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Research Article
Effects of L-Threonine and L-Tryptophan Supplementation on Growth Performance of Native Chickens during the Grower Phase

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Abstract

Objective: This study was conducted to determine the effect of L-threonine and L-tryptophan feed supplementation on body weight gain, feed intake, feed conversion, carcass percentage and abdominal fat of native chickens during the grower phase. **Materials and Methods:** A total of 112 six-week-old native chickens were randomly divided into 4 treatments and 4 replications, with 7 birds in each replicate. The dietary treatments were: T0 (control feed without L-tryptophan and L-threonine supplementation); T1 (supplementation with 0.07% L-tryptophan and 0.25% L-threonine), T2 (0.14% L-tryptophan and 0.58% L-threonine) and T3 (0.20% L-tryptophan and 0.85% L-threonine). Feed intake, body weight gain, feed conversion ratio, carcass percentage and abdominal fat were measured and the data were analyzed using one-way analysis of variance. Differences between treatments were examined using Duncan's test. **Results:** Body weight gain, feed intake, carcass percentage were increased with increasing amounts of L-threonine and L-tryptophan ($p<0.05$), while the feed conversion was decreased. Meanwhile, the percentage of abdominal fat was similar between the treatments. **Conclusion:** Feed formulations supplemented with 0.20% L-tryptophan and 0.85% L-threonine (group T3) produced the best growth performance.

Key words: Abdominal fat, body weight gain, L-threonine, L-tryptophan, native chicken,

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

In Indonesia, native chickens have long been a source of meat and eggs, especially for rural communities. For maximizing production of meat and egg, must consider nutrient requirements. Optimal feed composition, not only in terms of the energy-protein ratio but also the balance of micronutrients. Among micronutrients, appropriate amounts of amino acids in the feed are needed. In an earlier study, feed having metabolizable energy (ME) of 2,971 kcal kg^{-1} with 15.26% crude protein, 1.47% calcium and 0.59% phosphorus that was supplemented with 0.25% methionine and 0.60% lysine and given during the grower phase increased chicken productivity[1]. Productivity of native chickens can also be increased by supplementation with other limiting amino acids such as tryptophan and threonine. Several previous studies showed that tryptophan can regulate feed consumption, behavior, growth, immunity, protein synthesis and intestinal integrity of livestock[2,3]. Supplementation of broiler chicken feed with 0.75 and 0.77% threonine increased the body weight and feed efficiency, respectively, of broiler chickens[4,5]. Tryptophan and threonine are the most critical amino acids after methionine and lysine for broiler chickens. Tryptophan is a serotonin precursor and stimulates niacin production, which can in turn increase appetite and feed efficiency as well as stimulate growth and increase body weight[6,7]. Addition of 0.23-0.31% tryptophan in the feed was associated with an increase in broiler weight[8]. Threonine plays a role in bone formation, regulating the function of the immune system, liver, nerves and digestive system, maintaining muscle and promoting fat metabolism[9]. However, there are currently no standards for optimal amounts of tryptophan and threonine in feed for native chicken. In this study, we examined feed formulations supplemented with different amounts of L-tryptophan and L-threonine to investigate the effects of these two amino acids on growth performance of native chickens.

MATERIALS AND METHODS

This study was conducted in Kefamenanu, East Nusa Tenggara Province, Indonesia, between March and May 2019. A total of 112 six-week-old native chicks were randomized into 16 cage units based on a completely randomized design, consisting of 4 treatments and 4 replications (Table 1). The treatments given were: T0 (control feed without supplementation, T1 (0.07% L-tryptophan and 0.25% L-threonine), T2 (0.14% L-tryptophan and 0.57% L-threonine) and T3 (0.20% L-tryptophan and 0.85% L-threonine). Feed intake, body weight gain and feed conversion ratio were measured weekly across an 8-week experimental period. Carcass weight and the percentage of abdominal fat were measured at the end of the experimental period. The data were analyzed by analysis of variance based on a completely randomized design and Duncan's test.

Table 1: Composition (%) and nutrient content (%DM) of experimental diets fed to native chickens during the grower phase (6-14 weeks)

	Treatments (%)			
Ingredients	T0	T1	T2	T3
Yellow corn	50.50	50.50	50.50	50.50
Rice bran	36.48	36.15	35.76	35.42
Soybean meal	5.18	5.18	5.18	5.18
Fish meal	6.48	6.48	6.48	6.48
Limestone	0.30	0.30	0.30	0.30
Vitamin premix	0.29	0.29	0.29	0.29
DL-methionine	0.23	0.23	0.23	0.23
L-lysine HCl	0.55	0.55	0.55	0.55
L-Threonine		0.25	0.58	0.85
L-Tryptophan		0.07	0.14	0.20
Total	100.00	100.00	100.00	100.00
Calculated nutrients				
Metabolized energy (kcal kg^{-1})	2949.15	2941.77	2933.11	1925.54
Crude protein (%)	15.34	15.30	15.26	15.22
Ether extract (%)	5.93	5.90	5.87	5.84
Ash (%)	8.01	7.98	7.94	7.90
Crude fiber (%)	7.31	7.26	7.20	7.15
Methionine (%)	0.25	0.25	0.25	0.25
Lysine (%)	0.60	0.60	0.60	0.60
Threonine (%)	0.05	0.30	0.63	0.90
Tryptophan (%)	0.03	0.10	0.17	0.23
Calcium (%)	1.24	1.24	1.23	1.23
Phosphorus (%)	0.59	0.59	0.58	0.58

RESULTS

Supplementation with all concentrations of L-tryptophan and L-threonine significantly increased the feed intake, body weight gain and carcass weight of native chickens over that for birds given feed that did not have supplementation (Table 2). Meanwhile, the feed conversion ratio was decreased with increasing amounts of L-tryptophan and L-threonine. The percentage of abdominal fat was similar among all treatments (Table 2). Supplementation with 0.20% L-tryptophan and 0.85% L-threonine (T3) increased feed intake by 4.38% compared with feed without supplementation (T0). The increased feed intake was significantly associated with an increase in body weight ($p<0.01$). T1 group (0.07% L-tryptophan and 0.25% L-threonine) had a 3.60% increase in body weight compared to T0. The T2 group (0.14% L-tryptophan and 0.58% L-threonine) had a 3.14% increase in body weight gain compared to T1. The T3 group (0.20% L-tryptophan and 0.85% L-threonine) had the highest body weight gain among the four treatments (143.92 g bird^{-1} week^{-1}) (Fig. 1). Feed conversion was also affected by the amount of L-tryptophan and L-threonine supplementation ($p<0.01$). The T1 group showed a 1.91% decrease in feed conversion ratio relative to the control (T0) group. For the T3 group, the decrease was 4.92% relative to the T0 group (Fig. 2).

For carcass weight, supplementation with 0.07% L-tryptophan and 0.25% L-threonine (T1) produced a significant ($p<0.01$) increase of 4.98% over that seen for the T0 group (Table 2). The T2 group had an additional increase over T1 of 3.61%. The highest average carcass weight (702.70±23.16) was 3.24% higher than that for T2. Although, the carcass weight increased, the carcass percentage was not affected by L-tryptophan and L-threonine supplementation as evidenced by the similar levels of abdominal fat weight and abdominal fat percentage among the four groups at 14 weeks (Table 2).

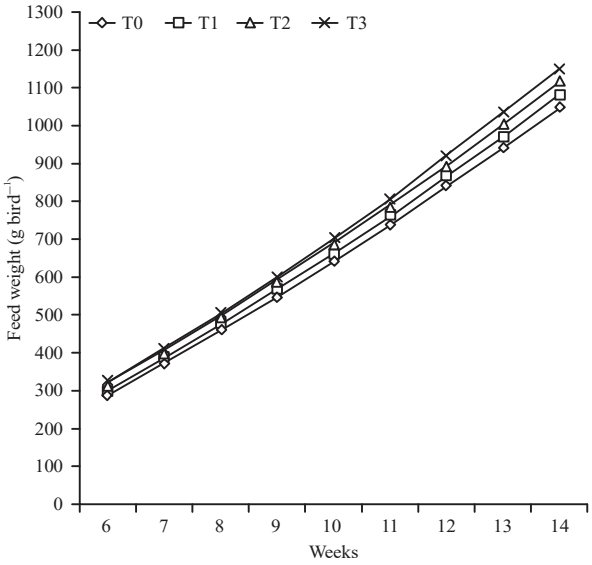

Fig. 1: Relationship between diet treatment and body weight of native chickens aged 6-14 weeks

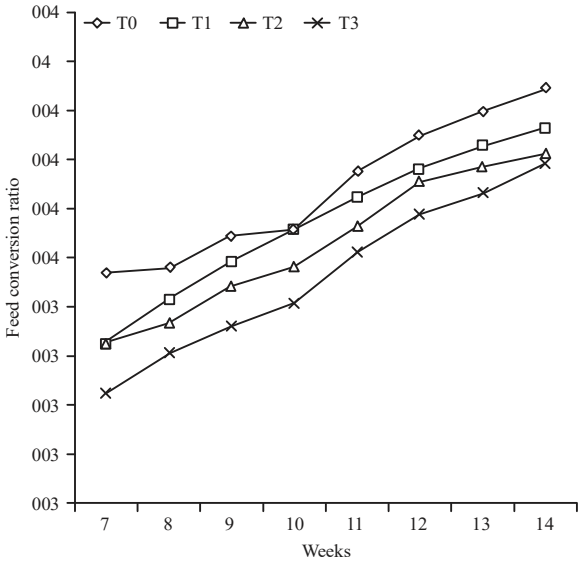

Fig. 2: Relationship between diet treatment and feed conversion ratio of native chickens aged 7-14 weeks

Table 2: Performance of native chickens fed different diets during the grower phase (6-14 weeks of age)

	Treatments			
Parameters	T0	T1	T2	T3
Feed intake (g bird^{-1} week^{-1})	346.09±7.68^{b}	349.10±2.91^{ab}	352.02±4.60^{ab}	361.26±8.34^{a}
Body weight (g bird^{-1})	1048.28±21.03^{d}	1081.91±5.49^{c}	1115.95±14.97^{b}	1151.34±28.38^{a}
Body weight gain (g bird^{-1} week^{-1})	94.86±3.44^{d}	97.38±1.095^{c}	99.45±1.85^{b}	103.89±2.54^{a}
Feed conversion	3.65±0.07^{a}	3.59±0.01^{b}	3.54±0.02^{b}	3.48±0.03^{c}
Carcass weight (g bird^{-1})	624.20±12.98^{c}	655.29±13.93^{b}	678.95±13.20^{ab}	702.70±23.16^{a}
Carcass (% bird^{-1})	59.55±1.43	60.57±1.23	60.84±1.66	61.03±1.29
Abdominal fat (g bird^{-1})	3.66±0.76	3.86±0.36	3.54±0.92	3.48±0.99
Abdominal fat (% bird^{-1})	0.35±0.07	0.36±0.03	0.32±0.08	0.30±0.08

^{a,b,c,d}Different superscript on the same line indicates significant difference ($p<0.05$)

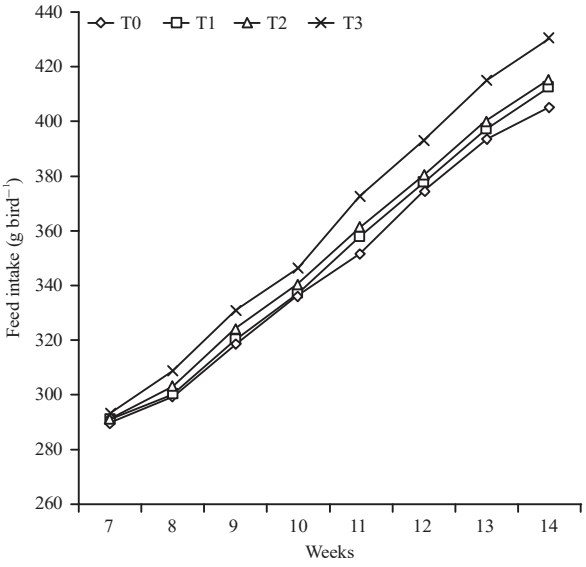

Fig. 3: Relationship between diet treatment and feed intake of native chickens aged 7-14 weeks

DISCUSSION

Here we examined how feed supplementation with tryptophan and threonine affected productivity of native chickens during the growth period. Supplementation with these two amino acids was associated with increased feed intake, with the largest increase seen for the highest concentration of L-tryptophan and L-threonine, 0.20 and 0.85%, respectively (T3; Fig. 3). Increased feed intake was correlated with body weight (Fig. 1). In heavier chickens, the digestive tract is also longer and heavier, which translates to increases in the amount of feed consumed and absorbed.

Feeds that lack protein are associated with reduced feed intake and can lead to amino acid imbalances[10]. In this study, crude protein levels were 15.34% and after supplementation with of tryptophan and threonine, the feed intake increased. In tropical regions such as Indonesia, feed intake is also limited by heat and high humidity. Supplementation with threonine in particular can increase palatability and feed intake[11,12], whereas tryptophan can regulate feed intake and protein synthesis[3]. In poultry feed that is deficient in niacin, tryptophan plays an important role in promoting niacin synthesis as well as weight gain and feed consumption[13].

Supplementation with essential amino acids (tryptophan and threonine) in the feed increases growth rates. Lisnahan *et al.*[1] found that the body weight gain of native chickens given feed supplemented with dL-methionine and L-lysine (but not L-threonine and L-tryptophan) was 133 g bird^{-1} week^{-1}. Here, the addition of 0.20% L-tryptophan and 0.85% L-threonine to feed increased body weight gain to 143.92 g bird^{-1} week^{-1} (Fig. 1). In a study involving broilers, the highest weight gain was seen with 0.31% tryptophan supplementation[8].

Threonine was also shown to have a significant effect on feed intake and body weight[14]. L-threonine and L-tryptophan consumed by chickens are directly absorbed from the small intestine and transported into body tissues due to their high digestibility rate of 98%. In cells, threonine and tryptophan as well as other amino acids are used for protein synthesis. Threonine and tryptophan are the next most limiting amino acids after methionine and lysine[9]. Threonine, lysine, methionine, valine and isoleucine are important components of muscle proteins and deficiencies in these amino acids are associated with body weight loss[3].

The highest feed conversion ratio was seen for T3 (0.20% L-tryptophan and 0.85% L-threonine). Threonine contributes to a balance of proteins and amino acids and also helps maintain intestinal function and improve immune responses[5,9,12,14,15]. Previous studies showed that threonine supplementation increases nitrogen retention and reduces nitrogen loss in chickens that together can maximize nitrogen use for growth[16].

Tryptophan together with lysine controls stress, increases feed palatability and body weight and decreases the feed conversion ratio[17]. Tryptophan plays a role in protein biosynthesis and is an important constituent of muscle mass. Moreover, tryptophan stimulates immune responses and immune system function, maintains protein stability and increases production of antibodies, as well as that of serotonin precursors, which can help control aggressiveness[7,18].

The body weight of native chickens in this study was positively correlated with both carcass weight and the amount of L-tryptophan and L-threonine supplementation. As mentioned above, among essential amino acids, tryptophan is prominent due to its role in protein synthesis and asa precursor to serotonin, which stimulates feed consumption[19]. A previous study reported that tryptophan deficiency affects carcass quality in both terms of overall protein synthesis and synthesis of important neurotransmitters such as serotonin and melatonin[20]. Tryptophan can control feed intake, behavior, growth, immunity, protein synthesis and intestinal integrity of livestock[3]. L-tryptophan has high digestibility (98%), which increases its availability to promote systemic immune responses and enhance growth performance in poultry[21].

In this study, the percentage of abdominal fat was not affected by tryptophan and threonine supplementation. This outcome could be due to the lack of fat deposits seen for

native chickens of this age (14 weeks).The ME of the feed in this study ranged from 1,925-2,949 kcal kg^{-1}, which is below the amount that would result in storage as excess fat. The results of this study were consistent with a previous study conducted by Lisnahan[22], who showed that 20 week-old native chickens had no difference in the percentage of abdominal fat when given feed supplemented with methionine and lysine.

CONCLUSION

Supplementation of feed with increasing amounts of L-threonine and L-tryptophan increased the feed intake, body weight gain and carcass weight while decreasing the feed conversion ratio of native chickens during the grower phase (6-14 weeks). Supplementation with 0.20% L-tryptophan and 0.85% L-threonine was associated with the largest increase in productivity.

SIGNIFICANCE STATEMENT

This study revealed effects of L-threonine and L-tryptophan supplementation that can enhance the growth performance of native chickens during the grower phase. Results of this study provide a basis for a better understanding of actual nutrient requirements for native chickens as well as a guide for formulating standards for threonine and tryptophan supplementation of native chicken diets.

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