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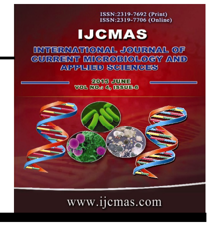

Original Research Article

Carcass Parameters and Sensory Characteristics of Broiler Chicken Fed Diets Containing Palm (*Elaeis guineensis*) Kernel Oil Residue

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A B S T R A C T

Palm Kernel Oil Residue (PKOR) is a waste product obtained after extracting oil from palm kernel by cottage industries. The residue is dumped at processing sites and the stench that emanates from the oxidizing product, causes nuisance to processors and nearby residents. Animal scientists are advocating the use of the fresh product as energy resource in broiler rations. This study was therefore conducted to determine the effects of partial replacement of maize in broiler rations with PKOR, on carcass parameters and sensory characteristics of broiler chicken. A total of 80 birds (10 from each treatment) were randomly selected from 160 birds fed diets containing 0% (control), 2.5%, 5.0%, 7.5%, 10%, 12.5%, 15% and 17.5% PKOR when they attained maturity age (8 weeks old). The selected birds were slaughtered, and hot carcass and viscera weights were taken. Carcasses were sectioned into primal cuts after 24-hour chilling at 3°C, and each part was weighed. The breast muscles were grilled for sensory evaluation. Proximate composition, ultimate pH (pH_u) and peroxide value of the muscles were determined. Data obtained were analyzed using the General Linear Model of ANOVA component of Minitab software. The results indicate that PKOR inclusion up to 17.5% in broiler rations has no significant ($p>0.05$) effects on carcass parameters and sensory characteristics of the meat. Crude protein and fat contents of the carcasses were not significantly ($p>0.05$) different. However, PKOR inclusions beyond 7.5% significantly ($p<0.001$) increased the moisture content of the muscles. Ultimate pH (pH after 24hours of slaughter) and peroxide value after 7 days in storage were not significantly affected by the use of PKOR. The study indicated that farmers can include PKOR up to 17.5% in broiler rations without adverse effects on the carcass and sensory characteristics of the meat.

Keywords

Palm kernel oil residue, Carcass parameters, Sensory characteristics, Broiler chicken

Introduction

The demand for poultry products especially chicken has increased over the years. Poultry meat importation increased from 9,160.00 metric tons in 1997 to 70,900.20 metric tons in 2010 (MOFA, 2011). This called for alternative ways of increasing production since there is demand for the product. The sector is however, met with high costs of production due to increasing costs of feed ingredients and other inputs, thus increasing excessively the costs of production (Flake and Ashitey, 2008).

This necessitated investigations into the potential of non-conventional, less expensive and readily available ingredients for use in formulating livestock rations. One of such ingredients is palm kernel oil residue (Anyang, 1999; Odoi *et al*., 2006).

Palm Kernel Oil Residue (PKOR) is the solid waste left after manual extraction of oil from the kernel of palm nut by cottage industries. Studies indicate that it is rich in energy, hence could be used in formulating livestock rations (Odoi *et al.*, 2006). Feeding trials involving the use of PKOR reported that growth rates and feed conversion ratios of broiler chicken were comparable with those fed conventional rations (Odoi *et al.*, 2006; Apori *et al*., 2013). The authors consequently advocated an extensive use of PKOR in broiler rations to reduce production costs.

Meanwhile, meat related studies indicate that the carcass quality of livestock, especially non-ruminant livestock is directly affected by the type of feed given and the inclusion rates of the various feed ingredients (Teye *et al.*, 2006; Lawrie and Ledward, 2006).

According to Okine *et al.* (2009) some feed ingredients contain anti-nutritive factors which result in adverse effects on the carcass yield and eating qualities of poultry. The present study therefore, sought to determine the effects of feeding PKOR to broiler chicken on the carcass parameters and sensory characteristics of the meat.

Materials and Methods

Study area

The study was conducted at the experimental house and laboratories of the School of Agriculture Teaching and Research Farm, College of Agriculture and Natural Sciences, University of Cape Coast, Ghana.

Experimental birds and rations

A total of eighty (80) broiler chicken (Cobb 500) of eight weeks old with a sex ratio of 1:1 were randomly selected for the study, from 160 birds raised on broiler rations in which dietary maize was substituted with palm kernel oil residue (PKOR) at levels of 0% (T1, control), 2.5% (T2), 5% (T3), 7.5% (T4), 10% (T5), 12.5% (T6), 15% (T7), and 17.5% (T8) PKOR inclusions. The experimental diet was fed to the birds from day-old till maturity (8 weeks old). The composition of the experimental diets is shown in Table 1.

Slaughtering of birds

Feed was withdrawn from the birds at 24 hours prior to slaughter. Each live bird was weighed with an electronic scale (Sartorius, CP 245S) and given robust identification tags to differentiate them especially during scalding and removal of feathers.

The birds were then stuck with a sharp knife to cut the jugular veins, and were allowed to bleed for approximately 60 seconds, after which they were scalded in warm water (70°C). The feathers were manually plucked, and the head and shanks removed. An incision was then made at the vent area to remove the viscera organs. The carcass was washed and hot carcass weight was recorded.

Carcass yield

The viscera were separated into intestines, gizzard, liver and spleen. The dressed carcass was chilled for 24 hours and cold weight taken. Primal cuts were obtained from the chilled carcass and each part weighed. The breast muscles were used for sensory evaluation and laboratory analyses.

pH of the muscles at 24 hours (pH_u) after slaughter

The ultimate pH (pH_u, taken 24 hrs after slaughter) of the muscles was done by making an incision at the breast region of the carcass and digital ph meter (CRISON, Basic 20, Spain) was inserted into the breast muscle. The readings were taken at approximately 1minute after the insertion of the pH meter.

Sensory evaluation of products

A total of twenty (20) panellists aged between 18 and 25 years (12 males and 8 females) were randomly selected and trained according to the British Standard Institution (BSI, 1993) guidelines to evaluate the products. The breast muscles were thawed and grilled to a core temperature of 70°C in an electric oven (Turbofan, Blue seal, UK). The products were sliced into uniform sizes (about 2cm) and wrapped with coded aluminium foils and presented to the panellists. Each panellist was provided with water and pieces of bread to serve as neutralizers between the products.

A five-point category scale was used to evaluate the sensory characteristics of the products as follows:

Colour: very pale (1), pale (2), intermediate (3), Dark (4), very Dark (5)
Off-odour: very weak (1), weak (2), intermediate (3), strong (4), very strong (5)
Juiciness: very juicy (1), juicy (2), intermediate (3), dry (4), very dry (5)
Flavour intensity: very weak (1), weak (2), intermediate (3), strong (4), very strong (5)
Flavour-liking: like very much (1), like (2), intermediate (3), dislike (4), dislike very much (5)
Overall acceptability: like very much (1), like (2), intermediate (3), dislike (4), dislike very much (5)

Proximate composition and Peroxide values (POV) of the muscles

Portions of the breast muscles were used to determine the proximate composition and peroxide value (after 7 days in storage), according to the methods of the AOAC (1999). Analyses were conducted in triplicates.

Data analysis

Data obtained were analyzed using the General Linear Model (GLM) of the Analysis of Variance (ANOVA) component of the Minitab Statistical Package, version 15 (MINITAB, 2007). Where significant differences existed, means were separated using the Tukey pair-wise comparison at 5% level of significance.

The dressing percentage, chilling loss (shrinkage), weights of visceral organs and primal cuts of the birds are presented in Table 2. There were no significant (p□0.005) differences in the various parameters measured.

The dressing percentages ranged between 79.34% and 82.83%.These figures were slightly higher than the findings of Taylor and Field (1998), who reported dressing percentage of 78% in commercial broilers. Teye *et al.* (2011) also reported dressing percentage range of 75.64% to 77%. The relatively higher dressing percentages recorded in the present study is an indication that the PKOR did not have any adverse effect on weight gain of the birds.

The weights of the breast, thigh, drumstick and wings did not vary significantly (P>0.05) from their respective control products. These cuts are the retail parts that are sold on weight basis to consumers. A reduction in the weights of these parts would result in revenue losses to producers and processors. The similarity in the weights of these parameters with their respective control treatments is an indication that the use of PKOR in broiler rations will not bring revenue losses to farmers and poultry processors.

There were no significant (P>0.05) differences in the weights of the visceral organs in the present study (Table 2). Occurrence of diseases in animals is evident in change in size and appearance of visceral organs of the animals. The colour of the organs did not vary from those of the control animals, indicating that the use of PKOR did not have adverse health effects on the animals.

The results from Table 2 indicate that PKOR could be used as a feed ingredient in broiler rations without adverse effects on carcass parameters and visceral organs. The moisture, crude protein and fat contents of the meat are presented in Table 3. The crude protein and fat contents of the meat were not significantly (P>0.05) different from their respective control products. The moisture content was however significantly (p<0.001) higher in the T6, T7 and T8 products than in the other products.

Protein and Fat are important constituents of meat. Meat serves as a major source of protein in human diets, hence meat is graded according to the level and quality of protein it possesses (Warris, 2010). The similar protein level of meat in the present study is an indication that the use of PKOR in broiler rations will not reduce the protein quality of the meat. Fat improves appearance, juiciness and other sensory qualities of meat (Lawrie and Ledward, 2006). The similar fat level in the meat is an indication that the sensory qualities of the meat will not be adversely affected.

There was no significant (P>0.05) differences in the sensory characteristics of the meat (Table 4).

Visual appraisal of products is one of the most important characteristics of food, and determines whether a consumer chooses or rejects products. According to Van Oeckel *et al*. (1999); Bell and Weaver, (2002), colour is a major indicator of quality of meat, as the appearance influences consumer acceptance. The similar colour of the products from this study is an indication that PKOR did not impart strange colour to the meat.

Odour is another important sensory parameter consumers consider when making purchasing decisions. An odour in a product which varies from what is traditionally known is considered as an off-odour. Consumers always select against products possessing off-odour, and that is detrimental to meat marketing. Salmon *et al.* (1984) reported that the frequency of off-flavor increased (P<0.05) when broilers were fed diets containing 5% herring fishmeal and this adversely affected product patronage. The results from this study indicated that there was no significant difference in Juiciness of the various treatments. Juiciness in meat arises from moisture released by meat during chewing, and moisture from saliva (Howard, 1976; Christensen *et al.*, 2000).

Table.1 Composition of the experimental diets/100kg formulation

Ingredient (kg)	T1	T2	T3	T4	T5	T6	T7	T8
Maize	46.0	44.8	43.6	42.4	41.2	40.0	38.8	37.6
Wheat bran	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
Soy bean	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
Fish meal	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5
Oyster shells	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
$NaCl_2$	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
RE3	75ml	75ml	75ml	75ml	75ml	75ml	75ml	75ml
***Toxibind**	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
PKOR	_	1.2	2.4	3.6	4.8	6.0	7.2	8.4

**Toxibind is an additive used to bind mycotoxins to render them inactive in the feed. The same feed was used for both day-old and growers, but the quantities of feed offered per day increased as the birds aged.*

Table.2 Carcass parameters of the birds

Parameter	T1	T2	T3	T4	T5	T6	T7	T8	SED	PV
Dressing %	80.32	82.83	81.21	79.34	82.32	80.99	81.02	81.38	1.14	0.060
Chilling loss (%)	0.69	0.64	0.75	0.63	0.54	0.53	0.78	0.65	0.01	0.300
Drumstick (g)	347.0	371.8	298.5	332.7	310.1	390.4	402.3	316.7	18.69	0.070
Thigh (g)	306.3	354.1	339.1	366.7	376.6	384.0	419.8	350.7	15.6	0.060
Breast (g)	799.3	900.4	855.4	847.2	881.0	859.0	994.8	892.8	31.49	0.090
Wing (g)	234.6	268.6	251.8	258.3	246.7	259.3	256.3	249.8	13.85	0.070
Spleen (g)	2.89	2.74	2.16	2.90	2.68	2.45	2.91	2.22	0.72	0.060
Gizzard (g)	54.35	57.46	52.66	54.78	56.44	52.99	52.56	54.23	5.37	0.080
Intestine (g)	81.34	82.84	84.63	83.08	81.96	82.49	82.05	82.44	3.64	0.240
Liver (g)	31.56	33.42	32.44	31.85	31.27	32.76	33.47	31.99	4.67	0.900
Heart (g)	6.33	5.87	6.02	6.49	7.00	6.61	6.08	5.99	1.20	0.090

SED= Standard error of difference; PV= p-value; WCW= warm carcass weight

Table.3 Proximate composition of the meat

Parameter	T1	T2	T3	T4	T5	T6	T7	T8	SED	PV
Moisture	72.89[b]	71.24[b]	72.26[b]	71.45[b]	75.31[a]	76.42[a]	76.45[a]	77.29[a]	3.24	0.000
C.P.	19.46	18.99	18.24	19.65	19.38	18.79	18.55	18.43	1.96	0.082
Fat	10.05	10.58	9.67	9.98	9.82	9.94	10.21	9.97	1.06	0.054

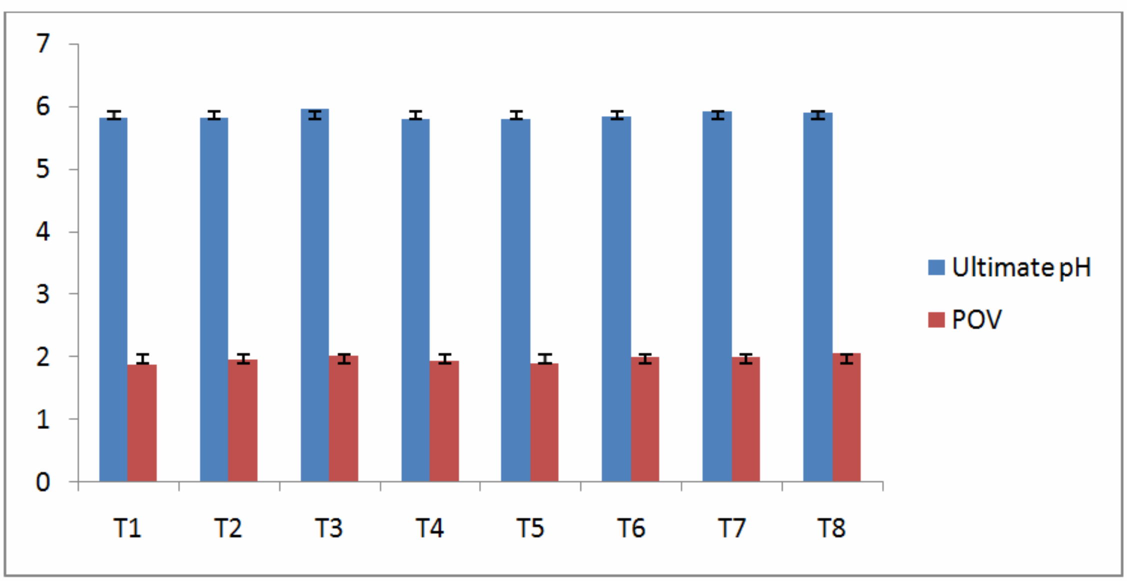
SED= Standard error of difference; PV=p-value, CP= crude protein

Table.4 Sensory characteristics of the meat

Parameter	T1	T2	T3	T4	T5	T6	T7	T8	SED	PV
Colour	2.6	2.4	2.3	2.4	2.3	2.2	2.4	2.3	0.49	0.23
Off-odour	1.8	1.9	2.1	1.8	1.9	1.9	1.8	1.9	0.31	0.19
Juiciness	3.3	3.4	3.6	3.6	3.5	3.8	3.5	3.7	0.22	0.64
Flavour intensity	3.4	3.6	3.5	3.4	3.4	3.6	3.5	3.8	0.19	0.25
Flavour liking	3.4	3.6	3.5	3.8	3.6	3.6	3.4	3.4	0.35	0.06
Overall acceptability	3.7	3.9	3.9	3.8	3.8	3.7	3.7	3.9	0.24	0.08

SED= Standard error of difference; PV= p-value; WCW= warm carcass weight

Figure.1 Peroxide values (POV) and ultimate pH (pHu) of the muscles



Juicier meat appears more palatable than less juicy ones. Early research indicates that the sensation of juiciness is composed of two organoleptic components. The impression of wetness during first chews produced by the rapid release of meat fluid, and sustained juiciness largely due to stimulatory effect of fat on salivation (Dransfield *et al.,* 1984; Thompson, 2004). Juiciness is directly related to tenderness, thus more tender meat readily liberate juices during chewing, compared with tougher meat.

Several studies indicated that when the sensory attributes of meat products vary significantly from the known, such products will be rejected by consumers (Lawrie and Ledward, 2006; Warris, 2010; Teye *et al.,* 2011). Since the PKOR-fed chicken had similar sensory characteristics as those on the control diet, is an indication that PKOR as a feed ingredient in broiler rations would have no adverse effect on the sensory characteristics of the meat.

Lipid per-oxidation (per-oxide value) and Ultimate pH of the muscles

The ultimate pH (pH of the products at 24hours after slaughter), and the rate of lipid per-oxidation in the product (after 7 days in storage) were determined and the results are presented in Figure 1.

The POVs of the products ranged between 1.88 and 2.07millequivalent of active O_2 /kg muscle. There were no significant ($p>0.05$) differences in the peroxide values of the muscles compared with the control products (Figure 1). It was expected that the fat present in the PKOR might influence lipid oxidation in the muscles, but that was not the case. This indicates that meat of PKOR-fed birds would not be prone to lipid per-oxidation. Lipid per-oxidation results in stale, rancid flavour in food (Kerler and Grosch, 1996). In all the products however, the POVs were significantly lower ($p<0.001$) than 25millequivalent of active O_2/kg product, which is considered as the limit of acceptability in fatty foods (Evranuz, 1993; Narasimhan *et al.,* 1986).

The pH_u of the muscles ranged between 5.81 and 5.92. Similarly, there were no significant ($p>0.05$) differences in the pH_u of the muscles. The ultimate pH of animals is influenced mainly by the degree of glycogen reserves in the muscles of the birds prior to slaughter. Warriss (2010) reported pH_u of 5.80 in turkeys. The slight variations observed in the present study could be due to differences in stress exposure to the animals during restraining and slaughter.

Costs of acquiring maize and PKOR

The costs of acquiring and processing the PKOR and maize used in this study are presented in Table 5.

The cost of acquiring and processing a ton of maize cost $350 whilst that of PKOR was $110. The PKOR was obtained at virtually no cost, as its collection was a relief to the processors and residents around processing sites.

The women who assisted with the collection were however given a honorarium of $10 per ton of PKOR collected. This was to motivate them to assist whenever the need arises. The PKOR was however obtained moist and was quite bulky, so cost of drying was quite high.

In conclusion, the use of palm kernel oil residue as substitute for maize up to 17.5% inclusion had no significant effect on carcass parameters, sensory characteristics and storability of the meat. Farmers can replace dietary maize with palm kernel oil residue up to 17.5% in broiler rations to minimize production costs.

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