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Effects of Ensiled *Ficus nota* Fruit Meal on Growth Performance and Nitrogen Balance in Broiler Chickens

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ABSTRACT

Increasing antimicrobial resistance has driven demand for phytogenic feed additives in poultry production. The present study aimed to assess phytochemical, proximate, and antinutritional profiles of *Ficus nota* (Blanco) Merr. fruit meal processed by drying or ensiling, and evaluated the effects of processing method and antibiotic supplementation on growth performance, carcass traits, and nutrient digestibility in broiler chickens. In a 42-day trial, 144 day-old unsexed broiler chickens (35 ± 0.5 g) were randomly assigned to a 2 × 4 factorial arrangement of antibiotic inclusion (with or without doxycycline) and *Ficus nota* (FN) administration. The treatments consisted of a control diet without FN, 100 g/kg dried FN (DFN), 100 g/kg ensiled FN (EFN), and a 50 + 50 g/kg combination of DFN and EFN (DFN + EFN), replicated three times with six chickens each. Growth performance was evaluated weekly from days 14 to 42, carcass traits at slaughter, and crude protein (CP) digestibility and nitrogen and phosphorus balance from total excreta. Ensiling preserved flavonoids (1.30 mg QE/g) and phenolics (12.01 mg GAE/g) while reducing tannin concentration compared to drying process. FN treatment significantly affected body weight, with the DFN group (852.21 g) significantly lower than the control (920.68 g). The DFN group exhibited the poorest feed conversion ratio (FCR) during the starter phase (1.13) but the highest during the finisher phase (0.97). Antibiotic-supplemented groups had lower overall FCR (1.06) than antibiotic-free groups (1.15), across all FN treatments. Antibiotic-supplemented groups had lower CP digestibility (64.50% versus 65.52%), higher nitrogen (17.48 versus 16.20 mg/kg) and phosphorus (2.77 versus 2.53 mg/kg) excretion than antibiotic-free groups. Among FN treatments, the control group achieved the highest CP digestibility (66.68%). The EFN group achieved the highest nitrogen retention (33.65 mg), followed by the control (32.74 mg), DFN (30.19 mg), and DFN+EFN (28.92 mg) groups. Carcass recovery (79.47%) and chilling loss (0.63%) did not differ significantly among treatments. Ensiled FN fruit meal was a viable phytogenic feed additive that improved nitrogen retention while maintaining growth performance. Blending dried and ensiled FN fruit meals exhibited antagonistic interactions between tannins and organic acids.

Keywords: Antibiotic, Broiler chicken, Ensiling, *Ficus nota*, Nitrogen retention, Phytogenic feed additive, Tannin

INTRODUCTION

The global poultry industry reached 141.9 million metric tons of meat in 2024 (Learmonth, 2026), and egg production is anticipated to exceed 900 billion annually in the next five years (Learmonth, 2026; Market Report Analytics, 2026). The Philippines aimed to produce 1.63 million metric tons of chicken by 2025 (Gomez, 2024). Despite the expansion of the Philippine poultry sector, production remains reliant on antibiotics for prophylaxis (91.67%) and growth promotion (50%; Imperial et al., 2022). Concerns regarding antimicrobial resistance are growing, as the prolonged use of antibiotics, even at sub-therapeutic doses, enhances the selection of resistant bacterial strains, threatening animal and human health (Imperial et al., 2023; Aminullah et al., 2025). Many countries have restricted the use of antibiotic growth promoters (Rahman et al., 2022), yet limited access to effective local alternatives in Southeast Asia, including the

Philippines, hinders the transition toward antibiotic-free poultry production.

These challenges have increased interest in phytogenic feed additives. Phytogenic feed additives, derived from plants, offer a range of beneficial properties including antimicrobial, antioxidant, anti-inflammatory, and immunomodulatory effects (Abdelli et al., 2020; Jin et al., 2020; Ojediran et al., 2024). These compounds enhance nutrient utilization, decrease nitrogen excretion, and positively influence gut microbiota without contributing to antimicrobial resistance (Gadde et al., 2017; Sodipe et al., 2025). However, different results across studies have highlighted the need to evaluate specific phytogenic feed additive candidates for efficacy in improving growth performance and nutrient utilization under defined dietary inclusion levels, processing methods, and production environments (Windisch et al., 2008; Abdelli et al., 2021).

Ficus nota (Blanco) Merr., locally known as tibig, is a Moraceae tree endemic to the Philippines (Taer et al., 2026). *Ficus nota* contains alkaloids, tannins, flavonoids, and saponins with documented antibacterial and antioxidant activities (Mapatac, 2015; Santiago et al., 2017), making it a cost-effective phytogenic additive candidate in tropical production systems. Favorable responses to ensiled *Ficus nota* fruit in mallard ducks and fermented fruit juice in broilers have been reported (Cungihan, 2024; Gaviola et al., 2024), yet integrated evidence on its nutritional, phytochemical, and antinutritional composition and implications for broiler chickens' performance remains limited.

The primary limitation of *Ficus nota* fruit meal is its tannin content, which reduces protein digestibility by binding dietary proteins and inhibiting digestive enzymes (Makkar, 2003; Gilani et al., 2005). The magnitude of tannin-related effects varies with tannin concentration, chemical form, and chicken age (Pertiwi et al., 2023). Ensiling may reduce tannins via microbial degradation during anaerobic fermentation, whereas drying stabilizes the existing nutrient and phytochemical composition of the fruit meal (Gefrom et al., 2013). However, the extent to which drying and ensiling alter the nutritional quality of *Ficus nota* fruit meal, and how each processed form interacts with antibiotic supplementation, remains unresolved.

The present study aimed to characterize the phytochemical, proximate, mineral, and antinutritional profiles of *Ficus nota* fruit meal processed by drying and ensiling, and examine the effects of processing method (dried, ensiled, and blended *Ficus nota* fruit meal) and antibiotic (doxycycline) inclusion on growth performance, carcass characteristics, and nutrient digestibility in broiler chickens.

MATERIALS AND METHODS

Ethical statement

The current study adhered to the ethical guidelines of the College of Agriculture, Surigao del Norte State University Research Ethics Committee, Philippines, in compliance with Republic Act No. 8485 (Animal Welfare Act of the Philippines). All procedures followed humane animal care practices throughout the experiment.

Study location

The study was conducted at Surigao del Norte State University, Mainit Campus (9°32′N, 125°31′E), Philippines, from October to December 2025. This site has a Type II climatic under the Corona classification (no dry season with pronounced maximum rainfall from November to January), a mean annual temperature of 27°C, relative humidity of 75-85%, and no distinct dry season.

Experimental design

The present study comprised two parts. The first part of the study was to characterize the *Ficus nota* fruit meal processed by direct drying or ensiling using a two-sample independent design with three replicates per method. During the pre-experimental period, all broiler chickens received a common booster diet from days 1 to 4 with crude protein (CP) at 23.00% and metabolizable energy (ME) of 3200 kcal/kg) and a common starter diet (CP at 22.00% and ME at 3200 kcal/kg) from days 5 to 14, with no antibiotic or *Ficus nota* supplementation. Dietary treatments were applied only from day 14 onward. The second phase of the study involved a 42-day feeding trial with 144 unsexed Ross 308 broiler chickens, initially weighing 35 ± 0.5 g, that were randomly allocated into a 2 × 4 factorial design. The first factor was antibiotic inclusion at two levels, with antibiotic-supplemented doxycycline (15 g per 50 L of drinking water) and antibiotic-free treatment groups. Doxycycline was selected based on its wide availability at local veterinary stores in the study area, the Philippines. The second factor was *Ficus nota* fruit meal at three dietary inclusion levels, including a control group without FN inclusion (control), a group receiving 100 g of dried FN per kg of diet (DFN), a group receiving 100 g of ensiled FN per kg of diet (EFN), and a combined group receiving both 50 g of dried and 50 g of ensiled FN per kg of diet (DFN+EFN). Each treatment was replicated three times with six broiler chickens per replicate.

Collection and processing of *Ficus nota* fruit meal

Fresh *Ficus nota* fruits at maturity stages 3 (light green with minor firmness loss) and 4 (half-purple soft), as defined by Freiman et al. (2014), were harvested from Surigao del Norte State University (SNSU), Mainit campus mini-forest tree area, cleaned, and immediately processed at SNSU, Mainit Food Laboratory, Mainit, Surigao del Norte, Philippines. For drying, whole fruits were dehydrated in a Gorenje food-grade dehydrator (Gorenje, Slovenia) at ≤ 50°C for 48 hours. For ensiling, chopped fruits were wilted for 24 hours, mixed with 4% molasses, stored in sealed barrels at room temperature (28-30°C) for 60 days, then dried at ≤ 50°C for 48 hours using the same dehydrator and ground into a uniform meal. The drying and ensiling procedures followed the methods described by Wimalasiri and Somasiri (2021), with some minor modifications.

Chemical analysis

Representative samples (1 kg) of both dried and ensiled *Ficus nota* fruit meals were analyzed for proximate composition (moisture, crude protein, fat, fiber, ash) according to AOAC (2023). Phytochemicals, including total phenolics, flavonoids, and tannins, were measured using colorimetric methods (Sulaiman and Balachandran, 2012). Qualitative analysis was performed for antinutritional factors such as alkaloids and saponins (Holstege et al., 1995). Mineral analysis involved the Kjeldahl method for nitrogen, molybdenum blue colorimetry for phosphorus, and flame photometry for potassium (AOAC, 2023).

Experimental animals and housing

A total of 144 day-old broiler chickens were housed in 24 elevated cages (50 × 50 × 30 cm), with six broiler chickens per cage. Temperature was maintained at 29.4°C during the first week and 26.7°C during the second week by 100-W bulbs during brooding on days 1-14 (Deaton et al., 1996). After brooding (day 14), broiler chickens were weighed (261.39 ± 43.60 g mean initial weight) and randomly distributed into the eight dietary treatment groups to begin the 14- to 42-day feeding trial.

Experimental diets and feeding management

Feed was provided *ad libitum* across two phases, including the chicken grower phase (days 14-28) and finisher phase (days 29-42), meeting NRC (1994) requirements (Table 1). From day 14 onward, Ficus nota fruit meal was incorporated into the diets. The experimental design included two diet types (antibiotic-supplemented and antibiotic-free) crossed with four FN inclusion levels, including a control with no FN inclusion (0FN), 100 g/kg dried FN (DFN), 100 g/kg ensiled FN (EFN), and a 50 g/kg dried + 50 g/kg ensiled FN combination (DFN+EFN). The 100 g/kg inclusion level was adopted from the mid-range dose in the Gaviola et al. (2024) dose-response trial in mallard ducks, in which *Ficus nota* fruit was included at 50-200 g/kg as a dietary feed ingredient rather than as a concentrated phytogenic extract. Feed was mixed for 15 minutes, stored in sealed containers, and distributed at 07:00 am and 16:00 pm. Doxycycline (Unilab, Philippines) was administered via drinking water at a dosage of 15 g/50 L of water, following the manufacturer's recommended dose for swine and poultry. Doxycycline was administered three times weekly for 24 hours per dose, with a one-day interval between doses, from day 14 onward.

Table 1. Nutrient composition of the standard corn-soya-based diet for broiler chickens

Nutrients	Starter phase	Grower phase	Finisher phase
Crude Protein	22.00%	20.00%	18.00%
Crude Fat	5.20%	4.00%	6.00%
Crude Fiber	2.00%	3.50%	5.50%
Moisture	10.00%	12.00%	12.00%
Calcium	1.04%	0.85-1.15%	0.80-1.10%
Phosphorus	0.75%	0.70%	0.70%
Metabolizable energy(kcal/kg)	3200	3100	3000

Each diet contained 0.25 kg of vitamin premix: Vitamin A, D, E, K, B_1, B_2, and B_{12}. Niacin, Biotin, Folic acid, Pantothenic acid, Choline chloride, Manganese, Copper, Magnesium, Iron, Zinc, Iodine, and Selenium.

Health management

Chickens were vaccinated against Newcastle disease (Vaxchora; Unilab, Mandaluyong, Philippines) via subcutaneous injection on day 7, infectious bronchitis (Bronchivac; Lloyd Laboratories, Quezon City, Philippines) via intranasal administration on day 7, and Gumboro disease (Gumboro Vaccine; Biovac, Quezon City, Philippines) via intramuscular injection on day 14. No booster doses were administered during the feeding trial (days 14-42) to avoid confounding treatment effects with vaccine-induced immune responses. The vaccination protocol followed the Philippine National Standard for Good Animal Husbandry Practices for Chickens (BAFSDA, 2016). No supplemental vitamins or health support additives were provided beyond the vitamin premix included in the basal diet (Table 1).

Data collection

Growth performance

Body weight was recorded on days 14, 21, 28, 35, and 42 by a Shenlan digital balance (Shenlan, China; 0.1 g precision). Broiler chickens were not fasted prior to weighing. However, all measurements were taken before the morning feeding to ensure consistency, and residual feed was accounted for and replaced with fresh feed at each weighing interval. Weekly measurement periods were defined as days 14-21, 22-28, 29-35, and 36-42 based on consecutive weighing intervals. Daily feed intake was determined as the difference between the weighed feed offered and residual feed and wastage (Aydin et al., 2015). Feed conversion ratio (FCR) was calculated as total feed consumed divided by total weight gain (Wen et al., 2018), with mortality-adjusted values accounting for dead chickens.

Carcass evaluation

On day 42, two broiler chickens per pen were fasted for 12 hours, weighed, humanely slaughtered, scalded, defeathered, and eviscerated. Warm carcass weight was recorded immediately after evisceration. Carcasses were chilled at 4°C for 24 hours, and cold carcass weight was recorded and calculated accordingly.

Carcass recovery (%) = (warm carcass weight / live weight) × 100
Formula 1

Chilling loss (%) = (warm − cold carcass weight) / warm carcass weight × 100
(Young and Smith, 2004). Formula 2

Nutrient digestibility and mineral balance

Total excreta were collected from galvanized trays placed under each cage over 48-hour collection periods during days 21, 28, 35, and 40. Excreta collected from each collection period were pooled by experimental unit and cleaned of contaminants, following standard total excreta collection methodology (Dourado et al., 2010). Samples were then dried using a food dehydrator at ≤50°C for 48 hours, a modification of the oven-drying method described by Dourado et al. (2010), who used 55°C for 72 hours. Nitrogen and phosphorus in feed and excreta were determined in triplicate (nitrogen determinator and molybdenum blue colorimetry; AOAC, 2023). Crude protein digestibility, nitrogen and phosphorus intake, excretion, and retention were calculated using the following formula described by AOAC (2023).

$$\text{CP digest. \%} = \frac{\text{(CP in diet)-(CP in excreta)}}{\text{(CP in diet}} \text{ x } 100$$

Nitrogen and phosphorus intake were calculated based on dry matter (DM) feed intake and dietary nutrient concentration, using the following formula:

N/P intake (g) = feed intake (g DM) × diet N/P content (%)
Chrystal et al. (2021)

Where N stands for nitrogen, P stands for phosphorus, and DM stands for dry matter.

The excretion of nitrogen and phosphorus was calculated as the product of dry matter (DM) excreta output and the corresponding nutrient concentration within the excreta. Excretion was expressed as mg/kg body weight, and retention was expressed as absolute amounts (mg) for cross-treatment comparison.

Nutrient retention was calculated as the difference between intake and excretion, using the following formula:

$$\frac{N}{P}\text{ retention \%} = \frac{\left(\text{FI x}\frac{N}{P}\text{diet}\right) - \left(\text{ EO x}\frac{N}{P}\text{excreta}\right)}{\left(\text{Feed intake x}\frac{N}{P}\text{diet}\right)} \text{ x } 100$$

Where N stands for nitrogen, P stands for phosphorus, FI stands for feed intake, and EO stands for excreta output. Feed intake and excreta output were expressed on a dry matter basis.

Statistical analysis

Differences between drying and ensiling methods were assessed using the Mann-Whitney U test, given the small sample size (n = 3 per processing method). Effect sizes were calculated as r ($r = Z/\sqrt{n}$) to quantify the magnitude of difference between methods, with values interpreted as small (0.10), medium (0.30), or large (0.50). A p-value less than 5% was considered statistically significant ($p < 0.05$). Antinutritional factors were summarized qualitatively. For the feeding trial, body weight, weight gain, feed intake, and FCR were analyzed by repeated-measures ANOVA (split-plot in time), with period as the within-subject factor and antibiotic inclusion (two levels) and *Ficus nota* treatment (four levels) as between-subject factors. Mauchly's test evaluated sphericity; the Greenhouse–Geisser correction was applied when violated. Carcass traits and crude protein digestibility were analyzed using two-way ANOVA. Nitrogen and phosphorus responses were analyzed by MANOVA (Wilks' Lambda) followed by separate two-way ANOVAs. Partial eta squared (ηp^2) was the effect size metric. Tukey's HSD was used for post hoc comparisons when the p-value was less than 5% ($p < 0.05$). All analyses used IBM SPSS Statistics (version 26).

RESULTS

Phytochemical, proximate, and mineral analysis

Flavonoid content (1.30 mg QE/g; Cohen's r = 0.27) and phenolic content (12.01 mg GAE/g; Cohen's r = 0.85) did not differ significantly between dried and ensiled *Ficus nota* fruit meals (Table 2). Proximate composition did not differ significantly between drying and ensiling methods for crude protein (7.93%), crude fat (2.33%), ash (9.15%), or crude fiber (37.02%; $p > 0.05$). The difference in crude fiber between drying and ensiling methods indicated a large effect size (Cohen's r = 0.80; p = 0.10), suggesting a meaningful difference that did not reach statistical significance due to the limited sample size. Potassium was numerically higher in ensiled (3.10%) than in dried (2.33%) samples (Cohen's r = 0.80; $p > 0.05$). Alkaloids (highly abundant) and saponins (moderately abundant) were detected in both dried and ensiled forms, whereas tannin abundance decreased from moderate to slightly abundant after ensiling (Table 3).

Table 2. Phytochemical, proximate, and mineral composition of dried and ensiled *Ficus nota* fruit meals

Parameter	Dried	Ensiled	Mean	Mann-Whitney U	Exact Significance	r -value
Flavonoids (mg QE/g)	1.30 ± 0.11	1.30 ± 0.02	1.30 ± 2.07	3	0.70^{ns}	26.74
Phenolics (mg GAE/g)	17.55 ± 0.11	6.47 ± 0.01	12.01 ± 0.07	0	0.10^{ns}	85.20
Crude protein (%)	7.86 ± 0.10	7.99 ± 0.10	7.93 ± 0.11	1	0.20^{ns}	62.46
Crude fat (%)	2.49 ± 0.10	2.16 ± 0.10	2.33 ± 0.20	0	0.10^{ns}	80.02
Ash (%)	10.48 ± 0.10	7.81 ± 0.10	9.15 ± 1.46	0	0.10^{ns}	80.02
Crude fiber (%)	38.42 ± 0.10	35.62 ± 0.10	37.02 ± 1.54	0	0.10^{ns}	80.02
Nitrogen (%)	1.40 ± 0.15	1.4 ± 0.13	1.4 ± 0.13	4.5	1.00^{ns}	0.00
Phosphorus (%)	0.15 ± 0.01	0.15 ± 0.02	0.15 ± 0.01	4.5	1.00^{ns}	0.00
Potassium (%)	2.33 ± 0.11	3.1 ± 0.20	2.715 ± 0.44	0	0.10^{ns}	80.02

^{ns} Not significant,QE: Quercetin equivalent; GAE: Gallic acid equivalent

Table 3. Qualitative antinutritional profile of dried and ensiled *Ficus nota* fruit meals

Sample	Alkaloids	Saponins	Tannins
DFN	+++	++	++
EFN	+++	++	+

+++ = Highly abundant, ++ = Moderately abundant, + = Slightly abundant. DFN: Dried *Ficus nota* group, EFN: Ensiled *Ficus nota* group

Growth performance

Body weight

Body weight differed significantly across measurement periods ($p < 0.05$; $\eta p^2 = 0.922$), with significant linear, quadratic, cubic, and order-4 effects ($p < 0.05$). Body weight did not differ significantly between antibiotic-supplemented and antibiotic-free groups ($p > 0.05$). The interaction between antibiotic inclusion and *Ficus nota* treatment across the eight dietary treatment groups was not significant ($p > 0.05$). Regardless of antibiotic inclusion, *Ficus nota* treatment significantly affected body weight ($p < 0.05$; $\eta p^2 = 0.063$). Among *Ficus nota* treatment groups, the 0FN group achieved the highest mean body weight (920.68 g), followed by the EFN group (887.92 g), the DFN+EFN group (876.08 g), and the DFN group (852.21 g), regardless of antibiotic inclusion. The DFN group differed significantly from the control group ($p < 0.05$), whereas the EFN and DFN+EFN groups were intermediate and did not differ significantly from either the control or the DFN group ($p > 0.05$; Table 4).

Weight gain

Weekly weight gain differed significantly across measurement periods ($p < 0.05$; $\eta p^2 = 0.172$), with peak gains observed during the grower phase (days 22-35) and a decline during the finisher phase (days 36-42). Neither antibiotic inclusion nor *Ficus nota* treatment affected weekly weight gain ($p > 0.05$). The interaction between antibiotic inclusion and *Ficus nota* treatment was not significant ($p > 0.05$; Table 5)

Feed intake

Feed intake varied significantly across measurement periods ($p < 0.05$; $\eta p^2 = 0.926$), with the highest intake observed during the grower phase. No significant effects of antibiotic inclusion, *Ficus nota* treatment, or their interaction were detected ($p > 0.05$; Table 6).

Feed conversion ratio

Feed conversion ratio differed significantly across measurement periods ($p < 0.05$; $\eta p^2 = 0.522$). Overall, FCR was lowest during the early grower phase (days 14-21;0.88), increased during the mid-grower phase (days 22-28; 1.21), and remained elevated during the finisher phase (days 29-35; 1.19) and (days 36-42; 1.17). The interaction between measurement period and *Ficus nota* treatment was significant ($p < 0.05$; $\eta p^2 = 0.428$). The DFN group regardless of antibiotic inclusion, had the poorest FCR during the early grower phase (days 14-21; 1.13) but the best FCR during the finisher phase (days 36-42; 0.97), whereas the 0FN group regardless of antibiotic inclusion, had the best FCR during the early grower phase (days 14-21 0.78) but the poorest during the finisher phase (days 36-42; 1.35; Figures 1 and 2; Table 7).

Carcass characteristics

The inclusion of antibiotics, Ficus nota treatment, or their interaction did not significantly impact carcass recovery or chilling loss ($p > 0.05$; Table 8). On average, carcass recovery was 79.47% and chilling loss was 0.63% across all treatment groups.

Nutrient digestibility and mineral balance

Crude protein digestibility

Antibiotic inclusion significantly affected crude protein digestibility ($p < 0.05$; $\eta p^2 = 0.251$). The antibiotic-free groups had higher digestibility (65.52%) than the antibiotic-supplemented groups (64.50%; $p < 0.05$). *Ficus nota* treatment significantly affected crude protein digestibility ($p < 0.05$; $\eta p^2 = 0.816$). The highest crude protein digestibility was observed in the 0FN groups (66.68%). The EFN group (with or without antibiotic inclusion) had a digestibility of 64.76%. This digestibility in the EFN groups was not significantly different from the 0FN groups ($p > 0.05$). However, the digestibility of the EFN group was significantly lower than that of the control groups ($p < 0.05$). The DFN+EFN, regardless of antibiotic inclusion, had the lowest crude protein digestibility (62.08%) and differed significantly from all other *Ficus nota* treatment groups. The interaction between the antibiotic and *Ficus nota* treatment was not significant for crude protein digestibility ($p > 0.05$; $\eta p^2 = 0.110$; Table 9).

Nitrogen and phosphorus excretion

The present results revealed the significant effects of antibiotic inclusion (Wilks' $\Lambda = 0.029$; $\eta p^2 = 0.971$), *Ficus nota* treatment (Wilks' $\Lambda = 0.021$; $\eta p^2 = 0.857$), and the antibiotic and *Ficus nota* interaction (Wilks' $\Lambda = 0.005$; $\eta p^2 = 0.929$; $p < 0.05$) on combined nitrogen and phosphorus excretion. Antibiotic-supplemented groups had significantly higher nitrogen excretion (17.48 mg/kg; $p < 0.05$; $\eta p^2 = 0.376$) and phosphorus excretion (2.77 mg/kg; $p < 0.05$; $\eta p^2 = 0.474$) than antibiotic-free groups ($p < 0.05$). *Ficus nota* treatment did not significantly affect nitrogen or phosphorus excretion ($p > 0.05$). The interaction between the antibiotic and *Ficus nota* treatment was not significant for either nitrogen or phosphorus excretion ($p > 0.05$; Table 10).

Nitrogen and phosphorus retention

The present results revealed a significant effect of *Ficus nota* treatment on combined nitrogen and phosphorus retention (Wilks' $\Lambda = 0.316$; $\eta p^2 = 0.438$; $p = 0.05$). The effects of antibiotic inclusion and the interaction between antibiotics and *Ficus nota* on nitrogen retention were not statistically significant ($p > 0.05$). *Ficus nota* treatment significantly affected nitrogen balance ($\eta p^2 = 0.479$; $p = 0.05$). Nitrogen retention was highest in the EFN group (33.65 mg), followed by the 0FN group (32.74 mg). Notably, both of these groups differed significantly from the DFN+EFN group, which had a nitrogen retention of 28.92 mg ($p < 0.05$). The 0FN group (32.74 mg) and the DFN group (30.19 mg) were intermediate and did not differ significantly from the EFN and the DFN+EFN groups ($p > 0.05$). Nitrogen balance did not differ significantly between antibiotic-supplemented and antibiotic-free groups ($\eta p^2 = 0.061$; $p > 0.05$). Antibiotic inclusion, *Ficus nota* treatment, and their interaction did not significantly affect the phosphorus balance ($p > 0.05$; Table 10).

Table 4. Effects of antibiotic inclusion and *Ficus nota* fruit meal treatment on the weekly and overall body weight in broiler chickens

Treatment \ Weekly body weight (g)	Initial (14-D)	14-21D	22-28D	29-35D	36-42D	Overall mean
Antibiotics						
Supplemented	259.15	469.24	858.18	1253.10	1630.83	894.10
Antibiotic-free	263.63	463.45	841.42	1230.56	1572.54	874.32
Ficus nota						
Control (0g FN)	259.31	468.61	895.97	1310.78	1668.75	920.68^{b}
DFN	258.97	458.89	820.39	1182.5	1540.28	852.21^{a}
EFN	264.72	470.42	844.19	1244.03	1616.25	887.92^{ab}
DFN+EFN	262.54	467.57	838.57	1230	1581.71	876.08^{ab}
Total	261.39	466.36	849.79	1241.83	1601.73	
Within-subject effects	Linear	Quadratic	Cubic	Order 4	p - value	ηp²
Measurement periods	<0.001***	<0.001***	<0.001***	<0.001***	<0.001***	0.922
Measurement periods * Antibiotics	0.268^{ns}	0.611^{ns}	0.604^{ns}	0.832^{ns}	0.476^{ns}	0.005
Measurement periods * *Ficus nota*	0.202^{ns}	0.947^{ns}	0.566^{ns}	0.978^{ns}	0.473^{ns}	0.020
Measurement periods * antibiotics * *Ficus nota*	0.374^{ns}	0.620^{ns}	0.937^{ns}	0.971^{ns}	0.655^{ns}	0.015
Between-subject effects						
Antibiotics					0.237^{ns}	0.010
Ficus nota					0.032*	0.063
Antibiotics * *Ficus nota*					0.211^{ns}	0.033

Greenhouse-Geisser correction applied for within-subjects effects; ^{ab}Values in the overall mean column followed by different superscript letters differ significantly at 0.05 levels. Significance levels: ***p < 0.001, *p < 0.05, ns = not significant (p > 0.05). Polynomial contrasts (linear, quadratic, cubic, and order-4) were tested for within-subject effects. ηp² = partial eta squared (effect size). FN: *Ficus nota*, DFN: Dried *Ficus nota*, EFN: Ensiled *Ficus nota.* Antibiotic treatments: With (doxycycline at 15 g per 50 L of drinking water) and Without (no doxycycline) across Ficus nota levels. Ficus nota (FN) treatments: Control (0 g FN per kg antibiotic-supplement or antibiotic-free diet), DFN (100 g dried FN/kg antibiotic-supplement or antibiotic-free diet), EFN (100 g ensiled FN/kg antibiotic-supplement or antibiotic-free diet), and DFN+EFN (50+50 g dried and ensiled FN/kg antibiotic-supplement or antibiotic-free diet).

Table 5. Effects of antibiotic inclusion and *Ficus nota* fruit meal treatment on the weekly and overall weight gain in broiler chickens

Treatment \ Weekly weight gain (g)		14-21D	22-28D	29-35D	36-42D	Overall mean
Antibiotics						
Supplemented		210.08	388.94	404.36	377.74	345.28
Antibiotic-free		199.24	372.72	383.74	337.22	323.23
Ficus nota						
Control (0g FN)		209.31	427.36	414.81	357.97	352.36
DFN		199.92	361.5	362.11	357.78	320.33
EFN		205.69	373.78	399.83	372.22	337.88
DFN+EFN		203.72	360.69	399.44	341.94	326.45
Total		204.66	380.83	394.05	357.48	334.25
Within subject effects	Linear	Quadratic	Cubic	Order 4	p -value	ηp²
Measurement periods	<0.001***	<0.001***	0.243^{ns}	-	<0.001***	0.172
Measurement periods * Antibiotics	0.427^{ns}	0.791^{ns}	0.932^{ns}	-	0.860^{ns}	0.001
Measurement periods * *Ficus nota*	0.958^{ns}	0.559^{ns}	0.933^{ns}	-	0.950^{ns}	0.006
Measurement periods * antibiotics * *Ficus nota*	0.730^{ns}	0.880^{ns}	0.972^{ns}	-	0.980^{ns}	0.004
Between subject effects						
Antibiotics					0.060^{ns}	0.026
Ficus nota					0.225^{ns}	0.031
Antibiotics * *Ficus nota*					0.793^{ns}	0.008

Greenhouse-Geisser correction applied for within-subjects effects. Significance levels: ***p < 0.001, *p < 0.05, ns = Not significant (p > 0.05). Polynomial contrasts (linear, quadratic, cubic, and order-4) were tested for within-subject effects. ηp² = Partial eta squared (effect size). FN: *Ficus nota*, DFN: Ddried *Ficus nota*, EFN: Eensiled *Ficus nota*

Table 6. Effects of antibiotic inclusion and *Ficus nota* fruit meal treatment on the weekly and overall feed intake in broiler chickens

Treatment \ Weekly feed intake (g)		14-21D	22-28D	29-35D	36-42D	Overall mean
Antibiotics						
Supplemented		1655.42	4767.25	4673.58	3853.5	3737.44
Antibiotic-free		1677.92	4549.58	4809.58	3764.58	3700.42
Ficus nota						
Control (0g FN)		1665.83	4510.33	4575.5	4307.5	3764.79
DFN		1619.17	4536.67	4795	3287	3559.46
EFN		1665	4727.5	4857.5	3890	3785.00
DFN+EFN		1716.67	4859.17	4738.33	3751.67	3766.46
Total		1666.67	4658.42	4741.58	3809.04	3718.93
Within subject effects	Linear	Quadratic	Cubic	Order 4	p -value	ηp²
Measurement periods	<0.001***	<0.001***	<0.001***	-	<0.001***	0.926
Measurement periods * Antibiotics	0.987^ns	0.969^ns	0.069^ns	-	0.520^ns	0.034
Measurement periods * *Ficus nota*	0.414^ns	0.129^ns	0.266^ns	-	0.256^ns	0.211
Measurement periods * antibiotics * *Ficus nota*	0.663^ns	0.224^ns	0.146^ns	-	0.389^ns	0.169
Between subject effects						
Antibiotics					0.809^ns	0.004
Ficus nota					0.688^ns	0.086
Antibiotics * *Ficus nota*					0.756^ns	0.069

Greenhouse-Geisser correction applied for within-subjects effects. Significance levels: ***p < 0.001, *p < 0.05, ns = Not significant (p > 0.05). Polynomial contrasts (linear, quadratic, cubic, and order-4) were tested for within-subject effects. ηp² = Partial eta squared (effect size).. FN: *Ficus nota*, DFN: Ddried *Ficus nota*, EFN: Eensiled *Ficus nota*. Antibiotic treatments: With (doxycycline at 15 g per 50 L of drinking water) and Without (no doxycycline) across Ficus nota levels. Ficus nota (FN) treatments: Control (0 g FN per kg antibiotic-supplement or antibiotic-free diet), DFN (100 g dried FN/kg antibiotic-supplement or antibiotic-free diet), EFN (100 g ensiled FN/kg antibiotic-supplement or antibiotic-free diet), and DFN+EFN (50+50 g dried and ensiled FN/kg antibiotic-supplement or antibiotic-free diet).

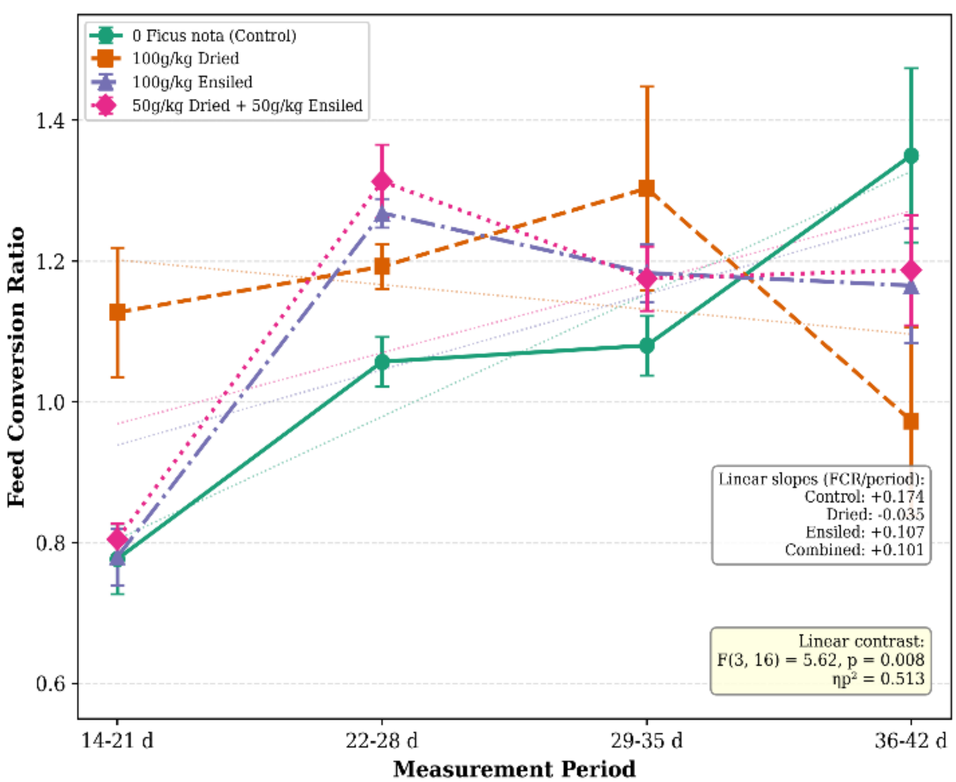

Figure 1. Linear contrast of feed conversion ratio trajectories across measurement periods by *Ficus nota* fruit meal treatment in broiler chickens

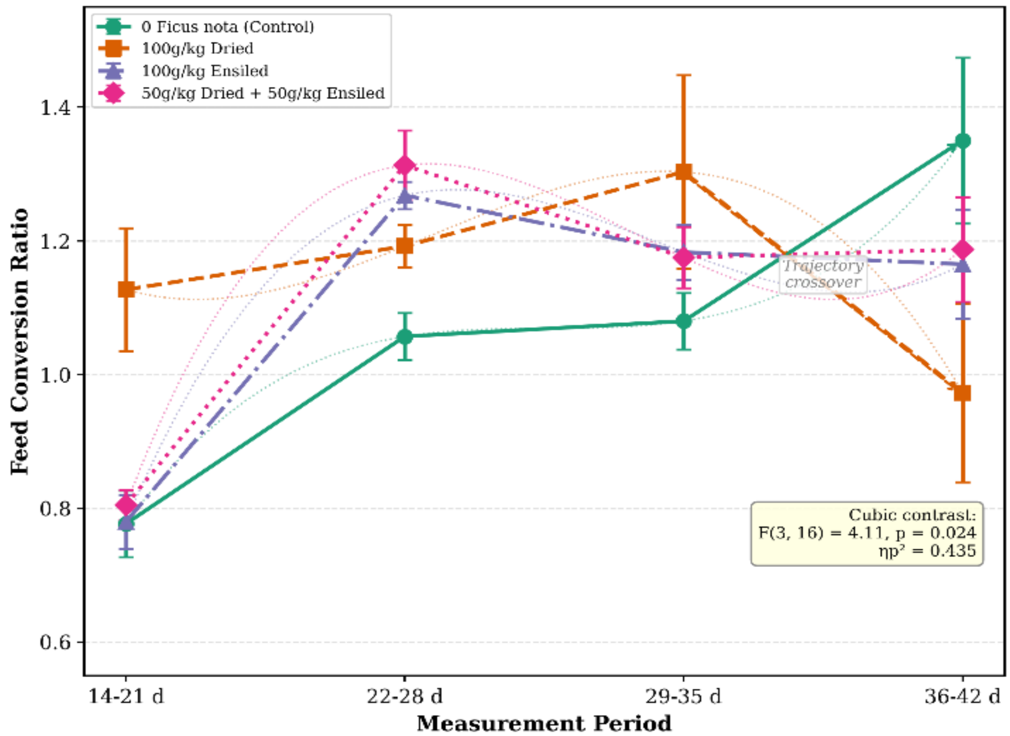

Figure 2. Cubic contrast of feed conversion ratio trajectories across measurement periods by *Ficus nota* fruit meal treatment in broiler chickens

Table 7. Effects of antibiotic inclusion and *Ficus nota* fruit meal treatment on the weekly and overall feed conversion ratio in broiler chickens

Weekly FCR (g/g gain) / Treatment		14-21D	22-28D	29-35D	36-42D	Overall mean
Antibiotics						
Supplemented		0.79	1.22	1.12	1.12	1.06^{a}
Antibiotic-free		0.95	1.19	1.25	1.21	1.15^{b}
Ficus nota						
Control (0g FN)		0.78	1.06	1.08	1.35	1.07
DFN		1.13	1.19	1.3	0.97	1.15
EFN		0.78	1.27	1.18	1.17	1.10
DFN+EFN		0.81	1.31	1.18	1.19	1.12
Total		0.88	1.21	1.19	1.17	1.11
Within-subject effects	Linear	Quadratic	Cubic	Order 4	p -value	ηp^2
Measurement periods	< 0.001***	< 0.001***	< 0.001***	-	<0.001***	0.522
Measurement periods * Antibiotics	0.318	0.326	0.293	-	0.320	0.069
Measurement periods * *Ficus nota*	0.005**	<0.001***	0.024*	-	0.005*	0.428
Measurement periods * antibiotics * *Ficus nota*	0.525	0.561	0.479	-	0.530	0.140
Between-subject effects						
Antibiotics					0.013*	0.004
Ficus nota					0.320	0.086
Antibiotics * *Ficus nota*					0.210	0.069

Greenhouse-Geisser correction applied for within-subjects effects, [ab]Values in the overall mean column followed by different superscript letters differ significantly Significance levels: ***p < 0.001, *p < 0.05, ns = Not significant (p > 0.05). Polynomial contrasts (linear, quadratic, cubic, and order-4) were tested for within-subject effects. ηp^2 = Partial eta squared (effect size). - Effect size. FN: *Ficus nota*, DFN: Ddried *Ficus nota*, EFN: Eensiled *Ficus nota*. Antibiotic treatments: With (doxycycline at 15 g per 50 L of drinking water) and Without (no doxycycline) across Ficus nota levels. Ficus nota (FN) treatments: Control (0 g FN per kg antibiotic-supplement or antibiotic-free diet), DFN (100 g dried FN/kg antibiotic-supplement or antibiotic-free diet), EFN (100 g ensiled FN/kg antibiotic-supplement or antibiotic-free diet), and DFN+EFN (50+50 g dried and ensiled FN/kg antibiotic-supplement or antibiotic-free diet).

Table 8. Carcass recovery and chilling loss of broiler chickens as influenced by antibiotic inclusion and *Ficus nota* fruit meal supplementation

Treatment	**Carcass recovery (%)**	**Chilling loss (%)**
Antibiotics		
Supplemented	79.12	0.61
Antibiotic-free	79.82	0.64
Ficus nota		
Control (0g FN)	79.74	0.58
DFN	78.95	0.78
EFN	80.58	0.64
DFN+EFN	78.61	0.52
p - values		
Antibiotics	0.430^{ns}	0.691^{ns}
Ficus nota	0.404^{ns}	0.125^{ns}
Antibiotics * *Ficus nota*	0.552^{ns}	0.485^{ns}

^{ns} Not significant. FN: *Ficus nota*, DFN: Ddried *Ficus nota*, EFN: Eensiled *Ficus nota.* Antibiotic treatments: With (doxycycline at 15 g per 50 L of drinking water) and Without (no doxycycline) across Ficus nota levels. Ficus nota (FN) treatments: Control (0 g FN per kg antibiotic-supplement or antibiotic-free diet), DFN (100 g dried FN/kg antibiotic-supplement or antibiotic-free diet), EFN (100 g ensiled FN/kg antibiotic-supplement or antibiotic-free diet), and DFN+EFN (50+50 g dried and ensiled FN/kg antibiotic-supplement or antibiotic-free diet).

Table 9. Crude protein digestibility in broiler chickens as influenced by antibiotic inclusion and *Ficus nota* fruit meal supplementation

Treatment	**CP digestibility (%)**	
Antibiotics		
Supplemented	64.50^{a}	
Antibiotic-free	65.52^{b}	
Ficus nota		
Control (0g FN)	66.68^{c}	
DFN	64.76^{b}	
EFN	66.53^{bc}	
DFN+EFN	62.08^{a}	
p - values; ηp^2	p - value	ηp^2
Antibiotics	0.034*	0.251
Ficus nota	<0.001***	0.816
Antibiotics * *Ficus nota*	0.598^{ns}	0.11

Column means by antibiotics and *Ficus nota* treatments on different superscript letters are not statistically significant at 0.05 levels, *** Very highly significant p-value, * Significant p-value at 0.05 levels, ^{ns} Not significant, CP: Crude protein, FN: *Ficus nota*, DFN: Dried *Ficus nota*, EFN: Ensilaged *Ficus nota.* Antibiotic treatments: With (doxycycline at 15 g per 50 L of drinking water) and Without (no doxycycline) across *Ficus nota* levels. Ficus nota (FN) treatments: Control (0 g FN per kg antibiotic-supplement or antibiotic-free diet), DFN (100 g dried FN/kg antibiotic-supplement or antibiotic-free diet), EFN (100 g ensiled FN/kg antibiotic-supplement or antibiotic-free diet), and DFN+EFN (50+50 g dried and ensiled FN/kg antibiotic-supplement or antibiotic-free diet).

Table 10. Multivariate and univariate effects of antibiotic inclusion and *Ficus nota* fruit meal treatment on nitrogen and phosphorus excretion and retention in broiler chickens

MULTIVARIATE	**Wilks' Λ**	**p-value**	**ηp²**
Nitrogen and Phosphorus Excretion			
Antibiotic inclusion	0.029	<0.001**	0.971
Ficus nota treatment	0.021	<0.001**	0.857
Antibiotic × *Ficus nota*	0.005	<0.001**	0.929
Nitrogen and Phosphorus Retention			
Antibiotic inclusion	0.939	0.624^{ns}	0.061
Ficus nota treatment	0.316	0.005**	0.438
Antibiotic × *Ficus nota*	0.901	0.948^{ns}	0.051

UNIVARIATE								
Antibiotics	N excretion (mg/kg)		P excretion (mg/kg)		N retention (%)		P retention (%)	
Supplemented	17.48^{b}		2.77^{b}		31.88		5.46	
Antibiotic-free	16.20^{p}		2.53^{p}		30.87		5.32	
Ficus nota								
Control (0g FN)	16.36		2.59		32.74^{pb}		5.46	
DFN	16.41		2.56		30.19^{pb}		5.38	
EFN	16.94		2.7		33.65^{b}		5.41	
DFN+EFN	17.65		2.76		28.92^{p}		5.31	
p – values; ηp²	p – value	ηp²	p – value	ηp²	p – value	ηp²	p – value	ηp²
Antibiotics	0.007*	0.376	0.002^{ns}	0.474	0.325^{ns}	0.061	0.398^{ns}	0.045
Ficus nota	0.136^{ns}	0.285	0.146^{ns}	0.279	0.0133^{ns}	0.479	0.937^{ns}	0.025
Antibiotics * *Ficus nota*	0.769^{ns}	0.066	0.355^{ns}	0.179	0.780^{ns}	0.064	0.898^{ns}	0.035

Column means by antibiotics and *Ficus nota* treatments on different superscript letters are not statistically significant at 0.05 levels, ** Highly significant p-value at 0.001 levels, * Significant p-value at 0.05 levels, ^{ns} Not significant, Wilks' Λ: Wilks' Lambda, ηp²: Effect size, N: nitrogen, P: phosphorus, FN: *Ficus nota*, DFN: Ddried *Ficus nota*, EFN: Eensiled *Ficus nota*. Antibiotic treatments: With (doxycycline at 15 g per 50 L of drinking water) and Without (no doxycycline) across *Ficus nota* levels. *Ficus nota* (FN) treatments: Control (0 g FN per kg antibiotic-supplement or antibiotic-free diet), DFN (100 g dried FN/kg antibiotic-supplement or antibiotic-free diet), EFN (100 g ensiled FN/kg antibiotic-supplement or antibiotic-free diet), and DFN+EFN (50+50 g dried and ensiled FN/kg antibiotic-supplement or antibiotic-free diet).

DISCUSSION

Phytochemical, proximate, and mineral content

Both drying and ensiling preserved the flavonoid and phenolic contents of *Ficus nota* fruit meal. The preservation of phenolic compounds was consistent with the evidence that fermentation can maintain or enhance the availability of bioactive compounds in plant-based feedstuffs (Nantapo and Marume, 2025). Proximate composition was conserved across drying and ensiling methods. Despite showing large effect sizes, the differences in crude fat, ash, and crude fiber between dried and ensiled *Ficus nota* fruit meals were not notable. The stability of fiber during ensiling was consistent with the findings of Kamota et al. (2011), who reported that neutral- and acid-detergent fiber remained constant during ensiling of transgenic *Bacillus thuringiensis* (Bt) maize. The comparable crude fiber levels in dried and ensiled *Ficus nota* fruit meals indicated that anaerobic fermentation successfully preserved structural carbohydrate fractions, regardless of the plant material. Hristov et al. (2020) reported that most fiber components were preserved during corn silage ensiling, despite alterations in fractions such as hemicellulose and lignin. This observation supported the current finding of an unremarkable difference in crude fiber between dried and ensiled *Ficus nota* fruit meals. Mineral concentrations did not substantially differ between dried and ensiled *Ficus nota* fruit meals. Potassium was numerically higher in the ensiled form than in the dried form. The present results indicated a large effect size for crude fiber, but this finding was not significant. This was likely due to the small sample size (n = 3 per processing method), which limited the statistical power of the study. Alkaloids and saponins were unaffected, whereas tannins decreased from moderately to slightly abundant after ensiling, consistent with microbial degradation during anaerobic fermentation reported by Rooke and Hatfield (2003) and Martineau-Côté et al. (2022). The reduced tannin content in ensiled *Ficus nota* fruit meal is important because tannins can negatively impact digestion; they bind to proteins, making them less digestible. Additionally, tannins interfere with key digestive enzymes such as trypsin, amylase, and lipase (Makkar, 2003; Gilani et al., 2005).

Body weight and weight gain

During the grower phase, broiler chickens exhibited accelerated body weight gain, which progressively decreased as chickens approached market weight (days 29-42). The curvilinear growth pattern observed in the present study was consistent with the findings of Tallentire et al. (2016), who reported that broiler feed consumption decreased near market age as energy utilization efficiency increased and energy-demanding activities such as locomotion and thermoregulation declined. According to Ravindran et al. (2021), broiler chickens have immature digestive tracts and limited digestive enzyme secretion during their first week post-hatch. This finding is consistent with the rapid growth during the grower phase in the present study. Body weight reflected the cumulative outcome of weekly growth increments and provided an integrated measure of treatment effects over the entire feeding trial. By day 42, significant differences in body weight were observed among the *Ficus nota* treatment groups, stemming from the accumulation of small weekly weight gain differences over the 28-day feeding trial. The notable main effect of *Ficus nota* treatment confirmed that the processing method influenced broiler growth performance. Gilani et al. (2005) found that tannins decreased protein digestibility in poultry and pigs by creating insoluble protein-tannin complexes and inhibiting digestive enzymes, leading to a reduction in digestibility of up to 23%. The reduced body weight observed in the DFN group was consistent with the findings of Gilani et al. (2005) and Pertiwi et al. (2023), indicating that the tannin content of 100 g/kg dried *Ficus nota* fruit meal may have exceeded the tolerable threshold for broiler chickens. Intermediate body weights in the EFN and DFN+EFN groups, regardless of antibiotic inclusion, indicated that fermentation mitigated the adverse effects of dried *Ficus nota* fruit meal on growth. According to Nantapo and Marume (2025), the fermentation process breaks down indigestible compounds in phytogenic feed additives and increases the bioavailability of their secondary metabolites, thereby improving growth efficiency in poultry. The intermediate body weight recovery in the EFN and DFN+EFN groups was consistent with tannin degradation during ensiling, as described by Makkar (2003) and Rooke and Hatfield (2003), and with the fermentation-enhanced nutrient availability reported by Nantapo and Marume (2025). The 50:50 blend in the DFN+EFN group only partially mitigated the antinutritional effects of dried *Ficus nota* fruit meal, as their recovery to control levels was incomplete.

Weekly weight gain peaked during the grower phase (days 22-35) and declined during the finisher phase (days 36-42). The decline in weight gain during the finisher phase was due to a higher proportion of dietary energy directed toward maintenance rather than tissue deposition in older, heavier broiler chickens (Samarakoon and Samarasinghe, 2012). Gaviola et al. (2024) reported that supplementing mallard duck diets with ensiled *Ficus nota* fruit produced body weight and weight gain comparable to those of the unsupplemented control, consistent with the intermediate body weight observed in the EFN group. Cungihan (2024) reported that broiler chickens fed *Ficus nota* exhibited improved weight gain. The positive growth response reported by Cungihan (2024) contrasted with the reduced body weight observed in the DFN group. The contrasting result may be attributed to the higher tannin levels retained in dried *Ficus nota* fruit meal compared to the fermented fruit meal used by Cungihan (2024).

Feed intake

Feed intake increased from days 14-21 to 22-28, peaked during days 29-35, and then declined as chickens approached market age. Jie et al. (2024) reported that broiler chickens' feed consumption increased continuously from 4 to 6 weeks of age and identified three distinct individual patterns, including continuous increase, increase followed by a plateau, and increase followed by a decrease. The feed intake pattern observed in the present study was consistent with the increase-followed-by-decrease pattern described by Jie et al. (2024). The unremarkable effect of *Ficus nota* treatment on feed intake suggested that the lower body weight in the DFN group was attributable to impaired nutrient utilization rather than reduced voluntary feed consumption. Makkar (2003) reported that while tannins at moderate concentrations bind dietary proteins and thus impair protein utilization, they do not affect voluntary feed intake. Similarly, Pertiwi et al. (2023) reported that tannin supplementation reduced feed intake in broiler chickens only at higher inclusion levels. The tannin concentration in 100 g/kg dried *Ficus nota* fruit meal appeared sufficient to impair protein utilization but insufficient to reduce palatability, which was consistent with the moderate-tannin responses described by Makkar (2003) and Pertiwi et al. (2023).

Feed conversion ratio

Feed efficiency was best during the early grower phase (days 14-21), worsened during the mid-grower phase (days 22-28), and declined slightly during the finisher phase (days 29-42). However, individual treatment groups demonstrated contrasting FCR patterns across rearing phases. The DFN group, regardless of antibiotic inclusion, exhibited the poorest feed efficiency during the early grower phase, but had the best feed efficiency during the finisher phase. While the control group, regardless of antibiotic inclusion, indicated the opposite trend. The enhanced feed efficiency observed in the finisher phase during the present study could be attributed to the maturation of pancreatic enzymes in older broiler chickens. Nikonov et al. (2017) noted that poultry pancreatic enzyme secretion occurs in two developmental stages, with lipase activity notably increasing between days 15 and 35 post-hatch. This aligns with the FCR improvement of the DFN group during the finisher phase, suggesting that increased digestive enzyme activity helped to partially overcome the nutrient utilization issues caused by tannins. Buyse et al. (2021) reported that chestnut tannins at 2,000 mg/kg lowered broiler chicken performance during the grower and finisher phases regardless of basal diet composition, whereas 500 mg/kg had no detectable effect. The poorest FCR observed in the DFN group, regardless of antibiotic inclusion, during the early grower phase was consistent with the dose-dependent performance reduction reported by Buyse et al. (2021), implying that the 100 g/kg of dried *Ficus nota* fruit meal contained a tannin concentration exceeding the threshold that impairs feed efficiency. Similarly, Pertiwi et al. (2023) reported that tannin supplementation impaired growth performance in broiler chickens, primarily during the grower phase, further supporting the phase-dependent FCR response observed in the DFN group. Antibiotic supplementation improved overall FCR without affecting body weight or feed intake. The primary effect of antibiotic supplementation was improvement in nutrient utilization efficiency rather than increasing feed consumption or growth rate. Banerjee et al. (2018) reported that sub-lethal doses of antibiotics enrich short-chain fatty acid-producing bacteria, particularly butyrate producers, which efficiently metabolize indigestible feed components such as glycans, thereby increasing the energy availability of the host. The improved FCR observed in antibiotic-supplemented groups was consistent with the microbiota-enrichment mechanism described by Banerjee et al. (2018). According to Fernández et al. (2024), antibiotics boosted nutrient utilization by lowering gut inflammation, improving mitochondrial function, and altering the gut microbiome. *Ficus nota* treatment did not notably affect overall FCR. Gaviola et al. (2024) reported that mallard ducks supplemented with ensiled *Ficus nota* fruit had a slightly higher FCR than the control group, which was partially consistent with the present findings. Cungihan (2024) reported that broiler chickens fed *Ficus nota* exhibited improved FCR, which is in contrast to the present findings. The contrasting results suggested that the effects of *Ficus nota* on FCR depend on processing method, inclusion level, and rearing phase.

Carcass characteristics

Carcass recovery averaged 79.47% across all treatment groups, a value within the upper range reported for commercial broiler chickens (Lilic et al., 2021; Haruna et al., 2023). Antibiotic supplementation and *Ficus nota* treatment did not affect the carcass recovery. Marpana (2016) reported that live body weight and body composition, rather than dietary additives, are the primary factors of dressing percentage. The absence of remarkable carcass recovery differences among antibiotic inclusion and *Ficus nota* treatment groups in the present study was consistent with the findings of Marpana (2016). The EFN group, regardless of antibiotic inclusion, had numerically higher carcass recovery than the DFN group, consistent with the higher body weight observed in the EFN group. Chilling loss averaged 0.63% across all treatment groups, a value below the range that is commonly reported for air-chilled broiler chicken carcasses (Young and Smith, 2004; Huezo et al., 2007). The DFN group, regardless of antibiotic inclusion, had the highest chilling loss (0.78%) in the present study. However, all values remained below 1%, and the numerical differences among *Ficus nota* treatment groups were not substantial, indicating that the dietary treatments did not affect moisture retention in broiler carcasses.

Crude protein digestibility

Crude protein digestibility was lower in antibiotic-supplemented groups despite improved FCR. According to Banerjee et al. (2018), antibiotics modify the gut microbiota by favoring *Firmicutes* and short-chain fatty acid-producers, shifting metabolism to carbohydrates. This could decrease microbial nitrogen metabolism and increase undigested nitrogen in excreta. The lower crude protein digestibility in antibiotic-supplemented groups was consistent with the antibiotic-mediated shift in microbial function described by Banerjee et al. (2018) and the microbial disruption reported by Bossila et al. (2025), suggesting that altered gut microbiota composition reduced microbial contributions to protein digestion. Fernández et al. (2024) indicated that antibiotics improved nutrient utilization by saving energy on gut maintenance and enhancing mitochondrial function. This explains the improved FCR during the present study, driven by reduced metabolic expenditure, not improved protein digestion. In contrast, *Ficus nota* treatment accounted for most of the variation in crude protein digestibility. Sabuna et al. (2025) reported that the processing method affected crude protein digestibility in broiler chickens. Boiled (81.82%) and distilled (82.35%) herbal preparations produced higher digestibility than unprocessed controls (77.24%). The variation in crude protein digestibility observed across different *Ficus* nota treatment groups was consistent with the processing effects reported by Sabuna et al. (2025). In the DFN+EFN group, the combined presence of intact tannins from dried *Ficus nota* and organic acids from ensiled *Ficus nota* may have lowered the luminal pH. According to Aw and Swanson (2006), lower pH strengthens the binding between tannins and proteins, which likely explains the lowest crude protein digestibility (62.08%) observed in the DFN+EFN group. Additionally, the combined exposure to intact tannins and organic acids in the DFN+EFN group may have increased endogenous nitrogen losses through greater mucosal protein turnover. Dal Pont et al. (2020) reported that antinutritional compounds induce low-grade chronic intestinal inflammation in poultry, increasing mucosal protein turnover and reducing apparent digestibility. The lowest crude protein digestibility in the DFN+EFN group was consistent with the findings of Dal Pont et al. (2020), who linked inflammation to reduced apparent digestibility. This finding indicated that the simultaneous presence of intact tannins and organic acids in the blended treatment likely induced greater intestinal mucosal damage compared to exposure to either component alone. Combining dried and ensiled *Ficus nota* fruit meal resulted in lower crude protein digestibility compared to using either the dried or ensiled form alone.

Nitrogen and phosphorus excretion and retention

Nitrogen and phosphorus excretion shifted in a coordinated pattern across *Ficus nota* treatment groups, detectable only when both variables were analyzed together. Antibiotic supplementation increased nitrogen and phosphorus excretion. The higher nitrogen output was consistent with the lower crude protein digestibility in antibiotic-supplemented groups. Antibiotics alter gut microbes, favoring carbohydrate metabolism and potentially reducing phytase activity, leading to increased phosphorus excretion (Banerjee et al., 2018). The increased phosphorus excretion in antibiotic-supplemented groups during the present study was consistent with the findings of Banerjee et al. (2018) regarding the gut microbial shifts. Imperial et al. (2023) reported that antibiotic use in Philippine poultry farming poses environmental risks beyond antimicrobial resistance and emphasized the need for sustainable production practices. The higher nitrogen and phosphorus excretion in antibiotic-supplemented groups compared with antibiotic-free groups in the present study was consistent with the environmental concerns raised by Imperial et al. (2023). Elevated nitrogen and phosphorus excretion from chickens that received antibiotics might increase the risk of nutrient pollution in waterways surrounding intensive production systems in the Philippines.

Nitrogen and phosphorus retention demonstrated a contrasting pattern relative to nitrogen and phosphorus excretion. *Ficus nota* treatment was the primary factor affecting nitrogen and phosphorus retention. Antibiotic supplementation did not affect nitrogen retention despite the remarkable effects on crude protein digestibility and nitrogen excretion. The EFN group achieved the highest nitrogen retention (33.65 mg), indicating that ensiling reduced the antinutritional constraints of dried *Ficus nota* fruit meal and enhanced nitrogen utilization beyond control levels. The improved nitrogen retention in the EFN group was consistent with the findings of Nantapo and Marume (2025), who reported that fermentation reduced tannin content and produced metabolites that enhanced nutrient utilization efficiency in poultry. The improved nitrogen retention in the EFN group was consistent with the findings of Zhao et al. (2025), suggesting that the reduced tannin level in ensiled *Ficus nota* fruit meal fell within a beneficial range for nitrogen utilization. The lower nitrogen retention in the DFN group was consistent with the findings of Hassan et al. (2003), who reported that broiler chickens fed sorghum with high tannin concentrations had reduced weight gain and mineral absorption. The lower nitrogen retention in the DFN group was also consistent with the findings of Mansoori and Acamovic (2009), who reported that tannic acid increased amino acid excretion and reduced protein retention in broiler chickens, suggesting that tannins in dried *Ficus nota* fruit meal impaired nitrogen retention through reduced amino acid absorption. Buyse et al. (2021) reported that higher doses of chestnut tannins (2,000 mg/kg) reduced performance in broiler chickens, whereas lower doses (500 mg/kg) had no detectable effect. This finding supported the dose-dependent tannin response, as the reduced nitrogen retention in the DFN group indicated that the tannin concentration in dried *Ficus nota* fruit meal exceeded the threshold for hindering nitrogen utilization. The increased nitrogen retention in the EFN group, compared to the DFN group, supported the reduced nitrogen waste found by Schiavone et al. (2008), indicating that lower tannin concentrations might favor nitrogen retention over excretion. The contrasting nitrogen retention between the EFN and DFN groups in the present study supported the dose-dependent tannin response described by Zhao et al. (2025), in which the effect of tannins shifted from beneficial to detrimental as concentration increased. The lowest nitrogen retention in the DFN+EFN group was consistent with the antagonistic interaction observed for crude protein digestibility in the DFN+EFN group. Blending dried and ensiled *Ficus nota* fruit meals resulted in lower nitrogen retention than either processed form used separately. Phosphorus retention was not notably affected by antibiotic inclusion, *Ficus nota* treatment, or the antibiotic and *Ficus nota* interaction, despite the substantial antibiotic effect on phosphorus excretion. Hassan et al. (2003) reported that broiler chickens fed sorghum with high tannin concentrations had reduced mineral absorption, yet phosphorus balance remained within a narrow physiological range through compensatory adjustments in absorption and excretion. The stable phosphorus retention across all *Ficus nota* treatment groups in the present study was consistent with this compensatory mechanism, suggesting that broiler chickens maintained phosphorus homeostasis despite the tannin content in *Ficus nota* fruit meal. *Ficus nota* treatment affected nitrogen retention but did not affect phosphorus retention. The differing retention of nitrogen and phosphorus supports the protein-binding mechanism as the main antinutritional effect of tannins in Ficus nota fruit meal when included at 100 g/kg in the diet.

CONCLUSION

Ensiling *Ficus nota* fruit meal with 4% molasses for 60 days reduced tannin abundance while maintaining proximate composition and phytochemical content. Over a 42-day feeding trial, ensiled Ficus nota fruit meal at 100 g/kg supported broiler chicken production without antibiotic supplementation, leading to sustained growth performance and achieving the highest nitrogen retention (33.65 mg) among all Ficus nota groups. However, the present study evaluated only a single inclusion level (100 g/kg) and a single ensiling duration (60 days), and further investigations are needed to determine the optimal inclusion level and ensiling period for broiler chickens. Broiler chickens fed 100 g/kg dried *Ficus nota* fruit meal had significantly lower body weight due to tannin-mediated reduction in crude protein digestibility and nitrogen retention. The 50:50 blend of dried and ensiled forms produced negative interactions, resulting in the lowest crude protein digestibility and nitrogen retention, suggesting that blending may reduce efficacy and should be avoided in feed formulation. Antibiotic supplementation improved the FCR but did not interact with the effects of *Ficus nota*, and increased nitrogen and phosphorus excretion. Future studies should evaluate the effects of different inclusion levels of ensiled *Ficus nota* fruit meal on gut morphology, microbial composition, and long-term production performance in broiler chickens under commercial farming conditions.

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Availability of data and materials

The gathered and analyzed data are available from the corresponding author upon reasonable request.

Authors' contributions

Albino Namoc Taer and Imelda Ulep Hebron conceptualized and crafted the methodology. Renante Decenella Taylaran and Charly Guillermo Alcantara conducted data validation and visualization. Nelda Ruba Gonzaga and Eric Randy Reyes Politud analysed and wrote the original draft. Rudy Merabueno. Camay was responsible for the data curation and editing. All authors read and approved the final edition of the manuscript.

Ethical considerations

This manuscript was screened for plagiarism, and the authors confirmed that all data are authentic and that no artificial intelligence (AI) tools were used for preparing and writing the present study.

Competing interests

The authors have declared that no competing interests exist.

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