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# Evaluation of Carcass Characteristics of the Broiler Chicken Fed with Seaweed (Spinosum) as Mineral Source: A Case Study in Zanzibar

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## Abstract

An experiment was conducted at the Poultry unit of Kizimbani Agriculture Training Institute in Zanzibar to evaluate the effect of seaweed as mineral source in the carcass characteristic of broiler chickens. A one week chicks were assigned to their respective treatments (Sw0, Sw1, Sw1.5 and Sw2) and each treatment was replicated four times with fifteen (15) chicks in each replicate making total of (240 chicks) allocated to four dietary treatments with varying inclusion level of sea weeds (Sw0, Sw1, Sw1.5 and Sw2), containing 0, 1, 1.5 and 2% seaweeds, from 8 - 49 days of age.

Feed intake was measured daily while live weight was measured on a weekly basis. After seven weeks 2 chickens from each replicate were slaughtered to determine carcass yield and carcass characteristics. Proximate analysis of seaweed showed high ash content (47.65%) low levels of CP (5.42%) and CF (3.29%). Mineral analysis in see weed showed that it is rich in both macro and micro elements and low in amino acids. Body weight was significantly ($P < 0.05$) higher in Sw1.5 (2549.0g) and lower for Sw2 (2275.3g). Significant differences in carcass and non-carcass components were observed ($P < 0.05$). Final body weight was lower in Sw0 (2229.4g) and high in Sw1.5 (2481.9g). Carcass weight was highest in Sw1.5 (1961.3g) followed by Sw2 (1903.8g) and lowest in Sw0 (1673.8g) whereas dressing percentage was lowest in Sw0 (75%) and highest in Sw1.5 (79%). Dietary treatments had insignificant effect on overall lean, bone and fat weights. Dietary treatments had no effect on meat tenderness. Similarly, dietary treatment had no significant effect on tissue distribution apart from the bone in the drumstick. It is included that Seaweed inclusion at 1.5% (Sw1.5) had overall positive effect on all dependent variables hence dietary treatments which contained 1.5% can be considered as optimum in broiler diets.

***Keywords:*** *Broiler; Experimental Diets; Carcass Characteristics; Tenderness; Zanzibar*

## Abbreviations

DAARS: Department of Animal, Aquaculture and Range Science; CP: Crude Protein; ME: Metabolisable Energy; SW: Seaweed; WBSF: Warner Bratzler Shear Force

## Introduction

Poultry keeping is currently a booming economic activities in most developing countries, in Tanzania due to characteristics of this production activities especial its simple management, most household farmers keep poultry. Apart from its economic, social and cultural uses in most household farmers poultry serve as an important animal protein source in these household meals [1,2].

In most developing countries Zanzibar being among them poultry keepers of the are mostly faced with the problem of obtaining good feed (in terms of quality and quantity) which can meet the chicken's requirements on a daily basis. Most of the feed companies formulating and supplying feed to farmers produce feeds of poor nutritional value that is low ability to produce high quality feeds [3], leading to poor growth rate and leg problems in broilers. Following this many poultry farmers get low returns and profit from their birds sometimes failing to repay the loans or even recovering their investment capitals. The availability of high quality poultry feed at a reasonable cost is crucial, since it can result into increase in cost of production.

More over in Zanzibar most of the materials that are used in poultry feed formulation are imported from Tanzania Mainland and from outside Tanzania and only 10% comes from within. The quality of the imported materials is not known and therefore, feeds formulated by most millers are of low quality especially minerals. Minerals ensure proper growth and bone development since broilers have rapid weight gain hence having strong bones can prevent legs problems. Currently most of the feed producers, use synthetic products as source of minerals in broiler diets, these include Dicalcium phosphate (DCP), bone meal, commercial broiler premix and limestone. The cost of the materials is high and availability for some of the supplements is a problem. Using alternative products as mineral sources (feed additives) in broiler diets and other livestock feeds might reduce cost of production and improve performance. One such source is seaweed since seaweed is rich in minerals (both macro- and micro elements), vitamins, protein as well as essential amino acids. The availability of seaweeds in Zanzibar is not a problem, however, the available information shows that, there has been limited use of seaweeds in animal diets particularly for the varieties found in Tanzania (Zanzibar). In view of this the present study was undertaken to evaluate the effectiveness of seaweed as a mineral supplement in broiler diets.

## Aim of the Study

The aim of this study is to evaluate carcass characteristics of the broiler chicken fed with seaweed (spinosum) as mineral source a case study in Zanzibar.

## Materials and Methods

### Area of experiment study

The study was conducted at Kizimbani Agriculture Training Institute in Zanzibar (KATI) about 5 kilometers from Zanzibar Stone Town. The Institute is situated at latitude 6º South, longitude 39º East and 20m above sea level. The area receives an average rainfall of 1564 mm/annum and annual average temperature of 25.7ºC.

### Experimental diets and preparations

Dried Seaweed was obtained at the selling point at Zanzibar East Africa Company (ZANEA), from Unguja Island. The obtained seaweed was sun dried one day before grinding after which it was well packed in polythene bags and stored at room temperature. Other feed ingredients including maize bran, sunflower meal, fish meal, maize meal, broiler premix, DL- Methionine, salt, limestone and other were purchased from Agrovet shops and were then stored at room temperature.

The chemical composition of both seaweed meal and other feed ingredients were determined at the Department of Animal, Aquaculture and Range Science (DAARS) Laboratory for Proximate (SUA) analysis and at Soil Science Laboratory (SUA) for minerals analysis before the diets were compounded. Four dietary treatments (Sw0, Sw1, Sw1.5 and Sw2) were locally compounded and their chemical and minerals compositions were determined, using AOAC (1995). The dietary treatments contained different levels of seaweed as mineral premix, Treatment one (Sw0) no seaweed (0% seaweed) it contained (0.25% commercial premix as control), Treatment two (Sw1) had 0.9% seaweed, Treatment three (Sw1.5) 1.5% seaweed and Treatment four (Sw2) contained 2% seaweed. All experimental diets were thoroughly mixed, well packed in 50kg bag, and marked accordingly for easy identification i.e. Sw0, Sw1, Sw1.5 and Sw2, and were then stored at room temperature ready for feeding.

The estimated Crude Protein (CP) and Metabolisable Energy (ME) of each ingredient in the diet was calculated by taking the estimated values of Crude Protein and Metabolisable Energy of the ingredients multiplied by the inclusion level in the diet. Calculated CP and ME of each experimental diet was obtained by adding calculated CP and energy of all ingredients present in the diet. Table 1 and 2 shows physical and chemical composition of the experimental diets and their calculated CP and energy.

| | Levels of seaweed meal | | | |
|---|---|---|---|---|
| **Ingredient** | **Sw0** | **Sw1** | **Sw1.5** | **Sw2** |
| Seaweed meal | 0 | 0.875 | 1.5 | 2 |
| Maize meal | 68 | 68 | 68 | 68 |
| Maize bran | 10 | 9.25 | 7.68 | 7.25 |
| Fish meal | 16 | 16 | 16 | 16 |
| Sunflower meal | 5 | 5 | 5 | 5 |
| DL-Methionine | 0.25 | 0.25 | 0.25 | 0.25 |
| Broiler premix | 0.25 | 0.125 | 0.07 | 0 |
| Limestone | 0.25 | 0.25 | 0.25 | 0.25 |
| Salt | 0.25 | 0.25 | 0.25 | 0.25 |
| Total | 100 | 100 | 100 | 100 |
| Calculated CP% | 19 | 19 | 19.30 | 19.25 |
| Calculated Energy ME kcal/kg | 3047.35 | 3028.00 | 3016.39 | 3005.55 |

***Table 1:** Physical composition of the experimental diets (%).*
*Sw0 = 0% seaweed; Sw1 = 0.9% Seaweed; Sw1.5 = 1.5%; Sw2 = 2% Seaweed.*

| Nutrients | Sw0 | Sw1 | Sw1.5 | Sw2 |
|---|---|---|---|---|
| DM (%) | 90.73 | 90.05 | 89.95 | 89.73 |
| CP (%) | 21.13 | 17.66 | 18.16 | 21.84 |
| EE (%) | 5.1 | 5.23 | 4.73 | 5.09 |
| CF (%) | 1.74 | 2.99 | 1.81 | 2.86 |
| ASH (%) | 6.01 | 6.28 | 7.45 | 5.84 |
| MC (%) | 9.27 | 9.99 | 10.06 | 10.27 |
| NFE (%) | 43.25 | 42.15 | 42.21 | 45.9 |
| Lysine (%) | 1.4 | 1.48 | 1.62 | 1.63 |
| Tryptophan (%) | 0.38 | 0.42 | 0.84 | 0.84 |
| Met/Cyst (%) | 0.84 | 0.84 | 0.83 | 0.83 |
| K (%) | 0.43 | 0.40 | 0.45 | 0.58 |
| Ca (%) | 0.59 | 0.74 | 0.56 | 0.69 |
| P (%) | 0.49 | 0.52 | 0.58 | 0.45 |
| Ca:P ratio | 1.18 | 1.14 | 0.97 | 1.53 |
| Mg (%) | 0.15 | 0.16 | 0.15 | 0.17 |
| Na (%) | 0.18 | 0.18 | 0.26 | 0.33 |
| Cu (ppm) | 4.33 | 3.27 | 3.27 | 2.20 |
| Zn (ppm) | 41.55 | 41.07 | 36.78 | 38.21 |
| Fe (ppm) | 212.77 | 181.34 | 181.34 | 263.85 |
| Mn (ppm) | 16.729 | 15.052 | 13.375 | 12.536 |
| ME kcal/kgDM | 3007.35 | 3008.00 | 3019.55 | 3013.39 |

***Table 2:** Chemical composition of the experimental diets.*
*Key: DM = Dry Matter; CP = Crude Protein; EE = Ether Extract; CF = Crude Fibre; ASH = ASH; MC = Moisture Content; K = Potassium; Ca = Calcium; Mg = Magnesium; P = Phosphorus; Na = Sodium; Cu = Copper; Zn = Zinc; Fe = Iron; Mn = Manganese; ME = Metabolisable Energy; kcal = Kilocalories; kg = Kilogram; Sw0 = 0% seaweed; Sw1 = 1% Seaweed; Sw1.5 = 1.5% Seaweed; Sw2 = 2% Seaweed.*

| Proximate | Macro mineral (%) | Micro mineral (ppm) | Amino acid (%) |
|---|---|---|---|
| DM (%) 94.59 | Ca 0.59 | Cu 11.09 | Lysine 0.69 |
| CP (%) 5.42 | Mg 1.54 | Zn 18.99 | Trypto 0.14 |
| CF (%) 3.29 | K 13.48 | Mn 22.95 | Meth/Cyst 0 |
| NFE (%)56.66 | Na 6.71 | Fe 523.22 | |
| Ash (%) 47.65 | P 0.03 | | |
| ME kcal/kg 873.1 | | | |

***Table 3:*** *Proximate, mineral and amino acid composition of seaweed.*
*Key: Macro-elements: Ca = Calcium: Mg = Magnesium: K = Potassium: Na = Sodium: P = Phosphorus: and for the Micro-elements: Cu = Copper: Zn = Zinc: Mn = Manganese: Fe = Iron: Amino acid: Lysine, Trypto = Tryptophan, Met/Cyst = Methionine/Cysteine: CP = Crude Protein: CF = Crude Fiber: EE = Ether Extract: NFE: Nitrogen Free Extract: DM = Dry Matter: MC = Moisture Content: ASH = Mineral: kcal/kgDM ME = Kilocalories Per Kilogram Dry Matter Metabolisable energy.*

### Experimental design and birds' management

The experiment involved the evaluation of the effect of seaweed on growth performance and carcass quality of broilers birds. A total of two hundred and forty (240), day old broiler chicks were purchased from "Thuirachicks and Company" in Zanzibar and were brooded together for one week at Kizimbani poultry unit. Before placing chicks in the brooder room the initial weight of each chick was taken and recorded, and chicks were provided with "Vitalyte" (feed additive containing some minerals, electrolyte and essential amino-acids) during the first 5 days. During the preliminary period i.e. first week of age brooding period all chicks were offered a commercial diet *ad libitum* purchased from one Agrovet shop in Zanzibar. At the same time the brooder was provided with drinkers to meet the requirement of chicks as far as water was concerned. The indoor temperature was maintained at 35ºC, the electric bulbs were well placed in the brooder to ensure the constant supply of the required heat.

After a week, the chicks were assigned to their respective treatments and each treatment was replicated four times with fifteen (15) chicks in each replicate making total of (240 chicks). The rearing room's floor were covered with wood shavings and feeding and drinking equipment's were put in place. During the growing period day light was used as source of light during day time whereas electrical bulbs were used at night. All chicks were vaccinated against Newcastle disease on day seven, and on day twelve they were vaccinated against Infectious Bursa disease and it was repeated at day 19. At four weeks of age all chicks were provided with amprolium (ant-coccidiosis) as prophylaxis for 3 days.

### Experimental procedure and data collection

### Growth performance

All chicks were initially weighed on individual basis and their weights were recorded before being introduced in the brooding room. During this time chicks were wing tagged for easy identification. Weighing of chicks was done on a weekly basis to get weekly weight of each bird. Weight difference between $t_1$ and $t_2$ was used to calculate weight gain.

### Carcass characteristics

After seven weeks, two (2) broiler chicks were randomly selected from each replicate for slaughter, (making a total of 32 broiler chicks for the whole study). Slaughtering was done by cutting off the head, at the head neck using a sharp knife. After slaughter each bird was soaked in hot water at (70ºC) for 2 minutes followed by removal of feathers. The feet were carefully cut off at the tibia femur joint after which the abdomen was incised at the mid ventral using a sharp knife and then whole gastro intestinal tract was removed. Edible organs (Gizzard, liver, spleen and heart) were separated from the gut, each internal organ was separately weighed. The percentage of the component was calculated as weight of the component over the live weight as shown in the formula below:

$$\% \text{ weight of component} = \frac{\text{Weight of component}}{\text{Live weight}} \times 100.$$

The gizzard was longitudinally opened so as to remove the contents and the inner membrane before weighing. After removal of all internal organs the carcass weight of each chicken was measured and then halved along the spine. Tissue from the breast, thigh and drumstick were separated and tissue distribution i.e. fat, muscles and bone were also determined and expressed as percentage by using formula:

$$\% \text{ tissue} = \frac{\text{Weight of tissue}}{\text{Weight of component}} \times 100$$

Where by weight of component could be breast, thigh and drumstick weight.

Dressing out percentage was calculated as shown in the formula:

$$\text{Dressing } \% = \frac{CW}{LW} \times 100$$

Where by:

CW = carcass weight; LW = live weight.

Meat samples from the breast, thigh and drumstick muscles were taken from each bird for tenderness assessment.

### Tenderness determination

The meat samples (muscles) from the breast, thigh and drumstick used for the determination of tenderness were preserved in a deep freezer at -20ºC for about 48 hours then weighed and refrigerated overnight at 4ºC. After refrigeration the meat samples were mopped (minced) and re-weighed, ready for vacuum packing procedure. After packing the meat was cooked in a water bath set at 70ºC for 1hr, then the samples were removed from water bath and were put in cold water and then refrigerated for 24 hours.

After refrigeration the samples were removed from the polythene packs and water was drained, then weighed again, thereafter the cooking loss was determined by calculating different between two weights (weight of meat samples before cooking and weight of meat samples after cooking). The meat samples were sliced into one centimeter cubes ($cm^3$) thickness and were subjected to the Warner Bratzler Shear Force (WBSF) machine (Zwick/Roell Z2.5. Germany) for tenderness determination (Available at DAARS- SUA). The shaped rectangular meat blocks were cut (length 2.5 x width 1.0 x height x 1.0 $cm^3$) and each block was sheared perpendicular to the muscle fibre direction, then Zwick was set with 30KN load cell, with a crosshead speed of 100 mm/min. The values for meat tenderness of the samples were displayed in $N/cm^3$ and were recorded in excel sheet then statistically analysed (SAS, 2000).

### Data analysis

The data were analyzed by using SAS (2000) software and any variations between treatment means were determined at 5% level of significance. The model for comparisons of treatment effects shown below:

Analysis on weight gains and carcass characteristic

$Yijk = \mu + Tij + (X_2 - X_1) + eijk$

Where; Yijk = Effect of the $i^{th}$ dietary treatments on the $j^{th}$ bird in $k^{th}$ period

μ = General mean effect

Tij = Effect of $i^{th}$ dietary treatment on $j^{th}$ birds

$X_2$ = Final group mean weight after $k^{th}$ period

$X_1$ = Initial group mean

Eijk = Random error.

## Results

### General condition of the birds

Generally there was no mortality of the birds after allocation to treatment diets, all birds were in good health throughout the experimental period. This showed that, the survival of the birds and health status were not affected by the addition of the seaweeds in the diets of broilers.

### Effect of dietary treatments on final weight gain, carcass and non-carcass component on broiler chicken

Table 4 shows the least square means for carcass and non-carcass components of broiler chicken fed diets containing different levels of Seaweed (Spinosum). Inclusion of Seaweed affected some parameters of carcass and non-carcass components. Final body weight was affected by inclusion of seaweed in the diet whereby a higher weight was noted for Sw1.5 and Sw2 and was slightly lower for Sw0 and Sw1. Carcass weight was highest for Sw1.5 and lowest for Sw0 and the differences between the treatments were significant. The trend for dressing percentage, was similar to that of carcass weight and whereby highest dressing percentage was in Sw1.5 followed by Sw2, Sw1 and lowest in Sw0. No significant differences were observed for breast, thigh, drumstick and head percentages between dietary treatments. Statistical differences between treatments were observed for legs but there was no significant difference for GIT %, GIT Length, Liver % and Heart % between all dietary treatments. On the other hand, gizzard % was lowest for Sw1.5.

| Variables | Sw0 | Sw1 | Sw1.5 | Sw2 | P-Value |
|---|---|---|---|---|---|
| Final body wt (gms) | $2229.4 \pm 100.5^{a}$ | $2271.9 \pm 100.5^{b}$ | $2481.9 \pm 100.5^{a}$ | $2465.0 \pm 100.5^{a}$ | 0.0056 |
| Carcass wt (gms) | $1673.8 \pm 83.0^{b}$ | $1730.6 \pm 83.0^{ab}$ | $1961.3 \pm 83.0^{a}$ | $1903.8 \pm 83.0^{ab}$ | 0.0035 |
| Dressing % | $75.0 \pm 0.7^{c}$ | $76.0 \pm 0.7^{bc}$ | $79.0 \pm 0.7^{a}$ | $77.2 \pm 0.7^{ab}$ | 0.0039 |
| Breast % | 7.5 ± 0.3 | 7.4 ± 0.3 | 8.3 ± 0.3 | 7.8 ± 0.3 | 0.2257 |
| Thigh % | 5.9 ± 0.4 | 6.8 ± 0.4 | 6.0 ± 0.4 | 6.2 ± 0.4 | 0.5389 |
| Drumstic % | 4.8 ± 0.2 | 4.9 ± 0.2 | 4.8 ± 0.2 | 4.8 ± 0.2 | 0.8435 |
| Head % | 2.3 ± 0.1 | 2.3 ± 0.1 | 2.3 ± 0.1 | 2.1 ± 0.1 | 0.3903 |
| Legs % | $3.7 \pm 0.2^{ab}$ | $4.0 \pm 0.2^{a}$ | $3.4 \pm 0.7^{b}$ | $3.7 \pm 0.7^{ab}$ | 0.0031 |
| GIT % | 4.7 ± 0.3 | 4.9 ± 0.3 | 4.3 ± 0.3 | 4.6 ± 0.3 | 0.7682 |
| GIT Leng % | 7.6 ± 0.4 | 8.1 ± 0.4 | 7.6 ± 0.4 | 7.6 ± 0.4 | 0.9675 |
| Gizzard % | $2.6 \pm 0.2^{a}$ | $2.4 \pm 0.2^{ab}$ | $1.8 \pm 0.2^{b}$ | $2.0 \pm 0.2^{b}$ | 0.0334 |
| Liver % | 2.0 ± 0.2 | 2.0 ± 0.2 | 2.1 ± 0.2 | 2.1 ± 0.2 | 0.7665 |
| Heart % | $0.5 \pm 0.1^{a}$ | $0.5 \pm 0.1^{a}$ | $0.5 \pm 0.1^{a}$ | $0.5 \pm 0.1^{a}$ | 0.0334 |
| Spleen % | $0.1 \pm 0.0^{a}$ | $0.2 \pm 0.0^{b}$ | $0.1 \pm 0.0^{a}$ | $0.1 \pm 0.0^{a}$ | > 0.0001 |

***Table 4:*** *Effect of dietary treatments on carcass and non-carcass components at 7 weeks of age.*

*[a, b, c] Least square mean within the same row with at least one common letter script do not differ significantly (p > 0.05).*

*Note: Values are expressed as percentage of live weight.*

### Effect of dietary treatment on lean, bone and fat

The least square means on lean, bone and fat are shown in table 5. The effect of dietary treatments on lean, bone and fat showed no significant difference between treatments. The effect of seaweed as mineral premix for bone was insignificant but values in Sw0 and Sw1 were slightly higher than Sw1.5 and Sw2. Proportion of fat was slightly affected by treatment whereby an increase with increasing levels of seaweed was noted.

| | Dietary treatments (%) | | | | |
|---|---|---|---|---|---|
| **Variables** | **Sw0** | **Sw1** | **Sw1.5** | **Sw2** | **P-Value** |
| Lean | 56.4 ± 1.5 | 56.5 ± 1.5 | 59.6 ± 1.5 | 59.5 ± 1.5 | 0.3179 |
| Bone | 18.9 ± 0.8 | 18.6 ± 0.8 | 17.5 ± 0.8 | 17.8 ± 0.8 | 0.7550 |
| Fat | 9.2 ± 10.9 | 9.9 ± 10.9 | 24.7 ± 10.9 | 25.4 ± 10.9 | 0.3565 |

***Table 5:*** *Least square means (± SE) for broiler performances on lean, bone and fat.*
*Key: Sw0 = 0% Seaweed; Sw1 = 1% Seaweed; Sw1.5 = 1.5% Seaweed Sw2 = 2% Seaweed.*

### Effect of dietary treatments on tissue distribution

The effect of dietary treatments on tissue distribution of breast, thigh and drumstick are presented in table 6. The present study observed insignificant differences ($P > 0.05$) between the dietary treatments as far as muscles were concerned for each tissues (breast, thigh and drumstick). However the breast muscles were a bit heavier in Sw1.5, followed by Sw0, Sw1 and Sw2 was the last. Chickens from Sw0 had heaviest thigh muscles whereas the lowest were from $T_2$.

| | Dietary treatments | | | | |
|---|---|---|---|---|---|
| **Variables** | **Sw0** | **Sw1** | **Sw1.5** | **Sw2** | **P- Value** |
| Breast Muscle | 97.6 ± 1.0 | 97.0 ± 1.0 | 97.8 ± 1.0 | 96.8 ± 1.0 | 0.8708 |
| Bone | 1.0 ± 0.4 | 1.1 ± 0.4 | 0.9 ± 0.4 | 0.8 ± 0.4 | 0.9741 |
| Fat | 1.3 ± 0.8 | 1.8 ± 0.8 | 1.2 ± 0.8 | 2.3 ± 0.8 | 0.7153 |
| Thigh Muscle | 79.6 ± 3.5 | 69.9 ± 3.5 | 78.9 ± 3.5 | 77.9 ± 3.5 | 0.2411 |
| Bone | 12.5 ± 0.9 | 11.9 ± 0.9 | 12.6 ± 0.9 | 13.8 ± 0.9 | 0.5130 |
| Fat | 7.9 ± 1.7 | 10.4 ± 1.7 | 8.4 ± 1.7 | 8.3 ± 1.7 | 0.7451 |
| Drumstick Muscle | 70.5 ± 1.5[ab] | 66.9 ± 1.5[b] | 70.7 ± 1.5[ab] | 73.0 ± 1.5[a] | 0.0819 |
| Bone | 1.0 ± 0.0[d] | 2.0 ± 0.0[c] | 3.0 ± 0.0[b] | 4.0 ± 0.0[a] | <0001 |
| Fat | 2.5 ± 0.6 | 2.5 ± 0.6 | 2.5 ± 0.6 | 2.5 ± 0.6 | 1.000 |

***Table 6:*** *Least square means (± SE) on tissue distribution of breast, thigh and drumstick of broiler chickens.*
*Key: Sw0 = 0% Seaweed; Sw1 = 1% Seaweed; Sw1.5 = 1.5% Seaweed; Sw2 = 2% Seaweed.*

For drumstick muscle chickens from Sw2 were a bit heavier, followed by Sw1.5, then Sw0 and Sw1 had lighter muscles. The difference in weight of bone for breast and thigh was insignificant ($p > 0.05$). But variations were noted in breast bone, Sw1 was slightly heavier, followed by Sw0, then Sw1.5 and Sw2. For Thigh bone, heavy weight was noted in Sw2, then followed by Sw1.5, Sw0 and Sw1. However, highly significant differences ($P < 0.05$) were noted for the bone of drumstick. The weight of drumstick bone from chicken in Sw2 was heavier, then Sw1.5, Sw1 and Sw0 was the lowest.

Differences in fat weight, were insignificant (P > 0.05) between all tissues (breast, thigh and drumstick) in their respective dietary treatments. Heaviest breast fat was noted in Sw2, followed by Sw1, then Sw0 and last one Sw1.5. Thigh fat was highest in Sw1, then Sw1.5, followed by Sw2 and lastly Sw0. Drumstick's fat, was similar across all treatment diets.

### Effect of dietary treatments on tenderness of broiler meat

The effect of seaweed inclusion in the diet as mineral premix on tenderness of different parts of broiler meat chicken is presented in table 7. The results in this study showed that, difference in tenderness for breast, drumstick and thigh muscles between the treatments were insignificant (P > 0.05), although shear force values were lowest for Sw0 and higher in Sw1, Sw2 and Sw1.5. However, significant differences (P < 0.05) tenderness for drumstick muscles between the dietary treatments were noted. The highest tenderness was for Sw1.5 and the lowest was in Sw2.

| | Dietary treatments | | | | |
|---|---|---|---|---|---|
| **Variables** | **Sw0** | **Sw1** | **Sw1.5** | **Sw2** | **P-Value** |
| Breast | 19.4 ± 1.7 | 20.1 ± 1.7 | 21.3 ± 1.7 | 20.5 ± 1.7 | 0.8320 |
| Thigh | 15.8 ± 1.2 | 16.7 ± 1.2 | 16.2 ± 1.2 | 19.9 ± 1.2 | 0.1334 |
| Drumstick | 16.0 ± 1.2 | 16.2 ± 1.2 | 15.1 ± 1.2 | 20.1 ± 1.2 | 0.0343 |

***Table 7:*** *Least square means (± SE) on tenderness of different parts in broiler chicken fed on diet supplemented with different level of seaweed as minerals source.*
*Key: Sw0 = 0% Seaweed; Sw1 = 1% Seaweed; Sw1.5 = 1.5% Seaweed; Sw2 = 2% Seaweed.*

## Discussion

### Effect of dietary treatment on final weight gain, carcass and non-carcass component of broiler chickens

The final means of live weight of broiler birds across the experimental diets at seven week of age ranged from 2.2 in Sw0 and 2.5kg in Sw2. The higher final weight observed in seaweed based diets (Sw1.5 and Sw2) in the present study was probably due to physical properties of seaweed such as high solubility, high nitrogen free extract and low anti-nutritional factors [4,5]. Another reason could be that the level of seaweed in the diets of the present study was within the acceptable limit, since it is believed that seaweed promote growth rate up to 5%, when the level is beyond 5% decline in growth rate is noted, possibly due to increased level of anti-nutritional factors contained in some seaweed species [6].

The results of the current study concur with the findings by [7] who reported weight of 2.3 kg of broiler birds during disposal. The minor differences in final body weight between findings of the present study and other studies was probably due to individual variation such observe since male animal have higher live weight gain and carcass weight compared to female [8]. Similar results of increasing body weight and other carcass components were also reported by [7] when inclusion of seaweed in pelleted diets resulted into better feed efficiency.

The carcass components such as breast, thigh and drumstick were not significantly affected by dietary treatment probably due to similarity of amino acids availability in the dietary treatments. The cause for the observed increase in spleen % noted in Sw1 in comparison with other dietary treatments is not clear. However, studies by [9] and [10] showed that some wild species of seaweed *Colpomenia sinuosa* led to increased weight of internal organs such as the kidney. This feature could be probably due to the presence of Anti-nutritional factor (ANF) whereby the detoxification processes tend to sometimes increase organ weight.

The lighter gizzard weight for Sw1.5 was probably due to the nature of the feed. The presence of aqueous milieu might have softened the feed, thereby increasing passage rate and solubility. This in turn led to less grinding/mechanical action by the gizzard. Similar results were reported by [11], whereby broilers fed cassava pellet diet showed lower gizzard weight than those fed corn or cassava chips diets. The insignificant differences for liver % amongst all dietary treatments was probably due to equal supply of glucose for hepatic regulation of blood glucose and its accumulation in the form of glycogen. Whether the increase of liver weight is caused by such proposed mechanism is not very clear. The cause for the slightly higher liver weight value obtained in the present study compared with the one reported by [7] is not clear although it might be associated with type and species of the seaweed used. The increase in absolute weight for legs observed in the present study for Sw1 and Sw2 conformed to the findings reported by [12], who found that Tibia weight and bone mineralization were influenced by level of Calcium whereby low-Calcium diet resulted into lower bone weight and ash content. Also these results agree with the findings obtained by [13] who stated that, bone - mineral content, bone mineral density and ash percentage increased linearly as the level of dietary calcium increased from 0.45 to 0.91%. The observed low Ca level in Sw1.5 despite high seaweed (1.5%) compared to 1% in Sw1 and subsequent low leg % was unexpected. Probably the unexpected results obtained in the present study might be due to uneven distribution of the individual feed ingredients during feed mixing (hand mixing). The insignificant differences observed for the other non- carcass components in the current study might be due to equal proportion of most of the required nutrients.

### Effect of dietary treatments on lean, bone and fat

The least square means on Lean, Bone and Fat are presented in table 5, the effect of dietary treatments on Lean percentage showed that, there was no significant difference between the treatments, however, minor variation were observed between them. In Sw0 and Sw1 had similar results (56.6 percentage) and the same situation with Sw1.5 and Sw2 (59.6 percentage). Based on the variations observed between treatments, we can still say that, the dietary treatments which had seaweed inclusion performed better than those receiving either small amount of seaweed or completely no seaweed. The report by [14] mentioned that, chicken with access to grass had higher percentage breast and drumstick and lower abdominal fat, however, it also stated that organic production system seems to be a good alternative production method due to better welfare conditions and good quality of the carcass meat. However, the values of the present study to some extent resemble those reported by [15] the similarity could be due to type of seaweed used i.e. *Eucheuma cottonii* and *Gracilaria verrucosa*.

Dietary treatments had no significant effect on bone percentage, although minor variations were observed between the treatments. These results indicate that seaweed as a premix in the diet tended to have a positive effect on body bone development. The present findings were similar to that of [16] who observed the effect of dietary supplemental probiotic on morphometric parameter and yield stress of the bones (tibia, tibiotarsal index). The similarity might be due to the minerals content available in the tested feed ingredient (seaweeds).

Dietary treatments of the present study showed no significant difference between the treatments as far as fat percentages was concerned, Yet differences in absolute weight within the treatments were noted whereby Sw0 and Sw1 had lighter weight of fat while Sw1.5 and Sw2 had the heaviest fat content. Heavy weight of fat in Sw1.5 and Sw2 could be due to the fact that, the dry matter feed intake of these two treatments were higher compared to Sw0 and Sw1. In that context, the broiler chickens under Sw1.5 and Sw2 consumed more calories, put on more weight, and had excess fat content compared to chickens in the other dietary treatments. Other studies showed that, naturally young animals including chickens need high concentration of nutrients in the diet during the early stages of growth in order to support multiplication of tissues and maintenance. The demand of nutrients decline towards attainment of maximum growth [17] For that reason, when the maximum growth of broiler is achieved the feed or nutrients are mainly used for maintenance only or fat deposition. However, the values obtained in the present study was different from that reported by [18]. The reason for the variations could be due to type of fat analysed such as (abdominal and body fat), fat content of the diet, chemical composition of the feed ingredients and mode of the diet preparation such as pellet or mash form.

### Effect of the dietary treatments on tissue distribution

The least square means of dietary treatments on tissues distribution are presented in table 6. The effect of seaweed inclusion (as mineral premix) was insignificant throughout tissue distribution. The only significant difference was for the drum stick tissues (bone tissue) and there were high significant differences ($P < 0.05$) between the Sw1.5 and Sw2. The heaviest drumstick bones of broilers in Sw2 then Sw1.5 compared to those in Sw1 and Sw0 treatments could be an indication that, Sw1.5 and Sw2 containing higher percentage of seaweed (1.5 and 2%) and that probably had higher mineral content thus influencing bone development. The increase in absolute weight for legs observed in the present study for Sw1.5 and Sw2 conformed to the findings reported by [12] who found that Tibia weight and bone mineralization were influenced by level of Calcium whereby low-Calcium diet resulted into lower bone weight and ash content. Also these results agree with the findings obtained by [13] who stated that, bone - mineral content, bone mineral density and ash percentage increased linearly as the level of dietary calcium increased from 0.45 to 0.91%.

The non-significant differences for tissue distributions such as lean especially breast muscle and fat tissues was an indication that, all dietary treatments had almost similar crude protein level in the diet. [19,20] reported that in balance level of CP in the broiler diet can lead to linear increases of fat deposition.

### Effect of dietary treatments on tenderness of broiler meat

The effect of experimental diets on tenderness of different parts of the broiler meat chicken showed that dietary treatments had no significant effect on tenderness. On other hand, the overall outcome showed that the meat in all dietary treatments were very tender since the maximum shear force values did not exceed 30 Newton. The tenderness of the meat is influenced by factors such as age, type and level of fatty acids in the diet. Normally a diet with low concentration of polyunsaturated fatty acids produces tender meat [21]. In the present study the level and type of fatty acids available in the diet were not determined. However, the values for fat obtained in the present study were different from those reported by [7]. The reasons for the differences might be age, type of chicks and level of fatty acid in the diet, could also be due to individual variation exist among the hybrid.

## Conclusion

Inclusion level of seaweed as mineral premix had effect on carcass yield and dressing percentage. However, no other effect was observed for breast, thigh and drumstick.

The seaweed inclusion in the diet had no effect on non-carcass components as percentage, the only effect was noted in some component whereby reduction in spleen percentage was noted.

Inclusion level of seaweed had effect on overall body fat content whereby increase of body fat was observed in Sw1.5 and Sw2.

The inclusion level of seaweed in the broiler diet had an effect on tissue distribution especially for bone tissues. There was increased weight of thigh and drumstick's bone in Sw1.5 and Sw2.

Seaweed inclusion at 1.5% (Sw1.5) had overall positive effect on all dependent variables i.e. dietary treatments which contained 1.5% can be considered as optimum in broiler diets.

## Recommendations

As far as the present study is concerned, the seaweed inclusion level at 1.5% (as source of premix) was the best, since good performance was observed for this dietary treatment. However, it can also be recommended that, broiler chickens supplemented with seaweed as premix, should be slaughtered at the age of six week, so carcass (subcutaneous/abdominal) fat content may be reduced, because it seems that, the diet with seaweed content increased appetite and thus more calories are taken by bird.

It is recommended that, further studies need to be done on the effects of seaweed in broiler chickens, layers and other class of poultry and livestock in general in mineral supplementation. Based on the potential of seaweed production in Tanzania the need of doing further research of various seaweed grown in the country is there, so as to understand their effect on animal performance.

## Conflict of Interest

Authors declare that they do not have any conflict of interest regarding the material discussed in this paper.

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## Bibliography

1. Aklilu H., *et al.* "Village poultry consumption and marketing in relation to gender, religious festivals and market access". *Tropical Animal Health and Production* 39 (2007): 165-168.
2. Guni FS., *et al*. "Performance evaluation of kruilor and Sasso Chicken Breeds Reared under on farm and on station management Conditions in Tanzania". *European Journal of Agriculture and Food Science* 3.2 (2021): 53-59.
3. Chauynarong N., *et al*. "Potential of cassava products in diets for poultry". *World's Poultry Science Journal* 65.1 (2009): 23-36.
4. Rioux LE., *et al*. "Characterization of polysaccharides extracted from brown seaweeds". *Carbohydrate Polymers* 69.3 (2007): 530-537.
5. Al-Harthi MA. and El-Deek AA. "Nutrient profiles of brown marine algae (*Sargassum dentifebium*) as affected by different processing methods for chicken". *Journal Food Agriculture Environment* 10 (2012): 475-480.
6. Zaki MA., *et al*. "The use of seaweed meal in feeding common carp (*Cyprinus carpio*)". Asian Australas". *Journal of Animal Science* 7 (1994): 183-189.
7. Broadbent LA., *et al*. "The composition of the broiler chicken at 56 days of age: output, components and chemical composition". *British Poultry Science* 22.4 (1981): 385-390.
8. El-Deek AA and Brikaa AM. "Effect of different levels of seaweed in starter and finisher diets in pellet and mash form on performance and carcass quality of ducks". *International Journal Poultry Science* 8 (2009): 1014-1021.
9. Widyarantne GP., *et al*. "Effects of protein level and digestibility on growth and carcass characteristics of broiler chickens". *Poultry Science* 90 (2011): 595-603.
10. AA El-Deekx and A Mervat Brikaa. "Effect of Different Levels of Seaweed in Starter and Finisher Diets in Pellet and Mash Form on Performance and Carcass Quality of Ducks". *International Journal Poultry Science* 8.10 (2009): 1014-1021.
11. El-Deek AA., *et al*. "The use of brown algae meal in finisher broiler diets". *Egyptian Poultry Science* 3 (2011): 767-781.
12. Promthong S., *et al.* "The comparative effects of corn and cassava diets on physiological properties of gastrointestinal tract of broilers". *Editorial Board: Natural Sciences and Social Sciences* (2007): 113.

13. Hamdi M., *et al.* "Effect of different levels of calcium and phosphorus and their interaction on the performance of young broilers". *Poultry Science* (2015): 177.

14. Onyango EM., *et al*. "Bone densitometry as an indicator of percentage tibia ash in broiler chicks fed varying dietary calcium and phosphorus levels". *Poultry Science* 82.11 (2003): 1787-1791.

15. Castellini C., *et al*. "Effect of organic production system on broiler carcass and meat quality". *Meat Science* 60.3 (2002): 219-225.

16. Pantjawidjaja S. "The effects of feeding diets containing sea-grass on the final body weight, carcass percentage, and abdominal fat of broilers". *Jurnal Ilmu Dan Teknologi Peternakan* 1.3 (2011): 56- 59.

17. Mutuş R., *et al*. "The effect of dietary probiotic supplementation on tibial bone characteristics and strength in broilers". *Poultry Science* 85.9 (2006): 1621-1625.

18. Goliomytis M., *et al*. "Growth curves for body weight and major component parts, feed consumption, and mortality of male broiler chickens raised to maturity". *Poultry science* 82.7 (2003): 1061-1068.

19. Bartov I and Plavnik. "Moderate excess of dietary protein increases breast meat yield of broiler chicks". *Poultry Science* 77 (1998): 680-688.

20. Rostagno HS., *et al.* "Brazillian table for poultry and swine: Composition of Feedstuffs and Nutritional Requirements". (Edited by Rostagno, H. S.), Brazil (2017): 22.

21. Schilling MW., *et al*. "Dietary inclusion level effects of distillers dried grains with soluble on broiler meat quality". *Poultry Science* 89 (2010): 752-760.

**Volume 7 Issue 9 September 2022**