

Research Article

# Carcass Characteristics, Meat Quality and Hematological Indices of Broiler Chickens Fed on Palm Kernel Ration

Thobias Lucas<sup>\*</sup> , Shedrack Kitimu , Robert Max , Gaymary Bakari 

Department of Veterinary Physiology, Sokoine University of Agriculture, Morogoro, Tanzania

## Abstract

The high cost and limited availability of conventional feed ingredients such as sunflower seed cake and cottonseed cake are among the major constraints to poultry production in developing countries like Tanzania. To address the challenges, this study evaluated the effects of incorporating palm kernel meal (PKM), a non-conventional feed ingredient, into broiler diets on carcass characteristics, meat quality, and hematological indices. A total of 195 one-day-old broiler chicks were used and randomly allocated to three dietary treatments in a completely randomized design (CRD), with 65 chicks assigned to each treatment and further subdivided into three replicates of 22 chicks each. The treatments were as follows: a control diet without PKM (T1), PKM replacing sunflower seed cake (T2), and PKM replacing cottonseed cake (T3). The experiment lasted for 42 days. Broilers in T2 showed significantly higher slaughter weight (2008.2g) compared with T1 (1759.3) and T3 (1834.2g) ( $p < 0.05$ ). Similarly, carcass weight (1563.1g) and dressing percentage (77.87%) were greater in T2 than in T1 (1271.1g; 72.2%) and T3 (1364.2g; 74.3%). Meat color and water-holding capacity were unaffected ( $p > 0.05$ ), although muscle temperature and pH values differed significantly ( $p < 0.05$ ), with T2 showing the highest temperature (37.28 °C) and T3 the lowest pH (5.79). Hematological profiles, including red blood cell (RBC), white blood cell (WBC), hemoglobin (Hb), hematocrit, and mean corpuscular volume (MCV), did not differ significantly ( $p > 0.05$ ), although minor but significant variations were observed neutrophils, monocytes, lymphocyte, and platelet counts ( $p < 0.05$ ), indicating no adverse effects on overall blood health. These findings demonstrate that replacing sunflower seed cake with PKM enhances carcass yield while maintaining meat quality and healthy blood profiles. PKM can therefore be considered a viable and sustainable alternative protein source in broiler diets, particularly in regions where conventional feed ingredients are limited or expensive.

## Keywords

Carcass Characteristics, Meat Quality, Hematological Indices, Palm Kernel Meal, Broiler Chickens

## 1. Introduction

The poultry industry is vital for meeting protein needs, especially in developing countries where broiler meat and eggs provide an affordable and nutritious source of animal protein. Nonetheless, the sustainability of poultry production is challenged by the high cost and limited supply of conven-

tional feed ingredients like sunflower seed cake and cottonseed cake, which are also heavily utilized by other livestock sectors such as ruminants [1]. Since feed can make for up to 70% of total broiler production costs [2, 3], there is an urgent need to identify cost-effective, locally available feed alterna-

<sup>\*</sup>Corresponding author: [thobiaslucas@yahoo.com](mailto:thobiaslucas@yahoo.com) (Thobias Lucas)

**Received:** 18 September 2025; **Accepted:** 4 October 2025; **Published:** 22 November 2025



Copyright: © The Author(s), 2025. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

tives. Palm kernel meal (PKM), a by-product of palm oil extraction, has attracted attention as a potential substitute feedstuff due to its availability and affordability in many tropical regions, particularly in West Africa and Southeast Asia [4, 5]. In addition to being economically accessible, PKM offers several advantages that make it a viable alternative to conventional protein sources; it is rich in fiber, contains a moderate level of crude protein 14-20% [6], and possesses appreciable amounts of essential minerals. Its inclusion in poultry diets has also been associated with reduced feed costs, improved gut health due to its fibrous nature, and enhanced environmental sustainability through the use of agro-industrial by-products [7, 8]. However, there is limited research information about the use of PKM in poultry production in Tanzania.

Despite previous studies showing that PKM can partially replace conventional protein sources in broiler diets without significantly impairing growth performance or feed utilization [9, 10], there is still a lack of comprehensive studies in Tanzania on the influence of PKM on carcass characteristics, meat quality, and hematological parameters. These parameters are important for evaluating animal health and physiological responses to dietary interventions, as well as influencing consumer acceptance and the marketability of poultry products [11].

Therefore, this study assessed the effects of incorporating Tanzanian palm kernel meal (PKM) into broiler diets on carcass characteristics, meat quality, and hematological profiles. The findings are expected to provide poultry producers with practical evidence on the utilization of PKM without adversely affecting product quality or animal welfare, thereby promoting both economic and environmental sustainability in farming.

## 2. Material and Methods

### 2.1. Ethical Approval

Ethical approval for this study was granted by the Tanzania Livestock Research Institute (TLRI), under reference number TLRI/CC.21/059.

### 2.2. Experimental Location

The experiments were conducted at the Sokoine University of Agriculture (SUA) - Morogoro, Tanzania. The area is situated 6 °S and 37 °E, and about 500 - 600m above sea-level.

### 2.3. Feed Ingredients and Formulation of Experimental Diets

The experimental diet included sunflower seed cake, cotton seed cake, roasted soybean, blood meal, maize, maize bran, salt, limestone, bone meal, premix, lysine and methionine.

Palm kernel meal, a by-product obtained during the extraction of palm kernel oil from the kernels (seeds) of the oil palm tree, was sourced from Kigoma Municipality located in the northwestern part of Tanzania, and incorporated into the diets. Three pelleted experimental diets were prepared to meet the nutritional requirements of broiler chickens at three growth stages; starter (1-14 days), grower (15-28), and finisher (29-42 days). The experimental diets used in this study were; a control diet without PKM (T1), one with PKM in place of sunflower seed cake (T2) and another with PKM in place of cotton seed cake (T3). Tables 1, 2 and 3 provide specific information about the nutrient composition of the prepared experimental diets.

**Table 1.** Percentage composition of broiler starter diets with incorporation of PKM.

| Ingredients            | T1   | T2   | T3   |
|------------------------|------|------|------|
| Maize                  | 40   | 40   | 40   |
| Maize bran             | 31   | 27   | 26   |
| Sunflower seed cake    | 4    | 0    | 4    |
| Cottonseed cake        | 4    | 5    | 0    |
| Palm kernel meal (PKM) | 0    | 8    | 8    |
| Soybean meal           | 4    | 4    | 4    |
| Fish meal              | 6    | 7    | 8    |
| Blood meal             | 9    | 7    | 8    |
| Salt                   | 0.5  | 0.5  | 0.5  |
| Limestone              | 0.88 | 0.88 | 1    |
| Bone meal              | 0.5  | 0.5  | 0.5  |
| Premix                 | 0.1  | 0.1  | 0.1  |
| Lysine                 | 0.01 | 0.01 | 0.01 |
| Methionine             | 0.01 | 0.01 | 0.01 |
| Total                  | 100  | 100  | 100  |
| Chemical composition   |      |      |      |
| DM                     | 89.2 | 89.2 | 89.2 |
| Crude Protein          | 23.4 | 23.4 | 23.4 |
| Crude Fat              | 4.8  | 4.3  | 4.3  |
| Crude Fiber            | 4.1  | 4.2  | 4.2  |
| Ash                    | 12.1 | 11.7 | 12.1 |
| Starch                 | 31.6 | 31.8 | 31.8 |
| Total sugar            | 3.9  | 3.8  | 3.8  |
| ME (Kcal/kg)           | 2695 | 2672 | 2672 |

DM = dry matter, ME = metabolizable energy

**Table 2.** Percentage composition of broiler grower diets with incorporation of PKM.

| Ingredients            | T1   | T2   | T3   |
|------------------------|------|------|------|
| Maize                  | 41   | 40   | 40   |
| Maize bran             | 31   | 29   | 29   |
| Sunflower seed cake    | 4    | 0    | 4    |
| Cottonseed cake        | 5    | 4    | 0    |
| Palm kernel meal (PKM) | 0    | 7    | 7    |
| Soybean meal           | 4    | 4    | 5    |
| Fish meal              | 6    | 6    | 6    |
| Blood meal             | 7    | 8    | 7    |
| Salt                   | 0.5  | 0.5  | 0.5  |
| Limestone              | 0.88 | 0.88 | 0.88 |
| Bone meal              | 0.5  | 0.5  | 0.5  |
| Premix                 | 0.10 | 0.1  | 0.10 |
| Lysine                 | 0.01 | 0.01 | 0.01 |
| Methionine             | 0.01 | 0.01 | 0.01 |
| Total                  | 100  | 100  | 100  |
| Chemical composition   |      |      |      |
| DM                     | 88.9 | 89.3 | 89.1 |
| Crude Protein          | 22.2 | 20.3 | 21.6 |
| Crude Fat              | 4.1  | 6.2  | 4.5  |
| Crude Fiber            | 3.0  | 3.6  | 3.4  |
| Ash                    | 8.9  | 11.4 | 9.5  |
| Starch                 | 37.7 | 34.1 | 36.6 |
| Total Sugar            | 4.1  | 3.8  | 3.9  |
| ME (Kcal/kg)           | 2863 | 2797 | 2819 |

DM = dry matter, ME = metabolizable energy

**Table 3.** Percentage composition of broiler finisher diets with incorporation of PKM.

| Ingredients            | T1 | T2 | T3 |
|------------------------|----|----|----|
| Maize                  | 42 | 41 | 40 |
| Maize bran             | 31 | 31 | 30 |
| Sunflower seed cake    | 4  | 0  | 4  |
| Cottonseed cake        | 5  | 4  | 0  |
| Palm kernel meal (PKM) | 0  | 6  | 6  |

| Ingredients          | T1   | T2   | T3   |
|----------------------|------|------|------|
| Soybean              | 4    | 4    | 5    |
| Fish meal            | 6    | 5    | 6    |
| Blood meal           | 6    | 7    | 7    |
| Salt                 | 0.5  | 0.5  | 0.5  |
| Limestone            | 0.88 | 0.88 | 0.88 |
| Bone meal            | 0.5  | 0.5  | 0.5  |
| Premix               | 0.10 | 0.10 | 0.10 |
| Lysine               | 0.01 | 0.01 | 0.01 |
| Methionine           | 0.01 | 0.01 | 0.01 |
| Total                | 100  | 100  | 100  |
| Chemical composition |      |      |      |
| DM                   | 89.4 | 88.7 | 89.4 |
| Crude Protein        | 22.5 | 22.1 | 22.4 |
| Crude Fat            | 3.0  | 4.4  | 4.3  |
| Crude Fiber          | 3.0  | 4.0  | 4.3  |
| Ash                  | 8.2  | 7.4  | 9.6  |
| Starch               | 39.9 | 40.6 | 38.9 |
| Total Sugar          | 3.8  | 4.2  | 3.3  |
| ME (Kcal/kg)         | 2868 | 2757 | 2743 |

DM = dry matter, ME = metabolizable energy

## 2.4. Proximate Analysis

In accordance with [12] guidelines, 250 g samples of each of the three formulated experimental diets were collected and submitted to the Tanzania Veterinary Laboratory Agency (TVLA) for proximate analyses.

## 2.5. Sample Size Determination

The sample size was estimated using the standard formula for comparing means [13, 14]:  $N = (2 \times k \times \sigma^2 \times (Z\alpha + Z\beta))^2 / \delta^2$ , where N is the total number of experimental units, k is the number of treatment groups,  $\sigma^2$  is the population variance,  $\delta$  is the minimum detectable difference (effect size),  $Z\alpha$  is the standard normal deviate corresponding to the level of confidence (1.96 for 95% confidence), and  $Z\beta$  is the standard normal deviate corresponding to the statistical power (1 -  $\beta$ ). In this study, the following parameters were used for sample size determination: minimum detectable difference ( $\delta$ )=2.46, number of treatment groups (k)=3, population variance ( $\sigma^2$ )=25 (corresponding to a standard deviation of 5),  $Z\alpha$ =1.96 (corresponding to a 95% confidence level), and  $Z\beta$ =0.84 (corresponding to statistical power of 0.80). Based on the values, the total sample size was calculated to be approxi-

mately 195 chicks, equivalent to 65 chicks per treatment group.

## 2.6. Experimental Layout and Broiler Chicken Management

A total of 195-day-old broiler chicks were obtained from a commercial hatchery in Iringa Region, Tanzania. Upon arrival, each chick was individually weighed, tagged for identification, and randomly assigned to one of three dietary treatment groups with 65 chicks [15]. Each treatment comprised three replicates of 22 chicks. All chicks were vaccinated against Newcastle, Gumboro, and fowl pox diseases. Chicks were brooded separately for two weeks on treatment-specific starter diets. The feeding trial spanned six weeks, with birds receiving age-appropriate diets. Feed and clean water were provided *ad libitum*, and standard poultry management practices were strictly followed throughout the study.

## 2.7. Carcass Characteristics and Meat Quality Assessments

A total of forty-five broiler chickens, with fifteen randomly selected from each treatment, were fastened for 12 hours, weighted individually and slaughtered by manual exsanguinations then defeathered. The carcasses were eviscerated and reweighted, dissected and its parts weighed. Weights for carcass parts including breast, thigh, drumstick, back, neck, legs, intestines, liver, heart, fat, wings and gizzard were recorded. Carcass weight was taken after evisceration and the carcass yield (dressing percentage) was calculated as a percentage of pre - slaughter body weight [16].

$$DP (\%) = \frac{\text{Carcass weight}}{\text{Live bodyweight}} \times 100$$

### 2.7.1. Measurement of Meat pH and Temperature

Post-mortem temperature and pH were measured on the breast muscle at 1-hour post-slaughter. The temperature was measured using the ThermoPro TP-02S Instant Read Meat Thermometer, while pH was determined with a spear-end digital portable pH meter (Knick Portamess®910, Germany). All measurements were taken in the central region of the muscle to ensure consistence and reduce variability. The 1 hour time was taken as an early post-mortem reference to access glycolytic activity and carcass cooling, both of which are important determinants of meat quality [17, 18]. Measured values were interpreted in relation to normal ranges of poultry meat, where early post-mortem pH typically falls between 5.7 to 6.0 and temperature ranges from 34 °C to 38 °C [19, 20].

### 2.7.2. Meat Color Measurement

Post-mortem breast muscle color was assessed 1 hour after

slaughter. Color readings were taken from the central region of the muscle using a portable colorimeter (MINOTA CR 200b colorimeter, Osaka, Japan) following the method described by [21]. Measurements were expressed using the CIE color system: L (lightness), R (redness) and Y (yellowness). The post-mortem time at 1 hour was used as an early reference to assess the initial visual meat quality, which can be affected by factors such as pH decline and carcass cooling [22, 18]. The observed color values were interpreted in accordance with normal ranges for poultry meat, where L typically ranges from 50-60, R from 2-8, and Y between 7-15, depending on breed and diet [23, 24].

### 2.7.3. Drip Loss

Chicken breast meat samples weighing 50 g cut parallel to the muscle fiber direction, were used to determine drip loss. Each sample was weighed to obtain the initial weight, then placed in a plastic container, sealed under atmospheric pressure, and stored at 4 °C for 24 hours. After storage, the samples were removed from the containers, blotted with paper towels to remove surface moisture [25], and reweighed. Drip loss was calculated as the percentage of weight lost due to water released from meat during storage.

$$DL (\%) = \frac{\text{Meat weight before storage} - \text{Weight after storage}}{\text{Meat weight before storage}} \times 100$$

### 2.7.4. Cooking Loss Measurement

Cooking loss was determined 24 hours post-slaughter. Raw chicken breast samples were cut, weighed and sealed in 30-micron plastic bags, cooked in a thermostatically controlled water bath at 75 °C for 45 minutes, as described by Rizzi et al [26]. The samples were then cooled under running water for 15 minutes, blotted dry with soft tissue and reweighed. Cooking loss was calculated as percentage loss of weight during cooking relative to the weight of raw muscle [27].

$$CL (\%) = \frac{\text{Raw Weight} - \text{Cooked weight}}{\text{Raw Weight}} \times 100$$

### 2.7.5. Meat Tenderness

The assessment of meat tenderness was conducted using meat strips measuring 1.0 x 1.0 x 2.5 cm, cut parallel to the muscle fiber direction, prepared from the chicken breast muscle. These strips were sheared across the muscle fiber directions using a Warner-Bratzler shear blade attached to Zwick/Roell (Z 2.5, Germany) instrument. The shear force values were recorded in Newtons (N) [28].

## 2.8. Hematological Indices

Blood samples were collected for hematological analysis from forty-five broiler chickens, with fifteen birds sampled from each dietary treatment group. Each selected chicken

was humanely sacrificed, and approximately 2ml of blood was drawn from the jugular vein using EDTA-coated vacutainer tubes [29]. Immediately after collection, the tubes were gently inverted several times to ensure proper mixing of blood with anticoagulant, preventing hemolysis. Samples were labeled according to replicate and treatment group. Then transported immediately to the laboratory for hematological analysis.

## 2.9. Statistical Analysis

Data obtained were organized in an Excel sheet and then imported into R-Software (version 4.5, 2025) for one-way analysis of variance (ANOVA). The means were compared using Duncan's Multiple Range Test (DMRT) at 0.05 probability level to identify significant differences among the treatments.

## 3. Results

### 3.1. Carcass Characteristics and Internal Organs

The inclusion of PKM in the broiler feed significantly influenced both carcass characteristics and internal organ weights in broiler chickens. Chickens in the T2 group showed significantly ( $p < 0.05$ ) higher slaughter weight, carcass weight, and dressing percentage compared to T1 and T3. Moreover, T2 chickens showed significantly greater weights for the breast, thigh, back, and wings than those in the control group. Abdominal fat content was also highest in T2, significantly greater than the values recorded in T1 and T3. Among internal organs, significant differences ( $p < 0.05$ ) were observed in the weights of the intestine, liver, and heart, all highest in the T2 group. However, there were no significant differences ( $p > 0.05$ ) among treatments for the weights of the head, legs, neck, or spleen. These findings are summarized in (Table 4).

**Table 4.** Effects of PKM on carcass characteristics and internal organs (weight in grams).

| Parameters              | Treatment groups      |                       |                                 |                     |          |
|-------------------------|-----------------------|-----------------------|---------------------------------|---------------------|----------|
|                         | T1                    | T2                    | T3                              | SE                  | P-VALUES |
| Carcass characteristics |                       |                       |                                 |                     |          |
| SW                      | 1759.333 <sup>b</sup> | 2008.222 <sup>a</sup> | 1834.222 <sup>ab</sup>          | 57.5928             | 0.0162   |
| CW                      | 1271.111 <sup>b</sup> | 1563.111 <sup>a</sup> | 1364.444 <sup>b</sup>           | 48.9639             | 0.00104  |
| DP                      | 72.168 <sup>b</sup>   | 77.869 <sup>a</sup>   | 74.336 <sup>a<sup>b</sup></sup> | 1.0693              | 0.00346  |
| Head                    | 48.222 <sup>a</sup>   | 50.444 <sup>a</sup>   | 45.889 <sup>a</sup>             | 2.2368              | 0.3700   |
| Legs                    | 70.222 <sup>a</sup>   | 73.889 <sup>a</sup>   | 67.333 <sup>a</sup>             | 3.8840 <sup>a</sup> | 0.499    |
| Breast                  | 444.89 <sup>b</sup>   | 517.11 <sup>a</sup>   | 455.44 <sup>ab</sup>            | 19.6172             | 0.0328   |
| Thigh                   | 215.67 <sup>b</sup>   | 279.70 <sup>a</sup>   | 276.48 <sup>a</sup>             | 17.2892             | 0.0244   |
| Drumstick               | 175.67 <sup>a</sup>   | 190.22 <sup>a</sup>   | 170.22 <sup>a</sup>             | 6.3513              | 0.0912   |
| Back                    | 255.78 <sup>b</sup>   | 296.67 <sup>a</sup>   | 269.67 <sup>ab</sup>            | 8.986               | 0.012    |
| Wings                   | 142.67 <sup>b</sup>   | 160.22 <sup>a</sup>   | 153.33 <sup>ab</sup>            | 4.2150              | 0.0235   |
| Neck                    | 75.67 <sup>a</sup>    | 85.44 <sup>a</sup>    | 78.667 <sup>a</sup>             | 6.3648              | 0.547    |
| Fat                     | 22.33 <sup>b</sup>    | 30.33 <sup>a</sup>    | 28.11 <sup>a</sup>              | 0.7902              | 6.55e-7  |
| Internal organs         |                       |                       |                                 |                     |          |
| Intestines              | 114.67 <sup>b</sup>   | 139.222 <sup>a</sup>  | 127.67 <sup>ab</sup>            | 5.2606              | 0.0112   |
| Heart                   | 8.22 <sup>b</sup>     | 9.67 <sup>a</sup>     | 8.44 <sup>b</sup>               | 0.2703              | 0.00184  |
| Spleen                  | 2.11 <sup>a</sup>     | 2.33 <sup>a</sup>     | 2.00 <sup>a</sup>               | 0.1504              | 0.298    |
| Liver                   | 32.89 <sup>b</sup>    | 37.33 <sup>a</sup>    | 35.67 <sup>ab</sup>             | 1.1763              | 0.0415   |
| Gizzard                 | 28.44 <sup>b</sup>    | 36.44 <sup>a</sup>    | 32.33 <sup>ab</sup>             | 1.9749              | 0.0293   |

SW = Slaughter weight, CW = Carcass weight, DP = Dressing percentage

### 3.2. Meat Quality

Post-mortem muscle temperature and pH differed significantly ( $p > 0.05$ ) among the dietary treatments, with T2 showing the highest muscle temperature (37.28 °C) and T3

recording the lowest pH value (5.79). In contrast, no significant differences were observed in drip loss, cooking loss, color attributes, or tenderness among the dietary treatment groups ( $p > 0.05$ ), findings are summarized in (Table 5).

**Table 5.** Effects of PKM on various meat quality parameters.

| Parameters        | Treatment groups   |                    |                    |        |          |
|-------------------|--------------------|--------------------|--------------------|--------|----------|
|                   | T1                 | T2                 | T3                 | SE     | P-VALUES |
| Temperature ( °C) | 35.66 <sup>b</sup> | 37.28 <sup>a</sup> | 34.90 <sup>b</sup> | 0.3503 | 0.000242 |
| pH                | 5.94 <sup>a</sup>  | 5.92 <sup>a</sup>  | 5.79 <sup>b</sup>  | 0.0324 | 0.004740 |
| Drip loss (%)     | 4.24 <sup>a</sup>  | 4.31 <sup>a</sup>  | 3.84 <sup>a</sup>  | 0.2524 | 0.379    |
| Cooking loss (%)  | 19.08 <sup>a</sup> | 20.65 <sup>a</sup> | 20.02 <sup>a</sup> | 0.4723 | 0.0808   |
| L                 | 66.67 <sup>a</sup> | 61.16 <sup>a</sup> | 62.91 <sup>a</sup> | 2.0724 | 0.179    |
| R                 | 1.14 <sup>a</sup>  | 0.94 <sup>a</sup>  | 1.06 <sup>a</sup>  | 0.2241 | 0.807    |
| Y                 | 5.90 <sup>a</sup>  | 4.47 <sup>a</sup>  | 5.64 <sup>a</sup>  | 0.6190 | 0.239    |
| Fmax (N)          | 37.35 <sup>a</sup> | 34.38 <sup>a</sup> | 32.34 <sup>a</sup> | 6.8559 | 0.874    |

L = Lightness, R = redness, Y = yellowness, N = Newtons

### 3.3. Hematological Indices

Statistically there were no significant variations among dietary treatments in the erythrocytic indices, including white blood cell (WBC) count, red blood cell (RBC) count, hemoglobin concentration (Hb), hematocrit (HCT), and mean

corpuscular volume (MCV) ( $p > 0.05$ ). However, significant variations were observed in neutrophils, lymphocytes, monocytes, and platelets ( $p < 0.05$ ). Neutrophils levels were highest in T3, while lymphocyte levels were lowest in T3. Monocyte counts were also lowest in T3 and PLT counts decreased progressively from T1 to T3, refer (Table 6).

**Table 6.** Effects of PKM on various hematological indices.

| Parameter  | Treatment groups     |                      |                      |         |          |
|------------|----------------------|----------------------|----------------------|---------|----------|
|            | T1                   | T2                   | T3                   | SE      | P-VALUES |
| WBC count  | 98.6058 <sup>a</sup> | 97.9458 <sup>a</sup> | 97.7546 <sup>a</sup> | 0.2706  | 0.0859   |
| RBC count  | 2.5442 <sup>a</sup>  | 2.6400 <sup>a</sup>  | 2.5836 <sup>a</sup>  | 0.00639 | 0.572    |
| Neutrophil | 6.2 <sup>c</sup>     | 9.37 <sup>b</sup>    | 12.94 <sup>a</sup>   | 0.7228  | 1.65e-6  |
| Lymphocyte | 87.2333 <sup>a</sup> | 86.3833 <sup>a</sup> | 82.7364 <sup>b</sup> | 0.7671  | 0.000715 |
| Monocytes  | 4.88 <sup>a</sup>    | 4.08 <sup>ab</sup>   | 3.78 <sup>b</sup>    | 0.2628  | 0.0167   |
| Hb         | 13.00 <sup>a</sup>   | 12.57 <sup>a</sup>   | 12.57 <sup>a</sup>   | 0.2701  | 0.451    |
| HCT        | 38.85 <sup>a</sup>   | 38.08 <sup>a</sup>   | 38.39 <sup>a</sup>   | 0.8243  | 0.805    |
| MCV        | 145.88 <sup>a</sup>  | 147.02 <sup>a</sup>  | 145.77 <sup>a</sup>  | 0.9455  | 0.597    |
| PLT        | 1.75 <sup>a</sup>    | 1.00 <sup>ab</sup>   | 0.545 <sup>b</sup>   | 0.2103  | 0.00145  |

WBC = white blood cell, RBC = red blood cell, Hb = hemoglobin, HCT = hematocrit, MCV = mean corpuscular volume, PLT = Platelet.



## 4. Discussion

### 4.1. Carcass Characteristics

The significant differences among dietary treatments (Table 4) were observed in slaughter weight (SW), carcass weight (CW), and dressing percentage (DP). T1 exhibited the lowest values, whereas T2 recorded the highest. These findings are consistent with earlier studies [30, 31], which reported that moderate inclusion of palm kernel meal (PKM) enhances carcass yield by supplying adequate protein and energy when diets are properly balanced. Similar observations were reported by Iyayi and Davies [32], particularly when enzyme supplementation was employed to improve digestibility.

Individual carcass components also showed significant differences, with T2 exhibiting the highest breast muscle weight, reflecting efficient protein utilization [6, 33] and emphasizing the importance of controlling crude fiber levels. According to Onifande *et al* [34], residual oil in PKM may contribute to increased lipid storage if energy expenditure or fiber balance is inadequate, which is supported by the increase in abdominal fat observed in PKM-fed groups, particularly in T2.

Significant differences were also noted in internal organ weights, with T2 showing the highest values. Potentially indicating an adaptive response to dietary fiber [35, 36]. Increased heart and liver weights may reflect higher metabolic activity, consistent with findings by Esonu *et al* [37] when different dietary ingredients were tested. Generally, Both PKM-based diets (T2 and T3) improved carcass parameters compared to T1, with T2 consistently outperforming T3.

### 4.2. Meat Quality

Post-mortem muscle temperature and pH varied significantly among the dietary treatment groups (Table 5). Chickens in T2 had the highest muscle temperature compared to T1 and T3. The elevated temperature in T2 may indicate slower carcass cooling or increased metabolic heat production influenced by diet composition [38].

Muscle pH also differed across treatments, with T3 showing the lowest pH, reflecting a faster early post-mortem glycolytic rate, whereas T1 and T2 had higher pH values which were not significantly different from each other. The pH decrease observed in T3, can affect water-holding capacity and tenderness, while higher pH in T1 and T2 indicates slower glycolysis and more stable early post-mortem conditions [39, 40]. Significantly, all measured values fell within normal ranges for poultry meat, confirming that none of the dietary treatments negatively affected the initial metabolic profile [19].

There were no significant differences in water holding capacity among the dietary treatments. These results align with Nuamah *et al* [41], who observed that chickens fed PKM-based diets maintained stable water-holding capacity when energy and amino acid levels were properly balanced.

Inclusion of PKM at tested levels had no adverse effect on the water-holding capacity of chicken meat. Although differences in meat color parameters: lightness (L), redness (R), and yellowness (Y) were not statistically significant, T1 had the highest (L) value, indicating slightly lighter meat. This is consistent with Jaturasitha *et al* [42], who found no significant variation in broiler meat coloration when agro-industrial by-products were used in place of conventional protein sources. The consistence in meat color across treatments indicates that PKM inclusion did not cause oxidative or pigment-related changes in muscle tissue. The non-significant reduction in yellowness (Y) observed in T2 may be attributed to the lower carotenoid content of PKM compared to sunflower seed cake as demonstrated by Qial *et al* [43], who emphasized the influence of dietary pigments in fat-soluble compounds on meat coloration. In addition, the lack of significant differences in peak force (Fmax), an indicator of meat tenderness among the dietary treatments, concur with the findings of Teguia [44] and Sundu *et al* [6] who reported no detrimental effects on shear force when diets were adequately formulated for energy and protein content.

### 4.3. Hematological Indices

When moderate PKM was substituted for sunflower or cotton seed cake, hematological parameters such as WBC, RBC, Hb, HCT and MCV were not adversely affected, as indicated by the lack of significant differences among dietary treatments (Table 6). These findings are consistent with those reported by Onifande *et al* [34], Salihu [45], and Essien [46] who confirmed that PKM is hematologically safe when included in poultry diets.

The observed increase in neutrophil levels, particularly in T3, suggests a dose-responsive activation of innate immunity or possible stress-related response, potentially due to higher fiber content or residual antinutritional compounds in PKM. Similar increase in neutrophils have been associated with immune responses in broilers fed high-fiber agro-industrial by-products [7, 47] indicating a shift in immune resources toward innate rather than adaptive responses in chickens receiving higher level of PKM.

The significant decrease in monocyte count in T3 may reflect reduced phagocytic activity or lower inflammatory responses [48], potentially indicating improved immune efficiency or decreased microbial challenges in PKM-fed chickens. Diets high in fiber can affect platelet formation and function [49]; thus, the reduction in platelet counts, particularly in T3, may reflect changes in thrombopoiesis or hemodilution caused by increased dietary fiber.

Generally, while erythrocytic indices remained unaffected, the changes observed in neutrophils, lymphocyte, monocyte and platelet profiles indicate the importance of monitoring immune and hematopoietic responses in broilers fed PKM-inclusive diets. These results corroborate previous con-

clusions by Sundu [6] and Chong *et al* [50], who emphasized the importance of controlled PKM inclusion accompanied by balanced nutrient formulations to maintain health and performance.

## 5. Conclusion and Recommendation

The findings of this study demonstrate that palm kernel meal (PKM) is a viable and efficient substitute for conventional protein sources in broiler diets, particularly sunflower seed cake. Improved slaughter weight, carcass yield, dressing percentages, and breast muscle development in broilers fed PKM-based diets, especially the T2 group indicate better nutrient utilization. Although a slight increase in organ weights and abdominal fat were observed, PKM inclusion did not adversely affect hematological parameters or meat quality.

The results indicate that PKM can serve as a practical and locally available non-conventional protein source in broiler production, offering a sustainable alternative to sunflower seed cake when diets are properly formulated to enhance growth, carcass quality, and chicken health. Future research should focus on assessing the economic implications of PKM in commercial production and exploring its potential application in other poultry species and livestock systems.

## Abbreviations

|             |                                             |
|-------------|---------------------------------------------|
| SUA         | Sokoine University of Agriculture           |
| TLRI        | Tanzania Livestock Research Institute       |
| TVLA        | Tanzania Veterinary Laboratory Agency       |
| AOAC        | Association of Official Analytical Chemists |
| NIRS        | Near-infrared Reflectance Spectroscopy      |
| PKM         | Palm Kernel Meal                            |
| DM          | Dry Matter                                  |
| ME          | Metabolizable Energy                        |
| CP          | Crude Protein                               |
| SW          | Slaughter Weight                            |
| CW          | Carcass Weight                              |
| DP          | Dressing Percentage                         |
| CL          | Cooking Loss                                |
| DL          | Drip Loss                                   |
| L           | Lightness                                   |
| R           | Redness                                     |
| Y           | Yellowness                                  |
| F           | Max (N)                                     |
| WBC         | White Blood Cell                            |
| RBC         | Red Blood Cell                              |
| Hb          | Hemoglobin                                  |
| HCT         | Hematocrit                                  |
| MCV         | Mean Corpuscular Volume                     |
| PLT         | Platelets                                   |
| DMRT        | Duncan's Multiple Range Test                |
| SE          | Standard Error                              |
| p-value (p) | Probability Value                           |

|    |                                                |
|----|------------------------------------------------|
| T1 | Control Diet Without PKM                       |
| T2 | Diet in Which PKM Replaced Sunflower Seed Cake |
| T3 | Diet Where Pkm Replaced Cottonseed Cake        |

## Acknowledgments

Authors are gratefully acknowledging the technical guidance provided by Mr Jaffary J. Madaraka, Mr. Nemes J. Ukani, Mr. Alferd G. Mwanyika, and Mr. Hussein N. Omary Laboratory Scientists, during the laboratory work. Their support enabled us to carry out the work effectively and to collect substantial, reliable information and data for this paper.

## Author Contributions

**Thobias Lucas:** Investigation  
**Shedrack Kitimu:** Writing - review & editing  
**Robert Max:** Methodology  
**Gaymary Bakari:** Conceptualization

## Funding

This work is not supported by any external funding.

## Data Availability Statement

The data is available from the corresponding author upon reasonable request.

## Conflicts of Interest

The authors declare no conflicts of interest related to the content of this article.

## References

- [1] C. C. Kpomasse, O. E. Oke, F. M. Houndonougbo, and K. Tona, "Broiler production challenges in the tropics: A review," *Vet. Med. Sci.*, vol. 7, no. 3, pp. 831-842, 2021, <https://doi.org/10.1002/vms3.435>
- [2] R. Gifford, A. Counselor, S. Serttas, and A. Specialist, "Turkey," no. August 2009, 2010.
- [3] M. J. Mbukwane, T. T. Nkukwana, P. W. Plumstead, and N. Snyman, "Sunflower Meal Inclusion Rate and the Effect of Exogenous Enzymes on Growth Performance of Broiler Chickens," *Animals*, vol. 12, no. 3, pp. 1-12, 2022, <https://doi.org/10.3390/ani12030253>
- [4] O. C. Onwudike, "Palm kernel meal as a feed for poultry. 1. Composition of palm kernel meal and availability of its amino acids to chicks," *Anim. Feed Sci. Technol.*, vol. 16, no. 3, pp. 179-186, 1986, [https://doi.org/10.1016/0377-8401\(86\)90108-2](https://doi.org/10.1016/0377-8401(86)90108-2)



- [5] A. A. Oladokun, W. A. Rahman, and N. M. Suparjo, "Prospect of maximising palm kernel cake utilization for livestock and poultry in Malaysia: A review," *J. Biol. Agric. Healthc.*, vol. 6, no. 13, pp. 107-113, 2016, [Online]. Available: [www.iiste.org](http://www.iiste.org)
- [6] B. Sundu, A. Kumar, and J. Dingle, "Palm kernel meal in broiler diets: Effect on chicken performance and health," *Worlds. Poult. Sci. J.*, vol. 62, no. 2, pp. 316-325, 2006, <https://doi.org/10.1079/WPS2005100>
- [7] S. Sugiharto, T. Yudiarti, I. Isroli, and E. Widiastuti, "The potential of tropical agro-industrial by-products as a functional feed for poultry," *Iranian Journal of Applied Animal Science*, vol. 8, no. 3, pp. 375-385, 2018.
- [8] Y. Martínez, J. L. Bonilla, M. A. Sevilla, I. Matamoros, A. Botello, and M. Valdiviá, "Effect of palm kernel (*Elaeis guineensis*) meal on laying, egg quality and economic feasibility of old laying hens," *Cuban Journal of Agricultural Science*, vol. 55, no. 2, pp. 1-12, 2021.
- [9] H. K. Zanu, J. Abangiba, W. Arthur Badoo, A. D. Akparibo, and R. Sam, "Laying chickens response to various levels of palm kernel cake in diets," *Int. J. Livest. Prod.*, vol. 3, no. 1, pp. 12-16, 2012, <https://doi.org/10.5897/ijlp11.022>
- [10] A. Fasuyi, O. Aturamu, and A. Lawal, "Part II: Economic Analyses and the Growth Performance of Broiler Finisher (29-58 day) Birds on High Fibre-low Protein Industrial Plant By-products," *Asian J. Adv. Agric. Res.*, vol. 6, no. 3, pp. 1-10, 2018, <https://doi.org/10.9734/ajaar/2018/40606>
- [11] N. Society, A. Production, N. Journal, and A. Production, "Department of Agricultural Technology, Yaba college of Technology, Lagos 2 Department of Animal Nutrition, Federal University of Agriculture, Abeokuta," vol. 47, no. 3, pp. 194-201, 2020.
- [12] AOAC, "Official Methods of Analysis of the Association of Official Analytical Chemists," *Assoc. Off. Anal. Chem. INC.*, vol. 1, 1990.
- [13] J. Cohen, *Statistical Power Analysis for the Behavioral Sciences Second Edition*. 1988.
- [14] M. Noordzij, F. W. Dekker, C. Zoccali, and K. J. Jager, "Sample size calculations," *Nephron - Clin. Pract.*, vol. 118, no. 4, 2011, <https://doi.org/10.1159/000322830>
- [15] O. Joseph, A. Ameh, O. Amos, and A. David, "Performance and haematological indices of broiler chickens fed varied inclusion level of palm kernel cake," vol. 21, no. 01, pp. 208-214, 2022.
- [16] S. Y. Park, D. S. Byeon, G. W. Kim, and H. Y. Kim, "Carcass and retail meat cuts quality properties of broiler chicken meat based on the slaughter age," *J. Anim. Sci. Technol.*, vol. 63, no. 1, pp. 180-190, 2021, <https://doi.org/10.5187/JAST.2021.E2>
- [17] A. Sikes, R. Jacob, B. arcy, and R. Warner, "Very fast chilling modifies the structure of muscle fibres in hot-boned beef loin," *Food Res. Int.*, vol. 93, Dec. 2016, <https://doi.org/10.1016/j.foodres.2016.12.027>
- [18] C. L. de C. Nunes *et al.*, "Chilling Rates Impact Carcass and Meat Quality Parameters of *Bos indicus* Cattle," *Meat Muscle Biol.*, vol. 8, no. 1, 2024, <https://doi.org/10.22175/mmb.16908>
- [19] T. Smolinksa and M. Korzeniowska, "Evaluation of a PSE and DFD abnormalities occurrence in chicken meat," *Eur. Symp. Qual. Poult. Meat*, no. May, pp. 190-193, 2005.
- [20] G. Zaboli, X. Huang, X. Feng, and D. U. Ahn, "How can heat stress affect chicken meat quality? - A review," *Poult. Sci.*, vol. 98, no. 3, pp. 1551-1556, 2019, <https://doi.org/10.3382/ps/pey399>
- [21] E. Baéza, "Measuring quality parameters," *Poult. Meat Process. Qual. A Vol. Woodhead Publ. Ser. Food Sci. Technol. Nutr.*, vol. 2005, pp. 304-331, 2004, <https://doi.org/10.1533/9781855739031.304>
- [22] E. Baéza, L. Guillier, and M. Petracci, "Review: Production factors affecting poultry carcass and meat quality attributes," *Animal*, vol. 16, 2022, <https://doi.org/10.1016/j.animal.2021.100331>
- [23] R. L. J. M. Van Laack, C. H. Liu, M. O. Smith, and H. D. Loveday, "Characteristics of pale, soft, exudative broiler breast meat," *Poult. Sci.*, vol. 79, no. 7, pp. 1057-1061, 2000, <http://doi.org/10.1093/ps/79.7.1057>
- [24] M. Petracci, M. Betti, M. Bianchi, and C. Cavani, "Color variation and characterization of broiler breast meat during processing in Italy," *Poult. Sci.*, vol. 83, no. 12, pp. 2086-2092, 2004, <https://doi.org/10.1093/ps/83.12.2086>
- [25] K. O. Honikel, "Reference methods for the assessment of physical characteristics of meat," *Meat Sci.*, vol. 49, no. 4, pp. 447-457, 1998, [https://doi.org/10.1016/S0309-1740\(98\)00034-5](https://doi.org/10.1016/S0309-1740(98)00034-5)
- [26] C. Rizzi, A. Marangon, and G. M. Chiericato, "Effect of genotype on slaughtering performance and meat physical and sensory characteristics of organic laying hens," *Poult. Sci.*, vol. 86, no. 1, pp. 128-135, 2007, <https://doi.org/10.1093/ps/86.1.128>
- [27] M. Petracci and E. Baéza, "Harmonization of methodologies for the assessment of poultry meat quality features," *Worlds. Poult. Sci. J.*, vol. 67, no. 1, pp. 137-153, 2011, <https://doi.org/10.1017/S0043933911000122>
- [28] T. L. Wheeler, S. D. Shackelford, and M. Koohmaraie, "Shear Force Procedures for Meat Tenderness Measurement," *Anim. Res.*, pp. 1-7, 2005.
- [29] L. M. Kelly and L. C. Alworth, "Techniques for collecting blood from the domestic chicken," *Lab Anim. (NY)*, vol. 42, no. 10, pp. 359-361, 2013, <https://doi.org/10.1038/aban.394>
- [30] O. Akinfala, A. O. Aderibigbe, and O. Matanmi, "Evaluation of the nutritive value of whole cassava plant as replacement for maize in the starter diets for broiler chicken," *Livest. Res. Rural Dev.*, vol. 14, pp. 44-49, Dec. 2002.
- [31] A. Mekbungwan, N. Thongwittaya, and K. E. Yamauchi, "Digestibility of soybean and pigeon pea seed meals and morphological intestinal alterations in pigs," *J. Vet. Med. Sci.*, vol. 66, no. 6, pp. 627-633, 2004, <https://doi.org/10.1292/jvms.66.627>

- [32] E. Iyayi and B. Davies, "Effect of Enzyme Supplementation of Palm Kernel Meal and Brewer's Dried Grain on the Performance of Broilers," *Int. J. Poult. Sci.*, vol. 4, pp. 76-80, Jan. 2005, <https://doi.org/10.3923/ijps.2005.76.80>
- [33] E. V. E. and J. M. O., "Comparative Performance of Broiler Chickens Fed Varying Levels of Palm Kernel Cake and Maize Offal," *Pakistan J. Nutr.*, vol. 3, no. 4, pp. 254-257, 2004, <https://doi.org/10.3923/pjn.2004.254.257>
- [34] A. A. Onifade and G. M. Babatunde, "Comparison of the utilisation of palm kernel meal, brewers' dried grains and maize offal by broiler chicks," *Br. Poult. Sci.*, vol. 39, no. 2, pp. 245-250, 1998, <https://doi.org/10.1080/00071669889204>
- [35] E. Jiménez-Moreno, J. M. González-Alvarado, A. González-Serrano, R. Lázaro, and G. G. Mateos, "Effect of dietary fiber and fat on performance and digestive traits of broilers from one to twenty-one days of age," *Poult. Sci.*, vol. 88, no. 12, pp. 2562-2574, 2009, <https://doi.org/10.3382/ps.2009-00179>
- [36] H. Hetland and B. Svihus, "Effect of oat hulls on performance, gut capacity and feed passage time in broiler chickens," *Br. Poult. Sci.*, vol. 42, no. 3, pp. 354-361, 2001, <https://doi.org/10.1080/00071660120055331>
- [37] B. O. Esonu, M. N. Opara, I. C. Okoli, H. O. Obikaonu, C. Udedibie, and O. O. M. Iheshiulor, "Physiological response of laying birds to neem (*Azadirachta indica*) leaf meal-based diets: Body weight organ characteristics and haematology," *Online J. Heal. Allied Sci.*, vol. 5, no. 2, pp. 1-7, 2006.
- [38] Y. H. B. Kim, R. D. Warner, and K. Rosenvold, "Influence of high pre-rigor temperature and fast pH fall on muscle proteins and meat quality: A review," *Anim. Prod. Sci.*, vol. 54, no. 4, pp. 375-395, 2014, <https://doi.org/10.1071/AN13329>
- [39] E. Lambooij, B. Hulsege, R. E. Klont, H. A. Winkelman-Goedhart, H. G. M. Reimert, and R. W. Kranen, "Effects of housing conditions of slaughter pigs on some post mortem muscle metabolites and pork quality characteristics," *Meat Sci.*, vol. 66, no. 4, pp. 855-862, 2004, <https://doi.org/10.1016/j.meatsci.2003.08.007>
- [40] L. M. Rodrigues, P. R. Fontes, and E. M. Ramos, "Rigor development and meat quality of Murrah buffalo from different production systems Desenvolvimento do rigor e qualidade da carne de bubalinos Murrah de diferentes sistemas de produção Desarrollo del rigor y calidad de la carne de búfalos Murrah de dif," vol. 2021, pp. 1-9, 2021.
- [41] E. Nuamah, M. Teye, F. N. A. Odoi, and P. K. Teye, "Growth performance and carcass characteristics of cross-bred rabbits fed diets containing palm kernel oil residue," *African J. Agric. Res.*, vol. 14, no. 33, pp. 1764-1771, 2019, <https://doi.org/10.5897/ajar2019.14055>
- [42] S. Jaturasitha, T. Srikanthai, M. Kreuzer, and M. Wicke, "Differences in carcass and meat characteristics between chicken indigenous to Northern Thailand (Black-Boned and Thai native) and imported extensive breeds (Bresse and Rhode Island Red)," *Poult. Sci.*, vol. 87, no. 1, pp. 160-169, 2008, <https://doi.org/10.3382/ps.2006-00398>
- [43] M. Qiao, D. L. Fletcher, D. P. Smith, and J. K. Northcutt, "The effect of broiler breast meat color on pH, moisture, water-holding capacity, and emulsification capacity," *Poult. Sci.*, vol. 80, no. 5, pp. 676-680, 2001, <https://doi.org/10.1093/ps/80.5.676>
- [44] A. Tegua, J. Awah Ndikum, and C. Puene, "The effects of replacing maize with dried leaves of *Desmodium* spp on the growth performances of broiler chickens," *Bull. Anim. Health Prod. Afr.*, vol. 50, pp. 106-114, Jan. 2002, <https://doi.org/10.4314/bahpa.v50i2.32748>
- [45] S. B. Salihu, "Comparative Effect of Three Different Energy Sources on Hematology and Serum Biochemistry of Rabbits," *J. Anim. Heal.*, vol. 2, no. 1, pp. 17-38, 2020, <https://doi.org/10.47604/jah.1164>
- [46] C. A. Essien, "Growth performance, carcass indices and blood profile of broiler chickens fed tiger nut residue," *J. Anim. Sci. Vet. Med.*, vol. 6, no. 2, pp. 50-57, 2021, <https://doi.org/10.31248/jasvm2021.253>
- [47] M. A. Soltan, "Growth performance, immune response and carcass traits of broiler chicks fed on graded levels of palm kernel cake without or with enzyme supplementation," *Livestock Research for Rural Development*, vol. 21, no. 3, 2009.
- [48] N. J. Anyanwu, V. U. Odoemelam, G. A. Kalio, and I. I. Ekpe, "Growth performance and haematological characteristics of broiler finisher chickens fed palm kernel cake as partial replacement for maize and Soya bean Nigerian Society for Animal Production Nigerian Journal of Animal Production ©," *Nig. J. Anim. Prod.*, vol. 2020, no. 4, pp. 111-119, 2020.
- [49] R. Jha and P. Mishra, "Dietary fiber in poultry nutrition and their effects on nutrient utilization, performance, gut health, and on the environment: a review," *J. Anim. Sci. Biotechnol.*, vol. 12, no. 1, pp. 1-16, 2021, <https://doi.org/10.1186/s40104-021-00576-0>
- [50] X. Yan *et al.*, "Geographic Pattern of Variations in Chemical Composition and Nutritional Value of *Cinnamomum camphora* Seed Kernels from China," *Foods*, vol. 12, no. 13, 2023, <https://doi.org/10.3390/foods12132630>

## Biography



**Thobias Lucas**, a postgraduate student pursuing M. Sc. Comparative Animal Physiology, at the department of Veterinary Physiology, Biochemistry and Pharmacology in the College of Veterinary Medicine and Biomedical Sciences, Sokoine University of Agriculture, Morogoro - Tanzania.



**Shedrack Kitimu**, Lecturer of Animal Physiology and Biotechnology at Sokoine University of Agriculture. Dr. Kitimu's research interests lie at the intersection of biotechnology, natural products, drug development and nanotechnology. He is passionate about harnessing the potential of natural products to develop novel therapeutics and enhance drug discovery. He is both a member and Principal Investigator of various research projects.



**Robert Max**, Professor of Biochemistry at Sokoine University of Agriculture in Tanzania. With a strong background in veterinary medicine and a PhD from the University of Nottingham, he focuses on natural products for veterinary and public health. He teaches, mentors students, and leads outreach programs, and has published extensively while collaborating with researchers worldwide.



**Gaymary Bakari**, Professor in the Department of Physiology, Biochemistry and Pharmacology at the College of Veterinary Medicine and Biomedical Sciences, Sokoine University of Agriculture. She completed her PhD at the Sokoine University in 2014. Her area of interest is natural medicinal plants physiology and biomedical sciences. She has presented her research findings at several conferences and workshops in more than 21 peer-reviewed articles in reputable academic journals. Apart from teaching, she also involved in research and mentoring more than 60 undergraduate and 17 post graduate students.

## Research Field

**Thobias Lucas:** Animal nutrition, Poultry production, Feed formulation, Meat quality evaluation, Sustainable livestock system.

**Shedrack Kitimu:** Biosafety, Animal Physiology, Biotechnology, Nanotechnology, Reproductive toxicology, Drug development, medicinal plants.

**Robert Max:** Oxidative stress biology, Reproductive toxicology, Phytochemistry of medicinal plants, Natural product pharmacology, Fertility control research, Poultry genetics.

**Gaymary Bakari:** Food safety and quality, Consumer awareness studies, Nutritional biochemistry, Ethnobotany of medicinal plants, Reproductive toxicology, Fertility control research.