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Assessment Of Performance And Carcass Characteristics In Broiler Chickens Fed Diets Based On Quality Protein Maize Varieties (*Abontem*And *Etubi*) Developed In Ghana

Moses A. Nartey, Frederick N. Odoi, Moses Teye
Jiangsu Key Laboratory of Sericultural Biology and Biotechnology, School of Biotechnology, Jiangsu University of Science and Technology, Zhenjiang, Jiangsu 212018, China.
Animal Science Department, School of Agriculture, University of Cape Coast, Cape Coast, Ghana.
Animal Science Department, School of Agriculture, University of Cape Coast, Cape Coast, Ghana.
Corresponding Author: Moses A. Nartey

ABSTRACT
The study was conducted to determine some growth performance and carcass characteristics of broiler birds fed diets based on two quality protein maize varieties (Abontem and Etubi), and a traditional variety. One hundred and twenty Arbor Acre day-old broiler chicks were used in a Completely Randomized Designed experiment. There were 3 treatments, each with 4 replicates of 10 chicks. Feed and water were supplied to birds ad libitum. The parameters measured were initial and final weight, feed intake, weight gain and feed conversion efficiency for birds in each replicate pen. At maturity (8 weeks), three birds from each treatment were randomly selected, tagged and slaughtered; hot carcass and viscera weights were taken for each bird.

Carcasses were sectioned into primal cuts after 24-hour chilling at 3°C. Breast muscles were grilled for sensory evaluation by a trained panel of twelve. Breast muscles from slaughtered birds were analysed for moisture, protein and fat content; as well as organoleptic parameters (juiciness, taste, texture, colour and likeness) were not significantly (P>0.05) influenced by dietary treatments. However, breast and back muscles differed significantly among dietary treatments (P<0.05).

It is recommended that follow–up experiments should be conducted to validate the findings in this work; this should particularly include determination of essential amino acids profile, as well as digestibility of the TM, ETM and ABM maize varieties.

KEYWORDS: *Quality protein maize, traditional maize, growth performance, organoleptic properties, proximate composition*

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I. INTRODUCTION

Maize (*Zea mays L.*) ranks third to rice and wheat as the most important cereal crops used both as staple food and animal feed in most developing countries (Mboya, Tongoona et al. 2011). Several million people, particularly in developing countries, derive their protein and calorie requirements from maize (Akande and Lamidi 2006, Mbuya, Nkongolo et al. 2011). Most of the traditional maize (TM) varieties used in the diets of farm animals have two significant limitations; firstly, they are low in protein (only 9-10%) and secondly, are deficient in some essential amino acids, especially lysine and tryptophan (Okai, S. A. Osei et al. 2005, Vasal 2006). As a result, maize has to be supplemented with protein-rich but expensive ingredients such as fishmeal and soyabean meal which are not always readily available (Osei, Donkoh et al. 1994, Okai, Osei et al. 2001). To compound this challenge, locally available fishmeal (usually made from anchovies) and maize are also major sources of protein and energy in human diets in Ghana (Okai 1988). This competition between humans and animals leads to high prices of these feed ingredients, and consequently highcost of feeding poultry and pigs (Okai, Tuah et al. 2001). Alternatively, the nutrient levels of maize can be boosted with the addition of the synthetic amino acids such as, lysine and tryptophan, to make up for the deficiencies.

The quest to find ways of improving nutritional quality of maize varieties with a better balance of essential amino acids led to breeding of the Opaque-2 and Floury-2 varieties which provided substantially higher lysine and tryptophan contents than traditional maize varieties. Feeding trials using these new varieties recorded improved animal performance (Mertz, Bates et al. 1964). The Opaque-2 maize variety, for example, could substitute for added soyabean meal. However, although, Opaque-2 maize had higher nutritive value (lysine and tryptophan), it had numerous other problems such as reduction in yields (of 10% or more), and slow drying kernels which made it more susceptible to insect and pest attacks (Mertz, Bates et al. 1964). The nutrient quality of maize can be boosted i.e. to make up for deficiencies with the addition of the synthetic amino acids, or protein-rich but expensive fishmeal and soyabean meal. A high lysine maize variety with a modified endosperm was developed to remedy the significant limitations in TM varieties and named Quality Protein Maize (QPM).

Further breeding work on maize led to the concept of Quality Protein Maize by the International Maize and Wheat Improvement Centre (CIMMYT 2001, Prasanna, Vasal et al. 2001, Vasal 2006). The Centre developed a high lysine corn variety with a modified endosperm and named it Quality Protein Maize (QPM). (Sproule, Saldivar et al. 1988, Sullivan, Knabe et al. 1989) reported that QPM had a higher nutritive value than traditional maize varieties when fed in low protein diets containing the same level of supplemental protein.

Following the release of these QPM varieties, little work has been done to compare the growth performance, carcass and sensory characteristics of broiler chicken fed diet with traditional maize varieties in Ghana. There is the need for work assessing the growth performance, carcass characteristics, sensory evaluation and physical properties of broiler meat (cooking loss, and proximate composition of meat) produced using the new maize varieties in Ghana.

This study sought to compare the effects of feeding two new QPM varieties (*Etubi* and *Abontem*) with a Traditional maize (local white) variety, on some growth performance and carcass characteristics of broiler chickens.

II. MATERIALS AND METHODS

Experimental Site

The experiment was conducted at the Animal Experimental Unit of the Teaching and Research Farm, University of Cape Coast, Ghana.

Sources of Ingredients for Experimental Diets

The *Abontem* (ABM) and *Etubi* (ETM) maize varieties used to formulate the experimental diets were purchased from breeders at the Crop Research Institute of the Council for Scientific and Industrial Research (CSIR), Fumesua Station, Kumasi. The other ingredients like traditional maize, fishmeal, soybean meal, oyster shell and vitamin premix were also purchased from the open market in Kumasi.

Experimental Design

After brooding for three weeks on a commercially sourced broiler starter mash, 120 of the broiler chicks were selected and allocated to three treatments; each with four replicates. In all, there were 10 birds per replicate; the experiment followed a Completely Randomized Design (CRD).

Growth Performance of Birds on experimental diets

Following the 3-week period of brooding, birds were moved into an open-sided grower house where some growth parameters were assessed over the following 5 weeks. These were:

Feed Intake

Feed intake per day per replicate treatment group (pen) was estimated as the difference between feed offered and leftover feed 24 hours later. Feed was weighed out into troughs in the morning and leftover feed weighed the following morning, before new feed was offered.

Live Weight Gain

Birds were weighed as a replicate group once every week, using an electronic balance (Sartorius, CP 245S). Weight gain was calculated as the difference between the previous weight and the new weight recorded after a week.

Feed Conversion Ratio (FCR)

Feed conversion ratios on the experimental diets were calculated as the ratio of feed taken to weight gain on each experimental diet.

Feed Analysis

Samples of experimental diets were taken to the Nutrition Laboratory of the School of Agriculture, University of Cape Coast to determine the proximate composition. The crude fat, crude protein and moisture contents of the products were determined according to the methods of the (AOAC 2000). Metabolizable Energy (ME) values were calculated according to the procedures of (Council 1994), as follows:

ME (Kcal/Kg) = 35×Protein (%) + 85×Fat (%) + 35×NFE (%); NFE (%) = 100 - (%moisture + %CP + %EE + %CF + %Ash).

Slaughtering and Dressing of Birds

At the end of the production phase, 12 birds were randomly selected from each treatment group, weighed with an electronic scale (Sartorius, CP 245S) after 12-hour feed withdrawal. They were then tagged to differentiate them. The birds were then stuck with a sharp knife to cut the jugular veins and carotid arteries, and then allowed to bleed for about 60 seconds, after which they were scalded in warm water (70˚C). The feathers were plucked manually, and the head and shanks removed.

An incision was then made around the vent to remove the viscera (internal organs). The viscera were separated into heart, liver, kidney, and gizzard, and each was weighed. The carcasses were washed and the warm weight taken. The dressed carcasses were chilled for 24 hours and the cold carcass weight taken. Primal cuttings (back, breast, drumsticks and thigh muscles) were made from the chilled carcass, and each was weighed and recorded.

Dressing Percentage

The dressing percentage is the proportion of the carcass weight to the live weight of the birds, expressed as a percentage:

$$DressingPercentage\,(\%) = \frac{carcassweight}{liveweightatslaughter} \times 100$$

Cooking Loss

Samples of about 200g were taken from the breast muscles of each carcass and cooked in a microwave (Elbee® 16100) to an internal temperature of 72˚C. The weight of the cooked meat was taken and cooking loss calculated using the formula proposed by (Symeon, Mantis et al. 2010).

$$Cookingloss = \frac{[wt.\,of samplebeforecooking - wt.\,aftercooking]}{[Wt.\,beforecooking]} x100$$

Sensory Evaluation of Meat

Sensory evaluation was conducted on meat from birds raised on the 3 dietary treatments.

Meat Sample Preparation

The breast muscles were used for the sensory evaluation. The frozen products were defrosted in a refrigerator at about 4˚C for 24hrs, then grilled to a core temperature of about 70˚C, in an electric oven (Cuisina EF70SS), and then cut into smaller sizes and individually wrapped in aluminum foils.

Sensory Evaluation of the Meat

Sensory evaluation of the meat was conducted to determine the consumer acceptability of products. A panel of 12 students (both undergraduate and graduate), aged between 18 and 30 years were selected randomly and screened for taste acuity. The panelists were then trained according to the British Standard Institution (Institution 1993) guidelines before evaluating the products. Each assessor was served with wrapped samples of meat from all three experimental diets. Water and slices of bread were provided as neutralizers in between evaluation. Questionnaires were provided to the panelists to indicate their reactions to the products.

Samples were coded with random three-digit numbers and presented to each assessor to evaluate, for different attributes of meat quality. Assessors were requested to rinse their mouth with water and take a bite of a piece of bread provided, after tasting each product. An eight-point category scale, as described by (KEETON 1983), was used to score the characteristics of the products evaluated as follows:

Colour: Extremely pale (1), Very pale (2), Pale (3), Intermediate (4), Pale Brown (5), Dark (6), Very Dark (7), Extremely Dark (8).

Off-odour: Extremely weak (1), Very weak (2), Weak (3), Slightly weak (4), Slightly strong (5), Strong (6), Very strong (7), Extremely Strong (8).

Juiciness: Extremely dry (1), Very dry (2), Dry (3), slightly dry (4), Slightly juicy (5), Juicy (6), Very juicy (7), Extremely juicy (8).

Flavour intensity: Extremely weak (1), Very weak (2), Weak (3), slightly weak (4) Slightly strong (5) Strong (6), Very strong (7), Extremely strong (8).

Texture: Extremely tough (1), Very tough (2), Tough (3), slightly tough (4) Slightly tender (5), Tender (6) Very tender (7), extremely tender (8).

Likeness: Dislike extremely (1), Dislike very much (2), Dislike Moderately (3), Dislike slightly (4) Like slightly (5), Like moderately (6) Like very much (7), Like extremely (8).

Proximate Composition of Muscles
Portions of the breast muscles were used to determine the proximate composition, according to the methods of (AOAC 2000). The frozen breast muscles were thawed, deboned and minced into smaller sizes and later taken to the laboratory to determine the crude protein, fat and moisture contents according to the methods of the (AOAC 2000). All analyses were conducted in triplicates.

Statistical Analyses
Data collected on various parameters assessed were analyzed using the Generalized Linear Model of the Genstat Discovery Edition (GenStat 2012) and Minitab Statistical Package, Version 15 (Minitab 2000). Any significant ($P < 0.05$) differences among means were separated using the Least Significant Difference (LSD)

RESULTS AND DISCUSSION

Table 1: Proximate Composition of Experimental Broiler Finisher Diets

Parameter	Traditional maize	*Etubi* Maize	*Abontem* Maize	SED	LSD	Sig.
Dry Matter	89.95^{a}	86.67^{c}	87.55^{b}	0.15	0.32	*
CP	11.24	11.36	11.41	0.39	0.85	NS
EE	2.49^{c}	2.86^{b}	3.05^{a}	0.05	0.09	*
CF	2.19^{c}	2.64^{b}	2.83^{a}	0.02	0.052	*
Ash	1.24	1.11	1.23	0.37	0.81	NS
#ME (Kcal/Kg)	3152.4^{a}	3045.1^{c}	3074.9^{b}	10.87	23.69	*

Means in a row with different letters of superscripts are significantly different ($P< 0.05$)
*= significant; NS= not-significant

Table 2: Dietary Treatment Effects on Some Growth Performance Parameters in Broiler Chickens (from 4-8 weeks of age)

Parameter	TM	ETM	ABM	SED	Sig.
Mean initial live weight (g/bird)	722.5	721.0	720.0	39.9	NS
Mean final live weight (g/bird)	2,500^{b}	2,912.5^{a}	2,752.5^{a}	102.3	*
Mean weight gain (g/bird)	1,777.5^{b}	2,191.5^{a}	2,032.5^{b}	211.9	*
Mean growth rate (g/day/bird)	50.78^{b}	62.61^{a}	58.07^{b}	33.5	*
Mean feed intake(g/bird/day)	135.9^{b}	147.3^{a}	145.4^{ab}	4.3	*
Mean total feed intake (g/bird)	4,759.8^{b}	5,154.8^{a}	5,089.3^{ab}	151.6	*
Mean FCR/bird	2.7^{a}	2.4^{c}	2.5^{b}	0.05	*

Parameter	TM	ETM	ABM	SED	Sig.
Mean warm carcass weight (g)	1,854	2,092	1,983	105.5	NS
Mean dressing percentage (%)	74.2	71.8	80.9	4.17	NS
Mean chilled carcass weight (g)	1,696	1,957	1,879	129.1	NS
Thigh (g)	322.3	361.8	330.6	22.63	NS
Drumstick (g)	276.7	309.2	270.4	21.04	NS
Wing (g)	244.8	258.5	240.3	13.52	NS
Breast (g)	597^{b}	742^{a}	648^{ab}	62.9	*
Back (g)	272^{b}	375^{a}	357^{ab}	43.0	*
Neck (g)	115.4	127.3	124.0	12.61	NS
Liver (g)	60.7	65.0	45.8	12.86	NS
Heart (g)	8.44	9.05	10.54	1.198	NS
Crop (g)	26.9	25.7	23.9	2.62	NS
Gizzard (g)	50.6	57.8	53.4	3.46	NS
Full Intestines (g)	192^{a}	109^{b}	204^{a}	24.8	*

Table 3: Dietary Treatment Effect on Some Carcass and Organ Weights in Broiler Chickens
Means in a row with similar superscripts are not significantly different (P>0.05)

Table 4: Proximate Composition (%) of the Meat from Birds on 3 Dietary Treatments

Parameter	TM	ETM	ABM	SED	Sig.
Moisture	74.23	74.83	73.21	3.86	NS
Fat	2.39	3.10	3.08	1.57	NS
Crude Protein	23.9	24.8	23.5	2.02	NS

Table 5: Sensory Characteristics of Cooked Meat

Parameter/Trait	TM	ETM	ABM	SED	P-value
Colour	2.83	3.12	3.58	0.64	0.07
Texture	6.42	6.00	6.00	0.81	0.65
Juiciness	5.67	5.33	5.83	0.66	0.26
Flavour	6.17	5.92	5.92	0.71	0.82
Likeness	6.33	6.25	6.42	0.89	0.92
Consumer Appraisal of Raw Meat					
Colour	3.67	3.33	3.08	0.54	0.17
Colour Preference	6.08	6.00	5.92	0.74	0.92
Off Odour	2.50	2.25	2.83	0.82	0.30

Table 6: Some Physical Properties of Carcass of Broiler Chickens

Parameter	TM	ETM	ABM	SED	Sig.
Cooking loss (%)	24.2	26.1	27.5	2.6	NS
Chilling loss (%)	8.52	6.45	5.24	3.5	NS

The proximate composition of the experimental diets is presented in Table 1. The *Etubi*, *Abontem,* and Traditionalmaize varieties had similar levels of crude protein, but the crude protein level of the *Abontem* maize variety was numerically higher than the *Etubi* and traditional maize varieties, though the differences were not significant (P>0.05). (Cromwell, Bitzer et al. 1983) reported similar values for traditionalmaize (11.24%), but (De Oliveira, Moreira et al. 2011) reported lower values of 7.70, 9.87 and 7.36 % for local corn, high lysine corn and high oil corn respectively. These differences could be due to the different environments in which the maize varieties were cultivated, and the varieties used, as reported by (Soh and Cheep 1994).

The mean body weight gain and feed conversion efficiency increased significantly (P<0.05) among birds fed diets containing the QPM (Table 2). The FCR from this study agree with (Onimisi, Omage et al. 2009) who all reported significantly higher weight gain and feed conversion efficiency in broiler chickens due to dietary replacement of TM with QPM. Birds on Traditional maize ration consumed significantly (P<0.05) lower amounts of feed, than birds on EtubiMaize ration (Table 2); intakes were however not different between birds on *Etubi* and *Abontem* Maize diets. This suggests QPM shows superiority in feed conversion efficiency overTraditional maize variety.

At the end of the feeding trial, birds on *Etubi* maize ration had significantly (P<0.05) higher final live weight, weight gain and growth rate than birds on *Abontem* and Traditional maize rations (Table 2). Whilst amino acid assays were not done in this trial because of logistical challenges, the superiority of QPM over Traditional maize varieties has been well established.

The warm carcass weights obtained in this study (Table 3) were slightly higher than those reported in some developing countries of between 70-75% (Lessler and Ranells 2007). The breed of birds, management and environmental conditions could all have contributed to the differences obtained in this study.

The dressing percentage of birds fed the traditional maize were higher than those fed ETM and ABMrations in the current study. The values obtained for maize-based diets were within the reported values for developing countries of 70-75%, by (FAO 1996, Lessler and Ranells 2007); implying that the maize varieties used in these broiler finisher rations supported good carcass traits.

The weight of breast and back muscles however, were significantly different among the birds fed the TM and QPM rations (P<0.05). The ration given to the birds did not have any adverse effect on any of the primal parts assessed. The breast is a prime and expensive cut in broiler birds and therefore higher weight means when carcass is cut up and sold in parts, much more revenue could be generated.

Proximate Composition of the Meat

The similar protein levels of meat in the present study are indications that the use of the QPM and TM varieties in broiler rations did not reduce the protein quality of the meat. Broilers fed with ETM diet recorded the highest crude protein value followed by birds fed with TM, and ABM (Table 4). The study, however, revealed that meat produced from birds fed on the QPM and TM rations had relatively lower fat contents, and therefore similar sensory characteristics. Such products might reduce fears of consumers having health risks associated with the consumption of very fatty meat and meat products.

Sensory Evaluation

Organoleptic values of the carcass were not significantly influenced (from the assessment of juiciness, flavour, off-odour, taste, colour and likeness) by the dietary treatments. This indicates that, the differences in the experimental diets did not interfere with the organoleptic qualities of the broiler meat. There was no significant difference (P>0.05) in all the parameters assessed for both the raw and cooked broiler meat among the dietary treatments (Table 5).

Chilling Loss

Fresh meat is approximately 70-75 % water, making carcasses very susceptible to evaporative cooling loss in the first 24 hours of chilling; such losses range from 3-5% of the hot carcass weight (Rentfrow 2010). The percentage chilling loss in the present study of between 5.2% and 8.5% (Table 6) were slightly higher than the findings of (Rentfrow 2010), who reported chilling loss of 3-5 %. Differences might be due to chiller capacity etc.

Cooking Loss

The birds across the dietary treatments had cooking loss values of 24-28%. The birds fed QPM rations recorded slightly lower cooking loss than birds fed TM diets. The cooking loss also depends on the raw meat quality and cooking method applied, as reported by (Aaslyng, Bejerholm et al. 2003); meat with relatively higher cooking losses will have lower water-holding capacity (WHC), as shown in this study (Table 6). This result agreed with (Okubanjo, Omojola et al. 2003), who had earlier reported that meat with lower cooking loss has higher quality and protein content.

III. CONCLUSION

Birds fed *Etubi* maize-based diet performed most highly in most of the parameters measured, followed by those on *Abontem* maize-based diet and Traditional maize-based diet.

Panel ratings of products were not significantly influenced by the juiciness, taste, colour, flavour and likeness, among the dietary treatments. There were no significant differences observed in the carcass and organ characteristics measured for all the dietary treatments. There were no significant differences observed in the physical properties of carcass (chilling loss and cooking loss) and proximate composition of meat measured.

It is recommended that follow–up experiments should be conducted to validate the findings in this work, particularly the determination of essential amino acids profile, as well as digestibility of the TM, ETM and ABM maize varieties.

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