + 7.5 g/kg turmeric powder), C=Treatment 2 (550 grams commercial feed + 450 grams sand roasted ground rice bean meal + 7.5 g/kg turmeric powder)

Thus, the result of the study indicated that supplementation of rice bean meal and turmeric rhizome powder in the diet seems to have the potential to improve the production performance of broilers. This might probably also be because, based on the studies conducted by Katoch (2013), rice bean seeds contain a well-balanced source of beneficial nutrients such as protein, carbohydrates, minerals, vitamins, polyunsaturated fatty acids (PUFAs), and antioxidants. These can formulate various products, including feed supplements intended for animal nutrition. The results align with the study of Ampode and Lagua (2021), wherein the results revealed that supplementation of TRP (Turmeric Rhizome Powder) into the diet of Japanese quails significantly influenced ($p< 0.05$) the voluntary feed intake, percent egg production, feed conversion ratio, and egg yolk color.

Average weight gain

The average weight gain per treatment was determined by subtracting the average initial weight from the average final weight of birds per treatment. Based on the data collected, as indicated in Table 1, column 4, Treatment 1 had the most significant mean (0.84 kg), followed by Treatment 2 (0.77 kg), with Treatment 0 (0.76 kg) having the lowest mean.

However, statistical analysis through variance analysis (ANOVA) showed that the treatments did not significantly affect weight gain ($F = 2.59$, $p = 0.1548$). This suggests that the treatments have a comparable effect with pure commercial feeding in terms of the increase in weight.

Sharma *et al.* (2021) stated that rice beans, with their high protein, fiber, minerals, and beneficial components, enhance the production of value-added products with superior nutritional quality. Katoch (2013) also highlighted rice beans' strong dietary profile, primarily due to their high protein and low-fat content and a relatively high amount of health-promoting unsaturated fatty acids. Bhagyawant *et al.* (2019) confirmed the nutritional value of this underutilized legume. In addition, numerous studies evaluated turmeric powder's effect on broiler chicken's growth performance. The variation in the findings might be due to several factors, such as basal diets, growing duration, statistical design, broiler breeds, and turmeric powder dosage (Dono, 2014). However, a recent Ekine *et al.* (2020) study reported that a 1% inclusion of turmeric powder in a corn-soybean-based diet improved body weight gain and FCR of Ross broiler chicken.

Average feed consumed

One significant indicator of broiler chicken performance is feed intake. Determining how feed additives affect an animal's feed intake is therefore crucial. By dividing the average feed consumption by the weight gain per treatment, the average feed consumption of broiler chicken per treatment was determined. The study results are shown in Table 1, column 5, and the data revealed that Treatment 1 had the highest mean (1.37 kg), followed by Treatment 2 (1.34 kg), and Treatment 0, with 1.20 kg, had the lowest mean. Statistical analysis revealed a significant difference between treatment means ($F = 11.00$, $p = 0.0098$). The results imply that the treatments have

impacted the average feed consumed by birds. The average feed consumption of birds under treatments 1 (1365.41 g) and 2 (1342.05 g) were considerably better than those of treatment 0 (1196.53 g).

The palatability of feed depends on the animal's sensory properties, nutritional value, perception, and appraisal. Chickens can detect odors owing to a well-developed olfactory system and the use of smell for searching for feed. Chickens also have a well-developed set of taste receptors for the different basic tastes (Erdoğan and Iwasaki, 2014). Roasting is perhaps one of the most excellent methods to enhance the sensory qualities of legumes, claim Ozalina *et al.* (2023). This process significantly improves the color, flavor, and texture of legume products while decreasing environmental contamination and increasing product shelf life. Roasted legumes experience Maillard reactions, in which sugars and proteins react with heat to produce a darker color and a deeper, toasted flavor. Legumes may become tastier and more attractive due to these flavors and visual modifications, particularly in broiler feed formulations where enhanced flavor may encourage increased feed consumption, a desirable and valuable addition to broiler diets. It is consistent with our findings, which show that roasting rice beans in broiler feed increases their palatability and consumption. However, according to Jiao *et al.* (2015), all the roasting treatment techniques mentioned require much energy, take a long time and produce little.

Moreover, published studies regarding turmeric's impact on the feed intake of broilers vary from one experiment to another. Emadi and Kermanshashi (2006) reported that 0.25-0.75% turmeric powder did not affect the feed intake of Ross broiler. This agrees with Mehala and Moorthy (2008) results, where a cobb broiler fed 0.1-0.2% turmeric powder did not influence feed intake.

Feed conversion efficiency

Feed conversion ratio, or FCR, measures an animal's efficiency in converting feed into increased body mass. It indicates how efficiently an animal converts feed mass to the desired output. Broilers in T2 had the highest feed conversion ratios (FCR) at 1.74, followed by T1 at 1.63 and T0 with the lowest means at 1.59 and according to the results presented in Table 1, statistical analysis through Analysis of Variance (ANOVA) indicated that the treatments significantly affected feed conversion efficiency ($F = 6.16$, $p = 0.0351$).

The results suggested Treatment 0 had the most desirable feed conversion ratio compared to the other treatments. The higher FCR values in the rice bean meal groups indicate that broilers fed these diets required more feed to gain the same weight as those in the control group. This suggests a decrease in feed conversion efficiency when rice bean meal is included in the diet. Efficient feed conversion is vital for the economic sustainability of broiler production, as it directly impacts feed costs, which are a significant portion of total production costs.

Several factors could contribute to the observed decrease in feed conversion efficiency. First, rice bean meals may have lower digestibility and nutrient availability than the control diet. Second, anti-nutritional factors in rice bean meal, such as tannins and phytic acid, could impair nutrient absorption and utilization, leading to poorer feed efficiency (Samtiya *et al.,* 2020). Previous studies have reported similar findings, where the inclusion of alternative plant protein sources with anti-nutritional factors adversely affected feed efficiency in broilers (Martens *et al.,* 2012).

Furthermore, although turmeric powder was used for 14 days to improve feed conversion efficiency in broiler chickens, as reported by Shohe *et al.* (2019), Hussein (2013), Fallah and Mirzaei (2016), Kafi *et al.* (2017) and Arslan *et al.* (2017), the results did not support their claims.

Mortality rate

In each treatment of T0 and T1, the investigation documented one incidence of mortality; however,

prior to this event, they exhibited no disease symptoms, making it challenging to identify the cause. It fits the Sudden Death Syndrome (SDS) pattern observed in rapidly growing male broiler chicks aged between two and four weeks. According to The Broiler Production Committee 2004 (2006), SDS is assumed to be caused by a metabolic disorder that results in cardiac arrhythmias, making intense and rapid pulses compelling and consequently resulting in death without practical tests and signs. It occurs in most instances where there are no indications of any sickness or ailment, and it is characterized by inflammation and microscopic cardiac scarring. It has been reported that controlling the growth rate between birth and three weeks of age via nutritional and light manipulations virtually eliminates the incidence of SDS (Zedek, 2024).

Table 2. Summary on the feed cost, gross income, production cost, net income, and return on investment

Treatment	Feed cost	Gross income (Php)	Production cost	Net income	ROI
A	59.97 [b]	175.43	172.63 [b]	2.80	1.60
B	68.43 [a]	190.60	181.09 [a]	9.51	5.22
C	67.26 [a]	182.50	179.92 [a]	2.58	1.40
F-Test	**	ns	**	ns	ns
CV (%)	3.67	4.56	1.35	120.65	3.17

A=Treatment 0 (1000 grams of pure commercial feed, control), B=Treatment 1 (650 grams commercial feed + 350 grams sand roasted ground rice bean meal + 7.5 g/kg turmeric powder), C=Treatment 2 (550 grams commercial feed + 450 grams sand roasted ground rice bean meal + 7.5 g/kg turmeric powder)

Effects on the economic profitability of the different treatments

Table 2 shows how the various treatments affected the feed costs, gross income, production costs, net income, and return on investment (ROI). With far reduced feed (₱59.97) and production costs (₱172.63), Treatment 0 was the most economical, making it perfect for cutting expenditures. Although the variations in income and ROI between treatments were not statistically significant, Treatment 1 had the highest gross income (₱190.60), net income (₱9.51), and ROI (5.22%), indicating the possibility of higher profitability.

High production costs incurred for some materials, such as those for cages and other infrastructure, were also found to lower ROI across treatments. Nevertheless, these expenses can be recovered if production is to be continued because they are a long-term investment. As a result, Treatment 0 is appropriate for short-term cost savings, whereas Treatment 1 may provide more considerable benefits over time. Ultimately, the treatment decision is based on priorities, such as whether to prioritize long-term profitability or cost reduction.

To maximize profitability, Gous (2022) stated that the best feeding regimen for broilers should balance nutritional density, amino acid concentrations, and feeding length while accounting for feed costs, animal reactions, and production system expenses. Because commercial feeds are made with exact nutrient compositions to support broiler growth, feed conversion, and overall production efficiency, they are mainly made to suit these criteria.

Commercial feeds streamline the intricate optimization process by integrating thorough data on growth rates, environmental factors, and processing results, guaranteeing broilers receive all the nutrition required for peak performance.

Conclusion

Based on the results, sand-roasted rice bean meal and turmeric rhizome powder are promising options for improving the growth performance of broilers. The effects on the average final weight gain are comparable with pure commercial feeds and thus can be used as an alternative to supplemental feed sources. The best result was shown in Treatment 1, 350 grams SRRBM + 7.5 g/kg turmeric powder, which had a feed consumed mean of 1.37 kg, followed by Treatment 2, 450 grams

SRRBM + 7.5 g/kg turmeric powder. Significant variations in feed and production costs were found among the treatments, with T0 having the lowest values for feed cost (₱59.97) and production cost (₱172.63) compared to T1 and T2.

Though the differences in these factors were not statistically significant, Treatment 1 continuously showed better economic performance, displaying the most excellent gross income (₱190.60), net income (₱9.51), and ROI (5.22) than the other treatments. Although Treatment 2 did not outperform Treatment 1, it did have intermediate results for most factors.

Overall, Treatment 1 outperformed Treatment 0 regarding profitability metrics, making it the choice for economic returns even if Treatment 0 was cost-effective.

Recommendations

An alternate supplement for broiler productivity is turmeric rhizome powder and sand-roasted rice bean meal. To address the labor-intensive characteristics of its preparation and make it more accessible for farmers, future research should investigate more effective processing methods for turning rice beans into meals. To properly validate the findings of this study, additional research with a bigger sample size and longer duration should be carried out. The efficiency and effectiveness of feed could be further maximized by looking at different dosages or combinations of these supplements. Furthermore, promoting the use of turmeric and rice beans might be consistent with government initiatives to improve rural employment, strengthen regional economies, and reduce dependency on imported feed additives. Although Treatment 1 is advised as the best course of action based on economic performance, adding Treatment 0's cost-cutting techniques could increase profitability even further. More research with bigger sample sizes and different settings is advised to validate these results and guarantee wider application.

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