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# GROWTH PERFORMANCE, CARCASS YIELD AND HAEMATOLOGICAL RESPONSE OF BROILER CHICKENS FED ON PROCESSED HARICOT BEAN (*Phaseolus vulagris L.*)

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**AUTHORS' CONTRIBUTIONS**
This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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## ABSTRACT

**Background:** Haricot bean is among the most important legumes grain in Ethiopia. The beans are good sources of protein, carbohydrates and mineral nutrients required for normal functioning of the body. Despite of its nutritional quality, it is poor digestible due to anti-nutritional factors present in the bean.
**Methods:** A total of 168 Sasso strain broiler chickens were used with an initial body weight of 39.65±2.15g for the trial. The chicks were randomly allotted into four treatments with 14 birds per replication. Haricot bean was soaked in water for five hours at ratio of 1 kilogram to 5 liters, and then cooked for an hour to reduce anti-nutritional factors. The treatment diets have contained the bean at proportion of 0, 10, 20 and 30% for T1, T2, T3 and T4, respectively.
**Results:** T3 and T4 gave best performance *($P \leq 0.05$)* in final body weight, slaughter weight, dressed carcass and eviscerated weight. A significant *($P \leq 0.05$)* increase were observed in white blood cell, red blood cell, haemoglobin and packed cell volume with increasing the rate of processed haricot bean in the treatment diets..
**Conclusions:** Therefore, an amalgamation of processed haricot beans in the broiler ration showed an optimistic result in the overall performance and immunity of broiler chickens.

**Keywords:** Broiler chicken**;** feed intake; performance; immunity.

## 1. INTRODUCTION

Driven by population and economic growth, global demand for meat consumption is forecasted to increase 60-70% in 2050, while chicken meat represents around 36% of this global meat production Makkar et al. [1]. It is projected that most increase in poultry production during the next two decades will occur in developing countries, where rapid economic growth, urbanization and higher household incomes will increase the demand for animal proteins [2]. Regarding to previous points chickens have

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economic, social and cultural benefit and play a significant role in family nutrition [3,4]. The broiler sector is among the most important world meat source and it plays a vital role in human nutrition Mulatu et al. [5]. Polyunsaturated fatty acids are found abundantly in the chicken meat and these fatty acids, especially omega-3 fatty acids such as linoleic acid are considered beneficial for human health [6]. Broiler production is also necessary for rapid and sustainable production of the highly required animal source protein in developing countries. Chicken meat is a foremost source of animal protein that consumers favourite for its' nutrient composition, low price and convenience in cooking [7].

The major constraint for chicken production in the developing countries is inadequate availability and high cost of feed ingredients regardless of production systems and geographical location. For maximum growth and good health, chickens need a balanced array of nutrients in their diet. The nutrients required by the animals vary according to species, age and the purpose of production whether they are being kept for meat or egg production [8]. Commercial chicken production is mainly dependent on soybean and noug seed as the main protein source. However, soybean and noug seed are very expensive and locally unavailable for practical diet formulation in Ethiopia. To mitigate this problem it is necessary to look into alternative feed resources that are non-conventional, less costly and locally available like haricot bean.

Haricot bean (*Phaseolus Vulagris L.*), locally known as 'Boleqe' also called common bean, kidney bean, field bean and dry bean is a very important legume grown worldwide. It is an annual crop which belongs to the family Fabaceae. The bean is among the most important grain legumes produced by small-scale farmers for both cash and subsistence, mainly in the lowlands and in the rift valley areas of Ethiopia. It has been cultivated as a food crop for a long period and has been recognized as an export crop for more than four decades [9]. The main production areas for the bean in the country are West Wellega, East Hararghe, West Arsi, East Shewa, East Gojam, Sidama, Wolayta and Wollo areas [10].

Haricot bean is an excellent source of vegetable protein, soluble and insoluble fiber, starch, vitamins (particularly B-group) and minerals (iron, potassium, magnesium, zinc and manganese). The bean is rich in vitamins, minerals, folate and amino acids such as threonine, isoleucine, tryptophan, arginine, glycine and histidine [11]. On the other hand, haricot bean embraces some anti-nutritional factors that can inhibit voluntary feed consumption in monogastric animals like chickens [12]. Anti-nutritional factors like raffinose, stachyose, trypsin inhibitors, tannins and phytic acid are found the beans, which can impede voluntary intake in chicken [13]. Hence, it is mandatory to process the bean before feeding of chicken to reduce the factors. The main objective of the study was to evaluate voluntary feed intake, growth performance, carcass characteristics and hematological responses of broiler chicks fed on different proportions of processed haricot bean.

## 2. MATERIALS AND METHODS

The experiment was conducted at Jajura town of Hadiya Zone, Southern Ethiopia during March to May, 2021. The town geographically lies between $7^0$ 28' North and $37^0$ 47' East latitude and longitude, respectively. The average annual rainfall of the area is 780 mm with an average minimum and maximum temperature of $20^0$C and $30^0$C, respectively. Processed haricot bean (PHB), soybean meal, corn grain, wheat short, noug seedcake, vitamin premix, salt, limestone, methionine, lysine and di-calcium phosphate were used for the treatment diets formulation (Tables 1 and 2). Before preparation of rations haricot bean was cleaned from dirt and dust materials and then soaked in water at a proportion of 1 kg to 5 liters for 5 hours. According to Emoila et al. [14] after soaking the beans were cooked for an hour at $100^o$C. After cooking, the bean was sun-dried by spreading on plastic until it was sufficiently dried. Haricot bean, maize grain and noug seedcake were hammer milled at 5 mm sieve size and mixed based on feed basis. Salt, limestone, methionine, lysine, di-calcium phosphate and vitamin premix were added to the feeds during mixing. For starter and finisher phases, treatment diets were contained PHB at rates of 0, 10, 20 and 30% for treatments T1, T2, T3 and T4, respectively. The treatments were formulated to enclose approximately 22% and 20% crude protein (CP) and 3100 and 3200 kcal/kg metabolizable energy (ME) for starter and finisher rations, respectively [15].

Design of the study was a one-factor experiment in a completely randomized design with four treatment rations. A total of 168 one-day-old unsexed Sasso broiler chicks were bought from Alema Farms PLC, Debre zeit, Ethiopia. The chicks were assigned in 12 pens and reared under intensive management for 50 days. Treatment diets were replicated in 3 groups having 14 chicks per pen. Experimental house, watering and feeding troughs were thoroughly cleaned, disinfected and sprayed against external parasites 15 days before the arrival of chicks. The pens were also disinfected with formaldehyde gas of 20 g of Potassium per Manganet powder (KMnO4). The house was filled with *teff* straw and dry grass (hay) at depth of 5 cm. Formulated feeds and water was offered *ad-libitum* in each pen and feeds were offered twice a day at 8:00 and 16:00 hours. Ox-tetracycline powder 20% was given with drinking water (0.5g to 1 litter) for the first 7 consecutive days to improve resistance to diseases and to recover from stresses. The chicks were also vaccinated against Newcastle disease, Marek disease, Coccidiosis and Infectious Bronchitis.

The chemical compositions of the feeds were determined by the proximate method of analysis [16]. The Kjeldahl procedure was used to determine the nitrogen (N) content of the feed. Crude protein (CP) was calculated as N x 6.25. Metabolizable energy (ME) content was determined by using the indirect method [17]. Feed consumption was determined as the difference between feed offered and refused on daily basis. Mean daily feed intake was computed as the ratio of mean total feed intake to experimental days. The chicks were weighed on a pen basis initially and each week afterward before the offering of morning feed. The mean body weight gain and feed conversion ratio of the birds was calculated.

A total of 6 **(**3 male and 3 female) chickens were picked randomly from each treatment at the end of the study to evaluate carcass traits. The chickens were starved for 12 hours and weighed before slaughter. For haematological response analysis, blood samples were collected from randomly selected two chickens per replications (from 6 chickens per treatment). The samples were collected from wing veins using sterile syringes and needles. Ethylene diamine tetra acetic acid was used as anti-coagulant. The samples were examined for white blood cell, red blood cell, packed cell volume and haemoglobin concentration. Dacie and Lewis [18] technique was used to determine the parameters.

Collected data were analyzed by one-way analysis of variance (ANOVA), and mean differences were assessed by Turkey test at the level of $P \leq 0.05$. The general linear model used for the statistical analysis.

**Table 1. The proportion of feed ingredients in the starter diets per 100 Kg (feed basis)**

| Ingredients | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
|---|---|---|---|---|
| PHB | 0 | 10 | 20 | 30 |
| Soybean meal | 21 | 19 | 18 | 15 |
| Wheat short | 16 | 14 | 10 | 9 |
| Maize | 42 | 38 | 36 | 32 |
| Noug seedcake | 18 | 16 | 13 | 11 |
| Limestone | 1 | 1 | 1 | 1 |
| DCP | 0.4 | 0.4 | 0.4 | 0.4 |
| Lysine | 0.2 | 0.2 | 0.2 | 0.2 |
| Methionine | 0.3 | 0.3 | 0.3 | 0.3 |
| Common Salt | 0.5 | 0.4 | 0.5 | 0.5 |
| Vitamin premix | 0.6 | 0.5 | 0.6 | 0.6 |

*DCP = Di-calcium phosphate, PHB = Processed haricot bean*

**Table 2. Proportion of feed ingredients in finisher diet per 100 Kg (feed basis)**

| Ingredients | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| PHB | 0 | 10 | 20 | 30 |
| Soybean meal | 22 | 20 | 17 | 15 |
| Wheat short | 13 | 11 | 7 | 7 |
| Maize | 49 | 45 | 43 | 42 |
| Noug seed cake | 13 | 11 | 10 | 9 |
| Limestone | 1 | 1 | 1 | 1 |
| Common Salt | 0.6 | 0.6 | 0.6 | 0.6 |
| Lysine | 0.2 | 0.2 | 0.2 | 0.2 |
| Vitamin premix | 0.5 | 0.5 | 0.5 | 0.5 |
| DCP | 0.4 | 0.4 | 0.4 | 0.4 |
| Methionine | 0.3 | 0.3 | 0.3 | 0.3 |

*DCP = Di-calcium phosphate, PHB = Processed haricot bean, $T_1$ (0% PHB), $T_2$ (10% PHB), $T_3$ (20% PHB), and T4 (30% PHB)*

## 3. RESULTS AND DISCUSSION

### 3.1 Chemical Composition of the Feeds

Nutritional composition of feed ingredients and dietary treatments are presented in Table 3. Crude protein (CP) content of PHB in the present study was 29.7% which is nearly the same to the report of Selamu et al. [19] (29.1%), but higher than the earlier respective reports 20.09, 23.6 and 26.8% [20, 11, 14]. The reason for this difference may be variation in a variety of the bean, soil type and agronomic practices. The CP content of the treatment diets was varied between 20.56% to 22.30% and 19.56% to 20.23% for starter and finisher periods, respectively. The average metabolizable energy (ME) content of starter and finisher diets was 3108.75 and 3211 kcal/kg, respectively (Table 4) which was nearly the same as the standard value recommended for both starter and finisher periods [21].

### 3.2 Feed Intake of the Chicken

Feed consumption of the chicks presented in Table 4. Feed intake during starter period was not statistically affected (*P>0.05*). However, it was significantly (*P≤0.05*) different during finisher phase. The reason might be due to the slight difference in dry matter content, crude fibre, CP and ME content of treatment diets. During finisher phase, amount of feed consumed was lower for T1 than T4, T3 and T2. The present result is agreed with finding of Fikiru et al. [22] who noted that feed intake between treatment diets containing processed kidney bean for white leghorn was increased with increasing rate of processed kidney bean. The present result also approved the report of Ofongo et al. [23] who stated that inclusion of cooked kidney beans in the diets of broiler chicks caused a highly significant (*P≤0.01*) increase in feed intake for finisher chickens. Emire et al. [13] also perceived higher intake in broiler chicken that fed on improved haricot bean variety compare to control group. Therefore, the present result affirms feeding of PHB in broiler rations up to 30% have positive effect on feed consumption.

### 3.3 Body Weight Gain

The growth performance of the chicks during the starter, finisher and the whole growth period are presented in Table 5. The initial body weight of the chicks during the starter phase was almost similar with a range of 36.87–38.95 grams. At finisher phase, the final body weight of chickens in T4 and T3 was significantly (*P≤0.05*) higher than T1 and T2. The present result affirm the previous research finding of Fikiru et al. [22] who reported that body weight gain of white leghorn chickens fed on treatment diets containing different levels of processed kidney bean for replacement of soybean meal showed superior gain than control group. Similar result was obtained by Emoila et al. [14]) feeding of processed haricot bean for broiler chicken improved the overall performance.

**Table 3. Chemical composition of feed ingredients and dietary treatments**

| Feeds types | | Chemical composition (DM based %) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **DM** | **CP** | **EE** | **CF** | **Ash** | **Ca** | **P** | **ME(Kcal/kg)** |
| **Feed ingredients** | Corn grain | 89.07 | 10.28 | 3.1 | 5.72 | 6.08 | 0.04 | 0.25 | 3364 |
| | Wheat short | 90.02 | 15.36 | 3.3 | 12.34 | 4.60 | 0.15 | 0.71 | 3435 |
| | Soybean meal | 94.22 | 38.84 | 2.7 | 7.42 | 5.45 | 0.37 | 0.32 | 3217 |
| | Nougseed cake | 90.89 | 30.76 | 7.2 | 15.74 | 10.55 | 0.35 | 0.83 | 3251 |
| | PHB | 91.46 | 29.7 | 2.94 | 5.29 | 5.01 | 0.12 | 1.40 | 3215 |
| **Starter rations** | T1 | 90.7 | 21.5 | 2.18 | 6.51 | 8.91 | 0.14 | 0.25 | 3128 |
| | T2 | 91.3 | 22.1 | 2.47 | 6.93 | 8.93 | 0.16 | 0.75 | 3106 |
| | T3 | 91.2 | 22.2 | 2.66 | 7.22 | 8.66 | 0.22 | 0.34 | 3101 |
| | T4 | 91 | 22.3 | 2.81 | 7.43 | 8.44 | 0.31 | 0.46 | 3100 |
| **Finisher rations** | T1 | 91.7 | 19.5 | 2.68 | 6.56 | 7.41 | 0. 41 | 0.32 | 3212 |
| | T2 | 92.3 | 20.1 | 2.97 | 6.71 | 7.33 | 0.22 | 0.55 | 3218 |
| | T3 | 92.2 | 20.2 | 2.85 | 7.21 | 6.46 | 0.44 | 0.21 | 3202 |
| | T4 | 92.1 | 20.3 | 3.07 | 7.31 | 6.31 | 0.71 | 0.38 | 3220 |

*DM = Dry matter, CP = Crude protein, EE = Ether extract, CF = Crude fiber, P = Phosphorus, Ca = Calcium, ME = Metabolizable energy, T1 = 0% PHB, T2 = 10% PHB, T3 = 20% PHB, T4 = 30% PHB, and PHB = Processed haricot bean*

**Table 4. Feed intake of the chicken fed on diets with different levels of PHB during the starter phase (1–21 days), finisher phase (22–50 days) and whole period (1–50 days)**

| Parameters | T1 | T2 | T3 | T4 | SEM | P-value |
|---|---|---|---|---|---|---|
| **Starter phase** | | | | | | |
| Feed intake (g/bird) | $814.8^{ab}$ | $829.5^{ab}$ | $840.21^{a}$ | $846.33^{a}$ | 13.09 | 0.85 |
| Feed intake (g/bird/day) | $38.8^{ab}$ | $39.5^{ab}$ | $40.01^{a}$ | $40.3^{a}$ | 2.15 | 0.630 |
| **Finisher phase** | | | | | | |
| Feed intake (g/bird) | $3,865.7^{b}$ | $3,984.6^{ab}$ | $4,054.2^{a}$ | $4,068.7^{a}$ | 65.88 | 0.001 |
| Feed intake (g/bird/day) | $133.3^{b}$ | $137.4^{ab}$ | $139.8^{a}$ | $140.3^{a}$ | 25.80 | 0.001 |
| **Whole period** | | | | | | |
| Feed intake (g/bird) | $4680.5^{b}$ | $4820.4^{ab}$ | $4,894.5^{ab}$ | $4,919.7^{a}$ | 126.0 | 0.001 |
| Feed intake (g/bird/day) | $93.61^{b}$ | $96.40^{ab}$ | $97.89^{a}$ | $98.40^{a}$ | 2.28 | 0.018 |

*Means within a row with different superscript letters are significantly different at (P< 0.05), PHB = Processed haricot bean, SEM = Standard error of the mean*

**Table 5. Body weight changes of the broilers during the starter phase (1–21 days), finisher phase (22–50 days) and the whole growth period (1–50 days)**

| Items | T1 | T2 | T3 | T4 | SEM | P-value |
|---|---|---|---|---|---|---|
| **Starter phase** | | | | | | |
| Initial weight (g/bird) | $38.63^{a}$ | $36.87^{a}$ | $38.95^{a}$ | $38.80^{a}$ | 5.11 | 0.65 |
| Final weight (g/bird) | $493^{c}$ | $508.67^{b}$ | $515.67^{b}$ | $530.17^{a}$ | 42.23 | 0.0008 |
| Weight gain (g/bird) | $454.37^{c}$ | $471.80^{b}$ | $476.72^{b}$ | $491.37^{a}$ | 5.00 | 0.0001 |
| ADG (g/bird/day) | $21.63^{a}$ | $22.46^{a}$ | $22.70^{a}$ | $23.40^{a}$ | 1.59 | 0.4891 |
| FCR | $1.79^{a}$ | $1.77^{a}$ | $1.76^{a}$ | $1.72^{a}$ | 0.026 | 0.9369 |
| **Finisher phase** | | | | | | |
| Initial weight (g/bird) | $493^{c}$ | $508.67^{b}$ | $515.67^{b}$ | $530.17^{a}$ | 34.82 | 0.0004 |
| Final weight (g/bird) | $1825^{c}$ | $1837^{b}$ | $1843.3^{ab}$ | $1866.67^{a}$ | 39.16 | 0.0003 |
| Weight gain (g/bird) | $1314^{c}$ | $1328.33^{b}$ | $1327.63^{ab}$ | $1336.5^{a}$ | 19.72 | 0.0018 |
| ADG (g/bird/day) | $46.92^{a}$ | $47.44^{a}$ | $47.41^{a}$ | $47.73^{a}$ | 3.77 | 0.9650 |
| FCR | $2.03^{b}$ | $2.37^{ab}$ | $2.42^{ab}$ | $2.71^{a}$ | 0.073 | 0.0478 |
| **Whole period** | | | | | | |
| Initial weight (g/bird) | $38.63^{a}$ | $36.87^{a}$ | $38.95^{a}$ | $38.80^{a}$ | 8.31 | 0.7983 |
| Final weight (g/bird) | $1821^{c}$ | $1837^{b}$ | $1843.3^{ab}$ | $1866.67^{a}$ | 40.05 | 0.0002 |
| Weight gain (g/bird) | $1786.37^{b}$ | $1800.1^{b}$ | $1804.3^{ab}$ | $1827.87^{a}$ | 28.16 | 0.0001 |
| ADG (g/bird/day) | $35.72^{b}$ | $36^{b}$ | $36.08^{ab}$ | $36.55^{a}$ | 5.69 | 0.8081 |
| FCR | $2.33^{b}$ | $2.37^{b}$ | $2.5^{a}$ | $2.45^{a}$ | 0.046 | 0.7860 |

*$^{abc}$ Means within a row with different superscript letters are significantly different at (P< 0.05), ADG = Average daily body weight gain, FCR = Feed conversion ratio, SEM = Standard error of the mean*

## 3.4 Feed Conversion Ratio

The effect of incorporation of varying levels of PHB on feed conversion ratio (FCR) is expressed as feed consumed per weight gain (Table 5). FCR of the chicks at the starter phase was not shown statistical differences (*P>0.05*). However, there was a significant difference (*P≤0.05*) in FCR during finisher period. Difference in FCR was expected at finisher diets since feed intake and body weight gain was significantly affected between the treatment groups. The present result is agreed with finding of Emoila et al. [14] who noted that feed conversion efficiency is lower in broiler chicken fed on a control diet compared with those diets containing processed kidney bean meal.

## 3.5 Carcass Characteristics

The mean carcass traits of the experimental chicken are presented in Table 6. In the current study, a significant difference (*P>0.05*) was observed in mean slaughter weight, dressed carcass weight, thigh weight, eviscerated weight, liver percentage and wing weight. However, gizzard weight, drumstick-thigh weight, breast meat, abdominal fat, wing and drumstick weight and spleen were not significantly affected. T1 (control group) showed smaller values *(P≤0.05)* on most carcass parameters like slaughter weight, dressed carcass weight and, wing weight. Slaughter weight and dressing percentage of chicks in T4 was superior to T1 and T2. The result shows that feeding of the bean up to 30% of total ration have better result on economically valuable internal organs.

### 3.6 Haematological Parameters

Haematological responses of the chicks are presented in Table 7. Packed cell volume, haemoglobin concentration, red blood cell count and white blood cell of the birds was significantly increased (*P≤0.05*) with inclusion of the bean than those in control treatment group. The amount of red blood cell count in chicken is affected by the condition of the animal [24]. Increase in packed cell volume, haemoglobin and red blood cell count in the blood of the chicken indicates that consumption of processed haricot bean enhanced the oxygen carrying capacity of the cell, improves nutrient availability and well-being for the animal. Platelet in the blood of the animal was reduced at higher inclusion rate of the bean in the diets. This indicates that processed haricot bean might be potentially useful for enhancing blood circulation due to its inhibition effects on aggregation of platelet.

**Table 6. Carcass yield and organ weight of the broilers fed on different levels of PHB**

| Parameters | T1 | T2 | T3 | T4 | SEM | P-value |
|---|---|---|---|---|---|---|
| Slaughter weight (g) | $1631.30^{b}$ | $1647.3^{b}$ | $1655.21^{a}$ | $1677.70^{a}$ | 44.50 | 0.021 |
| Breast meat weight (g) | $411.68^{b}$ | $409.99^{b}$ | $418.15^{ab}$ | $434.08^{a}$ | 9.70 | 0.032 |
| Breast meat (%) | $25.23^{a}$ | $24.88^{a}$ | $25.26^{a}$ | $25.87^{a}$ | 0.137 | 0.411 |
| Dressed carcass weight | $1530.84^{b}$ | $1550.84^{b}$ | $1576.77^{ab}$ | $1597.83^{a}$ | 32.08 | 0.001 |
| Dressed carcass (%) | $83.88^{b}$ | $84.42^{a}$ | $85.54^{a}$ | $85.59^{a}$ | 0.55 | 0.047 |
| Drumstick-thigh weight (g) | $317.46^{b}$ | $322.76^{b}$ | $328.07^{ab}$ | $337.44^{a}$ | 6.70 | 0.040 |
| Drumstick-thigh (%) | $19.46^{a}$ | $19.59^{a}$ | $19.82^{a}$ | $20.11^{a}$ | 0.37 | 0.331 |
| Thigh weight (g) | $151.04^{b}$ | $162.54^{ab}$ | $164.95^{a}$ | $167.64^{a}$ | 5.25 | 0.038 |
| Thigh (%) | $9.86^{a}$ | $10.54^{a}$ | $9.96^{a}$ | $10.00^{a}$ | 0.25 | 0.372 |
| Abdominal fat weight (g) | $30.73^{a}$ | $32.3^{a}$ | $36.56^{a}$ | $32.53^{a}$ | 2.67 | 0.284 |
| Eviscerated weight | $1244.65^{b}$ | $1252.85^{b}$ | $1268.94^{ab}$ | $1292^{a}$ | 31.43 | 0.048 |
| Eviscerated percentage | $76.30^{a}$ | $76.05^{a}$ | $76.66^{a}$ | $77.01^{a}$ | 0.91 | 0.354 |
| Wing weight (g) | $60.57^{b}$ | $64.24^{ab}$ | $67.53^{a}$ | $73.57^{a}$ | 1.50 | 0.027 |
| Wing (%) | $3.89^{b}$ | $3.46^{b}$ | $4.07^{ab}$ | $4.38^{a}$ | 0.34 | 0.254 |
| Drumstick(g) | $177.03^{a}$ | $168.52^{ab}$ | $166.12^{b}$ | $164.43^{b}$ | 4.70 | 0.044 |
| Drumstick (%) | $10.85^{a}$ | $10.04^{a}$ | $9.85^{a}$ | $9.56^{a}$ | 1.27 | 0.228 |
| Liver weight (g) | $46.62^{a}$ | $42.38^{a}$ | $30.38^{b}$ | $34.40^{b}$ | 1.79 | 0.043 |
| Liver (%) | $2.85^{a}$ | $2.57^{a}$ | $1.83^{b}$ | $2.05^{ab}$ | 0.20 | 0.033 |
| Gizzard weight (g) | $28.29^{b}$ | $30.77^{b}$ | $32.31^{ab}$ | $35.85^{a}$ | 1.23 | 0.046 |
| Gizzard (%) | $1.73^{a}$ | $1.86^{a}$ | $1.95^{a}$ | $2.14^{a}$ | 0.04 | 0.373 |
| Heart weight (g) | $11.83^{a}$ | $10.7^{ab}$ | $9.87^{ab}$ | $10.27^{ab}$ | 0.44 | 0.091 |
| Heart (%) | $0.68^{a}$ | $0.65^{a}$ | $0.59^{a}$ | $0.61^{a}$ | 0.05 | 0.280 |
| Spleen weight (g) | $1.96^{a}$ | $2.02^{a}$ | $2.60^{a}$ | $3.41^{a}$ | 0.41 | 0.232 |
| Spleen (%) | $0.12^{a}$ | $0.13^{a}$ | $0.15^{ab}$ | $0.20^{a}$ | 0.03 | 0.098 |
| Kidney weight (g) | $10.83^{b}$ | $11.60^{b}$ | $11.25^{b}$ | $13.70^{a}$ | 0.29 | 0.020 |
| Kidney (%) | $0.66^{a}$ | $0.70^{a}$ | $0.67^{a}$ | $0.81^{a}$ | 0.20 | 0.142 |

*abc Means within a row with different superscript letters are significantly different at (P< 0.05), PHB = Processed haricot bean, SEM = Standard error of the mean*

**Table 7. Hematological responses of broilers fed processed haricot bean**

| Parameter | T1 | T2 | T3 | T4 | SEM | P-value |
|---|---|---|---|---|---|---|
| WBC | $5.92^{b}$ | $6.21^{b}$ | $7.03^{a}$ | $7.25^{a}$ | 0.05 | 0.0003 |
| RBC | $2.02^{b}$ | $2.49^{b}$ | $2.71^{ab}$ | $2.97^{a}$ | 0.04 | 0.0033 |
| HB(g/dl) | $7.34^{c}$ | $7.80^{bc}$ | $8.60^{ab}$ | $9.00^{a}$ | 0.31 | 0.0235 |
| PCV(%) | $23.11^{c}$ | $24.82^{bc}$ | $25.63^{b}$ | $28.55^{a}$ | 1.26 | 0.0023 |
| Platelets | $171^{a}$ | $165^{a}$ | $144^{b}$ | $150^{b}$ | 12.75 | 0.001 |

*abc Means within a row with different superscript letters are significantly different at (P< 0.05), WBC = White blood cell, RBC = Red blood cell count, HB = Haemoglobin*

## 4. CONCLUSION

The present study was carried out for 50 days to evaluate growth performance and haematological responses of Sasso chicken. Incorporation of processed haricot bean in the broiler diets had better performance in terms of weight gain and improves haematological parameters. Therefore, result of the present study suggests that using processed haricot bean in the diets of broilers ration improves their overall performance and health. This study may possibly use as a base for more investigations on how to use and treat raw haricot bean for effective and efficient utilization in broilers sector as well as for layer. In addition, a further flow-up experiment is suggested to evaluate optimal and profitable inclusion levels of the bean with raw and treated haricot bean in broilers with other breeds.

## ETHICS OF THE STUDY

According to the guideline of National committee for Research Ethics in Science and Technology, the intrinsic value of the animals was respected and feel of pain was also taken into consideration.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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