ORIGINAL ARTICLE

The inclusion of tamarind leaf flour in the diet affects the productive performance and carcass yield of free-range chickens

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A inclusão de farinha de folhas de tamarindo na dieta afecta o desempenho produtivo e o rendimento da carcaça de frangos caipira

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Abstract

In Timor-Leste, raising free-range chicken is an important resource for smallholder farmers in rural areas, meeting sociocultural and economic needs, and also serving as a means of subsistence in these regions. The objective of this study was to investigate the effects of different levels of tamarind leaf meal (0%, 2%, 4%, and 6%) in a pelleted diet composed of yellow corn, soybean, and rice bran, on the productive performance and carcass yield of local chickens. An experimental method was used with a randomized block design, consisting of four treatments and four replicates. Ninety-six local chickens aged between 8 and 10 weeks were used, with six chickens per experimental unit, raised in a conventional intensive system for a period of 61 days. The variables observed included feed intake, average daily weight gain, feed conversion ratio, and carcass yield, including slaughter weight, carcass weight, and carcass percentage. The statistical analysis results revealed a significant effect at the 5% probability level ($p < 0.05$) for all variables observed in the study. Duncan's mean comparison test showed that the treatment with the inclusion of 2% tamarind leaf meal in the diet was the best compared to the control treatment and the treatments with the inclusion of 4% and 6% tamarind leaf meal in the diet. Thus, it is concluded that the inclusion of 2% tamarind leaf meal in pelleted feed formulations was the best treatment to improve local chicken production.

Keywords: Native chicken. Formulation. Pelleted feed. Meat yield. Performance.

Resumo

Em Timor-Leste, a criação de frangos caipira é um recurso importante para pequenos agricultores em áreas rurais, atendendo a necessidades socioculturais e econômicas, além de servir como meio de subsistência nessas regiões. O objetivo deste estudo foi investigar os efeitos de diferentes níveis de farinha de folha de tamarindo (2%, 4% e 6%) em uma dieta peletizada composta de milho amarelo, farelo de *soja e farelo de arroz, sobre o desempenho produtivo e o rendimento de carcaça de frangos caipira. Utilizou-se o método de pesquisa experimental com delineamento em blocos casualizados, consistindo em quatro tratamentos e quatro repetições. Noventa e seis frangos caipira com idade entre 8 e 10 semanas foram utilizados, com seis frangos por unidade experimental, criados em sistema intensivo convencional por um período de 61 dias. As variáveis observadas incluíram consumo de ração, ganho de peso diário médio, conversão alimentar e rendimento de carcaça, incluindo peso de abate, peso da carcaça e percentual de carcaça. Os resultados da análise estatística revelaram um efeito significativo ao nível de probabilidade de 5% (p < 0,05) para todas as variáveis observadas no estudo. O teste de comparação de médias de Duncan mostrou que o tratamento com a inclusão de 2% de farinha de folha de tamarindo na dieta foi o melhor em comparação com o tratamento controle e os demais tratamentos com a inclusão de 4% e 6% de farinha de folha de tamarindo na dieta. Assim, conclui-se que a inclusão de 2% de farinha de folha de tamarindo em formulações de ração peletizada foi o melhor tratamento para melhorar a produção local de frango caipira.*

Palavras-chave: *Frango caipira. Formulação. Ração peletizada. Rendimento de carne. Desempenho.*

Introduction

Timor-Leste has a variety of free-range chicken, most of which have not yet been scientifically described, but are generally considered potential native breeds. Generally, free-range chicken is a crucial resource for smallholder farmers in rural areas, providing economic and livelihood opportunities, and the flavoured and healthier meat causes the majority people to choose it as a main dish. Regarding genetics, the low uniformity is due to the deficient selection program for free-range chicken; however, among farming families that raise livestock in Timor-Leste, approximately 82% raise free-range chicken, estimated at 10 to 50 chickens per household (Timor-Leste, 2019). Although many chickens are raised in remote areas, their productivity has not been adequately developed. This is due to several factors, primarily the implementation of extensive or free-range farming systems, which inherently lack technical management, resulting in low productivity and high mortality rates. Their diet consists almost exclusively of food scraps found around the house or left loose in yards, and they constantly forage for seeds, insects, and earthworms. Some receive additional feed in the form of corn or rice bran, but breeders have not yet paid attention to nutritional content. Poor feed quality and lack of disease prevention led to low productivity in free-range chicken (Dal Bosco et al., 2021). However, these feeding systems cannot be denied due to a lack of technical expertise in formulating chicken diets.

In reality, free-range chickens are more resilient than commercial breeds, have socioeconomic value, contribute to income, and are an excellent source of animal protein in rural areas. According to Malik (2013) and Mavi et al. (2019), free-range chickens exhibit irregular body size, influenced by feed intake and genetics. Low growth and body weight gain (BWG) affect productive performance, including meat quality.

To meet the demand for chicken meat products, synthetic antibiotic growth promoters are generally added to livestock feed to stimulate growth, minimize mortality through infection prevention, improve gut function, antimicrobial activity, and antioxidant action (Windisch et al., 2008). The authors further emphasized that adding synthetic antibiotics to chicken feed can produce products that are harmful to health (Windisch et al., 2008). Therefore, this requires research into new substances and alternative strategies to promote growth and prevent disease, including the development of various alternative methods for using various herbaceous plants as replacements for growth-promoting antibiotics and as alternative feed in chicken diets, while simultaneously reducing production costs.

Tamarind (*Tamarindus indica* L.) leaves contain crude protein, fat, fiber, and vitamins such as riboflavin, thiamine, ascorbic acid, niacin, and beta-carotene (Minanga and Ampode, 2021). To obtain accurate and reliable scientific information about the use of tamarind leaf flour in chicken feed, it needs to be tested through scientific research so that the results can be useful to those interested. This study aims to investigate the impact of including tamarind leaf meal in pelleted feeds on the growth performance and carcass yield of free-range chickens.

Material and methods

The study was conducted in the henhouse of the laboratory at the Faculty of Agriculture of the National University of Timor Lorosa'e (UNTL), located in the village of Hera, Dili municipality, from October 2023 to January 2024, over a period of 61 days.

The study guaranteed ethical treatment practices and the fundamental rights enshrined in the Universal Declaration of Animal Rights of UNESCO (1978).

Experimental design

The experimental method was used, and the randomized block design with four treatment groups and four replications, where the trial employed 96 chickens aged 8 to 10 weeks, with six free-range chickens per unit and 24 chickens per treatment for robust statistical analysis. The treatments were: T0 (control treatment), without the inclusion of tamarind leaf flour in the pelleted diet, and T1, T2 and T3, with the inclusion of 2%, 4% and 6% respectively, of tamarind leaf flour in the pelleted feed or diet.

Feed and water were provided *ad libitum*. The temperature in the henhouse ranged between 20 and 22 °C, and the relative humidity between 60 and 70%. A single 100-watt compact fluorescent lamp was used for night-time illumination.

Before starting, the chickens were vaccinated to prevent disease contamination, especially infectious bursal disease, avian pox. Outcomes (variables) measured included feed intake, average daily weight gain (ADG), feed conversion rate (FCR), and the carcass yield (slaughter weight, carcass weight and percentage of carcasses. ADG was determined by dividing the weight gain by the number of chickens and the number of days of the trial. Daily feed intake was determined by subtracting the remaining feed from the total feed offered in 24 hours, and FCR was calculated for each replicate during the feeding trial as: FCR = daily feed intake (g) divided by ADG (g).

Four chickens were selected based on the live weight of each experimental unit, weighed to determine slaughter weight, and then slaughtered to measure carcass weight and percentage. Thus, a total of 64 chickens were slaughtered for carcass yield measurements.

The local ingredients used in the formulation of the pelleted feed included yellow corn, soybeans, rice bran, and tamarind leaf meal, with different percentages, allocated to each treatment. To determine the nutritional requirements according to the type and stage of development of the free-range chickens, the trial-and-error method was used. The feed ingredients were ground into flour to simplify ration formulation and pelleted to increase consumption efficiency. All ingredients used were derived from organic products and guaranteed free from any chemical contamination. Diets were formulated based on yellow corn, soybean meal, and rice bran. Tamarind leaf flour was used as an alternative supplement.

Drying and processing of tamarind leaves

The tamarind leaves were collected and selected to ensure they were neither too old nor too young. The selected tamarind leaves were dried indoors, avoiding direct sunlight to minimize loss of nutrients and secondary metabolites. After drying, they were ground into flour and mixed with other ingredients in the feed pelleting process, according to the specified percentage. The use of tamarind leaf flour should be an alternative to reduce operational production costs, as well as a technical way to take advantage of the potential and sustainability of local resources in the formulation of feed for free-range chickens.

Laboratory analysis

After determining the type of feed used to compile the ration, all ingredients must undergo laboratory analysis to determine the nutritional content of each ingredient; and, after being processed and formulated into pelleted feed, further laboratory testing must be performed to ensure the nutritional composition of the feed before being fed to the native chickens in the study.

Proximate analysis is a quantitative analytical method for determining macronutrient values in food and feed samples and these values are usually presented as nutritional information. Proximate analysis involves the analysis of protein, fat, fiber, and ash content. This test is essential for evaluating the quality of feed ingredients based on applicable standards. The proximate analysis results of the nutritional composition of feed ingredients and the nutritional composition of the rations used in the study are presented in Tables 1 and 2.

Table 1 - Result of laboratory analysis of the nutrient content of raw materials used in the research

Raw material	Crude protein	Ashes	Crude lipid	Crude fiber	Carbohydrate	Dry matter	Energy metabolism
Yellow corn	12.27	1.59	6.93	1.90	79.21	87.93	4,343.82
Soybeans	34.08	5.40	24.51	6.00	36.02	89.12	4,698.41
Rice bran	11.55	17.46	8.47	21.26	62.13	89.07	2,939.44
Tamarind leaf meal	15.77	8.47	8.56	22.53	67.26	90.54	3,249.00

Table 2 - Result of laboratory analysis of the nutritional content of the pelleted diet used in the research

Nutritional content	Treatments			
	T0	T1	T2	T3
Crude protein (%)	18.32	17.22	17.91	22.15
Ashes (%)	4.53	4.39	4.44	4.22
Crude lipid (%)	11.51	13.50	13.60	13.73
Crude fiber (%)	6.50	4.41	4.36	4.32
Carbohydrate (%)	65.64	64.90	64.01	59.90
Dry matter (%)	86.03	85.97	86.52	86.24
Energy metabolism (kcal/kg)	4,205.14	4,389.97	4,390.64	4,392.34

Note: T0 (control) = without inclusion of tamarind leaf flour in the pelleted diet; T1, T2, T3 = inclusion of 2%, 4% and 6% of tamarind leaf flour in the pelleted diet, respectively.

Data analysis

The data collected in the research were subjected to analysis of variance, and the treatment means were compared using the Duncan test and quadratic regressions, using the Statistical Package of Social Science software version 25, as recommended by Sampurna and Nindhya (2008).

Results and discussion

The statistical results analysis revealed significant effects ($p < 0.05$) for all productive performance indicators observed in the research. Details of average values of feed intake, FCR, BWG, and carcass yield means values are presented in Table 3.

Mean comparison tests showed that the control treatment, with 0% tamarind leaf flour in the feed formulation, presented the best performance in feed intake of native chickens, and the treatment with 2% tamarind leaf flour in the feed formulation presented the best performance in FCR and BWG of the native chickens used in the research. The results showed that the inclusion of tamarind leaf meal in feed formulations, up to 2%, can stimulate moderate growth in native chickens. Key indicators to be observed to measure the productive performance of native chickens include feed intake, feed conversion, BWG, and carcass yield.

The inclusion of 2% tamarind leaf flour in the pelleted feed resulted in a significantly lower average daily feed intake of 24.30 ± 1.69 g/head, representing a decreased of 4.30% compared to the control treatment. Notably, treatment with 2% of tamarind leaf flour showed the highest average daily BWG (3.97 ± 0.69 g/head), representing a 12.66% increase compared to the lowest performance recorded in treatments T2, T3 and T0.

Regarding FCR, the best result was also obtained in the treatment T1, with an average value of 6.97 ± 1.65. Analysis of carcass yield showed that the average slaughter weight in treatment T1 showed the highest value (564.38 ± 206.25 g); the carcass weight was 340.75 ± 161.15 g, and the carcass percentage was 62.30 ± 3.29%.

Table 3 - Result of statistical analysis of average feed intake (FI), feed conversion ratio (FCR), body weight gain (BWG), slaughter weight (SW), carcass weight (CW), and percentage of carcasses (PC) of native chickens (n = 24)

Treatments	FI (g/unit/day)	FCR	BWG (g/unit/ day)	SW (g)	CW (g)	PC (%)
T0	29.30 ± 5.69[a]	8.67 ± 0.52[a]	3.38 ± 0.70[b]	500.75 ± 168.95[a]	294.00 ± 122.10[b]	58.71 ± 4.19[b]
T1	27.00 ± 8.31[b]	6.97 ± 1.65[b]	3.97 ± 0.69[a]	564.38 ± 106.25[a]	340.75 ± 161.15[a]	60.38 ± 5.30[a]
T2	28.11 ± 4.47[ab]	8.51 ± 1.06[a]	3.30 ± 0.89[b]	483.75 ± 122.70[b]	269.00 ± 61.40[b]	55.61 ± 4.05[b]
T3	28.43 ± 4.50[ab]	7.56 ± 0.83[a]	3.36 ± 0.48[b]	512.50 ± 122.08[a]	319.13 ± 90.99[b]	62.30 ± 3.29[a]

Note: T0 (control) = TLF 0% + soybeans 30% + rice bran 9% + yellow corn 61%. T1 = TLF 2% + soybeans 31% + rice bran 8% + yellow corn 59%. T2 = TLF 4% + soybeans 28% + rice bran 6% + yellow corn 60%. T3 = TLF 6% + soybeans 31% + rice bran 8% + yellow corn 59%. TLF = Tamarind leaf flour.

There is limited information available on research results regarding the use of herb-based foods, including processed tamarind leaf meal, in pelleted poultry feed. The improvement in carbohydrate, lipid, and antioxidant metabolism can be attributed to the multifactorial effects of secondary metabolites present in tamarind leaves (Vasant and Narasimhacharya, 2012). On the other hand, the authors pointed out that these metabolites may also have acted individually or synergistically to reduce oxidative stress caused by fluoride consumption (Vasant and Narasimhacharya, 2012). These results strongly encourage the search for unconventional ingredients to formulate high-quality feeds, easily obtained at a lower cost, especially for free-range chickens raised in rural areas by small producers. According to Windisch et al. (2008), phytogenic feed additives are products derived from herbaceous plants used in animal feed to improve animal performance and this type of additive has attracted increasing interest recently, especially for use in swine and poultry.

Regarding slaughter weight, treatments T0, T1 and T3 did not differ each other's and T2 showed lower value. The carcass weight was significate higher in T1. Regarding carcass percentage, T0 and T1 did not differ from each other, both being higher than T2.

In general, conventional poultry feed is not only expensive but also has limited production and competing with human nutritional needs (Mulyantini and Lole, 2024). Tamarind leaves can be a solution, as this plant is widely available and nutritious for animal feed. The results presented in Table 3 showed that the inclusion of tamarind leaf meal in pelleted feed formulations, up to 2%, can stimulate moderate growth in broiler chickens raised outdoors without negative effects. It is observed that the inclusion of tamarind leaf meal is very beneficial for broiler chickens raised outdoors, although the presence of antinutritional substances, such as secondary metabolites (tannins, saponins, and flavonoids), is a limiting factor that must be considered in the quantity used.

Chickens' body weight and body condition score are linked to the nutrition supply (Wu et al., 2004) and strengthening the digestive organs' capacity for digestion and absorption. Blood proteins, such as total plasma protein, blood urea nitrogen, and albumin, are other indicators of bird welfare (Saki et al., 2018). Secondary metabolites, called flavonoids, contain compounds called phenols, and these compounds are used as antibacterials because they can denature proteins and damage bacterial cell membranes (Faradiba et al., 2016). Production performance is influenced by genes, nutrition and health (Dana et al. 2010). Synthetic antibiotics have had indirect adverse effects on human health due to residues in chicken meat and increased resistance in certain microbes (WHO, 2012). Due to the high cost of feed and the scarcity of essential raw materials, poultry farmers are seeking systems that can identify lower-cost, high-biological-value feed ingredients that can complement conventional energy and protein sources (Laing and Wongtangtintharn, 2013). Tamarind leaf flour is a potential herbaceous feed for animal feed, as it is a low-cost and easily accessible option, although it contains secondary metabolites that do not satisfy chickens if not prepared properly.

Conclusion

The inclusion of tamarind leaf meal in pelleted feed formulations in T1, at a concentration of 2%, showed, in terms of statistical analysis, a significant effect on productive performance indicators and carcass yield, demonstrating positive trends in specific parameters such as feed intake, BWG, FCR, and carcass yield. These results demonstrate the potential benefits of using tamarind leaf meal as a feed supplement to improve free-range chicken production.

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Authors´contributions

GSG was responsible for the conceptualization of the research and analysis of the results. CAMC, for tabulation and organization of data. CX and MDVF, for coding, classification, and correction of data. All authors approved the final version.

Data availability statement

The research data are not publicly available.

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