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(RESEARCH ARTICLE)

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The effect of herbal antibiotics through drinking water on broiler performance

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Abstract

The restriction on incorporating growth promoting antibiotics into poultry rations and drinking water has encouraged the development of herbal antibiotics as alternative feed additives to improve intestinal health and maintain broiler performance. *Piper betle* L. (betel leaf), *Uncaria gambir* Roxb. (gambier), and calcium hydroxide $Ca(OH)_2$ are natural materials with potential as herbal antibiotics. This trial evaluated the efficacy of incorporating a phytogenic additive into drinking water on broiler performance metrics to delineate the most effective administration level. A total of 80 one-day-old broiler chicks (CP 707 strain) were housed at the experimental facility of the Faculty of Animal Science, Udayana University, Sesetan. A Completely Randomized Design (CRD) consisting of four treatments and five replications, with four birds per replicate, was employed. The treatments were P0 (drinking water without herbal antibiotics/control), P1 (2% herbal antibiotics), P2 (4%), and P3 (6%). Parameters measured in this study comprised feed consumption, water intake, final live weight, body weight gain, and feed conversion ratio (FCR). Data were statistically processed via analysis of variance (ANOVA), followed by Duncan's multiple range test for mean comparisons whenever treatment effects reached significance. The results showed that supplementation with herbal antibiotics at 2%, 4%, and 6% had no significant effect ($P>0.05$) on body weight gain or final body weight. However, all supplementation levels significantly affected ($P<0.05$) feed intake, water intake, and FCR compared with the control. It was concluded that herbal antibiotic supplementation up to 6% was unable to improve body weight gain or final body weight but effectively reduced feed intake, water intake, and FCR, indicating improved feed utilization efficiency. Among all treatments, the 2% supplementation level produced the most optimal broiler performance, as indicated by the lowest feed intake, water intake, and FCR.

Keywords: Broiler; Herbal antibiotics; Performance; Drinking water

1. Introduction

Broilers represent highly productive poultry species primarily reared for meat production, rendering them a rapid and relatively affordable source of animal protein. As reported by [1], broilers exhibit distinct advantages, including rapid growth rates, superior feed conversion efficiency, and strong economic viability. Nevertheless, these birds remain highly susceptible to various pathologies, particularly respiratory infections and gastrointestinal disorders, which can severely compromise performance metrics, elevate mortality rates, and incur economic losses. To mitigate these issues, Antibiotic Growth Promoters (AGPs) are frequently incorporated into feed or drinking water as additive agents to enhance growth trajectories and immunocompetence. [2] observed that AGPs could augment body weight gain by up to 4.9% while optimizing feed efficiency. However, their prolonged administration carries the inherent risk of antibiotic residues and antimicrobial resistance (AMR), necessitating natural alternatives such as phytobiotics.

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Various indigenous flora offer significant potential for utilization as phytobiotics to optimize growth performance, immunocompetence, and feed utilization efficiency in broilers. Administration via drinking water provides a distinct advantage, as active bioactive compounds are absorbed more rapidly through the gastrointestinal tract [3]. One potential botanical combination involves betel leaf (*Piper betle* L.), gambier (*Uncaria gambir* Roxb), and slaked lime $Ca(OH)_2$. Betel leaf contains eugenol, hydroxychavicol, chavicol, chavibetol, flavonoids, tannins, and essential oils with antibacterial properties. Gambier is rich in catechins, tannins, flavonoids, and gallic acid, which serve as natural antioxidants and antimicrobial agents, whereas slaked lime contains $Ca(OH)_2$, which elevates solution pH, facilitates the release of phenolic compounds, and supplies calcium ions vital for maintaining intestinal mucosal integrity and mineral metabolism. [4] reported that incorporating betel leaf meal at 4 g/kg diet increased body weight gain, intestinal morphology, and nutrient digestibility in broilers. Conversely, [5] stated that betel leaf extract up to 2% in drinking water exerted no significant effect on final live weight, carcass percentage, or abdominal fat content. Furthermore, [6] demonstrated that gambier supplementation at 0.25–0.5% in feed or 5 g/L in drinking water effectively increased body weight gain, lowered the feed conversion ratio (FCR), and elevated the overall performance index. In addition, [7] reported that a calcium requirement of approximately 0.60% is essential for optimal broiler growth during 1–21 days of age, whereas around 1.00% is necessary to support systemic calcium metabolism and skeletal development.

Limited research has explored the combination of these three natural ingredients as a source of natural antibiotics for broilers. Driven by these considerations, this experiment aimed to assess the impact of supplying a betel leaf derived herbal antibiotics through drinking water.

2. Materials and methods

2.1. Materials

The study took place at the Sesetan Experimental Station, Faculty of Animal Husbandry, Udayana University. Eighty unsexed day-old chicks (CP 707 strain) were assigned to 21 colony battery cages and fed a commercial diet (CP 511B).

2.2. Methods

Experimental units were structured under a completely randomized design (CRD) across four treatments with five replicates per group. Each replication unit utilized four broilers of homogeneous body weight, bringing the total sample size to eighty broilers. The treatments evaluated in this experiment were as follows:

- P0: Drinking water without the addition of herbal antibiotics
- P1: Drinking water supplemented with 2% herbal antibiotics
- P2: Drinking water supplemented with 4% herbal antibiotics
- P3: Drinking water supplemented with 6% herbal antibiotics

2.3. Preparation of Herbal Antibiotics

The composition of the betel leaf-based herbal antibiotic comprised three ingredients: 98% betel leaf, 1.5% slaked lime, and 0.5% gambier. The preparation commenced by selecting mature, green betel leaves, followed by the separation of the leaves from their stalks. The leaves were then chopped and thoroughly washed. Betel leaves, gambier, and slaked lime were placed into a blender with water at a 1:1 ratio and homogenized. Filtration of the obtained mixture was performed to isolate the liquid fraction from the remaining insoluble pomace. The herbal antibiotic was administered via drinking water substitution at concentrations of 2%, 4%, and 6% per liter of water. Throughout the study, drinking water was provided *ad libitum*.

2.4. Observed Variables

2.4.1. Feed Intake

Daily feed intake was calculated by deducting the orts (refused feed) from the total quantity provided. Feed measurements were recorded at weekly intervals.

$$\text{Feed intake (g)} = \text{Feed offered} - \text{Feed refused}$$

2.4.2. Water Intake

Daily water intake was quantified by deducting the refused volume from the total quantity supplied to the broilers

Water intake (L) = Water provided (L) - Remaining water (L)

2.4.3. Initial and Final Body Weight

Broiler body weight was measured at initial arrival and at harvest to determine initial and final body weight, respectively.

2.4.4. Body Weight Gain

Body weight of the broilers was monitored on a weekly basis during the trial. Weekly weight gain was derived by deducting the prior week's body weight from the current week's measurement, applying the formula below:

BWG (g) = Current body weight - Previous week body weight

2.4.5. Feed Conversion Ratio (FCR)

The feed conversion ratio was evaluated by determining the quotient of total weekly feed consumed relative to the corresponding body weight gain, as expressed below:

$$\text{FCR (\%)} = \frac{\text{Feed intake}}{\text{Body weight again}}$$

2.5. Data Analysis

Experimental data were evaluated through an analysis of variance (ANOVA). Where treatment main effects reached statistical significance ($P < 0.05$) mean comparisons were performed using Duncan's multiple range test [8].

3. Experimental Findings

Table 1 Effect of herbal antibiotic administration via drinking water on the performance of experimental broilers at 4 weeks of age

Variable	Treatment[1)]				SEM[2)]
	P0	P1	P2	P3	
Initial body weight (g/bird)	39.25[a3)]	39.2[a]	39.25[a]	39.4[a]	0.10
Feed intake (g/bird)	2374.78[a]	2192.79[b]	2201.55[b]	2223.32[b]	29.82
Water intake (mL/bird)	5943.65[a]	5519.45[b]	5677.45[ab]	5672.45[ab]	88.71
Body weight gain (g/bird)	1661[a]	1633.90[a]	1624.70[a]	1649.10[a]	23.34
Final body weight (g/bird)	1700.25[a]	1673.10[a]	1663.95[a]	1688.50[a]	23.32
Feed conversion ratio (FCR)	1,43[a]	1,34[b]	1,35[b]	1,35[b]	0,02

Note : P0: Broilers provided with drinking water without herbal antibiotic; P1: Broilers provided with drinking water containing 2% herbal antibiotic; P2: Broilers provided with drinking water containing 4% herbal antibiotic; P3: Broilers provided with drinking water containing 6% herbal antibiotic.2) SEM: Standard Error of the Treatment Means.3) Values within a row carrying distinct superscript letters differ significantly ($P < 0.05$), while those sharing identical superscripts show no significant differences ($P > 0.05$).

Feed intake of broilers treated with the herbal antibiotic at levels of 2%, 4%, and 6% was significantly lower ($P < 0.05$) than that of the control group (P0). The reduction in feed intake among livestock administered the herbal antibiotic is presumably associated with the presence of active compounds acting as antimicrobial agents. Antimicrobial activity inherent to these active principles hinders the colonization of pathogenic bacteria throughout the intestinal tract, thereby promoting a healthier gut environment and optimizing nutrient utilization. With the increased efficiency of nutrient utilization, the requirement for feed intake tends to decrease. This statement is in agreement with the study by [9], which demonstrated that the combination of probiotics and inulin was able to improve intestinal morphology and enhance energy availability in broilers. According to [10], feed intake in chickens can be influenced by several factors, such as environmental temperature, dietary metabolizable energy level, body weight, palatability, feed quality, and growth rate. The decrease in feed intake of broilers receiving the herbal antibiotic is also thought to be attributed to the content of tannin compounds and essential oils, which can affect feed palatability and subsequently reduce consumption preference in broilers. [11] stated that water intake and feed intake in broilers share a close relationship.

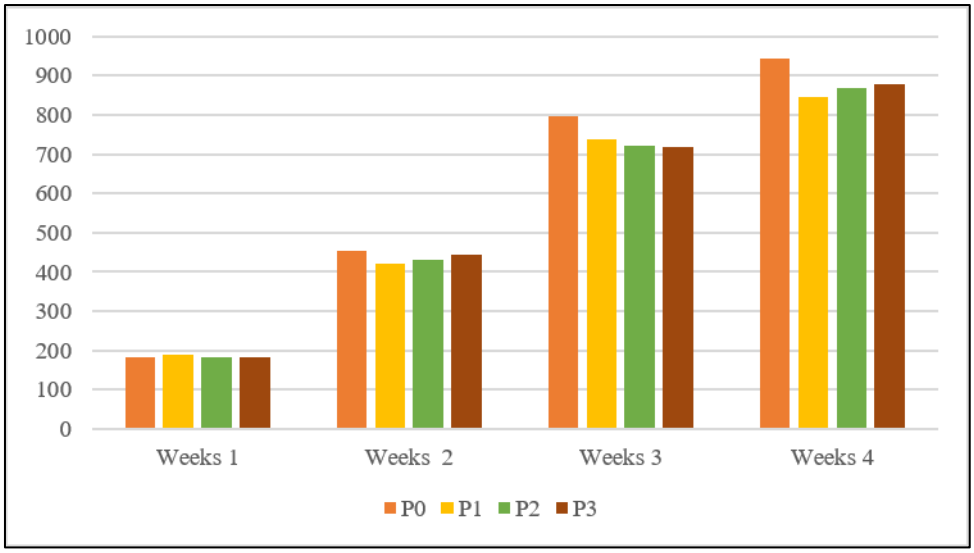

Figure 1 Average Feed Intake of Broilers During Weeks 1–4

In poultry water intake generally exhibits a direct correlation with feed intake. An increase in feed intake is followed by an elevated requirement for drinking water, as water plays a critical role in digestion, metabolism, nutrient transport, and thermoregulation. Conversely, a reduction in feed intake tends to decrease water consumption. In the present study, the water intake of broilers subjected to treatments P1, P2, and P3 was 7.14%, 4.48%, and 4.57% significantly lower ($P < 0.05$), respectively, compared to that of the control group (P0). Data in Table 1 reveal that dietary phytobiotic inclusion led to a decline in broiler feed consumption, which was concurrently mirrored by a lower water intake. This indicates that the inclusion of the herbal antibiotic in drinking water can maintain gastrointestinal health, wherein a healthy digestive tract improves the efficiency of digestion and nutrient absorption, thereby resulting in a more balanced metabolic activity. When nutrient absorption occurs optimally, the physiological requirement for water to facilitate digestion, excretion, and fluid homeostasis becomes more stabilized, leading to non-excessive water consumption. [12] reported that probiotic administration via broiler drinking water demonstrated that gastrointestinal health influences digesta passage rate, digestive tract pH, and small intestine conditions. The improvement in intestinal physiological conditions results in more optimal metabolic processes and nutrient absorption, thereby enhancing systemic water utilization efficiency. Furthermore, the reduction in water intake is presumably associated with the active compounds in the herbal antibiotic, which contains betel leaf and gambier. Both herbal ingredients contain essential oils, phenols, and tannins that impart a bitter and astringent taste, which may decrease drinking water palatability and subsequently lead to lower water intake compared to the control treatment. This is in agreement with [13], who stated that chickens possess a taste receptor system capable of detecting bitter compounds and various other taste stimuli related to feed and water consumption behaviors.

The absence of significant differences in body weight gain (BWG) and final body weight of broilers across all treatments indicates that the administration of the herbal antibiotic via drinking water has not yet exerted a significant effect on broiler growth performance. This condition allows nutrients to be utilized more optimally by the broiler's body, such that despite the decrease in feed intake, growth performance and final body weight can still be maintained. This finding is supported by the study conducted by [14], which demonstrated that the administration of a phytogenic feed additive did not significantly affect body weight, body weight gain, or feed intake, but significantly improved the feed conversion ratio (FCR). Similar outcomes were reported by [15], wherein betel leaf extract administration via drinking water yielded no significant improvements in either broiler final body weight or body weight gain. Additionally, [16] observed that incorporating a synbiotic mix of tape yeast and Moringa leaf into the diet exerted no significant effect on the final body weight or weight gain of 5-week-old broilers.

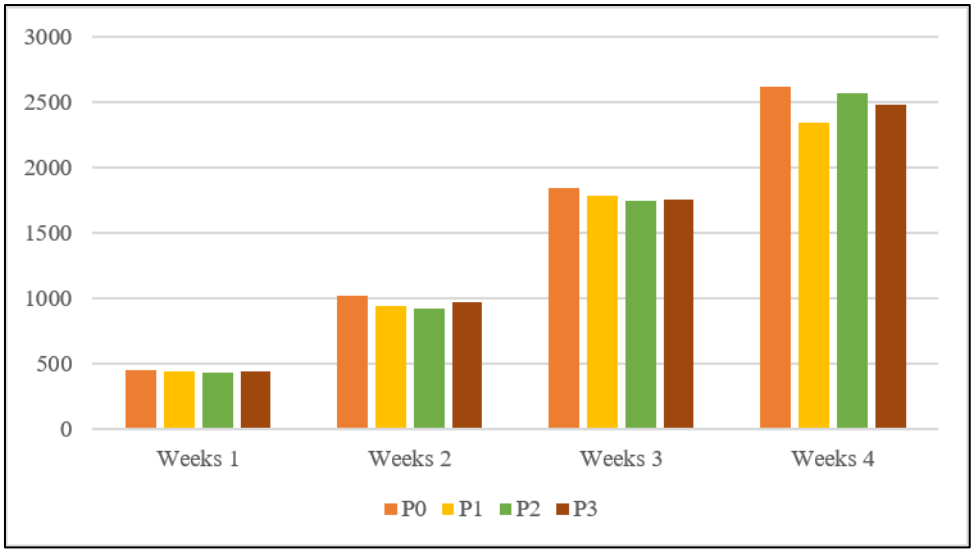

Figure 2 Average Water Intake of Broilers During Weeks 1–4

Feed conversion ratio (FCR) represents a pivotal parameter for determining feed utilization efficacy across livestock enterprises, used to evaluate the ability of animals to convert feed into body weight gain. A lower feed conversion ratio (FCR) value in broilers receiving the herbal antibiotic indicates that feed utilization occurred more efficiently compared to the control treatment. This condition signifies that a relatively smaller amount of feed was consumed while still generating body weight gain comparable to that of the control group. A lower FCR value demonstrates higher feed efficiency in livestock for producing body weight gain, thereby enhancing broiler production performance. According to [17], antibacterial compounds from plant extracts can improve gut microflora and intestinal health in broilers, thereby supporting enhanced nutrient absorption. The lower FCR values in the herbal antibiotic treatments are presumably attributable to the presence of antibacterial compounds in betel leaf and gambier, such as flavonoids, tannins, phenols, and essential oils, which function as natural antimicrobials. These compounds are thought to inhibit the growth of pathogenic bacteria within the digestive tract, thereby improving the balance of intestinal microflora. A reduction in pathogenic bacterial populations can decrease gastrointestinal disturbances and improve digestive tract health in broilers.

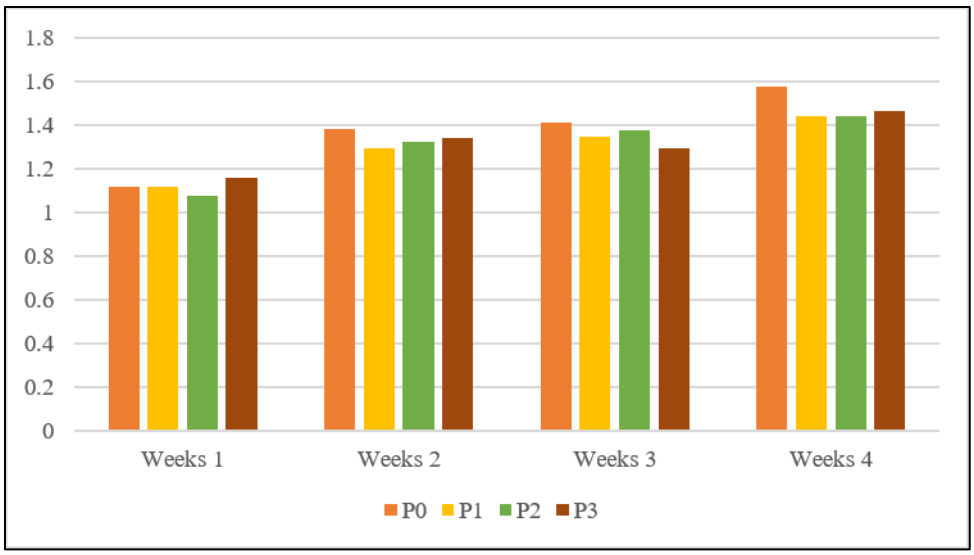

Figure 3 Average Feed Conversion Ratio (FCR) of Broilers During Weeks 1–4

A healthier digestive tract environment allows the processes of digestion and nutrient absorption to occur more optimally. Nutrients derived from the diet can be absorbed and utilized more efficiently by the animal's body to support tissue synthesis, growth, and other metabolic processes. Such efficiency in nutrient utilization leads to a lower requirement for feed intake to achieve equivalent body weight gain. This finding is supported by the study of [18], which

stated that feed efficiency (FCR) is closely related to the development of digestive organs and the intestinal tract health of broiler chickens. Consequently, the administration of herbal antibiotics has the potential to enhance feed utilization efficiency, as reflected in the lower FCR values of the broilers. These findings mirror those of [15], who reported that administering betel leaf extract through drinking water at 2%, 4%, and 6% concentrations enhanced broiler feed conversion efficiency. Furthermore, [6] showed that the inclusion of gambier powder in broilers, administered at levels of 0.25–0.5% in feed or 5 g/L in drinking water, improved body weight gain, decreased FCR, and increased the Performance Index compared to the control group.

4. Conclusion

In conclusion, supplementing drinking water with herbal antibiotic up to 6% failed to enhance cumulative weight gain or final live weight; nonetheless, it was capable of decreasing feed intake and water intake, as well as improving feed utilization efficiency, as indicated by a lower FCR value. Among all treatments, the administration of the herbal antibiotic at the 2% level yielded the most optimal broiler production performance, as demonstrated by the lowest feed intake, water intake, and FCR value.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

No potential conflicts of interest, whether commercial, financial, or institutional, were reported by the authors in connection with this manuscript

Statement of ethical approval

Experimental protocols involving broiler were reviewed and approved by the INSTITUTIONAL Animal Ethics Committee of the Faculty of Veterinary Medicine, Udayana University.

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