

# Optimizing Broiler Production Through Local Diets Supplemented with Ginger and Turmeric: Impacts on Physiology, Immunity, and Visceral Organ Development

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**Abstract.** Local feeds have the potential to be used as feed ingredients in poultry diets. This study was to evaluate the effects of local diets supplemented with ginger and turmeric meal and to compare with commercial broiler feeds. In total, 180 one-day-old broilers were assigned to 36 pens and kept for 5-7 weeks. The birds were fed experimental diets as follows control group (R1), the birds were fed as commercial diets, experimental diets were: local feed + 2% ginger (R2), local feed + 2% turmeric (R3), local feed + 1% ginger + 1% turmeric (R4) and slaughter age treatments: 5 weeks (P1), 6 weeks (P2), 7 weeks (P3) with 3 replicates. The results revealed no significant interaction between diet type and slaughter age. The inclusion of ginger and turmeric meal in local diets resulted in a significant ( $P<0.05$ ) enhancement of immunity, evidenced by increased sizes of immune organs, ventriculus, small intestine, and caecum compared to commercial diets. However, these dietary treatments significantly reduced rectal temperature and respiration rate. Differences in the slaughter age of chicken (5, 6, and 7 weeks) were significantly increased rectal temperature and respiration rate but significantly decreased immune organ sizes and visceral organs weights. This study concludes that the inclusion of 1% ginger and 1% turmeric meal in local diets (R4) offers a more efficient formulation, as it utilizes lower levels of additives while still yielding favourable outcomes. This dietary strategy enhanced immune organ development and visceral organ weights in broiler chickens, despite the general trend of increasing age being associated with elevated rectal temperature and respiration rate. Furthermore, based on physiological, immunological, and visceral organ parameters, the optimal slaughter age for broiler chickens fed local diets supplemented with ginger and turmeric meal (R2, R3, and R4) was determined to be 5 weeks (P1).

**Keywords:** broiler chicken, immunity, local feed, physiological, visceral organ

**Abstrak.** Pakan lokal berpotensi sebagai bahan pakan unggas. Penelitian ini bertujuan untuk mengevaluasi pengaruh pakan lokal yang ditambah tepung jahe dan kunyit serta membandingkannya dengan pakan ayam broiler komersial. Ayam broiler berjumlah 180 hari, ditempatkan di 36 petakan kandang dan dipelihara selama 5-7 minggu. Ayam diberikan pakan percobaan yaitu: pakan kontrol (R1), ayam diberi pakan komersial, pakan percobaan meliputi: pakan lokal + 2% jahe (R2), pakan lokal + 2% kunyit (R3), pakan lokal + 1% jahe + 1% kunyit (R4) dan umur potong perlakuan: 5 minggu (P1), 6 minggu (P2), 7 minggu (P3) dengan 3 ulangan. Hasil penelitian menunjukkan tidak ada interaksi antara jenis pakan dan umur potong. Penggunaan ransum lokal dengan penambahan tepung jahe dan kunyit menghasilkan peningkatan imunitas yang signifikan ( $P<0,05$ ) melalui peningkatan ukuran organ imunitas, persentase ventrikulus, usus halus, dan sekum dibandingkan dengan ransum komersial. Namun, hal ini secara signifikan mengurangi suhu rektal dan laju pernafasan. Perbedaan umur potong ayam (5, 6, dan 7 minggu) nyata meningkatkan suhu rektal dan laju pernafasan namun nyata menurunkan imunitas dan organ visceral. Penelitian ini menyimpulkan bahwa penggunaan ransum lokal dengan tambahan 1% jahe dan 1% kunyit dapat meningkatkan organ imunitas dan organ visceral ayam broiler dibandingkan dengan pertambahan umur, peningkatan suhu rektal dan laju pernafasan. Umur pemotongan optimal diperoleh pada waktu pemotongan 5 minggu (P1)

**Kata kunci:** ayam broiler, imunitas, pakan lokal, fisiologi, organ visceral

## Introduction

Local feed ingredients hold great potential as components of broiler rations owing to their availability and nutritional value. Numerous studies have investigated the use of such

ingredients, including local fish meal (Jassim, 2010) and Moringa leaves (Hafsa et al., 2013). However, the application of local feed is often accompanied by the inclusion of natural feed

additives to optimize its utilization. Feed additives play an essential role in improving feed quality, increasing feed efficiency, and enhancing the quality of animal products. For decades, synthetic antibiotics have been widely used as feed additives to promote growth and prevent disease in poultry. Nevertheless, growing concerns over antimicrobial resistance and chemical residues in animal products have prompted the search for safer alternatives. In this context, phytobiotics, plant-derived bioactive compounds, have emerged as promising substitutes. Hashemi and Davoodi (2011) reported that phytobiotics can enhance livestock productivity by modulating pathogenic bacteria, improving production performance, and upgrading the quality of animal products. Furthermore, Hayajneh (2019) demonstrated that natural feed additives reduce the negative impacts of chemical accumulation in poultry meat and eggs while improving nutrient digestion and absorption. Various phytobiotic sources have been evaluated in poultry nutrition, including turmeric and red ginger (Suanta, 2021), clove leaves (Tahir et al., 2019), and shallot by-products (Mozin et al., 2015). Among these, turmeric (*Curcuma longa*) and ginger (*Zingiber officinale*) have attracted considerable interest. Turmeric contains

curcuminoids curcumin, bisdemethoxycurcumin, and demethoxycurcumin which constitute approximately 2–4% of turmeric powder and exhibit immunomodulatory properties (Nouzarian et al., 2011). Antony et al. (1999) confirmed the immunomodulatory activity of turmeric, while Harun and Firdaus (2022) reported similar effects for ginger. These properties suggest that turmeric and ginger can serve as effective phytobiotic supplements in diets. Therefore, this study aimed to evaluate the effects of dietary supplementation with ginger and turmeric meal in local diets on the physiological responses, immune organ development, and visceral organ characteristics of broiler chickens slaughtered at different ages.

## Materials and Methods

### Animals and Diets

In this study, 180-day-old unsexed broiler chicks were bred. For seven days, the chicks were housed in electrically heated brooder pens. The chicks were then distributed into 36 pens on day seven and kept the chicks up to slaughter as a treatment. Data collection was started from day seven. The broiler basal and local diets (Table 1) were given ad libitum during the study.

Table 1. Diets Composition and Treatments

Material (%)	R1 (Control)	R2 (Ginger)	R3 (Turmeric)	R4 (Mix)
Commercial feed	100	-	-	-
Maize	-	60.0	60.0	60.0
Rice bran	-	8.00	8.00	8.00
Fish meal	-	15.0	15.0	15.0
Soybean meal	-	14.0	14.0	14.0
Ginger meal **	-	2.00	-	1.00
Turmeric meal	-	-	2.00	1.00
Top Mix	-	1.00	1.00	1.00
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>
Nutrient composition*				
Crude protein (%)	21.1**	21.8	21.8	21.7
Metabolic energy (kcal/kg)	3000	2885	2991	2893
Extract Ether (%)	6.20**	7.06	7.17	7.11
Crude Fiber (%)	4.12**	4.11	4.16	4.14

\* Based on calculated from NRC (1994);

\*\* Proximate analysis at Laboratory of Feed Nutrition, Faculty of Animal Husbandry and Fisheries Tadulako University (2022)

### **In Vivo Experiment and Parameters Observed**

A 4 x 3 factorial arrangement was employed within a completely randomized design for the experiment. The first factor was diet treatments as R1 = commercial diets; R2 = local diets + 2% ginger meal; R3 = local diets + 2% turmeric meal; R4 = local diets + 1% ginger meal + 1% turmeric meal. The nutritional composition of the local diets is presented in Table 1. The second factor was slaughter age, which was determined as follows: P1 = 5 weeks, P2 = 6 weeks, and P3 = 7 weeks. Rectal temperature and respiratory rate were observed at 5 weeks, 6 weeks, and 7 weeks old of the birds. The measurement of rectal temperature was conducted between 08.00 and 10.00 a.m., by using a digital thermometer inserted 2-3 cm into the cloaca and the value was read when the thermometer reading was stable for 15 seconds, while the respiration rate was measured counting the thoraco-abdominal movements of a quiescent bird using a stopwatch and recorded as breaths per minute, each measurement was repeated four times per bird. The two variables were measured according to Nascimento et.al. (2012). At the end of the experiment for each treatment age (5 weeks, 6 weeks, 7 weeks), the birds were weighed individually with 15 birds per treatment selected and after overnight fasting (8 h), all remaining birds were then sacrificed by cervical dislocation. The thymus was taken from the lateral neck and the bursa of fabricius from the back (below the cloaca). Visceral organs were observed at the same time as immune organs. The removal and dissection of proventriculus, ventriculus, small intestine, caecum, and colon was performed following the protocol of Taylor and Jones (2004). The relative weight (as a % of live body weight) of each organ was determined. Briefly, the ventriculus was emptied and rinsed before weighing, while other organs were weighed intact with their contents

The study used a 4 x 3 factorial design in a completely randomized layout (CRD). The four factors were dietary treatments (commercial, control and ginger, control and turmeric, and control with a combination ginger and turmeric), and three slaughter ages (5, 6, and 7 weeks). Each of the 12 treatment combinations was replicated three times. Data were analyzed using the General Linear Model (GLM) in SPSS 19 to test their interaction and the main effects. Tukey's HSD test was used for mean separation, with significance set at  $P < 0.05$ .

## **Results and Discussion**

### **Physiological Response and Immune Organs**

The results of treatment diets and ages on physiological (rectal temperature, respiration rate) and immune organs shown in Table 2.

As presented in Table 2, there is no interaction ( $P > 0.05$ ) between diets and age on rectal temperature, respiration rate, thymus, and bursa fabricius. However, the diet treatment showed a highly significant effect ( $P < 0.01$ ) on respiration rate and significantly ( $P < 0.05$ ) on bursa fabricius. Results of the LSD test showed that commercial diets (R1) provided a higher respiration rate than the local feed treatment. This study found the use of ginger and turmeric in local diets could reduce stress levels by regulating normal respiration rates. The finding of respiration rate in Table 2 ranges from 37.83-80.54 breath min<sup>-1</sup>, and 42-48 breath min<sup>-1</sup> (Marchini et al., 2007).

Rectal temperature and respiration rate were significantly ( $P < 0.05$ ) affected by bird age. LSD test showed increased significantly ( $P < 0.05$ ) with increasing the bird's age. Sola-Ojo et.al. (2020) stated that rectal temperatures were respectively: at 5 weeks old it was 40.19 (range 39.45-40.60°C), at 6 weeks old it was 42.15 (range 41.42-43.20°C), at 7 weeks old it was 41.65 (range 41.49-41.80°C).

Table 2. Averages of rectal temperature, respiration rate, thymus, bursa fabricius of the chickens

Variables	Treatments P1 (5 weeks)	P2 (6 weeks)	P3 (7 weeks)	Average	
Rectal Temperature (°C)	R1	41.11	41.34	42.54	41.67 <sup>a</sup>
	R2	40.33	41.17	40.50	40.67 <sup>c</sup>
	R3	40.74	41.26	41.45	41.15 <sup>b</sup>
	R4	40.60	41.12	41.72	41.14 <sup>b</sup>
	Average	40.69 <sup>c</sup>	41.22 <sup>b</sup>	41.55 <sup>a</sup>	
Respiration Rate (breath/min)	R1	55.15	69.89	80.54	68.53 <sup>a</sup>
	R2	44.89	46.96	49.50	47.12 <sup>c</sup>
	R3	48.11	53.70	60.45	54.09 <sup>b</sup>
	R4	37.83	51.19	54.39	47.80 <sup>c</sup>
	Average	46.50 <sup>c</sup>	55.44 <sup>b</sup>	61.22 <sup>a</sup>	
Thymus (%)	R1	0.36	0.23	0.31	0.30
	R2	0.33	0.28	0.26	0.29
	R3	0.41	0.25	0.27	0.31
	R4	0.37	0.25	0.26	0.29
	Average	0.36 <sup>a</sup>	0.25 <sup>b</sup>	0.27 <sup>b</sup>	
Bursa Fabricius (%)	R1	0.08	0.04	0.05	0.06 <sup>b</sup>
	R2	0.12	0.07	0.08	0.09 <sup>a</sup>
	R3	0.12	0.06	0.08	0.09 <sup>a</sup>
	R4	0.10	0.06	0.08	0.08 <sup>a</sup>
	Average	0.10 <sup>a</sup>	0.06 <sup>b</sup>	0.07 <sup>b</sup>	

\* Means on the same line and column with different superscripts differ significantly (P<0.05)

The immunity of birds is also influenced by their age; in this study, 5-week-old birds' thymus and bursa of fabricius showed a highly significant (P<0.01) effect compared to other age groups. Increasing the animal's age, the immunity organs to be decreased. This observation underscores the importance of incorporating dietary supplements to sustain immune function as birds age in the diets to maintain immunity. Ginger and turmeric are herbal ingredients that contain phytobiotics that can increase the immunity of animals. Using 2% of ginger and turmeric meal in the diets was found to significantly (P<0.05) raise the bursa of fabricius from 0.06% to 0.09%, or up to 50%, according to the LSD test results. Widhowati et al. (2017) stated that curcuminoids can modulate the immune system by increasing the proliferation of cells that play a role in immunity i.e. leukocytes, as well as increasing the number of heterophils and basophils that have an immunostimulating effect

There is no interaction (P>0.05) between the diets and age on proventriculus, ventriculus, small intestine, caecum, and colon.

Nevertheless, there were no changes in the caecum or colon despite the treatment diets having a significant (P<0.05) impact on the ventriculus and small intestine. The size of the ventriculus and small intestine of commercial diets (P1) was significantly (P<0.05) lower than local diets that added ginger and turmeric meal. The size of the ventriculus and small intestine is easy to change according to the diets consumed (Amrullah, 2003). Any modifications to the small intestine's function have an impact on the operation of the animal's other organs and system. It is a vital organ that aids in the digestion and absorption of nutrients from food (Toman, et al., 2015). According to the study, the small intestine of broilers fed local diets had a significantly (P<0.05) greater level than that of commercial diets. However, the weight of the small intestine dropped significantly (P<0.01) with increasing age (Table 3).

#### Visceral Organs

Table 3 displays the effects of treatment diets and ages on the visceral organs of broilers.

Table 3. Chicken visceral organs (proventriculus, ventriculus, small intestine, caecum, and colon).

Variables	Treatments	P1 (5 weeks)	P2 (6 weeks)	P3 (7 weeks)	Average
Proventriculus (%)	R1	0.79	0.48	0.54	0.60
	R2	0.75	0.65	0.74	0.71
	R3	0.76	0.53	0.67	0.65
	R4	0.69	0.66	0.62	0.66
Average		0.75 <sup>a</sup>	0.58 <sup>c</sup>	0.64 <sup>b</sup>	
Ventriculus (%)	R1	3.07	1.83	2.32	2.41 <sup>b</sup>
	R2	3.80	2.71	3.13	3.01 <sup>a</sup>
	R3	3.40	2.56	2.74	2.90 <sup>a</sup>
	R4	3.38	2.50	3.00	2.96 <sup>a</sup>
Average		3.26 <sup>a</sup>	2.40 <sup>b</sup>	2.80 <sup>c</sup>	
Small Intestine (%)	R1	6.09	4.32	4.59	5.00 <sup>b</sup>
	R2	6.25	6.28	6.35	6.29 <sup>a</sup>
	R3	6.79	4.64	6.58	6.00 <sup>a</sup>
	R4	6.90	5.78	5.57	6.08 <sup>a</sup>
Average		6.51 <sup>a</sup>	5.25 <sup>b</sup>	5.77 <sup>b</sup>	
Caecum (%)	R1	0.85	0.59	0.61	0.68
	R2	0.93	0.72	0.66	0.77
	R3	0.88	0.55	0.61	0.68
	R4	0.83	0.62	0.66	0.70
Average		0.87 <sup>a</sup>	0.62 <sup>b</sup>	0.63 <sup>b</sup>	
Colon (%)	R1	0.21	0.12	0.14	0.16
	R2	0.21	0.14	0.15	0.17
	R3	0.25	0.18	0.15	0.19
	R4	0.17	0.12	0.13	0.14
Average		0.21 <sup>a</sup>	0.14 <sup>b</sup>	0.14 <sup>b</sup>	

\* Means on the same line and column with different superscripts differ significantly (P<0.05)

The relative weights of the duodenum, jejunum, and ileum were determined by Ravindran et al. (2006) to be at their highest during the first and two weeks of life and to decrease quickly afterward. Similar findings are also in the caecum and colon, with increasing age, the weight of the caecum and colon also decreases.

## Conclusions

Both diet type and slaughter age significantly influenced all observed variables, inclusion of ginger and turmeric meal in local diets increased the percentage of visceral organs (ventriculus, small intestine, caecum, and colon) and immune organs (bursa fabricius), compared to commercial diets. Among all treatments, R4 (local feed supplemented with 1% ginger and 1% turmeric meal) was identified as the most optimal. Meanwhile, a decrease in physiological parameters such as rectal temperature and

respiration rate was observed. With increasing slaughter age, the proportions of visceral organs were found to decline. The optimal slaughter age for broiler chickens fed local diets supplemented with ginger and turmeric meal (R2, R3, and R4) was determined to be 5 weeks (P1).

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