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Research Article

Dietary Replacement of Maize with Graded Levels of Culled Composite Sweet Orange Fruit Meal on Growth, Nutrient Digestibility and Carcass Characteristics of Broiler Chickens

Ojinnaka Perpetua Ebere[1]*, Oluremi OIA[2] and Gwaza DS[3]

[1]*Department of Animal Production and Health, Federal University Wukari, Taraba State, Nigeria*

[2]*Department of Animal Nutrition, Federal University of Agriculture, Makurdi, Benue State, Nigeria*

[3]*Department of Animal Breeding and Physiology, Makurdi, Benue State, Nigeria*

***Corresponding Author:** Ojinnaka Perpetua Ebere, Department of Animal Production and Health, Federal University Wukari, Taraba State, Nigeria.

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Abstract

Background: The use of agricultural by-product for livestock has shown to reduce dependence of livestock on grains that is required by humans. This has become more important as the world human population and the amount of crop and food by-products have increased, particularly in developing countries.

Aim: A feeding trial was conducted to determine the effect of replacing maize with culled composite sweet orange fruit meal (CSOFM) in the diet of broiler chickens on their growth response. A total of one hundred and eighty (180) day old Marshall breed broiler chicks raised on deep litter were used. The birds were randomly grouped into 6, each of similar number and weight, and each group randomly assigned to one of the six dietary treatments. The treatments T1, T2, T3, T4, T5 and T6 were diets in which maize was replaced with culled composite sweet orange fruit meal at 0%, 5%, 10%, 15%, 20% and 25%, respectively. Each treatment had three replicates and ten (10) birds each, laid out in a completely randomized design. The feeding trial lasted eight (8) weeks of four (4) weeks starter phase and another four (4) weeks finisher phase. Growth performance and carcass analysis were carried out and subjected to analysis of variance and the statistically significant ($P<0.05$) means were separated using the Least Significant Difference.

Results: dietary replacement of maize with culled composite sweet orange meal had similar ($P>0.05$) growth response in starter and finisher broiler chickens. Treatment effect on carcass yield of finisher broiler chicken had comparable ($P>0.05$) dressing percent.

Conclusion: It was concluded that Culled composite sweet orange fruit meal could be included in broiler diets up to 25% without any adverse effect on growth and performance.

Keywords: Orange; Growth; Carcass; Nutrient Digestibility

Introduction

Despite the strong growth in food production, sub-Saharan Africa is the only region where the number of hungry has risen in the last decade [1]. The problem of people suffering from malnutrition in Africa is not only the result of insufficient food production and inadequate distribution, but also of the financial inability of average citizens to purchase food of reasonable quality in adequate quantities to satisfy their needs. Animal protein intake by most people in developing countries like Nigeria has consistently declined in recent years. To mitigate the growing protein-energy deficiency in livestock nutrition, several studies have been conducted and many more are on-going on the possibilities of employing inexpensive sources of protein and energy.

Agro-industrial by products (AIBPs) have been the focus of research in animal nutrition especially for monogastric animals. Babatunde [2] reported that integration of many of these AIBPs into animal feeding hold tremendous potentials in alleviating the existing situation of inadequate feed supply in the Nigeria poultry industry. Non-conventional feedstuffs (NCFs) refer to those feedstuffs which are not traditionally used as feedstuffs and/or are not normally used in commercial production of rations for animals. Several limitations to their utilization such as low protein content, high fibre, amino acids imbalance and presence of anti-nutritional factors have been identified [3,4]. Efforts have been made by researchers to discover non-conventional feed resources to substitute the ever increasing demand for these conventional feed resources. Large quantities of agricultural by-product which are regarded as non-conventional feed sources are produced in Nigeria [5].

The use of these agricultural by- product for livestock has been reported to reduce dependence of livestock on grains that can be consumed by humans in recent years. This has become more important as the world human population and the amount of crop and food by-products have increased, particularly in developing countries [6]. Due to the perishable property of surplus fruit during seasons of production in tropical countries, it would be convenient to develop methods of preservation that would enable these plant materials to be utilized as animal feeds for longer period of time [7]. Dried culled sweet orange (*Citrus sinensis*) is a potential source of some valuable nutrients for poultry feed as natural antioxidants [8]. Limonin is a tri-terpenoid present in the seeds and skins that imparts a bitter taste to citrus pulp. If large quantities of seeds are present their limonin content may render the pulp toxic to non-ruminants even at 2.5 % in their diets [9]. Limonene is practically non-toxic to birds and mammals [10].

Compounds such as tannis, saponin, phytate, oxalate and flavonoids have been identified in citrus peels but they are below the levels reported to be toxic to livestock species [11]. Oluremi *et al.* [12]. reported that sweet orange (*C. sinensis*) rind can be used to replace maize in the diet of broiler up to 15% inclusion level without any adverse effect on performance. This study is designed to determine the effect of graded levels of culled sweet orange (*Citrus sinensis)* fruit on the performance of broiler chickens.

Materials and Methods

Experimental site and description

The study was conducted at the Poultry unit of the Livestock Teaching and Research Farm, Federal University of Agriculture, Makurdi, Benue State. Makurdi is located on latitude 7°43' N and longitude 8°53' N [13]. Makurdi lies within the Guinea savannah region of Nigeria and has two distinct seasons which are the wet season which lasts from April to October with an annual rainfall that ranges from 1105 mm to 1600 mm and the dry season which lasts from November - March. The area is warm with an annual temperature range of 22.8°C to 40.0°C and annual relative humidity which ranges between 39.50 ± 2.20% and 64.00 ± 4.8% [14].

Preparation and source of test ingredient

Culled composite sweet orange (*Citrus sinensis*) fruits were collected from citrus fruit depot within Makurdi metropolis. The culled fruits were cut into four parts, the juices were manually extracted and the fruit waste was sun-dried on concrete floor until it attained about 10% moisture. Sun-dried composite sweet orange fruit waste was bagged for storage until when needed for feed compounding and it was milled, and analysed to determine its proximate composition using the Standard methods [15].

Experimental animals, design and management

A total of one hundred and eighty (180) day old Marshal breed broiler chicks were used for the feeding trial. The birds were randomly grouped into six (6) on equal number and similar weight basis. Each were assigned to one of the six (6) experimental dietary groups. Each treatment had three (3) replicates of ten (10) chicks each. The experiment was arranged in a completely randomized design and the birds were raised in deep litter. The feeding trial lasted for eight (8) weeks, consisting of four (4) weeks for the starter phase and four (4) weeks for the finisher phase. Feed and water were supplied to the birds *ad libitum.* Newcastle vaccine (i/o) was administered at day – old, infectious bursal vaccine was given at day 7, Newcastle vaccine (Lasota) at day 14, and infectious bursal vaccine at day 21using the dosage recommended by the National Veterinary Research Institute, Vom, Nigeria. Anti-stress supplement was administered, prior to and after each vaccination and pre and post weekly weighing of birds. Anti-coccidiosis was administered via drinking water at alternate weeks, and antibiotics given when necessary.

Experimental diets

Dried culled composite sweet orange fruit (CCSOF) was ground and used to replace maize in the control diet (T1) both at the starter and finisher phases at 5 %, 10 %, 15 %, 20 % and 25 % levels to give test experimental diets T2, T3, T4, T5 and T6, respectively. The other feed ingredients used in the formulation of the starter and finisher diets, were soybean meal, blood meal, brewers dried grain, limestone, premix, bone meal, palm oil, methionine, lysine and common salt as shown in table 1 and table 2 respectively.

Growth performance

The initial and final weights of the birds were taken at the start of both the starter and finisher phases and at weekly intervals. The weights were taken in replicate. Body weight gain was determined by the difference between weight of birds for the current week and previous week. Feed intake per replicate was determined weekly by the difference between weight of feed served and the left over. The feed conversion ratio (FCR) was computed using ratio of feed consumed and the body weight gain by birds using the formula:

$$FCR = \frac{\text{Feed consumed (g)}}{\text{Weight gain (g)}}$$

Ingredients	T1(0%)	T2(5%)	T3(10%)	T4(15%)	T5(20%)	T6(25%)
Maize	54.56	51.83	49.10	46.38	43.65	40.92
CCSOF	0	2.73	5.46	8.18	10.91	13.64
Soya bean meal	34.00	34.00	34.00	34.00	34.00	34.00
Blood meal	1.90	1.90	1.90	1.90	1.90	1.90
Brewers dried grains	4.30	4.30	4.30	4.30	4.30	4.30
Bone meal	2.90	2.90	2.90	2.90	2.90	2.90
Limestone	0.50	0.50	0.50	0.50	0.50	0.50
Common salt	0.25	0.25	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20	0.20
Palm oil	0.89	0.89	0.89	0.89	0.89	0.89
Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100
Calculated nutrients						
ME (kcal/kg)	2916.87	2940.80	2892.72	2880.69	2868.61	2856.53
Crude protein (%)	22.49	22.40	22.31	22.22	22.13	22.04
Crude fibre (%)	4.21	4.47	4.73	4.98	5.24	5.49
Ether extract (%)	3.84	3.77	3.70	3.63	3.57	3.50
Calcium (%)	1.23	1.23	1.23	1.23	1.23	1.23
Available phosphorus (%)	0.84	0.83	0.82	0.82	0.81	0.80
Lysine (%)	1.42	1.41	1.41	1.40	1.39	1.39
Methionine (%)	0.73	0.73	0.72	0.72	0.71	0.70

Table 1: Ingredients and Nutrient Composition of Broiler Starter Diet.

CCSOF: Culled Composite Sweet Orange Fruit, Premix (Animal care) supplied the following per kg: Vitamin A, 80000IU; Vitamin D3, 16000IU; Vitamin E, 5000mg; Vitamin K3, 200mg; ThiamineB1, 5000mg; RiboflavinB2, 4000mg; Pyridoxine B6, 500mg; Niacin, 16000mg; Vitamin B12, I mg; Pantothenic acid, 5000mg; Folic acid 5000mg; Biotin 20mg; Choline chloride 200mg; Antioxidant 125mg; Manganese 80mg; Zinc 50mg; Iron 20mg; Copper 5mg; Iodine 12mg; Selenium 200mg; Cobalt 200mg. ME= Metabolizable Energy = 37 (%CP) +81.8 (%EE) +35.5 (%NFE) by Pauzenga (1985). T1= Diet containing 0% dried culled composite sweet orange fruit, T2= Diet containing 5% dried culled composite sweet orange fruit, T3= Diet containing 10% dried culled composite sweet orange fruit, T4= Diet containing 15% dried culled composite sweet orange fruit, T5= Diet containing 20% dried culled composite sweet orange fruit.

Ingredients	T1 (0%)	T2 (5%)	T3 (10%)	T4 (15%)	T5 (20%)	T6 (25%)
Maize	55.60	52.82	50.04	47.26	44.48	41.70
CCSOF	0	2.78	5.56	8.34	11.12	13.90
Soya bean meal	31.00	31.00	31.00	31.00	31.00	31.00
Blood meal	2.40	2.40	2.40	2.40	2.40	2.40
Brewers dried grains	6.00	6.00	6.00	6.00	6.00	6.00
Bone meal	1.80	1.80	1.80	1.80	1.80	1.80
Limestone	1.20	1.20	1.20	1.20	1.20	1.20
Palm oil	0.95	0.95	0.95	0.95	0.95	0.95
Common salt	0.25	0.25	0.25	0.25	0.25	0.25
Premix*	0.30	0.30	0.30	0.30	0.30	0.30
Lysine	0.25	0.25	0.25	0.25	0.25	0.25

Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**	**100**	**100**
Calculated nutrients						
ME (kcal/kg)	2937.07	2924.77	2912.47	2900.18	2887.88	2875.58
Crude protein (%)	22.12	22.03	21.94	21.85	21.76	21.67
Crude fibre (%)	4.25	4.51	4.77	5.03	5.29	5.55
Ether extract (%)	3.89	3.82	3.75	3.68	3.62	3.55
Calcium (%)	1.17	1.16	1.16	1.16	1.16	1.16
Available phosphorus (%)	0.68	0.67	0.66	0.65	0.64	0.63
Lysine (%)	1.43	1.42	1.41	1.41	1.40	1.39
Methionine (%)	0.72	0.72	0.71	0.70	0.70	0.69

Table 2: Ingredients and Nutrients Composition of Broiler Finisher Diets.

CCSOF = Culled Composite Sweet Orange Fruit, Premix (Animal care) supplied the following per kg: Vitamin A, 80,000IU; Vitamin D3, 16000IU; Vitamin E, 5000mg; Vitamin K3, 2000mg; ThiamineB1, 5000mg; RiboflavinB2, 4000mg; PyridoxineB6,1500mg; Niacin, 16000mg; Vitamin B12, I mg; Pantothenic acid, 5000mg; Folic acid 5000mg; Botin 20mg; Choline chloride 200mg; Antioxidant 125mg; Manganese 80mg; Zinc 50mg; Iron 20mg; Copper 5mg; Iodine 12mg; Selenium 200mg; Cobalt 200mg. ME= Metabolizable energy calculated using the formula ME = 37 (%)+81.8 (%EE) + 35.5 (%NFE) by Pauzenga (1985). T1= Diet containing 0% dried culled composite sweet orange fruit, T2= Diet containing 5% dried culled composite sweet orange fruit, T3= Diet containing 10% dried culled composite sweet orange fruit, T4= Diet containing 15% dried culled composite sweet orange fruit, T5= Diet containing 20% dried culled composite sweet orange fruit.

Nutrient digestibility

Metabolic study was conducted in the last week of the feeding trial to determine dietary nutrient utilization of the broiler chickens. In each treatment, one bird per replicate were selected moved into metabolic cages and allowed an adjustment period of two days. Thereafter, the birds were served daily weighed ration (g) for five (5) days. Left over feed was collected and weighed to determine feed intake by difference. Wet faecal dropping were collected on daily basis from each replicate, weighed and oven-dried at 105^{0}C for 24 hours. Faecal sample per replicate were bulked, milled and an homogeneous sample analyzed for nutrient composition and gross energy content. A representative portion of feed sample per dietary treatment was analyzed using the procedure of A.O.A.C (16). Quantity of nutrients in diet and faeces were determined by multiplying nutrient percentage in diet and faeces by dry matter in diets and faeces respectively. Nutrient retained was then determined as nutrient intake minus nutrient voided in faeces. Apparent digestibility coefficient was calculated using the formula Where D = digestibility coefficient, I = nutrient intake and F = nutrient voided in faeces [17].

Carcass characteristics

At the end of the feeding trial, on the 56th day, three finisher broiler chickens were selected from each treatment such that their mean weight were similar to the whole treatment mean weight after they were fasted for 18 hours, and slaughtered. The slaughtered birds were dressed as recommended by Aduku and Olukosi [18]. Carcasses were de-feathered/plucked and eviscerated. The visceral, liver, heart, gizzard, intestine, spleen and abdominal fat were weighed and expressed as percentage of live weight. Cleaned carcass (without head, and shank), and carcass prime cuts (breast, thighs, neck, back, drumsticks, and wings) were weighed and expressed as percentage of dressed weight.

Statistical analysis

All data obtained were subjected to analysis of variance using Minitab [19] 16 Version, and where there were significance differences between means, the means were separated using the least significant difference (LSD) at 5% level of significance.

Result and Discussion

Effect of experimental diets on growth performance of starter broiler chicks

The effect of culled composite sweet orange fruit on growth performance of starter broiler chicks is presented on table 3. The initial body weight of the birds ranged from 42.30- 42.67g. No significant difference (P > 0.05) was observed in the final body weight of the birds and it ranged from 413.67 - 458.05g. The body weight gain ranged from 13.295-14.85 g/bird and was not affected significantly (P > 0.05) by the experimental diets. It was also observed that the diets had no significant (P > 0.05) effect on the feed conversion ratio and protein efficiency ratio and ranged from 1.95-2.27 and 0.41-0.52 respectively. Mortality did not vary significantly and was only recorded in groups fed the control diet, 5% and 10% of CCOSF based diets with values of 3.33%, 6.66% and 10% respectively. The daily feed intake as well as protein intake varied significantly (P < 0.05) and ranged from 27.16 - 32.20 g and 5.99 - 7.75 g respectively. Highest feed intake of 32.20 g was recorded in broilers fed 15% CCSOF, while the least (27.16g) was obtained in broilers fed 5% of CCSOF based diet. The protein intake was highest (7.75g) in birds fed 15% CCSOF based diet and least (5.99g) with those fed 25% of CCSOF based diet.

Parameters			Experimental Diets				SEM
	T1	T2	T3	T4	T5	T6	
Initial body weight (g/bird)	42.60	42.50	42.53	42.30	42.63	42.67	0.10^{ns}
Final body weight (g/bird)	433.26	433.66	458.03	454.66	413.67	414.67	24.25^{ns}
Daily body weight gain (g/bird)	13.95	13.97	14.85	14.73	13.25	13.28	0.87^{ns}
Feed intake (g/bird)	27.51^{bc}	27.16^{c}	29.84^{abc}	32.20^{a}	30.09^{ab}	30.43^{a}	0.86*
Feed Conversion ratio	2.02	1.95	2.01	2.19	2.27	2.29	0.86^{ns}
Protein efficiency ratio	0.47	0.47	0.41	0.52	0.46	0.45	0.08^{ns}
Protein intake (g/bird)	6.38^{b}	6.53^{b}	6.13^{b}	7.75^{a}	6.06^{b}	5.99^{b}	0.19*
Mortality (%)	3.33	6.66	10.00	0.00	0.00	0.00	3.04^{ns}

Table 3: Effect of Culled Composite Sweet Orange Fruit Peel Based Diets on Growth Performance of Starter Broiler Chicks.

$^{a, b, c}$ means on the same row with different superscripts are significantly different (P < 0.05), *(P < 0.05), ns= Not significant (P > 0.05), SEM = Standard error of mean, T1 = control diet, T2 = Diet containing 5% culled composite sweet orange fruit peel, T3= Diet containing 10% culled composite sweet orange fruit peel, T4 = containing 15% culled composite sweet orange fruit peel, T5 = Diet containing 20% culled composite sweet orange fruit peel, T6 = Diet containing 25% culled composite sweet orange fruit peel.

The initial body weight of the chicks across the dietary treatment did not differ significantly for a fair evaluation of the effect of the experimental diets on the starter broiler chicks. The significantly higher difference in feed intake at higher maize replacement with the composite sweet orange fruit showed improved dietary treatment palatability as against when the peels with astringent taste were used. The result of the study is in contrast to the findings of Oluremi., *et al.* [20], Agu., *et al.* [21] and Oluremi., *et al.* [11] who observed decline of feed intake with increased level of inclusion of sweet orange peel meal. The similarity of the final body weight across the dietary groups which is also shown in the body weight gain across the groups suggested that culled composite sweet orange fruit peel meal did not adversely affect the growth of the starter birds and thus can replace maize up to 25% level in broilers diets.

The daily body weight gain of 13.25 - 14.85g was lower than the range of 15.23 - 19.79g for starter broiler chicks reported by Ogar [22] and 34.44 - 43.17g reported by Madugu., *et al.* [23]. It was also within the range of 11.97 - 27.70g reported by Oluremi., *et al.* [20] when broiler chicks were fed with fermented sweet orange fruit peel meal. Feed conversion ratio of 1.95-2.29 in this study was however better than 2.25 - 3.09 reported by Oga [22] and 2.57 - 2.88 by Oluremi., *et al.* [20], but was within the range of 1.85 to 2.62 reported by Agu., *et al.* [21].

Management system and quality of feed are some of the factors responsible for variations in FCR [24] and may have contributed to the trend obtained in this study. Protein intake was higher at 15% replacement of maize with culled composite sweet orange fruit peel meal in starter broiler chicks diets, hence suggests that the dietary protein was best utilized at 15% maize replacement. Mortality varied from 0 - 10% and cannot be said to be as a result of dietary effect because no mortality occurred at 15%, 20%, and 25% maize replacement levels. The initial body weight of the chicks across the dietary treatment did not differ significantly for a fair evaluation of the effect of the experimental diets on the starter broiler chicks. The significantly higher difference in feed intake at higher maize replacement with the composite sweet orange fruit showed improved dietary treatment palatability as against when the peels with astringent taste were used. The result of the study is in contrast to the findings of Oluremi., *et al.* [20], Agu., *et al*. [21] and Oluremi *et al*. [11] who observed decline of feed intake with increased level of inclusion of sweet orange peel meal. The similarity of the final body weight across the dietary groups which is also shown in the body weight gain across the groups suggested that culled composite sweet orange fruit peel meal did not adversely affect the growth of the starter birds and thus can replace maize up to 25% level in broilers diets.

Nutrient digestibility of starter broiler chicks fed culled composite sweet orange fruit peel based diets.

The nutrient digestibility of starter broiler chicks fed composite sweet orange fruit peel based diets is presented in table 4. The result shows that there was no significant difference (P > 0.05) among dietary nutrients across the dietary treatments, with the exception (P < 0.05) of ether extract and ash. Ether extract content ranged from 69.84 - 87.30%. While the digestibility of the nutrient by the starter chicks in the sweet orange fruit peel diets were generally higher than the control, there was no particular trend in ether extract digestibility among the treatments. The ash level obtained ranged from 50.13 - 71.62% and the birds in the sweet orange based diets had lower values. As with the ether extract, there was no particular order in the significant variation of ash and the highest ash value was obtained in the control group (71.62%) while the least (39.57%) was in those fed 15% CCOSF based diet.

The digestibility of crude protein, nitrogen free extract and dry matter was high and were not significantly different (P > 0.05) while crude fibre was low among the treatments and ranged from 35.59 - 47.13%. CP, NFE and DM, digestibility ranged from 78.35-83.01%, 86.24 - 91.27% and 76.54 - 84.13% respectively. The highest dry matter digestibility was obtained in 10% dietary group, though not significantly different from those of the other treatment groups. The crude protein digestibility values obtained in this study were higher than 58.01-70.61% obtained by Orayaga [25] who fed soaked and unsoaked sweet orange peel meal to broiler chickens. The differences might be due to the fact that whole fruit was used in this current study whereas, only the peel were used in the study reported by Orayaga [25]. Crude fibre digestibility tends to be low across the dietary groups and did not vary significantly. This places the culled composite sweet orange fruit peel meal at a nutritive advantage. It has been reported by McDonald., *et al*. [26]. that high crude fibre depresses digestibility. Ether extract (EE) digestibility varied significantly among the treatment groups and appeared to be high in all treatment groups with the exception of group fed 5% CCSOF based diet. Ash retention varied significantly and was comparatively higher in the control diet than in the sweet orange based diets. The nitrogen free extract (NFE) digestibility was high and could be attributed to the fact that the entire culled composite sweet orange fruits meal were used as compared to most other studies in which peels were used [27,28].

Nutrients (%)			Experimental Diets				SEM
	T1	T2	T3	T4	T5	T6	
Dry matter	83.94	79.83	84.13	76.54	80.42	79.90	1.62^{ns}
Crude protein	82.67	81.44	83.01	78.35	78.79	78.78	1.83^{ns}
Crude fibre	42.24	47.13	46.18	45.50	35.59	45.01	4.20^{ns}
Ether extract	70.92^{cd}	69.84^{d}	77.27^{bc}	73.21^{cd}	87.30^{a}	82.24^{ab}	2.00*
Ash	71.62^{a}	50.13^{cd}	66.07^{ab}	39.57^{d}	67.03^{ab}	55.12^{bc}	4.65*
Nitrogen free extract	91.27	88.39	90.94	86.24	88.24	88.69	1.18^{ns}

Table 4: Nutrient Digestibility of Starter Broiler Chicks Fed Culled Composite Sweet Orange Fruit Peel Based Diets.

$^{a, b, c}$ means on the same row with different superscripts are significantly different (P < 0.05), *(P < 0.05), ns= Not significant (P > 0.05), SEM = Standard error of mean, T1 = control diet, T2 = Diet containing 5% culled composite sweet orange fruit peel, T3 = Diet containing 10% culled composite sweet orange fruit peel, T4 = containing 15% culled composite sweet orange fruit peel, T5 = Diet containing 20% culled composite sweet orange fruit peel, T6 = Diet containing 25% culled composite sweet orange fruit peel.

Effect of experimental diets on growth performance of finisher broiler chickens

The result of the growth performance of finisher broiler chickens fed CCOSF based diets is presented in table 5. Similar values (P > 0.05) were observed for initial body weight, final body weight, body weight gain, feed intake, feed conversion ratio, and mortality. However, experimental diets had significant effect (P < 0.05) on protein intake and protein efficiency ratio. The initial body weights ranged from 413.67 - 458.03g, final body weight, ranged from 1502.33 - 1852.00g. Daily body weight gain was least (P>0.05) in broilers fed 25% CCSOF based diet (38.13g) and highest in those fed the control diet (50.67g). The feed intake ranged from 114.37 - 117.55g. Feed conversion ratio did vary from 2.32 (control) to 2.99 (25% CCSOF). The highest protein intake of 21.07g was recorded in the control group and least intake of 15.27g was obtained in broilers fed 20% CCSOF based diet. Protein efficiency ratio ranged from 0.35 - 0.52. No mortality was obtained in the groups fed 20% and 25% of CCSOF based diets, while mortality recorded for the control, 5%, 10% and 15% dietary group was 33.3%, 6.66%, 3.33% and 3.33% respectively.

Parameters			Experimental Diets				SEM
	T1	T2	T3	T4	T5	T6	
Initial body weight (g/bird)	433.26	433.67	458.03	454.67	413.69	414.67	25.25^{ns}
Final body weight (g/bird)	1852.00	1612.33	1730.33	1751.33	1636.33	1502.33	2.48^{ns}
Daily body weight gain (g/bird)	50.67	42.09	45.44	46.31	43.67	38.13	2.94^{ns}
Feed intake (g/bird)	117.55	117.09	115.18	114.37	116.34	115.18	2.94^{ns}
Feed Conversion ratio	2.32	2.85	2.57	2.47	2.67	2.99	1.23^{ns}
Protein intake (g/bird)	21.07^{a}	20.49^{ab}	20.15^{b}	20.01^{b}	15.27^{c}	20.15^{b}	1.83*
Protein efficiency ratio	0.41^{bc}	0.49^{ab}	0.45^{abc}	0.43^{abc}	0.35^{c}	0.52^{a}	1.00*
Mortality (%)	3.33	6.66	3.33	3.33	0.00	0.00	1.14^{ns}

Table 5: Effect of Experimental Diets on Growth Performance of Finisher Broiler Chickens.

$^{a, b, c}$ means on the same row with different superscripts are significantly different (P < 0.05), *(P < 0.05), ns= Not significant (P > 0.05), SEM = Standard error of mean, T1 = control diet, T2 = Diet containing 5% culled composite sweet orange fruit peel, T3= Diet containing 10% culled composite sweet orange fruit peel, T4 = containing 15% culled composite sweet orange fruit peel, T5 = Diet containing 20% culled composite sweet orange fruit peel, T6 = Diet containing 25% culled composite sweet orange fruit peel.

The final body weights in this study varied from 1502.33 - 1852.00g. Oluyemi and Robert [29] reported that attainment of body weight of 1.6 kg to 1.8 kg at 8 - 10 weeks is a good performance. There was no significant difference among the treatments for body weight gain. This suggests that the diets containing the sweet orange fruit meal supported daily growth of experimental chickens as much as the control diet did. Feed consumption by the chickens was not significantly affected by the experimental diets and was higher than 83.04 - 94.95g obtained by Ogar [22]. Agu *et al*. [21] reported a similar feed intake in broilers fed varying levels of sweet orange peel as a replacement for maize. The non- significant difference in the amount of feed consumed across the dietary groups suggests that both the control diet (T1) and culled composite sweet orange fruit meal-based diets could meet the dietary requirements of the birds. Feed conversion ratio was better than 1.85 - 2.62g reported by Agu., *et al.* [21]. The feed conversion ratio range obtained in the present study is within the recommended range of 2- 5g considered normal for broilers chickens by Oluyemi and Roberts [29]. Oluremi., *et al.* [12] reported that sweet orange rind can be used in broiler up to 15% inclusion level without any adverse effect on their growth performance.

Protein intake in this study were significantly (P < 0.05) different and higher at 5% replacement of maize with composite sweet orange fruit meal in finisher broiler chick diets. A depression in protein intake was observed in the broiler chickens fed 20% CCSOF based diet which for reasons not yet clear, and this would have caused the significant variation in the protein intake among the dietary treatments, and in protein efficiency ratio in addition to the different test ingredients used for the study. Mortality was recorded in all the dietary treatments with the exception of 20% and 25% maize replacement with culled composite sweet orange fruit peel meal. This shows that the mortality recorded in other treatment was most probably not dietary induced.

Effect of experimental diets on the carcass yield of finisher broiler chickens

The result of the carcass yield of finisher broiler chickens fed CCSOF based diets is presented in table 6. No significant difference (P < 0.05) was observed on carcass yield characteristics of the broiler chickens. The fasted live weight was included to only to show the live weight of the chickens slaughtered and ranged from 1516.67g in 25% CSSOF dietary group to 1816.67g in the control group. Eviscerated weight varied narrowly and ranged from 1079.00g in broilers fed 20% CCSOF based diet to 1360.33g in the control group. Dressed weight followed varied from 974.00g in 20% dietary group to 1241.33g in the control group and dressing percent varied from 59.88 in 20% dietary group to 70.50 in 25% dietary group. All the carcass cuts were similar (P < 0.05) across the dietary treatments. The % DW of the breast cut which varied from 29.87 - 34.85% was higher than the % DW of each of the other carcass cuts namely drumstick 22.96 - 23.95%, thigh 23.16 - 23.5%, back 21.48 - 23.27%, wing 19.7 - 20.43% and neck 16.60 - 17.49%. None of the carcass cuts had a consistent sequence of variation.

Carcass indices			Experimental Diets				SEM
	T1	T2	T3	T4	T5	T6	
Fasted live weight (g/bird)	1816.67	1650.00	1716.67	1733.33	1616.67	1516.67	41.75^{ns}
Eviscerated weight (g/bird)	1360.33	1173.33	1222.33	1258.00	1079.00	1185.66	60.77^{ns}
Dressed weight (g/bird)	1241.33	1065.33	1110.66	1144.00	974.00	1070.66	54.86^{ns}
Dressing percent	68.33	64.72	65.21	65.98	59.88	70.50	3.69^{ns}
Thigh (% DW)	23.33	23.34	22.99	23.57	23.40	23.16	0.35^{ns}
Breast (%DW)	32.69	32.87	34.85	33.09	32.57	29.87	1.42^{ns}
Drumstick (%DW)	23.47	22.96	22.99	23.95	23.43	23.24	0.40^{ns}
Back (%DW)	23.27	23.20	21.48	22.54	22.29	22.74	0.57^{ns}
Neck (%DW)	17.49	17.05	16.85	16.60	17.22	17.10	0.46^{ns}
Wings (%DW)	19.74	20.26	19.47	20.06	20.06	20.43	0.29^{ns}

Table 6: Effect of Experimental Diets on the Carcass Yield of Finisher Broiler Chickens.

^{ns} Not significant (P < 0.05), SEM = Standard Error of Mean. T1 = Control Diet, T2 = Diet containing 5% culled composite sweet orange fruit peel, T3 = Diet containing 10% culled composite sweet orange fruit peel, T4= Diet containing 15% culled composite sweet orange fruit peel, T5=Diet containing 20% culled composite sweet orange fruit peel, T6 = Diet containing 25% culled composite sweet orange fruit peel, DW = Dressed weight.

The effect of experimental diets on the carcass yield of the finisher broiler chicken was not significant across the treatment groups in all the parameters considered namely thigh, breast, back, neck, wing, drumstick, dressed weight and dressed percent. Dressing percent values of 59.88 - 70.50% in the present study were lower than 74.49 - 89.94% reported by Ogar [22] but higher than 56.56 - 60.14% reported by Oluremi., *et al*. [20] when 30% of maize was substituted by fermented sweet orange peel meal in broiler diets. The difference could be attributed to the different types of test ingredients used. In the present study, whole sweet orange fruit was used, while in the study by Oluremi., *et al*. [20] sweet orange peel meal was used. Chemically, sweet oranges are valuable source of vitamin C as well as energy [30,31] and these could have been responsible for the insignificant variation in the carcass traits of broiler chickens across the dietary treatments. The meal with the culled composite sweet orange fruit tends to supply more nutrients than the peel based diets.

Conclusion

The replacement of maize with up to 25 % culled composite sweet orange fruit meal in the diets of starter and finisher chickens produced comparative growth response and had similar dressing percent with chickens fed the maize based control diet.

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Conflicts of Interest

The authors declare no conflict of interest.

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