Original Article

Detrimental Effect of Tannin on Growth Performance, Visceras Weight and Blood Biochemistry in Broiler Chickens Reared Under Tropical Area

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ABSTRACT

Restriction of antibiotic growth promoters (AGP) in Indonesia reduces broiler production due to bacterial diseases. Some poultry farmers have attempted to replace AGP with phytogenic compounds, such as tannin as an in-feed additive. Therefore, this study was carried out to investigate the effects of tannin administration on the production performance, viscera weight, and lipoprotein levels of tropically-raised broiler chickens. Cobb Strain broiler chicks aged one day were used in an experiment with a completely random design, three treatments, and four replicate pens, each containing nine birds. Three dietary treatments were assigned to the birds: basal diet (negative control), basal diet+0.03% Zn Bacitracyn (positive control), and basal diet+0.05% tannin for the starter phase of 1-21 days and the grower phase of 22-42 days, respectively. Tannin supplementation significantly increased the feed conversion ratio in all phases relative to the control group. Tannin supplementation in the diet significantly reduced daily feed intake during the grower phase, final body weight, carcass weight, intestine weight, liver weight, and total visceral weight, compared to the control group. Tannin had lower levels of aspartate aminotransferase but higher levels of low-density lipoprotein and alanine aminotransferase. Tannin addition in broiler diets might not improve growth performance and health. Therefore, it is not suggested as a substitute for AGPs in broiler diets.

Keywords: Antibiotic growth promoters, Blood biochemistry, Broiler chicken, Growth, Tannin

1. Introduction

Antibiotic growth promoters (AGP) are frequently added to animal feed. AGP suppresses stress, produces ammonia, reduces infection, decreases toxins, and increases intestinal absorption of nutrients from feed (1). Local farmers in Indonesia frequently utilize zinc bacitracin, spiramycin, bambermycin, virginiamycin, tylosin phosphate, avilamycin, and neomycin (2).

The Animal Husbandry and Health Act No. 18, 2009 jucto No41/2014 began to prohibit the use of AGP in Indonesia at the beginning of 2018. This regulation resulted in the discontinuation of AGP imports. However, farm antibiotics used for therapeutic purposes will be permitted with a prescription from a qualified veterinarian. Local broiler farmers have accused the government of restricting AGP, resulting in a reduction in broiler production. There was a decline in broiler chicken productivity in high numbers due to many broiler farmers' exposure to bacterial diseases (3). Some livestock industries have attempted to replace AGP with phytogenic compounds, such as tannin as an in-feed additive.

Tannins are polyphenolic plant secondary metabolites chemicals that have been demonstrated to influence microbial activity, which may influence fermentation, methane synthesis, protein degradation, and the ability to reduce food-borne infections (4). Numerous broadleaf forage plants that can bind proteins can produce tannins. In warm climates, broadleaf plants typically have a higher concentration of tannins (5).

According to Bunglavan and Dutta (6), the preservation of proteins is crucial for polygastric animals whose protein needs cannot be provided by microbial protein production. Tannin's impact on protein digestion is one of its chief advantages (7). There has been significant interest in decreasing protein degradation in the rumen. Tannin-rich plants can also enhance the absorption of essential amino acids (8) and prevent the development of intestinal parasites (9). In addition, the effects of tannin extracted from Acacia catechu, Eichhornia crassipes, and Terminalia chebula as a phytochemical medicine compound were observed well in a previous study (10); however, the information about tannins supplementation in poultry is limited. Therefore, this experiment was conducted to investigate the effects of tannin on the growth performance, viscera weight, and blood biochemistry profiles of broiler chickens raised in a tropical environment.

2. Materials and Methods

2.1. Birds and Housing

The study was conducted on a commercial chicken farm in Jombang, East Java, Indonesia. In total, 108-day-old Cobb strain broiler chicks were randomly distributed among 12 litter pens in a 1 m2 open house cage (nine chicks per pen). Each pen was facilitated with a hand-operated drinker and a feeder. Each enclosure was assigned nine-day-old chicks with comparable body weights (48-58 grams). During the first week of the study, there were 24 hours of lighting, followed by 12 hours of light and 12 hours of darkness. Each chicken had unrestricted access to feed and water. The temperature ranged between 32 and 39 degrees Celsius, while the relative humidity varied between 49% and 69%.

2.2. Diets

The control/T1 group's starter (1-21 days of age) and grower (22-42 days of age) diets were formulated according to the NRC (11) guideline (Table 1). As AGPs, 0.03% Zn Bacitracyn and 0.05% tannin were added to the control meals for the T2 and T3 groups, respectively, to create two distinct diets.

2.3. Measurements

During the growth-to-finishing phase, feed intake, body weight, feed conversion ratio and mortality were recorded (14-28-42 days). In the last day of experiment, six chickens per group were sacrificed for carcass identification to determine the weights of eviscerated carcasses and the weight of viscera.

The biochemical blood ALT, AST, HDL, and LDL were evaluated (LDL) analysis was automated based on the manufacturer's instructions for Weiner Kinetic Kits. Each test analysis was separately processed by spectrophotometry using temperature-controlled incubation cuvets, and the machine printed the results directly.

Table 1. Ingredients and composition of the broiler diets

Item (% unless noted)	Starter			Grower		
	T1	T2	T3	T1	T2	T3
Corn	48	48	48	57	57	57
Soybean	42	42	42	32	32	32
wheat pollard	0	0	0	3	3	3
palm oil	6	6	6	3	3	3
Dicalcium phosphat	2	2	2	2	2	2
Lime stone	1	1	1	1	1	1
Premix	2	1.97	1.95	2	1.97	1.95
AGP (Zn Bacitracyn)	0	0.03	0	0	0.03	0
Tannin	0	0	0.05	0	0	0.05
***Nutrition composition* (%)**						
Dry matter	88.52	88.52	88.52	89.05	89.05	89.05
Crude protein	15.74	15.74	15.74	22.82	22.82	22.82
Crude fiber	8.00	8.00	8	8.51	8.51	8.51
Crude fat	9.00	9.00	9	3.73	3.73	3.73
Ash	12.05	12.05	12.05	9.01	9.01	9.01
BETN	43.46	43.46	43.46	38.93	38.93	38.93
ME (Kcal.Kg)	2802.46	2802.46	2802.46	2861.64	2861.64	2861.64

T1: AGPs 0% supplementation, T2: AGPs 0.03% supplementation, T3: tannin 0.05% supplementation

2.4. Statistical Analysis

The obtained data were analyzed in SPSS software (version 16.0), and a one-way ANOVA procedure was used to analyze the data randomly.

3. Results and Discussion

The effect of tannin addition on the growth efficiency of broiler chickens is shown in table 2. There were no substantial changes among experimental diets for broiler daily feed intake during the starter and finisher phases, ultimate body weight during the starter and grower periods, or carcass percentage. Supplementing the control diet with tannin significantly increased feed conversion rates at all feeding stages (P=0.01). However, broilers treated with AGPs (0.03%) had the most weight gain and carcass, whereas those fed diets containing tannin (0.05%) had the least.

Table 3 demonstrates the influence of tannin supplementation on the viscera weight of broiler chickens at ages 14, 28, and 42 days. Significant alterations were observed during the finisher phase, particularly in the intestine, liver, and total viscera, which decreased dramatically in the tannin supplementation group (P3). Except for low-density lipoprotein (LDL) (P=0.05), alanine aminotransferase (ALT) (P=0.01), and aspartate aminotransferase (AST) (P=0.05), neither of the treatments had a significant impact on ALT, AST, high-density lipoprotein (HDL), or LDL levels (Table 4).

3.1. Production Performance

Tannins are polyphenols that alter appetite and absorption directly or indirectly (12). In dairy cattle, tannin has a beneficial effect to increase the quality of milk produced (13). In contrast to ruminant animals, poultry lacks bacteria in their gastrointestinal tract that detoxify or reduce the effect of tannins, it generates compounds with proteins and carbohydrates or blocking digestive enzymes, Therefore by this mechanism, tannins decreased growth and feed efficiency. However, numerous approaches have been employed to reduce the tannin content of chicken meals for improved utilization. These processes are primarily physical and chemical in nature (14). Tannins in chicken diets decreased dry matter intake, ultimate body weight, feed conversion rate, and nutritional digestibility, according to research by Hassan, Elzubeir (15), (16). The result of this study was in agreement with the findings of a study by Fionita and Pertiwi (17) that supplemented condensed tannin from waste turmeric meal (WTM) to layer quails (*Cortunixcortunix japonica*) and reported that WTM lowered egg productivity, hen day, and egg weight, followed by an increase in feed gain.

Tannins had a negative influence on production performance as a result of reduced feed consumption and protein digestibility. Tannins may bind digestion enzymes and form indigestible complexes with cell wall carbohydrates (12). It slowed nutrient absorption from the feed well, initiated malnutrition, and reduced daily gain, growth rate, final body weight, feed conversion rate, and carcass weight.

Table 2. Effect of tannin supplementation on growth performance response in broiler chicken

Paramters	T1	T2	T3
Starter Phase			
Daily Feed Intake (grams)	103.0±19.9	146.6±35.2	159.0±51.6
Final Body Weight (grams)	271.0±22.2	292.0±18.7	295.3±29.0
Feed Convertion Ratio	3.0±0.3 [a]	3.6±0.7 [b]	4.0±1.2 [ab]
Grower Phase			
Daily Feed Intake(grams)	170.6±19.1 [a]	196.3±43.7 [b]	117.0±16.7 [ab]
Final Body Weight	481.7±80.8	440.0±57.7	313.3±145.1
Feed Convertion Ratio	3.8±0.5 [a]	5.4±0.3 [b]	5.5±0.9 [ab]
Finisher Phase			
Daily Feed Intake (grams)	289.0±21.2	268.0±49.3	201.7±35.2
Final Body Weight (grams)	1505.8±211.9[a]	1655.5±138.9 [b]	905.8±153.6 [ab]
Feed Convertion Ratio	3.8±0.2 [a]	3.9±0.4[b]	5.2±0.2 [ab]
Carcass (grams)	1063.3±112.6[a]	1041.3±76.7 [b]	595.3±88.2 [ab]
Carcass Precentage	63.9±2.4	62.6±4.8	58.7±3.9

Means in the same row with different letters are significantly difference. T1: AGPs 0% supplementation, T2: AGPs 0.03% supplementation, T3: tannin 0.05% supplementation

Table 3. Effect of tannin supplementation on visceras weight (grams) of broiler chicken

Paramters	T1	T2	T3
Starter Phase			
Heart (grams)	1±0.0	1.0±0.0	1.0±0.0
Gizard (grams)	25±0.6	27.0±1.0	25.0±3.4
Intestine (grams)	37.3±3.2	40.6±8.1	40.7±3.21
Liver (grams)	9.0±2.0	10.3±1.2	9.7±1.5
Total Viscera (grams)	73.3±4.9	81.3±6.4	78.7±6.1
Grower Phase			
Heart (grams)	1.0±0.0	1.0±0.0	1.0±0.0
Gizard (grams)	40.0±5.0	31.6±10.4	50.0±26.5
Intestine (grams)	68.3±2.8	73.3±10.4	50.0±26.5
Liver (grams)	23.0±2.8	21.7±2.8	18.7±5.5
Total Viscera (grams)	126.7±10.4	121.7±10.4	8.3±52.5
Finisher Phase			
Heart (grams)	9.0±0.0	9.0±0.0	6.7±2.5
Gizard (grams)	77.0±12.7	75.0±4.6	61.0±4.7
Intestine (grams)	156.0±7.6 [a]	136.0±4.0 [b]	99.3±19.3 [ab]
Liver (grams)	40.0±2.1 [a]	48.3±5.1 [b]	27.0±4.2 [ab]
Total Viscera (grams)	284.7±21.5[a]	264.7±10.7 [b]	194.7±26.6 [ab]

Means in the same row with different letters are significantly difference. T1: AGPs 0% supplementation, T2: AGPs 0.03% supplementation, T3: tannin 0.05% supplementation

Table 4. Effect of tannin supplementation on HDL-LDL and ALT-AST of broiler chicken

Paramters	T1	T2	T3
Week 2			
HDL (mg/dL)	36.0±4.4	42.3±6.5	47.0±18.0
LDL (mg/dL)	20.3±9.3	14.3±6.5	16.7±5.9
ALT (IU/L)	23.8±4.0	23.2±4.1	24.6±2.3
AST (IU/L)	20.40±3.7	24.24±2.2	28.16±1.9
Week 6			
HDL (mg/dL)	51.66±16.7	44.3±3.2	49.0±11.5
LDL (mg/dL)	19.33±6.11	23.7±3.1^{b}	21.0±2.6^{ab}
ALT (IU/L)	37.89±21.03^{a}	22.66±12.31	33.51±11.49
AST (IU/L)	22.76±2.76	15.37±6.16	16.59±6.59

Means in the same row with different letters are significantly difference. T1: AGPs 0% supplementation, T2: AGPs 0.03% supplementation, T3: tannin 0.05% supplementation

3.2. Visceral Weight

Average organ weights for 42-day-old broiler chickens are 42.5 to 49.9 grams for the liver, 9.6 to 10.3 grams for the heart, and 32 to 36.6 grams for the proventriculus and ventriculus (18). In this study, supplementation with tannins significantly reduced the liver and intestine mass. The average T3 liver weight is only 27 grams, which is extremely low, compared to usual standards. The liver is primarily crucial for keeping homeostasis in the body. There is no replacement for optimal liver function. It controls the metabolism of lipids, polysaccharides, and proteins, as well as fat-soluble vitamin absorption and detoxification (19, 20).

According to Medugu, Kwari (21), tannins can induce the hydropic degeneration of liver hepatocytes. Tatukude, Loho (22) reported that administering 0.48 cc/day of Sarang semut plant (containing high tannins) to Wistar rats caused liver inflammation, hepatocyte necrosis, and hepatic lipidosis. Tannin hepatotoxicity could be classified as a protease inhibitor because it forms complexes with protein and carbohydrates, preventing protein absorption in the intestines of monogastric animals. However, this mechanism will be advantageous for Ruminantia as it could encapsulate protein, prevent protein degradation in the rumen, and allow the tannin-degraded protein to pass.

3.3. Blood Chemistry

In this study, broilers' LDL and ALT levels decreased significantly, followed by a remarkable increase in the AST level. It was associated with abnormal weight loss in the liver and intestines due to tannin hepatotoxicity. In contrast, Medugu, Kwari (21) discovered no negative effects on blood components in broiler chicks administered high- and low-tannin sorghum-based meals in place of maize.

Activities of ALT and AST enzymes in the blood serum can indicate liver physiology and identify hepatocyte cell disorder. Increasing levels of AST correlate with cellular damage in the body. After 12 hours of cell destruction, the AST level will rise and remain elevated for five days (23).

Changes in hepatocyte cell wall permeability initiate abnormal ALT and AST levels. It is a sign of hepatocellular integrity impairment due to liver ischemia caused by long-term hypotension, acute heart failure, drugs, and toxins. Blood serum ALT and AST levels may indicate the severity of liver damage. On acute hepatocellular inflammation (degradation of liver cell membranes), the ratio of AST/ALT should be less than 0.8. In contrast, ALT/AST ratios greater than 0.8 indicate chronic hepatocellular inflammation and mitochondrial degeneration (20). PrameelaRani, NissarAhmad (24) explained that elevated levels of ALT, AST, and alkaline phosphatase in broiler chickens indicate liver and intestinal damage. This inhibits the absorption and digestion of protein, resulting in stunting syndrome in broiler chickens.

LDL increases and suppresses HDL activity, preventing the removal of excess cholesterol from the blood. Hypercholesterolemia will disrupt lipoprotein metabolism (25). It directly affected steroid hormone production, including growth hormone activity; consequently, muscle development was inhibited, and the growth rate dropped dramatically.

Based on the initial data analysis, there may be more effective strategies for enhancing growth performance and health than adding tannin to broiler diets. Therefore, its replacement for AGPs in broiler feed is not recommended.

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Authors' Contribution

Study concept and design: L. T. C. and H. P.
Acquisition of data: S. E. R. and H. P.
Statistical analysis: H. P.
Drafting of the manuscript: H. P.
Study supervision: L. T. C.

Ethics

The study was approved by the Research Ethics Committee of Airlangga University, Indonesia.

Conflict of Interest

The authors declare that they have no conflict of interest.

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