

*Original Article*

# The most balance composition of calcium-phosphorus in the feed to support growth performance and tibia profile of broiler chicken strain CP 707

Charles Venirius Lisnahan \*, Afred Nubatonis

Faculty of Agriculture, University of Timor, East Nusa Tenggara, 85613

\*Correspondence: [charleslisnahan@yahoo.co.id](mailto:charleslisnahan@yahoo.co.id)

Received: September 23<sup>th</sup>, 2020; Accepted: March 10<sup>th</sup>, 2021; Published online: July 24<sup>th</sup>, 2021

## Abstrak

**Tujuan:** Kalsium dan fosfor adalah makromineral yang diperlukan untuk metabolisme dan mineralisasi tulang ayam. Tujuan penelitian ini untuk mengetahui kinerja pertumbuhan dan profil tibia ayam broiler strain CP 707 yang diberikan pakan dengan perbedaan rasio kalsium-fosfor.

**Metode:** Penelitian ini dilakukan di Kefamenanu, Nusa Tenggara Timur selama 42 hari. Sebanyak 96 anak ayam berumur satu hari digunakan dalam penelitian ini. Anak ayam dialokasikan dalam 16 unit kandang, berdasarkan rancangan acak lengkap terdiri dari 4 perlakuan dan 4 ulangan. Perlakuan yang diberikan adalah T0 (pakan kontrol tanpa suplementasi kalsium-fosfor), T1 (pakan kontrol + 1,0% kalsium + 0,5% fosfor), T2 (pakan kontrol + 1,5% kalsium + 0,5% fosfor) dan T3 (pakan kontrol + 2,0% kalsium + 0,5% fosfor).

**Hasil:** Analisis statistik menunjukkan bahwa rasio kalsium-fosfor berpengaruh nyata terhadap berat badan, konversi pakan, berat karkas, berat tulang tibia, berat kering tulang tibia dan kadar abu tulang tibia ( $P < 0,05$ ), sedangkan konsumsi pakan dan panjang tulang tibia tidak signifikan. Berat badan tertinggi pada T3 ( $2142,25 \pm 31,84$  g/ekor) dengan penambahan berat badan  $62,41 \pm 2,20$  g/ekor/hari. Konversi pakan terbaik pada T2 dan T3 yaitu  $1,94 \pm 0,33$  dan  $1,85 \pm 0,70$ . Berat karkas tertinggi pada T3 sebesar  $1354,45 \pm 39,12$  g/ekor dengan persentase karkas  $63,20 \pm 0,32$  %. Berat tulang tibia tertinggi pada T2 dan T3 yaitu  $18,57 \pm 0,73$  and  $19,43 \pm 0,66$  g/ekor dengan berat kering  $40,61 \pm 0,75$  dan  $41,42 \pm 1,33$  %. Kadar abu tulang tibia tertinggi pada T3 yaitu  $44,72 \pm 0,91$  %.

**Kesimpulan:** Kesimpulan dari penelitian ini adalah rasio 2,0% kalsium dan 0,5% fosfor memberikan kinerja pertumbuhan dan profil tulang tibia yang optimal.

**Kata Kunci:** ayam broiler; kalsium; fosfor; kinerja pertumbuhan; tulang tibia

## Abstract

**Objective:** Calcium and phosphorus are macrominerals that are needed for metabolism and mineralization of chicken bones. This study aims to determine the growth performance and tibial profile of broiler chicken strain CP 707 which are fed by using different calcium-phosphorus balance compositions.

**Methods:** This research was conducted in Kefamenanu, the East Nusa Tenggara for 42 days. A total of 96 day old chicks were used in this study. Chickens were allocated in 16 units of cages, based on

a completely randomized design consisting of 4 treatments and 4 replications. The treatments given were T0 (control feed without calcium-phosphorus supplementation), T1 (control feed + 1.0% calcium + 0.5% phosphorus), T2 (control feed + 1.5% calcium + 0.5% phosphorus) and T3 (control feed + 2.0% calcium + 0.5% phosphorus).

**Results:** The findings showed that the calcium-phosphorus ratio affected weight gain, feed conversion, carcass weight, tibial bone weight, tibial bone dry weight and tibial bone ash content ( $P < 0.05$ ), while feed consumption and tibial bone length were not significant. The highest body weight was in T3 ( $2142.25 \pm 31.84$  g/bird) with a weight gain of  $62.41 \pm 2.20$  g/bird/day. The best feed conversions at T2 and T3 were  $1.94 \pm 0.33$  and  $1.85 \pm 0.70$ . The highest carcass weight at T3 was  $1354.45 \pm 39.12$  g/bird with a carcass percentage of  $63.20 \pm 0.32\%$ . The highest tibial weight at T2 and T3 were  $18.57 \pm 0.73$  and  $19.43 \pm 0.66$  g/bird with dry weight of  $40.61 \pm 0.75$  and  $41.42 \pm 1.33\%$ . The highest tibial bone ash content was at T3, namely  $44.72 \pm 0.91\%$ .

**Conclusions:** The conclusion of this study is that the balance of 2.0% calcium and 0.5% phosphorus provides optimal growth performance and tibial profile.

**Keywords:** broilers; calcium; phosphorous; growth performance; tibia bones

---

## INTRODUCTION

Calcium and phosphorus are macro-nutrients needed by chickens for bone growth. About 70% of chicken bones contain calcium and phosphorus. Wilkinson et al. [1] and Xue et al. [2] stated that the minerals calcium and phosphorus are two minerals needed for bone growth and egg production, carbohydrate and fat metabolism. Bone is a place where muscles attach. Strong, large bones increase the amount of muscle that can be supported. Poor bone growth is influenced by low calcium and calcium-phosphorus imbalance in the feed.

Mineral imbalance, especially calcium (Ca) is one of the problems that is responsible for the economic loss in poultry. Calcium and phosphorus (P) supplementation in appropriate ratios is important for performing various functions in the body [3]. Calcium is important for bone development, blood clot formation, muscle contraction and egg shell quality. Calcium and phosphorus do not have a direct effect on weight gain and feed efficiency but increase Ca content of bone ash [4]. However, bones act as a support for the body and a place where body muscles attach, so that indirectly affects body weight and feed conversion.

Based on some recommendation, Abdulla et al. [5] reported that the calcium and phosphorus requirements of broiler chickens are 1: 1 - 2: 1. However, this recommendation is for sub-tropical areas. The requirements

for calcium and phosphorus in the tropics are different from those in the sub-tropics. This is due to differences in temperature and humidity, and differences in feed constituents. Feed ingredients such as corn, soybean meal bran contain many phytates which will affect the digestion and absorption of calcium and phosphorus [6]. To overcome this problem, beside use the phytase enzyme [7], given calcium and phosphorus are available such as di-calcium phosphate or mono-calcium phosphate.

It is important to pay attention to the provision of Ca and P regarding the balance of their needs in the body. If the Ca content in the feed is less or exceeds the standard requirement, it will affect the absorption of other minerals such as Mg, Mn, and Zn so that it is not optimal. Calcium and phosphorus work together with vitamin D so that the absorption process of both can run optimally. If the intake of vitamin D is insufficient, then a lot of calcium and phosphorus will be wasted in excreta because most of it is not absorbed and utilized by the chicken body for bone formation and other functions. Calcium and phosphorus contained in feed will be absorbed by the digestive tract and deposited into the bones / skeleton. If the intake of Ca and P is not sufficient for chicken, then the effect that usually occurs is slow skeletal growth and a low correlation to weight growth. In poultry, especially chickens, the bone that suffers the most when lacking calcium and phosphorus is the tibia,

which causes clubfoot and paralysis. The purpose of this study was to determine the calcium-phosphorus balance on the growth performance and tibia bone profile of broiler strain CP 707.

## MATERIALS AND METHODS

### Ethical approval

The research protocol was approved by the Veterinary Ethics Committee for Animal Husbandry Studies Program, Faculty of Agriculture, University of Timor, Indonesia, with 02/UN60.1/SR/2020 number recommendation.

### Location and time of study

This research was conducted in Sasi Village, Kefamenanu for 2 months from June to July 2020 and at the Laboratory of the Faculty of Agriculture, University of Timor, Indonesia.

### Research material

This study used 96 DOC broilers with CP 707 strain. The cages used were 16 plots of litter cages measuring 1 m X 1 m X 70 cm, located in a 6 m X 10 m X 6 m open cage with wire, iron roof and concrete floor. The cage floor is covered with rice husks and chalk with a ratio of 5: 1 with a thickness of 7 cm. The equipment used is a place for feeding, a place to drink, a scale, a thermometer, incandescent lamp, oven, furnace, laboratory equipment and cage cleaning equipment. The feed given was control feed consisting of yellow corn, rice bran, fish meal, soybean meal, amino acids methionine, lysine, threonine, tryptophan, vitamin premix, calcium and phosphorus. Feed and drinking water are provided ad libitum or readily available. The composition and nutrient content of feed is presented in Table 1. For disease prevention, the Newcastle

Disease Hitchner B1 vaccine is given at the age of 3 days through eye drops and the Newcastle Disease Lasota vaccine at the age of 21 days through drinking water. Chicks are randomly placed in 16 cages.

### Research methods

This study used a completely randomized design (CRD) with 4 treatments and 4 replications, each replication consisting of 6 chickens. The treatments given were T0 (control feed without calcium and phosphorus supplementation); T1 (supplementation of 1.0% calcium and 0.5% phosphorus; T2 (supplementation of 1.5% calcium and 0.5% phosphorus) and T3 (supplementation of 2.0% calcium and 0.5% phosphorus). The treatment was started on chickens aged 14 days. The feed ingredients according to the treatment are mixed in the form of flour. The feed is given and the rest is weighed every morning. Weighing chicken is carried out every week to determine the development of body weight. On the 42nd day, 2 chickens per unit of cage were slaughtered for carcass and tibial profile variables. Slaughter is done in a halal manner, after fasting for 12 hours. The cattle are hung head down, and cut at the neck, namely the jugular vein. After plucking the feathers at a water temperature of 60°C - 70°C, the carcass is processed and the tibia bone is separated from the thigh meat.

### Research variable

The variables observed included body weight, weight gain, feed consumption, feed conversion, carcass weight and percentage, tibial dry weight and length, and tibial bone ash content. Body weight gain was weighed every week to determine the progress (g/bird). Body weight gain is the final body weight minus the initial body weight divided by the length of the study (g/bird/day) [8].

$$\text{Body weight gain (g/bird)} = \frac{\text{Final body weight} - \text{DOC body weight}}{42 \text{ days}}$$

Feed intake is calculated based on the amount of feed consumed every day during the study (g/bird/day) [8].

$$\text{Feed intake} = \frac{\text{The amount of feed consumed} - \text{Remaining feed}}{42 \text{ days}}$$

**Table 1.** Composition (%) and nutrient content (% DM) of experiment diets of broilers strain CP 707

Ingredients	Treatments (%)			
	T0	T1	T2	T3
Yellow corn	54.52	54.52	54.52	54.52
Rice bran	17.95	16.45	15.95	15.45
Soybean meal	15.00	15.00	15.00	15.00
Fish meal	10.00	10.00	10.00	10.00
Vitamin premix	0.42	0.42	0.42	0.42
DL-methionine	0.27	0.27	0.27	0.27
L-lysine HCl	0.79	0.79	0.79	0.79
L-tryptophan	0.20	0.20	0.20	0.20
L-threonine	0.85	0.85	0.85	0.85
Calcium	0.0	1.00	1.50	2.00
Phosphorus	0.0	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00
Calculated nutrients				
Metabolized energy (kcal kg-1)	3,056.12	3,022.71	3,011.57	3,000.43
Crude protein (%)	21.08	20.92	20.87	20.81
Ether extract (%)	5.06	5.04	5.02	5.00
Ash (%)	8.11	7.95	7.90	7.85
Crude fiber (%)	5.39	5.16	5.09	5.01
Methionine (%)	0.30	0.30	0.30	0.30
Lysine (%)	0.85	0.85	0.85	0.85
Tryptophan (%)	0.23	0.23	0.23	0.23
Threonine (%)	1.00	1.00	1.00	1.00
Calcium available (%)	0.85	1.85	2.35	2.85
Phosphorus available (%)	0.20	0.70	0.70	0.70
Phosphorus phytate (%)	0.36	0.35	0.35	0.35
Phosphorus non-phytate (%)	0.20	0.20	0.20	0.20

Feed conversion is the feed intake divided by body weight gain[8].

$$\text{Feed conversion} = \frac{\text{Final intake}}{\text{Body weight gain}}$$

Carcass weight (g/bird) is the part of the chicken's body after its blood, feathers, head and neck, legs (metatarsus), abdominal fat, and offal were taken. Carcass percentage is carcass weight divided by live body weight times 100% [8].

$$\text{Carcass percentage} = \frac{\text{Carcass weight}}{\text{Body weight}} \times 100\%$$

The tibial profiles observed were tibial bone weight (g/bird), tibia bone dry weight percentage (%/bird), tibial bone ash content (%/bird) and tibia bone length (cm/bird). The dry matter weight (DM) of the tibial bone was obtained after the tibial

bone sample was dried in an oven at 105°C [9], while the ash content of the tibial bone was obtained after the bone sample was inserted and burned in the furnace at 550°C for 24 hours [6].

#### Data analysis

The data obtained were analyzed with analysis of variance based on a completely randomized design and followed by the Duncan test[10] with the help of the SPSS 22 program:

$$Y_{ij} = \mu + \tau_i + \varepsilon_{ij}$$

Description:

$Y_{ij}$  : Observation of treatment-i and replication-j

$\mu$  : General average

$\tau_i$  : Effect of treatment-i

$\varepsilon_{ij}$  : Experimental error due to treatment-i and j replication-j

**Table 2.** Broilers performance after being fed by using different compositions of calcium-phosphorus diet

Variable	Treatment			
	T0	T1	T2	T3
Body weight (g/bird)	1,846.00±16.49 <sup>c</sup>	1,971.75±37.89 <sup>b</sup>	2,031.75±25.38 <sup>b</sup>	2,142.25±31.84 <sup>a</sup>
Body weight gain (g/bird/day)	52.36±0.99 <sup>d</sup>	56.65±1.72 <sup>c</sup>	59.00±0.67 <sup>b</sup>	62.41±2.20 <sup>a</sup>
Feed intake (g/bird/day)	112.78±1.85	115.81±0.88	114.29±1.17	115.35±0.37
Feed conversion	2.16±0.06 <sup>a</sup>	2.05±0.66 <sup>b</sup>	1.94±0.33 <sup>c</sup>	1.85±0.70 <sup>c</sup>
Carcass weight (g/bird)	1,110.70±13.57 <sup>d</sup>	1,216.90±54.15 <sup>c</sup>	1,276.85±16.98 <sup>b</sup>	1,354.45±39.12 <sup>a</sup>
Carcass percentage (%/bird)	60.46±0.44 <sup>c</sup>	61.67±1.24 <sup>bc</sup>	62.76±0.80 <sup>ab</sup>	63.20±0.32 <sup>a</sup>
Tibia weight (g/bird)	16.90±0.92 <sup>b</sup>	17.46±0.54 <sup>b</sup>	18.57±0.73 <sup>a</sup>	19.43±0.66 <sup>a</sup>
Tibia dry weight (%/bird)	37.22±2.33 <sup>b</sup>	39.85±1.56 <sup>a</sup>	40.61±0.75 <sup>a</sup>	41.42±1.33 <sup>a</sup>
Tibia ash weight (%/bird)	40.35±0.97 <sup>c</sup>	41.95±0.94 <sup>bc</sup>	43.45±1.89 <sup>ab</sup>	44.72±0.91 <sup>a</sup>
Tibia length (cm/bird)	7.52±0.11	7.56±0.15	7.54±0.15	7.64±0.20

<sup>a,b,c,d</sup> different superscript on the same line indicates significant difference (p<0.05)

## RESULT

### Body Weight

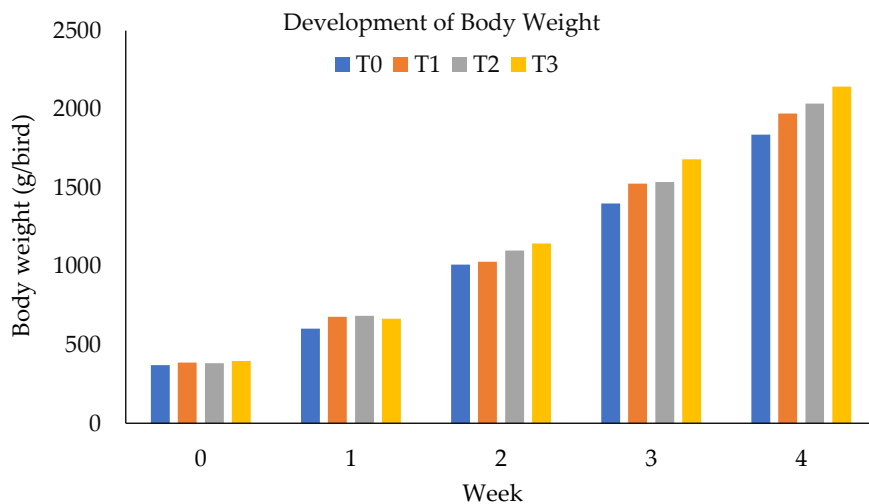
Statistical analysis showed that the ratio of calcium and phosphorous had a significant effect (P<0.05) on body weight. Supplementation of 1.0% calcium and 0.5% phosphorus in the feed (T1) increased body weight 6.88% compared to T0. When the calcium level is increased to 1.5% (T2), body weight is not significant compared to T1. Body weight increased at the 2.0% level (T3) by 5.06% compared to T2 (Table 2). At T1 with a calcium-phosphorus level of 1.0% and 0.5%, there was an increase of 7.57% compared to T0. When the calcium-phosphorus levels were increased to 1.5% and 0.5% (T2), the body weight gain increased by 3.98% compared to T1. Weight gain still increased at T3, namely 5.46% (Figure 1).

### Feed intake

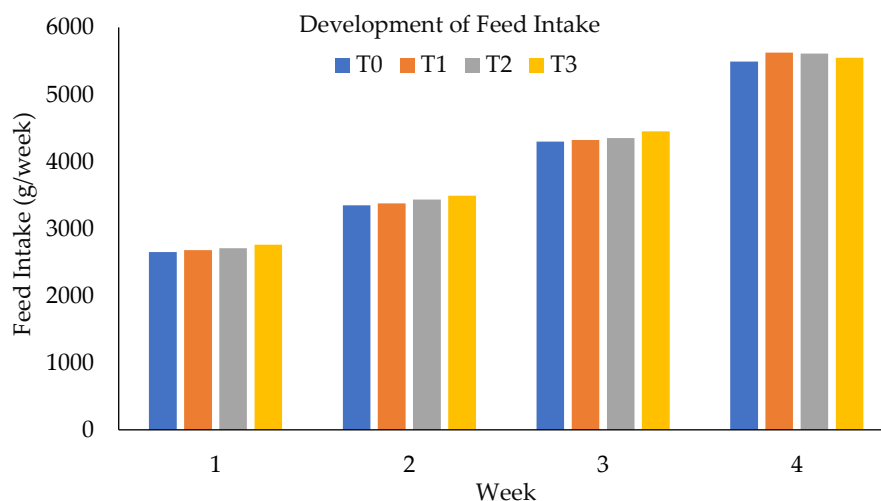
Statistical analysis showed that the ratio of calcium and phosphorous had no significant effect (P<0.05) on the broiler feed intake. Supplementation of 1.0% calcium and 0.5% phosphorus in feed (T1) to a level of 2.0% (T3), feed intake was not significant compared to T0 (Table 2 and Figure 2).

### Feed conversion

Statistical analysis showed that the ratio of calcium and phosphorous had a significant effect (P<0.05) on the feed conversion. Supplementation with 1.0% calcium and 0.5% phosphorus in the feed (T1) increased the feed conversion by 5.09% compared to T0. If the calcium level is increased to 1.5% (T2), the feed conversion increases by 5.37% compared to T1 (Table 2), but it is not significant at T3.



**Figure 1.** The development of body weight of broiler chicken strain CP 707



**Figure 2.** Development of feed intake of broiler chicken strain CP 707

### Carcass weight

Calcium levels significantly influenced carcass weight and percentage ( $P < 0.05$ ). At T1 with a calcium-phosphorus level of 1.0% and 0.5%, there was an increase of 8.73% compared to T0. When the calcium-phosphorus levels were increased to 1.5% and 0.5% (T2), carcass weight increased by 4.69% compared to T1. Carcass weight still increased at T3, namely 5.73% (Table 2).

### Tibia profile

Calcium levels significantly affected tibial weight and tibial ash content ( $P < 0.05$ ), while tibial length was not significant (Table 2). Calcium-phosphorus supplementation is 1.0% and 0.5% (T1), there has not been an increase in tibial weight or tibial ash content when compared to T0. If the calcium-phosphorus level was increased to 1.5% and 0.5% (T2), the tibia weight increased by 6.00% compared to T1, and the ash content increased by 3.45%. If the calcium level is increased to 2.0% (T3), the weight of the tibia is no longer significant but the ash content still increases by 2.84%.

## DISCUSSION

### Body weight

Calcium-phosphorus supplementation with different ratios affects broiler body weight. The higher the dietary calcium level, the more body weight increases. Calcium and phosphorus affect the metabolism of the chicken body. Calcium bound by protein

or calcium binding protein (CaBP) is present in the intestinal mucosa as a carrier for calcium into the duodenal mucosa. The CaBP is then transported to the target tissue, especially bone and meat which has an impact on the quality of the target tissue, both bone and meat. Calcium in meat in the form of ions acts as an activator for the activity of a meat proteolytic enzyme called calcium activated neutral protease (CANP), an enzyme that can trigger meat protein degradation. The increase in the concentration of calcium absorption that exceeds the requirement, causes an increase in CANP activity for meat protein degradation so that it will reduce protein synthesis which results in a decrease in meat protein mass [11]. In this study the ratio of calcium phosphorus 2.0: 0.5 (T3) still tolerated an increase in muscle mass. The impact of body weight on T3 is higher. The phenomenon in this study, it is possible that calcium binding protein (CaBP) is more than the ionic form so that it increases protein synthesis, not degradation, as indicated by the increased growth of meat at T3. In addition, it was also shown by the higher weight and ash content of the tibia [6,12]. Han et al. [3] stated that calcium plays a role in activating several enzymes such as pancreatic lipase, acid phosphatase, cholinesterase and succinink dehydrogenase. As an enzyme activator, calcium stimulates muscle contraction in regulating impulse transmission from one cell to another by controlling acetyl choline production [4]. In addition, calcium plays a role in the absorption of vitamin B12 and

maintains the integrity of cell membranes and skeletal tissue [5].

Calcium-phosphorus balance at T3 (2.0% - 0.5%) resulted in the highest body weight. There is a relationship between tibial weight and tibial ash content on body weight of broiler chickens strain CP 707. The mineralization process in T3 is better than other treatments so that the bones become bigger and heavier. Larger, heavier bones identify the more muscle that can be supported. Setiawati et al. [12] explained that Ca and P in a balanced feed determine bone formation because these two minerals in bone can increase the weight of bones that are still in the process of growth. Walk et al. [6] reported that tibia ash correlates with body weight gain after broiler chickens are given phytase to increase absorption of calcium and phosphorus. Talpur et al. [13] stated that a balanced calcium and phosphorus according to the needs of chickens, increases body weight and feed efficiency. Conversely, lack of calcium in chickens causes stunted growth, decreased feed efficiency and low bone mineralization [14].

### **Feed intake**

Feed intake is not directly related to dietary calcium level. Feed intake is more influenced by energy levels and feed protein. In this study, the energy and protein content of all treatments were the same [5]. Feed protein correlates with calcium absorption. Calcium consumed by chickens, once digested in the intestine, is absorbed with the help of calcium binding protein (CaBP) [15].

Feed containing protein as needed with low crude fiber improves protein digestibility. The digestibility of this protein results in a higher absorption of calcium intake [7]. Protein binds to calcium in intestinal mucosa and is translocated into bone tissue for mineral deposition [11]. If there is a lack of protein in the feed it will result in inhibited bone calcification. As a result, the formation of the organic matrix will be further inhibited [12].

Feed calcium that is consumed and digested will be absorbed across the membrane of the intestinal epithelial cell brush border. Calcium is immediately bound

to CaMP (calcium binding protein), which is the calcium binding protein with vitamin D. CaMP transfers calcium directly to the endoplasmic reticulum of epithelial cells and actively transports calcium into the body [16]. Active calcium transport occurs primarily in the duodenal region when calcium intake is low and via passive paracellular transport in the jejunum and ileum when calcium intake is high, depending on the level of vitamin D. Active absorption of calcium from the intestine is regulated by the concentration of calcitriol in the blood. By vitamin D will be converted into kolekalsiferol. Collecalciferol in the liver will become calcifediol. Parathyroid hormone plays a role in converting calcifediol in the kidneys into the active hormone calcitriol which acts on the epithelial cells (erythrocytes) that line the intestines to increase the rate of calcium absorption [16]. In this study, feed consumption in the first to third week (age 14-35 days of chickens) was higher at T3 and T2 (Figure 2). This indicates that a feed with a ratio of 2.0% calcium and 0.5% phosphorus is higher absorbed for bone mineralization. Bone is an organ that is involved in rapid growth compared to muscle building. Thus the need for calcium at the age of growth is higher than after the growth phase. Setiawati et al. [12] and Hamdi et al. [4] stated that bone formation is influenced by nutrient factors in the early growth phase. At the age of 1 - 4 weeks post hatching, growth performance (body weight gain, feed intake and feed efficiency) is better in broilers that receive higher calcium intake [3,17]. At week 4 (the age of the chicken is 6 weeks) the consumption at T3 tends to decrease, while T0 and T1 are still increasing so that the average feed consumption in this study is not different.

### **Feed Conversion**

In this study, feed conversion was inversely related to chicken body weight. Lower feed conversion indicates better feed efficiency. A diet with balanced calcium and phosphorus results in a better feed conversion. In the calcium-phosphorus balance T2 and T3 gave the best feed conversion compared to T0 and T1. This result is the same as

that reported by Walk et al. [6] and Zeller et al. [14] stated that FCR can be suppressed by balanced supplementation of calcium and phosphorus in feed. Calcium has an important role in muscle contraction, maintaining normal heart work, and is an activator of certain enzymes. Calcium absorption is assisted by vitamin D, vitamin C and lactose. Phosphorus in livestock is in the form of phospholipids as a structural component of cell walls and also as organic phosphates that play a role in energy storage or release in the form of Adenine Triphosphate [2]. Phosphorus is important for muscle function and red blood cells, the formation of adenosine triphosphate (ATP) and 2,3-diphosphoglycerate (DPG), and maintenance of acid balance, as well as for the nervous system and intermediate metabolism of carbohydrates, proteins, and fats.

Bone tissue formation is influenced by calcium and phosphorus feed as well as other nutrients such as protein and minerals. Protein helps in the transportation of calcium from the intestinal mucosa. Then the calcium is deposited into bone tissue to maximize bone mass and maintain normal bone density [18]. A balanced diet of nutrients and adequate calcium intake promotes bone growth [13]. Feed quality and feed consumption resulted in higher feed efficiency due to calcium. The positive impact of this is better bone growth [19].

### **Carcass profile**

Carcass weight has a positive correlation with body weight of chickens. The higher the weight of the chicken, the higher the carcass weight. It is the same with the percentage of carcass weight. Calcium and phosphorus ratio in feed 2.0: 0.5 gave the highest yield on carcass weight and carcass percentage of broiler chickens. Calcium and phosphorus in the form of microparticles (di-calcium phosphate) used in this study can be effectively absorbed by chicken intestinal mucosa. Protein and calcium or CaBP are then transported to the target tissue, especially bone and meat, which has an impact on the quality of the target tissue, both bone and meat [6]. Calcium is absorbed into the blood and

transported to other tissues that need it (bones and meat), in three forms, namely free ions, bound to protein, and insoluble ions [1]. If the calcium in the blood in the form of free ions ( $\text{Ca}^{++}$ ) is not sufficient, it affects muscle protein mass and has an impact on slow growth [1,17].

Walk et al. [6] stated that the presence of calcium in feed is absolutely necessary for the activity of a proteolytic enzyme in meat called calcium neutral activated protease (CANP). When calcium and also other nutrients are in an imbalance, it has a negative impact on the deposition of carcass protein such as breast and thigh meat [17]. The breasts and thighs are the largest components of chicken carcass. The protein mass of breast and thigh meat is an indicator of good or bad protein deposition. Calcium and phosphorus as needed, increase bone and meat formation so that the chicken carcass will be heavier.

### **Tibia profile**

Calcium and phosphorus in feed affect tibial performance of broiler chickens strain CP 707, namely tibial weight and tibial ash content. In a previous study reported by Hamdi et al. [4] that there was no increase in body weight and feed efficiency in broilers aged 3 weeks but significantly increased tibial calcium ash content. Likewise Wilkinson et al. [1] have reported that the ash content of metatarsus increases with the addition of 5-12% calcium retention. In this study, the T3 and T2 feed provided a more balanced availability of calcium and phosphorus so that the mineralization process of the tibia was better. Zeller et al. [14] stated that the metabolism of calcium and phosphorus feed in the body of broilers increases the quality of bone formation and strength, thereby reducing problems such as tibial dyschondroplasia.

Increased calcium in the feed given to broilers increased bone weight and tibial ash content, and was correlated with increased body weight and feed efficiency. Increasing tibial weight and tibial ash content results in increased body weight. This can be explained that the bones are the attachment places for muscles and the support of



the whole body of broilers. Big, strong bones have the potential to support more muscle. Wulandari et al. [20] reported that diets low in calcium and phosphorus decreased bone formation (cholecalciferol) which is characterized by low tibial ash content. Diets low in cholecalciferol increase the severity of tibial bone strength and weight loss.

Bone strength is determined not only by the mineral content of bone mass but also by the structural characteristics of the bone, namely the size, shape and structure of the bone architecture [12]. Decreased bone mass apart from being identified from bone density, can also be predicted from bone structural changes [3]. According to Abdulla et al. [5] calcium and phosphorus function for bone growth and eggshell formation. The function of calcium is to form a strong skeleton and protect important organs and aid in movement and growth [9]. Lack of calcium and phosphorus consumed can cause mobilization of calcium and phosphorus from the bones so that bone weight will be reduced and porous [15]. The tibia has better mineralization rate than other bones [17]. Feed is very important in influencing the growth rate and development of bones, if the content of food substances contained in the feed is sufficient, especially calcium and phosphorus, the bone growth rate in broiler chickens can develop well [21].

## CONCLUSION

The conclusion of this study is that the balance of 2.0% calcium and 0.5% phosphorus increasing body weight, feed conversion, carcass weight, tibial weight and ash content of broiler strain CP 707. The body weight of broiler 2142.25 kg/bird with feed conversion 1.85, carcass weight 1354.45 kg/bird, tibial weight and ash content 19.43 g/bird and 44.72%.

## CONFLICT OF INTEREST

The authors declare no conflicts of interest with any of the financial organizations discussed in this text.

## ACKNOWLEDGMENT

This research was funded by the Institute for Research and Community Service, University of Timor under the Laboratory Competency Grant scheme with 61/UN60/LPPM/PP/2020 contract number. For this reason, the authors say many thanks for the assistance of this research funding.

## REFERENCES

1. Wilkinson, S. J., P. H. Selle, M. R. Bedford, and A. J. Cowieson. 2011. Exploiting calcium-specific appetite in poultry nutrition. *Worlds Poult. Sci. J.* 67:21-30. Doi: 10.1017/S0043933911000699
2. Xue, P. C., K. M. Ajuwon, and O. Adeola. 2016. Phosphorus and nitrogen utilization responses of broiler chickens to dietary crude protein and phosphorus levels. *Poult. Sci.* 95:2615-2623. Doi: 10.3382/ps/pew156
3. Han, J., J. Wang, G. Chen, H. Qu, J. Zhang, C. Shi, Y. Yan, and Y. Cheng. 2016. Effects of calcium to non-phytate phosphorus ratio and different sources of vitamin D on growth performance and bone mineralization in broiler chickens. *Rev. Bras. de Zootec.* 45(1):1-7. Doi: 10.1590/S1806-92902016000100001
4. Hamdi, M., S. Lopez-Verge, E. G. Manzanilla, A. C. Barroeta, and J. F. Perez. 2015. Effect of different levels of calcium and phosphorus and their interaction on the performance of young broilers. *Poult. Sci.* 94:2144-2151. Doi: 10.3382/ps/pev177
5. Abdulla, N. R., T. C. Loh, H. Akit, A. Q. Sazili, H. L. Foo, K. Y. Kareem, R. Mohmad, and R. A. Rahim. 2017. Effects of dietary oil sources, calcium and phosphorus levels on growth performance, carcass characteristics and bone quality of broiler chickens. *J. Appl. Anim. Res.* 45(1):423-429. Doi: 10.1080/09712119.2016.1206903
6. Walk, C. L., T. T. Santos and M. R. Bedford. 2014. Influence of superdoses of a novel microbial phytase on growth performance tibia ash, and gizzard phytase and inositol

- in young broilers. Poult. Sci. 93:1172-1177. Doi : 10.3382/ps.2013-03571
7. Amerah, A. M., P. W. Plumstead, L. P. Barnard, and A. Kumart. 2014. Effect of calcium level and phytase addition on ileal phytate degradation and amino acid digestibility of broilers fed cornbased diets. Poult. Sci. 93:906-915. Doi: 10.3382/ps.2013-03465
  8. Lisnahan, C. V., Wihandoyo, Zuprizal, and S. Harimurti. 2017. Effect of addition of methionine and lysine into diets based on cafeteria stabdars on the growth performance of native chickens at starter phase. Int. J. Poult. Sci. 16(12): 506-510. Doi: 10.3923/ijps.2017.506.510
  9. Bangun, G. D. D., L. D. Mahfudz, dan D. Sunarti. 2013. Pengaruh penggunaan tepung rumput laut (*Gracilaria verrucosa*) dalam ransum ayam broiler terhadap berat ukuran tulang tibia dan tarsometatarsus. Journal Animal Agriculture. 2(1):489-496.
  10. Sugiyono. 2018. Statistika untuk Penelitian. Ebook. Alfabeta. Bandung.
  11. Prabowo, L. D. Mahfudz and U. Atmomarsono. 2019. Calcium and protein mass due to the use of waste product of carrot powder in ration. Jurnal Sain Peternakan Indonesia. 14(2):201-207. Doi: 10.31186/jspi.id.14.2.201-207
  12. Setiawati, D., B. Sukanto, dan H. I. Wahyuni. 2016. Pengimbuhan enzim fitase dalam ransum ayam pedaging meningkatkan pemanfaatan kalsium untuk pertumbuhan tulang dan bobot badan. Jurnal Veteriner. 17(3):468-476. Doi: 10.19087/jveteriner.2016.17.3.476
  13. Talpur, M. Z., M. I. Rind, A. Memon, F. N. Shar, and N. A. Ujjan. 2012. Effect of dietary calcium on the performance of commercial chicken. J. Vet. Anim. Sci. 2:101-106.
  14. Zeller, E., M. Schollenberger, M. Witzig, Y. Shastak, I. Kuhn, Ludwig, E. Hoelzle, and M. Rodehutschord. 2015. Interactions between supplemented mineral phosphorus and phytase on phytate hydrolysis and inositol phosphates in the small intestine of broilers. Poult. Sci. 94:1018-1029. Doi: 10.3382/ps/pev087
  15. Kismiati, S., T. Yuwanta, Zuprizal, and Supadmo. 2012. The performance of laying hens fed different calcium source. J. Indones. Trop. Anim. Agri. 37(4):263-270. Doi: 10.14710/jitaa.37.4.263-270
  16. Blaine, J., M. Chonchol, and M. Levi. 2015. Renal control of calcium, phosphate, and magnesium homeostasis. Clin. J. Am. Soc. Nephrol. 10(7): 1257-1272. Doi: 10.2215/CJN.09750913
  17. Fallah, H., A. Karimi, G. H. Sadeghi and N. Behroozi-Khazaei. 2019. The effects of calcium source and concentration on performance, bone mineralization and serum traits in male broiler chickens from 1 to 21 days of age. Anim. Prod. Sci. 59(6): 1090-1097. Doi: 10.1071/AN18166
  18. Rizkuna, A., U. Atmomarsono, dan D. Sunarti. 2014. Evaluasi pertumbuhan tulang ayam kampung umur 0-6 minggu dengan taraf protein dan suplementasi lisin dalam ransum. Jurnal Ilmu dan Teknologi Peternakan. 3(3): 121-125.
  19. Sholikhatin, E., F. Poernama, N. D. Dono, dan Zuprizal. 2016. Kebutuhan kalsium ayam broiler fase starter dengan penambahan enzim fitase. Buletin Peternakan. 40(3): 170-177. Doi: 10.21059/buletinpeternak.v40i3.12491
  20. Wulandari, E. C., W Murningsih, and H. I. Wahyuni. 2012. Deposition of calcium and phosphorous to egg shells of arab hens fed various levels of *Azolla Microphylla*. Animal Agriculture Journal. 1(1): 507-520.
  21. Kurniawan, L. A., U. Atmomarsono, dan L. D. Mahfudz. 2012. Pengaruh berbagai frekuensi pemberian pakan dan pembatasan pakan terhadap pertumbuhan tulang ayam broiler. Jurnal Agromedia. 30(2): 14-22. Doi : 10.47728/ag.v30i2.29