

# Sustainability of leftover food in restaurants as alternative cheap feed resources in poultry nutrition

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## ABSTRACT

**Aim:** The study was aimed to evaluate the impact of feeding dried restaurants food leftovers (DRFLM) as partial replacement of the expensive maize on growth performances and carcass characteristics of broiler chickens.

**Method and materials:** The DRFLM was mixed with other feed ingredients as replacement of maize at 0% (control diet, T<sub>1</sub>), 5% (T<sub>2</sub>), 10% (T<sub>3</sub>) and 15% (T<sub>4</sub>) respectively. After four weeks of brooding, one hundred sixty unsexed broiler chickens were randomly allocated into four treatment diets with four replicates of 10 chicks each. Feed consumption and body weight were measured on daily and weekly basis respectively. At the end of the feeding trial, two birds (one male and female) were used to evaluate the carcass components. The daily feed consumption (g/chicken) was 108, 109, 110 and 110 for T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> diets respectively.

**Results:** Chickens reared on control diet had the lower ( $p < 0.05$ ) final body weight (1790g) than those of T<sub>2</sub> (1834g), T<sub>3</sub> (1867g) and T<sub>4</sub> (1914g) but differed significantly ( $p < 0.05$ ) from each other. The lowest feed conversion ratio (kg feed/kg weight gain) was recorded with chickens fed on T<sub>4</sub> (2.77) as compared to those reared on T<sub>1</sub> (2.93), T<sub>2</sub> (2.89) and T<sub>3</sub> diets (2.85) and differed significantly ( $p < 0.05$ ) from each other. Male chickens had ( $p < 0.05$ ) higher values for all carcass components than females except for wings. Chickens fed with T<sub>4</sub> had higher ( $p < 0.05$ ) breast meat, thighs, drumsticks and keel bone meat values than those of T<sub>1</sub>. Chickens fed on T<sub>4</sub> had higher ( $p < 0.05$ ) thighs and drumsticks than those of T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> diets. The highest dressing percentage was observed in chickens reared in T<sub>4</sub> (68.1%) followed by T<sub>3</sub> (66.8%) and differed ( $p < 0.05$ ) from those of T<sub>2</sub> (64.2%) and T<sub>1</sub> (63.7%).

**Conclusion:** In conclusion, the DRFLM can safely be included up to 15% in the broiler diets by replacing maize grain in smallholder poultry settings for improved and sustainable food security of the poor community.

**Keywords:** Broiler Chickens, Carcass Consumption, Growth Performance, Restaurants Food Leftover.

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## Introduction

The major staple foods are maize, sorghum, banana, wheat, rice and millet. These staple foods contain small quantities of low-quality protein due to lack of some essential amino acids like lysine, threonine, the sulphur containing amino acids (methionine and cysteine) and tryptophan (Oko *et al.*, 2021). As a result, most of the people have been recurrently exposed to under nutrition. However, chicken meat and eggs are rich in these essential amino acids along with important vitamins and minerals (Aberra *et al.*, 2014).

Consequently, these products can bridge the gap in providing high quality protein (Odoemelam *et al.*, 2020) and other essential nutrients to the rural and urban communities. Nearly all rural and peri-urban families in developing countries keep a small flock of free-range poultry. They can be raised in a wide range of environments with little investment. Nevertheless, the productivity of poultry in most tropical regions has been limited due to inaccessibility and productive chickens (Yitbarek *et al.*, 2019). Tesfaye *et al.* (2015) further reported on suitability of dried restaurants leftover feed on nutrient digestibility in growing castrated male pigs. Thus, the aim of this study was to investigate the significance of feeding dried restaurants food leftover as a partial replacement of maize grain on growth performances and carcass components of broiler chickens.

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## Materials and Methods

### Location of Study Area

The study will be conducted at the Poultry Unit of Imo State Polytechnic Umuagwo, Nigeria. Imo State Polytechnic Umuagwo, Nigeria is located at the site is situated between longitudes 7° 01 06<sup>11</sup>E and 7° 03<sup>1</sup> 00<sup>11</sup> and latitudes 5° 28<sup>1</sup> 00<sup>11</sup>N and 5° 30<sup>1</sup> 00<sup>11</sup>N in the humid tropical West Africa (IMLS, 2009). The climate is marked by two seasons.

### Preparation of Feed Ingredients

The feed ingredients used in the formulation of the experimental rations contain dried restaurants food leftover, maize grains, wheat bran, soybean meal, lysine, methionine, salt, vitamin premix and limestone. The restaurants food leftover was collected from students' restaurants at Imo State Polytechnic Umuagwo, Nigeria from 31<sup>st</sup> March, 2021 to 30<sup>th</sup> April, 2021. It was then spread on plastic sheet and sun-dried for about 3 days to reduce the moisture content. During the drying process, it was hand-stirred about five times a day to facilitate the drying process while every evening it was kept indoors. After completing the drying process, any hard materials and indigestible wastes such as bones were collected by hand and discarded. The dried leftover was then milled to produce the final leftover, which is hereafter referred as dried restaurants leftover DRFLM). Maize grain was purchased feed ingredient vendor at Owerri, Imo State, Nigeria and milled. Wheat bran, soybean meal and limestone were also purchased from the feed ingredient vendor while vitamin premix, lysine, and methionine were obtained from local Feed Processing Plants. Finally, the experimental diets were formulated in a mash form by mixing all milled feed ingredients to meet the minimum nutrient requirements broiler chickens (NRC, 1994).

### Experimental Design and Treatment Diets

A completely randomized design consisting of four treatment diets with four replicates was applied (Table 1). The control diet (T<sub>1</sub>) contained maize as the main energy source without DRFLM and the remaining treatments were formulated to contain DRFLM at 5, 10, and 15% representing treatment 2 (T<sub>2</sub>), treatment 3 (T<sub>3</sub>) and treatment four (T<sub>4</sub>, Table 1). Three hundred day-old unsexed Cobb-500 broiler chicks were used for the study. The chicks were initially kept in a brooder house during which they were provided with a commercial starter ration *ad libitum*. At the end of

the brooding period, one hundred sixty unsexed broiler chicks were individually weighted and blocked into four categories based on similarities in their body weight. This blocking was essential to have a uniform bodyweight distribution across treatment diets. The individual chick from each block was then randomly allocated to four treatment diets in a completely randomized design. Each treatment diet was further replicated 4 times with 10 birds each.

### Management of Experimental Birds

Before the arrival of the experimental animals, each pen of the deep litter housing was cleaned and fumigated using formaldehyde solution. The concrete floor was covered with wood shavings at a depth of 5 cm. Each pen had a dimension of 1.5 × 2 m, which was designed to accommodate a minimum of ten chickens along with feeders and drinkers. The chicks were vaccinated against Newcastle (HB1 at day 7 through eye drop, Lasota at day 21 with drinking water) and Infectious Bursal Disease (Gumboro) at 14 and 28 days with drinking water respectively.

Table1. The proportion of feed ingredients used in formulating the experimental rations

Ingredients (%)	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>
Maize	54.0	49.0	44.0	39.0
Wheat bran	6.0	6.0	6.0	6.0
Soybean meal	35.0	35.0	35.0	35.0
DRFLM	0.0	5.0	10.0	15.0
Limestone	1.5	1.5	1.5	1.5
Salt	0.5	0.5	0.5	0.5
Vitamin premix	0.5	0.5	0.5	0.5
Methionine	1.5	1.5	1.5	1.5
Lysine	1.0	1.0	1.0	1.0
Total	100	100	100	100

## Data collection procedures

### Feed Intake and Body Weight

A measured amount of feed was offered twice a day at 8:30 am and late afternoon at 5:30 pm throughout the entire period. Feed refusal was collected the next day every morning before feed was offered. Feed intake was then calculated by difference between the feed offered and refused. Finally, the total feed intake per chicken was determined by adding the daily feed consumption. The chicks were weighed individually at the beginning of the experiment and then on weekly basis up to the end of the experimental period. Total bodyweight gain was then calculated as the difference between the final and initial weight, while the average daily weight gains were

computed by dividing the total weight gain by the number of the experimental days. Feed conversion ratio (kg feed/ kg gain) was calculated by dividing the total feed consumed (kg) with the total body weight gain (kg) during the experimental period. The experiment lasted 42 days exclusive of the brooding period.

#### *Carcass Components*

At the end of the feeding trial, two birds (one male and female) were randomly selected from each replicate and deprived food overnight. In the next morning, the birds were weighted (taken as pre-slaughter weight) on digital weighing balance and slaughtered by cutting the jugular vein and eviscerated manually. The weight of the dressed carcass was taken after removing all visceral organs and non-edible cuts. The dressed carcass was dissected to the different parts of the carcasses (skin, thighs and drumsticks, wings, breast region, neck, keel bone meat and thorax and backbone) and giblets (gizzard, heart and, liver). All carcass components were weighed inclusive of bones. The dressing percentage was calculated from dressed carcass weight as a percentage of the slaughter weight.

#### *Nutrient Composition Analysis*

Analyses of proximate nutrients were performed as outlined by AOAC (2005). Samples of feed ingredients were analyzed for dry matter (DM, method 950.46), ether extract (EE, method 920.39), crude fibre (CF, method 962.09) and ash (method 942.05). Nitrogen was determined according to the procedure of Kjeldahl and crude protein (CP) was calculated as  $N \times 6.25$ . Nitrogen free extract (NFE) was determined by using the following equation:  $NFE = 100 - (\% \text{ moisture} + \% \text{ CP} + \% \text{ CF} + \% \text{ Ash} + \% \text{ EE})$ .

Metabolisable energy (ME) of feed ingredients and experimental diets were calculated by indirect method according to Wiseman (1987) as follows:  $ME \text{ (kcal/kg DM)} = 3951 + 54.4 * EE - 88.7 * CF - 40.8 * Ash$ . Chemical analyses of experimental feed samples for determination of DM, EE, CF, ash and CP content were conducted at the Nutrition Laboratory of School of Science Laboratory Technology at Imo State Polytechnic Umuagwo Nigeria.

#### *Statistical Analysis*

For growth performances (final body weight, weight gain, feed intake and feed conversion ratio), the replicate was the average of all broiler chickens in each pen. The data were then subjected

to one-way ANOVA (SAS, 2012, ver. 9.4) by fitting the effect of treatment diets as independent variables. For carcass evaluation, the replicate was the average of two birds (female and male) per pen. Data on carcass components were then subjected to two-way ANOVA by fitting treatment diets, sex and their interactions as main effects. Since the interaction effect for all variables was insignificant, it was dropped from the statistical model. When ANOVA declared significant, the mean differences among fixed effects was compared by using Turkey's Studentized Range (HSD) Test.

## **Results and Discussion**

### *Nutrient Compositions of Experimental Diets*

The analyzed nutrient compositions, calculated ME and NFE values of feed ingredients in formulated ration and treatment diets were recorded (Table 2). The NFE represents the non-structural carbohydrates such as starches and sugars in a given feed ingredient. The content of NFE in DRFLM was comparable to that of maize. The results indicated that DRFLM had higher CP and ME contents than the replaced maize. The T<sub>3</sub> and T<sub>4</sub> diets had higher CP content than the control diet while control diet has slightly higher ME than other treatment diets.

### *Nutrient Intake*

The results of feeding different levels of DRFLM on average daily feed and nutrient consumption were recorded (Table 3). Significance difference was observed in intakes of daily feed, CP, CF, EE and ash among treatment diets. Accordingly, chickens fed with treatments diets had a higher ( $p < 0.05$ ) daily feed intake than those of the control diet. The CP intake was higher ( $p < 0.05$ ) in chickens reared in T<sub>4</sub> and T<sub>3</sub> than those of T<sub>2</sub> and T<sub>1</sub>. Chickens of T<sub>4</sub> and T<sub>3</sub> consumed lower ( $p < 0.05$ ) CF than those of T<sub>2</sub> and T<sub>1</sub>. Similarly, the EE intake was lowest in T<sub>4</sub> and T<sub>3</sub> and differed ( $p < 0.05$ ) from those of T<sub>2</sub> and T<sub>1</sub>. The highest ash intake was observed in chickens raised in T<sub>4</sub>, followed by T<sub>3</sub>, T<sub>2</sub> and T<sub>1</sub> and differed significantly from each (Table 3).

### *Growth Performance and Feed Conversion Efficiency*

The effect of feeding different levels of DRFLM on growth performances and feed conversion ratio was recorded (Table 4). The results showed that the final body weight and total body weight gain increased with increasing levels DRFLM resulting in a significant difference among treatment diets. The lowest FCR was observed in chickens fed with T<sub>4</sub> followed by T<sub>3</sub>, T<sub>2</sub> and T<sub>1</sub> diets and differed

Table 2. Nutrient compositions of feed ingredients and experimental diets (% in DM basis)

Ingredients and treatment diets	DM	CP	EE	CF	Ash	NFE	ME (kcal/kgDM)
<b>Feed ingredients</b>							
Maize	91.5	8.93	5.65	4.97	1.58	70.3	3753
DRFLM	92.3	16.1	3.02	2.16	2.55	68.4	3812
Soybean meal	94.2	40.6	7.01	8.82	5.62	32.2	3321
Wheat bran	89.7	15.0	2.51	7.26	3.89	61.1	3285
Starter ration	92.3	21.8	5.02	7.88	9.42	48.1	3141
<b>Treatment diets</b>							
T1	93.4	19.9	4.54	5.84	6.33	56.8	3422
T2	93.7	19.9	4.46	5.74	6.45	56.7	3405
T3	93.9	20.2	4.35	5.65	6.51	56.8	3404
T4	94.0	20.3	4.11	5.59	6.58	57.4	3401

DM = dry matter; CP = crude protein; EE = ether extract; CF = crude fiber; NFE = nitrogen-free extract; ME = metabolisable energy; DRFLM = dried restaurants food leftover meal

Table 3. Feed and nutrient intakes of chickens fed with experimental diets

Intakes	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	SEM	P- value
Feed (g/chicken/day)	108 <sup>b</sup>	109 <sup>a</sup>	110 <sup>a</sup>	110 <sup>a</sup>	0.25	0.0001
Crude protein	21.2 <sup>c</sup>	21.8 <sup>b</sup>	22.2 <sup>a</sup>	22.4 <sup>a</sup>	0.11	<0.0001
Crude fiber	6.30 <sup>a</sup>	6.28 <sup>a</sup>	6.21 <sup>b</sup>	6.16 <sup>b</sup>	0.02	0.0001
Ether extract	4.90 <sup>a</sup>	4.88 <sup>a</sup>	4.78 <sup>b</sup>	4.53 <sup>c</sup>	0.03	<.0001
Ash	6.83 <sup>d</sup>	7.06 <sup>c</sup>	7.16 <sup>b</sup>	7.25 <sup>a</sup>	0.04	<.0001

a-d Means between treatment diets with different superscript letters are significant at  $p < 0.05$  SEM = standard error of the mean

Table 4. Effects of substituting maize with different levels of dried restaurants food leftover on body weight, feed intake, feed conversion ratio and mortality rate

Parameters (kg/chicken)	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	SEM	P-value
Initial body weight	0.244	0.244	0.245	0.244	0.10	0.6257
Final body weight	1.790 <sup>d</sup>	1.834 <sup>c</sup>	1.867 <sup>b</sup>	1.914 <sup>a</sup>	11.7	<.0001
Weight gain	1.547 <sup>d</sup>	1.591 <sup>c</sup>	1.623 <sup>b</sup>	1.670 <sup>a</sup>	11.6	<.0001
Feed intake	4.532 <sup>b</sup>	4.596 <sup>a</sup>	4.616 <sup>a</sup>	4.627 <sup>a</sup>	10.7	0.0002
FCR (kg feed/ kg weight gain)	2.93 <sup>a</sup>	2.89 <sup>b</sup>	2.85 <sup>c</sup>	2.77 <sup>d</sup>	0.02	<.0001

a-d Means between treatment diets with different superscript letters are significant at  $p < 0.05$  FCR = feed conversion ratio; SEM = standard error of the mean.

significantly from each other. The result further indicated that various substitution levels of DRFLM did not show significance difference in mortality rate although the highest was observed in T<sub>2</sub>.

#### Carcass Components

The results showed that there was a significant difference in slaughter and dressed carcass weights among treatment diets (Table 5). Accordingly, chickens reared in T<sub>4</sub> had higher ( $p < 0.05$ ) slaughter and dressed carcass weights than those fed on the other treatment diets. However, no significance difference was observed in slaughter weight among chickens fed with T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> diets. Similarly, dressed carcass weight was insignificant between T<sub>1</sub> and T<sub>2</sub> diets. The dressing percentage was similar in chickens fed on T<sub>3</sub> and T<sub>4</sub> diets but was higher ( $p < 0.05$ ) than that of T<sub>1</sub> and T<sub>2</sub>. Chickens fed with T<sub>4</sub> diet had higher

( $p < 0.05$ ) breast meat, thighs, drumsticks and keel bone meat values than those of the control diet. The highest values for thighs, and drumsticks were observed in chickens fed with T<sub>4</sub> diet and differed ( $p < 0.05$ ) from those of T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>. No significant difference was observed in skin and giblets among treatment diets. Findings further indicated that male chickens recorded ( $p < 0.05$ ) higher values for all carcass components than females except for wings.

#### Nutrient Composition

The present findings indicated that the analyzed CP content (16.1%) of DRFLM was slightly lower than reported by Asmamaw and Dinberu (2015) and Enasa *et al.* (2018) (17.4-17.5%) while the EE content was higher than the findings of the same authors. Saki *et al.* (2006) reported 12.7% CP content in kitchen waste, which is lower than observed in the present study.

Table 5. Effects of substituting maize with different levels of dried restaurants food leftover on carcass components

Carcass traits (g).	Female	Male	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	SEM	P-value
Sex								
Slaughter weight	1801	1888	1790b	1834b	1836b	1918a	41.9	<.0001
Dressed carcass	1260	1353	1140c	1177c	1227b	1308a	28.3	<.0001
Dressing %*	66.1	67.6	63.7b	64.2b	66.8a	68.1a	1.26	0.0017
Breast meat	364	395	357c	372bc	387ab	403a	12.5	<.0001
Thighs	193	202	188c	194c	202b	208a	4.21	<.0001
Drumsticks	158	175	146c	155c	166b	200a	7.62	<.0001
Keel bone meat	155	164	155b	157ab	161ab	166a	6.58	0.0010
Backbone	91.0	103	85.9c	100ab	94.4bc	109a	7.83	0.0002
Skin	91.6	95.6	91.7	92.2	94.3	96.3	3.97	0.0083
Wings	68.5	69.6	67.9b	68.6ab	69.6ab	70.2a	1.52	0.0541
Neck	47.7	50.8	49.0c	38.5d	53.6b	56.0a	1.06	<.0001
Gizzard	38.8	41.0	38.4	40.8	38.5	41.8	2.51	0.0175
Heart	13.5	14.4	13.3	14.1	13.9	14.6	0.99	0.0172
Liver	36.4	40.9	37.0	37.9	38.8	41.0	4.34	0.0074

a- d Means between treatments with different superscript letters are significant at  $p < 0.0$  \*Exclusive of giblets; SEM = standard error of the mean.

Similarly, Tesfaye *et al.* (2015) reported much lower CP values (9.0%) for restaurants food leftover. On the other hand, Tesfaye *et al.* (2015) and Enasa *et al.* (2018) reported higher EE and ash values in restaurant leftover foods, respectively than found in the current study. Such variations might be due to the type of leftover (kitchens, hotels and restaurants) and the proportion of food components used to prepare the food by different catering services. The CP content of DRFLM in the current study was lower than the recommended CP requirement (19-21%) of broiler chickens (NRC, 1994). It is therefore necessary that energy rich feed ingredients such as maize or DRFLM must be mixed with the feed ingredients that have high protein contents to increase the average daily CP consumption of the birds. The (metabolisable energy) ME content of DRFLM in the present study was relatively higher than observed in the maize grain indicating its potential to be used as energy source feed (Akinfemi *et al.*, 2018) by substituting the much expensive maize grain. Saki *et al.* (2006) and NRC (1994) respectively reported 3530 and 3380 kcal/kg ME for kitchen waste and waste leftover, which was lower than of DRFLM in the present study. Such differences might be due to the composition of the original feed materials presented in both waste products.

#### Feed Intake and Growth Performance

Birds reared in treatments diets consumed significantly higher feed than those reared on the control diet, which is consistent with the results of Ahaotu *et al.* (2018) and Saki *et al.* (2006) reported a significant increase of feed consumption in broiler chickens fed with 10% kitchen waste as compared with the other treatments. Moreover,

consistent with current findings, Cho *et al.* (2004) reported significantly higher daily feed consumption at 20% level of dried leftover food than broilers fed with the control diet. Likewise, Ahaotu *et al.* (2019) and Kim *et al.* (2001) reported that higher levels of swine manure and food leftover mixture in layer hen's diet increased the feed consumption, which is in good agreement with the current observations.

On the other hand, Tesfaye *et al.* (2015) and Enasa *et al.* (2018) found that the inclusion of different levels of restaurants food leftover in pigs' diet and restaurant leftover food in duck's diet did not affect feed consumption. In another study, by Abera (2020) reported that feeding grain milling by-products significantly reduced feed intake of White leghorn chickens. Such variations are expected because of using different animal species as well as chicken breeds that could respond differently to such leftover feed materials. Chickens reared on T<sub>4</sub> diet had higher CP consumption as compared to those of T<sub>1</sub> and T<sub>2</sub> diets, which justify that the consumption was improved with increasing substitution levels of DRFLM. This can be explained by the fact that the CP content in DRFLM is much higher than that of maize grain, which would apparently result in increased consumption of CP. The current results also indicated that broiler chickens fed with T<sub>1</sub> and T<sub>2</sub> diets had a similar EE and CF intakes while the lowest CF consumption was observed in those fed on T<sub>4</sub> diet. The result further showed that chickens fed on T<sub>4</sub> diet had higher ash consumption than those of the control diet (T<sub>1</sub>).

Growth performance is one of the main factors for determining the productivity of broiler chickens. The observation of the current study indicated that chickens fed on increased DRFLM levels (T<sub>2</sub>, T<sub>3</sub>, and T<sub>4</sub> diets) had higher final weight and weight gain than those reared on control diet. These results were consistent with those of Chen *et al.* (2007) who found that the addition of 5% dehydrated food waste products to broiler's diets increased body weight gains up to 8 weeks of their age. The current findings further showed that chickens reared on diet containing a high level of DRFLM (15%) as a substitution of maize grain had the highest body weight gain when compared to those chickens reared on T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> diets. Farhat *et al.* (2001) and Enasa (2018) revealed that ducks fed on partial food wastes had higher growth performance than those fed on the control diet, which was in line with the current results. The findings also indicated that there was an increasing trend in body weight gain with an increased substitution level of restaurants food leftover over the experimental period. These observations were in good agreement with that of Saki *et al.* (2006) who reported that dietary inclusion of kitchen waste at 10, 20 and 30% improved the growth performance (body weight, weight gain and feed conversion ratio) of broiler chickens and the best level was obtained at 10% substitution level. Similarly, Tesfaye *et al.* (2015) reported an increasing trend in total body weight gain of pigs as the proportion of DRFLM increased in a conventional concentrate mixture diet. On the other hand, Westendorf *et al.* (1998) reported that the inclusion of kitchen wastes in broiler diets resulted in decreased body weight. Such variations might be associated with the constituents of the food leftover, type of chicken breed and maize varieties used in the study.

Uzoma *et al.*, (2019) and Hascik *et al.* (2010) reported that a low FCR (kg feed/kg gain) was a good indication of high quality feed with least cost benefit for poultry producers. The finding of this study showed that chickens fed on T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> diets had comparatively a reduced feed conversion ratio than those of the control diet. The best feed conversion ratio was recorded by the birds fed on diet containing 15% DRFLM (T<sub>4</sub>) as compared with those fed on the diet. This observation was consistent with that of Enasa *et al.* (2018) who reported a reduced feed conversion ratio as the dried food leftover increased. Cho *et al.*

(2004) and Chen *et al.* (2007) reported a significant increase of feed conversion ratio in layer and broiler chickens fed with diets containing dried leftover food as compared with the control group. On the other hand, Saki *et al.* (2006) and Tamasgen (2015) reported no significant effect of substitution of maize with leftover food on feed conversion ratio in the performance of White leghorn chickens. This could be explained by the fact that White leghorn chickens were layer type breeds with small body size, which could respond less to high levels of such unconventional feed materials. Moreover, it may be due to the difference in nutrient contents of feed ingredients used in the experimental ration, management, environmental and climate variations.

#### *Carcass Characteristics*

Chicken meat is an important protein source for consumers particularly to those whose daily food consumption is based on cereal grains. The combined effect of the feed consumptions, feed conversion ratio, and weight gain has a direct impact on the live weight, carcass weight and dressing percentage (Martinez *et al.*, 2015). The mean values of slaughter, dressed carcass, breast, thigh, and drumsticks were recorded higher values in male chickens than female chickens. The observations are in good agreement with the findings of Bogosavljevic *et al.* (2006) and Aberra *et al.* (2013) who reported that cocks had significantly larger breast and drumstick yields than hens. The higher values of carcass traits observed in male chickens might be attributed to the presence of sex hormones mainly that of androgen, which might be responsible for enhanced muscle development as compared with estrogen (the major sex hormone) that is mostly responsible for fat deposition rather than muscle tissue development (Aberra *et al.*, 2013).

In the current study, breast meat was significantly higher in T<sub>3</sub> and T<sub>4</sub> groups than other treatment diets which are in line with the findings of Saki *et al.* (2006) who reported that chickens fed with kitchen waste had significantly higher breast meat value than those of the control diet. In the current study, DRFLM had more CP and ME values than the substituted maize grain. In this regard, Marcu *et al.* (2013) and Infante-Rodríguez *et al.* (2016) reported that higher energy and protein contents in the diet increased the weight of carcass, thigh, and breast yields. On the other hand, Chen *et al.* (2007) reported no significant difference in

dressing percentage, carcass weight, and weights of drumsticks, breast, and thigh between chickens fed with control diet and different levels of dehydrated food wastes. Similarly, Enasa *et al.* (2018) reported the absence of significant effect of leftover food on carcass weights and dressing percentages of Muscovy duck. Such contradictory findings might be explained by the type of poultry species used in both experiments, in which the duck gastrointestinal tract might have a better ability to digest the relatively high fiber content of the leftover food as suggested by Chen *et al.* (2007).

The weight of giblets (gizzard, liver and heart) did not differ among treatment diets, which is in good agreement with the results of Enasa *et al.* (2018) who reported non-significant effect of leftover food on the diet of Muscovy ducks. This observation may suggest that DRFLM did not have any negative effect on the normal function of these vital organs. This has been further reflected to the levels of DRFLM in which the weights of heart, gizzard, and liver increased with increased levels of DRFLM in the diets. Moreover, Cho *et al.* (2004) reported an increase in the weight of total edible offal (which included giblets) without significant differences among chickens fed with an increased level of DRFLM.

### Conclusion

It was concluded that substitution of dried restaurants food leftover up to 15% in broilers diet had a positive effect on growth performances and carcass components. Therefore, levels of substitution from 5% to 15% can be used as an alternative energy sources in broilers diets by substituting the expensive maize grain. However, considering the advantage of reducing high costs of maize grain, a substitution rate of 15% and perhaps higher could be justifiable under smallholder production settings for optimum exploitation of the resource. It should be noted that such practices are only recommended if there is a reliable supply of restaurants food leftover in a given location. Authors suggest future works focusing on the comprehensive laboratory analysis of mineral (both macro and micro) and amino acid compositions of restaurants food leftover.

### Reference

- Aberra M (2014). Significance of scavenging chicken production in the rural community of Africa for enhanced food security. *World's Poultry Science Journal*, 70: 593-606.
- Aberra M (2020). Substitution effect of maize (*Zea mays*) with grain milling by-products on egg production and hatchability of eggs in White leghorn layer hens. *Journal of Biology, Agriculture and Healthcare*, 10 (9).
- Aberra M, Mengistu M and Aster A (2018). The substitution effect of noug seed (*Guizotia abyssinica*) cake with cassava leaf (*Manihot esculata* C.) meal on feed intake, growth performance, and carcass traits in broiler chickens. *Journal of Animal Husbandry and Dairy Science*, 2(2): 1-9.
- Aberra M, Yoseph G, Kefyalew B and Sandips B (2013). Effect of feeding graded levels of *Moringa stenopetala* leaf meal on growth performance, carcass traits and some serum biochemical parameters of Koekoek chickens. *Livestock Science* 157: 498-505.
- Ahaotu EO, Emeribe EO and Akinfemi A (2018). Carcass and Performance Characteristics of Finisher Broiler Birds Fed Jack Bean (*Canavalia ensiformis*) Sievate Fortified with Exogenous Enzyme. *Journal of Meat Science and Technology*, 06 (2): 19-24.
- Ahaotu EO, Onuoha W and Uwaleke G and Agiang EA (2019). Sustainability of black Nera laying birds on pig dung meal based diets. *Sustainability, Agri, Food and Environmental Research*, 7(1): 1-17.
- Akinfemi A, Ososanya TO and Ahaotu EO (2018). Nutrient and Anti-Nutrient Components of Some Tropical Tree Seeds. *Nigerian J. Anim. Sci.*, 20 (1): 115-122.
- AOAC (Association of Official Analytical Chemists) (2005). *Official Methods of Analysis of the Official Analytical Chemists*, 18th Edn. (Horwitz, W., Eds.). Washington DC.
- Asmamaw Y and Dinberu M (2015). Effect of replacing conventional ration by cafeteria leftover on performance of Ross 308 broiler chicken. *International Journal of Life Sciences*, 4(4): 270-276.
- Bogoslavjevic-Boskovic S, Kurčubić V, Petkovic MD and Radovic V (2006). The effects of sex and rearing system on carcass composition and cut yields of broiler chickens. *Czech Journal of Animal Science*, 51(1): 31-38.
- Chen KL, Chang HJ, Yang SH, Jenq HD and Yu B (2007). Effect of dietary inclusion of dehydrated food waste products on Taiwan native chicken. *Asian-Australasian Journal*

- of Animal Sciences, 20(5): 754-760.
- Cho Y, Lee G, Jang J, Shin I, Myung K, Choi K, Bae I and Yang C (2004). Effects of feeding dried leftover food on growth and body composition of broiler chicks. *Asian-Australasian Journal of Animal Sciences*, 17(3): 386-393.
- Enasa A (2018). Using dried leftover food as nontraditional feed for Muscovy duck diet. *Assiut Veterinary Medical Journal*, 64: 107-114.
- EPHI (Ethiopian Public Health Institute) (2019). *Ethiopia National Food Consumption Survey*. August 2013.
- Farhat A, Normand L, Chavez ER and Touchburn SP (2001). Comparison of growth performance, carcass yield and composition, and fatty acid profiles of Pekin and Muscovy ducklings fed diets based on food wastes. *Canadian Journal of Animal Science*, 81(2): 107-114.
- Hascik P, Kacaniova M, Mihok M, Pochop J and Benzova E (2010). Performance of various broiler chicken hybrids fed with commercially produced feed mixtures. *International Journal of Poultry Science*, 9 (11): 1076-1082.
- Imo State Ministry of Lands and Survey (IMLS) (2019). Longitudes and Latitudes locations of Umuagwo, Ohaji Egbema Local Government Area of Imo State, Nigeria.
- Infante-Rodríguez F, Salinas-Chavira J, Montaña-Gómez MF, Manríquez-Nuñez OM, González-Vizcarra VM, Guevara-Florentino OF and Ramírez De León JA (2016). Effect of diets with different energy concentrations on growth performance, carcass characteristics and meat chemical composition of broiler chickens in dry tropics. *Springer Plus* 5: 1937.
- Kim CH, Song YH, Chae BJ and Rhee YC (2001). Effects of feeding extruded swine manure and food waste mixture diets on growth performance, body composition and feeding behavior of broilers. *Journal of Animal Science and Technology* 43(1): 91-100.
- Kojima S (2005). Dehydrated kitchen waste as a feedstuff for laying hens. *International Journal of Poultry Science*, 4 (9): 689-694.
- Marcu A, Vacaru-Oprîș I, Dumitrescu G, Marcu A, Petculescu CL, Nicula M, Dronca D, Kelcirov B (2013). Effect of diets with different energy and protein levels on breast muscle characteristics of broiler chickens. *Animal Science and Biotechnology*, 46: 333-340.
- Martinez Y, Carrión Y, Rodríguez R, Valdiviél M, Olmo C, Betancur C, Liu G, Dhahi NA and Duraipandiyan V (2015). Growth performance, organ weights and some blood parameters of replacement laying pullets fed with increasing levels of wheat bran. *Revista Brasileira de Ciência Avícola*, 17(3): 347-354.
- Myer RO, Brendemuhl JH and Johnson DD (1999). Evaluation of Dehydrated Restaurant Food Waste Products as Feedstuffs for Finishing Pigs. *Journal of Animal Science*, 77: 685-692.
- NRC (National Research Council) (1994). *Nutrient Requirements of Poultry*. 9th rev. ed. Natl. Acad. Press, Washington, DC, USA.
- Odoemelam S, Simeon-Ahaotu VC, Patricio De Los Ríos and Ahaotu EO (2020). Effects of Frangipanni (*Plumeria Rubra*) Leaf Meal as Feed Additive on the Performance and Egg Laying Index of Hy-Line Brown Birds. *International Journal of Research in Agriculture and Forestry*, 7 (2): 1-6.
- Oko EC, Ahaotu EO and Lawal M (2021). Evaluation of Market Demand for Alternative Poultry Feeds in Nigeria. *Acta Scientific Nutritional Health*, 5(8): 36-43.
- Saki A, Tabatabaie M, Ahamadi A, Hossenin S, Mirzayi S and Kianin A (2006). Nutritive value, metabolizable energy and viscosity of kitchen-waste on broiler chicken performance. *Pakistan Journal of Biological Sciences*, 9(10): 1970-1974.
- Tafese B, Lambert C, Riedel S, Aberra M and Biesalski HK (2019). Dietary diversity and anthropometric status of mother-child pairs from Enset (False Banana) staple areas: A panel evidence from southern Ethiopia. *International Journal of Environmental Research and Public Health*, 16 (12): 2170.
- Tamasgen N (2015). The effect of feeding graded level of dried cafeteria food leftover on egg production and quality of White Leghorn chickens. *Journal of Natural Sciences Research*, 5(7): 93-105.
- Tesfaye A, Mengistu U and Mitiku E (2015). Effects of different levels of dried cafeteria leftover feed on nutrient digestibility in growing castrated male pigs: implication for efficient



- alternative feed resources utilization. *International Invention Journal of Agricultural and Soil Science*, 3(1): 1-8.
- Truong L, Morash D, Liu Y and King A (2019). Food waste in animal feed with a focus on use for broilers. *International Journal of Recycling of Organic Waste in Agriculture*, 8: 417-429.
- Uzoma UF, Ahaotu EO, Olowo P and Nyako HD (2019). Response of High Dietary Energy Profile Meal from Processed Maize Products on Performance Parameters and Egg Quality of Shaver Brown Laying Birds. *International Journal of Research in Agriculture and Forestry*, 6 (1): 29-37.
- Westendorf M, Dong Z and Schoknecht P (1998). Recycled cafeteria food waste as a feed for swine: Nutrient content, digestibility, growth and meat quality. *Journal of Animal Science* 76: 2976- 2983.
- Wiseman J (1987). Feeding of non-ruminant livestock. Butterworth and C. Ltd. 370 p.
- Yitbarek MB, Abdelnour SA, Ahaotu EO and Olueze C (2019). Effects of Dried Unripe Plantain Peel Meal (*Musa paradisca*) on Performance, Carcass Quality and Internal Organs in Poultry Broiler Birds. *Acta Scientific Veterinary Sciences*, 1(5): 22-26.

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