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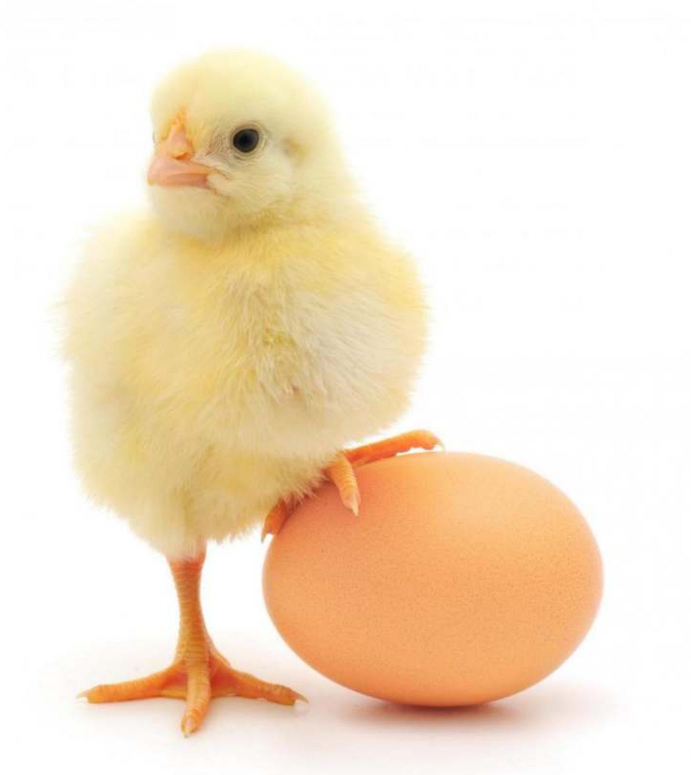

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Assessing the Performance Characteristics of Chicken Layers Fed with Pito Mash Inclusion Diets Treated with Cocoa Pod-Husk Ash Extract

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Abstract: A nutritional balance trial was conducted, with 176 strain of Lohmann breed of brown layers at 8 weeks old, weighing between 340-341 g. The chickens were grouped into 4 dietary treatments of 44 chickens per group. A complete randomized design (CRD) was applied in which the dietary treatments included 0, 5, 10 and 15% level of the alkali-treated pito mash. Feed and water were provided *ad libitum* over the 11-month experimental period. The parameters measured were body weight changes, feed intake, water intake, hen-day egg production, hen-housed egg production, feed conversion ratio (kg/dozen egg), age at the onset of egg production, body weight at the onset of egg laying, weight of the first egg laid, shell thickness, number of broken egg, yolk colour, yolk diameter, albumen height, Haugh unit and mortality rate. Results showed that apart from body weight at the start of feed trial, feed/dozen eggs and body weight at the onset of egg laying, shell thickness and mortality of chickens, all the alkali-treated pito mash based diets exhibited significantly ($p<0.05$) higher performances than the control group in all the other parameters considered, although at varying magnitudes. The costs/100 kg grower and layer diets were progressively reduced as the level of treated pito mash increased in the diets. Alkali-treated pito mash inclusion in grower and layer chicken diets up to 15% is therefore recommended.

Key words: Feed intake, haugh unit, feed conversion ratio, dietary treatment

INTRODUCTION

The increasing cost of livestock and poultry production as a result of high cost of feed and feeding has necessitated the urgent need to employ the use of non-conventional feed sources as alternative, especially to grain and energy source in mongastric nutrition.

According to Devendra and Burns (1992) non-conventional feedstuffs are feed ingredients that are neither been traditionally used in feeding animals or are not normally used in commercially produced diets for animals. These are normally referred to as Agricultural and industrial by-products. Among such by-products include cocoa pod-husk, cassava peal, sorghum spent grain locally known as ‘pito mash’, etc. These by-products are locally available in adequate amounts and animals do not compete with man as feed stuff.

In some parts of Africa, especially Ghana, ‘pito mash’, a by-product from locally brewed gin from sorghum, normally come in wet form which are thrown away as waste, thereby causing environmental pollution. Lamptey (1978) reported that ‘pito mash’is intermediate source of protein and energy. Though bulky in wet form, it is high in crude fiber (about 21%) and moderate in. Highly digestible and may be used for all classes of farm animals including poultry. It is fairly nutritive and various replacement levels of the by-product for maize as the main energy source have been utilized in poultry and pig diets. The major obstacle to the use of large quantities of pito mash as feed ingredient is its high fiber content. Alkali treatment of various fibrous material have been used to improve their nutritional value and several successes achieved (Isikwenu *et al*., 2008). There has been relatively few studies with cocoa-pod husk ash extract treated feed ingredient on layer chickens in this respect and yet, these researchers have concentrated mainly on the performance of either broilers or on layers which had been in lay for some months.

The study therefore seeks to assess the performance characteristics of chicken layers fed diets containing the alkali-treated pito mash from 8-49 weeks.

MATERIALS AND METHODS

A total of 240 kg of treated pito mash with 3600 L of alkali cocoa pod extract was thus prepared and stored for use in the feeding trials. A grower (8-22 weeks) and layer (22-49 weeks) diets were prepared using the following ingredients, maize, treated pito mash, wheat bran, fish meal, soya bean meal, palm oil, oyster shells, dicalcium phosphate, vitamin premix, methionine+lysine and common salt. Each of the diets consists of four dietary treatments containing 0, 5, 10 and 15% of the treated pito mash with the control diets containing no pito mash (Table 3). Other ingredients were adjusted to maintain iso protein, energy, calcium and phosphorus

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levels as treated pito mash was increased. Palm oil was included primarily to balance the energy level as the energy content of the pito mash was much lower than maize it replaced partially. Each diet was thoroughly mixed manually on the floor with spade, transferred into sacs and kept in moist-free store in the Animal Science Department Farm. The diets were formulated to meet the nutrient requirements for growing and laying hens according to NRC (2001), (Table 1 and 2).

Pre-experimental management of the chicks: Two hundred and fifty day-old commercial layer chicks from Lohmann commercial strains of brown layers were used for the study. They remained in the brooder house for 8 weeks before the commencement of the feeding trials. During the brooding period, the chicks were fed on commercial starter layer diet. All chicks were vaccinated against gumboro, Newcastle disease and fowl pox in accordance with the sanitary veterinary program for this category. Prophylactic treatment with antibiotics plus vitamins, coccidiostat and dewormer were given at the recommended periods and dosage.

Experimental chicks: One hundred and seventy six (176) chicks at eight weeks old, selected from the remaining chicks after brooding were used in this experiment for a 49-week nutritional study including two weeks adjustment period to the experimental diets. They were thereafter transferred from the brooder house to the treatment cages of deep litter system measuring 2.30 x 1.30 m in width and length per cage. A wood rectangular feeder and a plastic round drinker were placed in each of the cages.

Experimental design: The experimental design is the complete randomization (CRD) in which the experimental diet is the source of variability. There were four treatments and four replicates. The 176 birds were divided into four groups of forty four chickens each and randomly assigned to the four diets (Table 1 and 2). Each group of forty four chickens was further subdivided into four replicates of eleven birds each (representing 0.27 m^2/bird) and allocated to individual cage throughout the experimental period. The control group had no alkali-treated pito mash in the diet.

Dietary treatment: The feeding started immediately the chickens initial weights had been taken at 8 weeks old, after been fasted for about 13 h by withdrawing feed only. This was to flush out the guts of the birds previous feed residues. Each replicate was supplied with 6 kg feed/week, representing 0.08 kg feed/bird/day and 1.5 L of water once daily. The chickens were provided with grower diets from 8-21 weeks old and layer diets from 22-49 weeks old. The quantity of feed and water were increased as the chickens get older. To maintain adequate sanitation, drinkers were cleaned every morning and disinfect weekly before supplying the day's measured water. Likewise, the feed troughs were cleaned weekly. Six chickens were randomly selected from each replicate, leg-banded in three separate groups of two birds and weighed on a spring balance. The initial body weights were between 347 and 352 g. The chickens were fed the experimental diets for 49 weeks excluding 2 weeks of pre-data collection period. Water and feed were provided *ad lib*.

Feed residue and water leftover: The quantity of feed and water supplied were recorded. From the data, the

Table 1: Composition of the experimental diet for growers (8-22 weeks)

	Level of DPM (%)			
Ingredient	0	5	10	15
Maize treated	52.8	48.8	43.8	39.5
pito mash	0	5.0	10	15
Wheat bran	23	23	23	23
Fish meal	7.5	5.3	4.0	2.0
Vegetable oil	2.4	3.6	4.9	6.2
Soya bean meal	8.0	8.0	8.0	8.0
Dicalcium phosphate	2.0	2.0	2.0	2.0
Oyster shell	3.5	3.5	3.5	3.5
Methionine + Lysine	0.05	0.05	0.05	0.05
Salt	0.5	0.5	0.5	0.5
Vit premix	0.25	0.25	0.25	0.25
Total (kg)	100	100	100	100
Proximate analysis				
Crude protein (%)	17.4	17.0	16.8	17.0
Crude fiber (%)	3.45	4.57	4.68	4.73
Ether extract (%)	5.50	8.00	9.00	10.00
Ash content (%)	6.50	7.50	7.50	8.00
Moisture content (%)	8.00	7.50	8.00	6.00
Calculated values				
ME (Kcal/kg)	2702.4	2702.2	2700.1	2710.8
Calcium	2.12	2.10	2.03	1.98
Phosphorus	0.68	0.65	0.62	0.57

Table 2: Composition of the experimental diets (layers 22-34 weeks)

	Level of DPM (%)			
Ingredient	0	5	10	15
Maize	51.0	46.0	40.6	37.5
Dried pito mash	0	5.0	10	15
Wheat bran	16	16	16	16
Fish meal	9.0	7.5	6.5	4.0
Vegetable oil	2.5	4.0	5.4	6.0
Soya bean meal	11	11	11	11
Dicalcium phosphate	2.0	2.0	2.0	2.0
Oyster shell	7.5	7.5	7.5	7.5
Methionine+lysine	0.25	0.25	0.25	0.25
Salt	0.5	0.5	0.5	0.5
Vit premix	0.25	0.25	0.25	0.25
Total (kg)	100	100	100	100
Proximate analysis				
Crude protein (%)	17.9	18.3	18.2	17.9
Crude fiber (%)	2.45	2.47	3.01	3.70
Ether extract (%)	4.00	4.50	5.00	6.00
Ash content (%)	11	12	12	12.50
Moisture content (%)	13.00	13.00	12.50	13.00
Calculated values				
ME (Kcal/kg)	2665.0	2676.2	2677.9	2647.3
Calcium	3.7	3.7	3.7	3.6
Phosphorus	0.7	0.9	0.7	0.7

Table 3: Performance and Egg quality characteristics of the experimental chickens

Parameters	T1	T2	T3	T4	SEM	Sign.
Body weight (8 wks) at the start of feed trial (g)	340.0	339.8	340.8	341.0	16.11	NS
Feed intake/bird/day (g)	98.80^{c}	101.2^{b}	103.2^{a}	105.5^{a}	3.25	*
Water intake/bird/day (mL)	152.6^{a}	161.1^{b}	173.5^{c}	175.2^{c}	4.19	*
Hen-day egg production (%)	73.0^{c}	75.5^{a}	76.5^{a}	78.2^{b}	2.39	*
Hen-house egg production (%)	69.3^{c}	70.5^{b}	72.0^{a}	73.4^{a}	2.19	*
Feed conversion ratio in kg/dozen	2.65	2.61	2.59	2.58	0.137	NS
Age at the onset of egg laying (wks)	20.5^{a}	21.3^{b}	21.5^{b}	21.0^{b}	0.427	*
Body weight at the onset of egg laying (kg)	1.37	1.36	1.38	1.39	0.022	NS
Weight of 1st egg laid (g)	39.20^{a}	44.80^{b}	46.20^{b}	50.70^{c}	3.10	*
Shell thickness (mm)	0.38	0.38	0.39	0.39	0.009	NS
Number of egg droken	0.50^{a}	0.00^{c}	1.00^{b}	0.50^{a}	0.456	*
Yolk colour	4.00^{c}	5.00^{b}	6.00^{a}	6.00^{a}	22.00	*
Yolk diameter (mm)	36.00^{a}	36.50^{a}	37.50^{b}	38.25^{c}	0.625	*
Albumen height (mm)	7.00^{a}	6.95^{b}	7.00^{a}	7.00^{a}	0.025	*
Haugh unit	77.50^{c}	77.75^{c}	78.15^{a}	78.65^{b}	0.171	*
Mortality rate (%)	11.4	11.4	13.6	11.4	3.01	NS

^{a,b,c}Means within the same row bearing different superscripts are significantly different. (*p<0.05), NS: Not significant. SME: Standard error of the mean

feed residue and the water leftover were subtracted from the quantity supplied to record the weekly feed intake and the daily water consumption. Based on these data, the average daily feed intake of the chickens were calculated as follows. Average feed intake/day within a week of 7 days = weekly intake of feed divided by number of days i.e., 7 days.

Data collection

Body weight: Prior to the commencement of the feeding trial diet, the initial body weight of the chickens were taken. They were subsequently weighed every fortnight. This continued until 20 weeks when the age at the onset of egg laying (AOEL) was determined. A week before the termination of the feeding trial the chickens' weights were again taken.

Age at first egg laying: Age at the onset of egg laying for all replicate was fixed as the age in weeks at which the first egg was laid by each replicate as recommended by Donald and North (1990). The mean date for each treatment was calculate based on the age at the onset of egg laying records.

Weight of the first egg laid: At the onset of egg laying, the first laid in the trial in each replicate group was found by weighing the egg using a Scout pro analytical balance with a capacity of 400 and 0.01 g precision.

Egg quality parameters: Egg quality characteristics, i.e., yolk colour, shell thickness, Haugh unit and yolk index were measured fortnightly and the average was calculated for each quality parameter. Three egg per replicate totaling twelve per treatment were selected from eggs collected during the second week of each weeks meant for the egg quality analysis. The eggs were then cleaned, weighed individually with a scout pro analytical balance with capacity of 400 g and 0.01 precision. The eggs were gently broken with a blunt knife and the entire content emptied on a broken piece of louver blade place on a flat surface. The following internal characteristics: yolk height, yolk diameter, albumen height were measured. The values obtained were used to determine the Haugh unit.

Shell thickness: Shell thickness was determined by using a micrometer screw gauge. This was done after the egg shell from the broken eggs was further broken into smaller pieces and the shell membrane manually removed. Three reading were taking one from the middle portion, one from the broad and the last from the narrow region of the eggs. The average of these three readings was considered as the shell thickness of a particular egg.

Yolk colour: The yolk colour of each broken egg was determined in turn by comparing with the Roche yolk colour (RYC) Fan as arrange of yolk colour (Wesley and Stadelman 1959).

Mortality: Daily mortality was recorded for each replicate and treatment. This was then used to calculate the monthly mortality rate by subtracting the number of dead chicks from the number of live chicks at each interval.

Broken eggs: The numbers of eggs broken were recorded for each replicate and treatment. The data collected at the end of the experiment was used to compute the percentage broken eggs for each treatment.

Data analysis: The data was subjected to analysis of variance according to GenStat discovery system software (2013) computer program. Probability values <0.05 were taken to indicate statistical significance. The treatment means were compared using the least significant difference (LSD).

RESULTS AND DISCUSSION

According to Ensminger *et al.* (2004) among the factors affecting feed intake include energy level of the feed, environmental temperature, palatability of the feed etc.

The average feed intake/bird/day significantly (p<0.05) improved with increasing levels of alkali treated pito mash from 0-15%. This same trend was observed by (El-Deek *et al*., 2009; Oladunjoye *et al*., 2010) who intimated that the increased feed consumption is definitively a response to energy dilution of the diets and that the attempt by the birds to consume adequate amount for maintenance as well as growth. Dagbir (2008) noted that feed intake and energy level (ME) of diets are inversely related and laying hens had the ability to regulate feed intake according to dietary metabolizable energy (ME). Chickens tend to consume more when the energy level of the feed is low. Sobamiwa and Longe (1993) reported that one factor that might have poorly affected the feed intake and subsequently lower performance of birds fed with alkali treated cocoa pod husk diet, particularly the 150 g/kg level, probably be due to the fact that the feed did not remain sufficiently long in the digestive tract for optimum nutrient digestion as the chickens on these diets consumed more water possibly to flush out residual ash content.

The trend in the increased feed intake in the present study, could neither be related to the energy density of diets nor faster digester passage rate since the diets were about iso-caloric. One of the possible reasons for this difference in feed intake could be due to the advantage moderate levels of crude fiber in diet has. For instance, Campbell *et al*. (2003) suggested that crude fiber prevents compaction by providing laxative effects, thereby providing and maintaining the proper muscular tone in the gastro intestinal tract to promote increased feed intake. This study therefore, suggests that alkali-treated pito mash inclusion in the experimental diets might have provided the required moderate level sufficient enough to provide the combined laxative effect and the faster digester passage rate to induce chickens to consume more. This is evident in the fact that feed intake increased as the treated pito mash inclusion level was increased from 0-10%. Another possible reason for this variation could be the addition of various quantities of palm oil to the diets. Palm oil apart from increasing the caloric density of the ration, increase palatability, helps homogenize and stabilize certain feed additive, especially those of very fine particles (Ensminger *et al*., 2004). This could possibly reduce the dustiness of the diets and enhanced feed intake. It is therefore not surprising that 15% alkali treated pito mash based diet registered, the highest feed intake since it contained the highest quantity of palm oil.

A notable increased of feed intake across the treatment groups was most likely due to the presence of appreciable amount of most inorganic elements in the treated pito mash which might have stimulated higher feed intake, as the alkali-treated pito mash level was increased in the experimental diets. The study recorded a significant (p<0.05) increased in water intake as the quantity of the treated pito mash was increased in the diet. These results agreed with those obtained by Squires *et al*. (1992) who reported that alkali treatment of cannery waste might have caused improvement in water intake, when fed to broiler chickens. In this regard the possible cause of increased in water intake, according to Sobamiwa and Longe (1993) and McDonald (2002) might be due to the alkali, since alkali-treated feed leaves residues of sodium which increases the water intake of animals. The average hen-day production and hen-housed egg production significantly (p<0.05) improved as the alkali-treated pito mash inclusion level in the diets was increased, implying that the inclusion of the treated pito mash had improved performance of the birds higher than the control. Several factors might have accounted for this trend. Significant among them was the enhanced feed intake as a result of increased levels of treated pito mash in the experiment diets. This seems to agree with (Odunsi *et al*. 2002) that lowered feed intake also resulted in reduced hen-day egg production rate and that to improve egg production parameters such as hen-day and hen-housed egg production, management should be geared towards enhanced feed intake. Improved feed intake, could also mean that the diets provided for the experimental chickens were adequate in nutrient composition to sustain growth and egg production. Campbell *et al*. (2003) observed that laying hen needs a substantial increase in dietary mineral intake, hen egg production significantly drops when it is deficient in calcium and phosphorus. Again, Iron has been reported as an important element that is necessary in the haemoglobin of the red blood cells and that because of this function, it is normal to add this mineral in a supplement to poultry diet (Thomas, 2002). Furthermore, Campbell *et al*. (2003) found that sodium has been shown to be involved in the active transport of glucose and certain amino acids, deficiency of sodium may therefore leads to loss of weight, cannibalism in poultry and drop in egg production. It is therefore reasonable to suggest that a general increased in the amount of the most inorganic elements in the alkali-treated pito mash, might have promoted the significant (p<0.05) improvement in egg production.

Generally, the less the amount of feed required to produce a dozen of eggs, the more economical the cost of production. The feed conversion ratio of control was 2.65 and that of chickens raised on diets containing treated pito mash were 2.61, 2.59 and 2.58 for 5, 10 and 15% inclusion levels, respectively. Thus feed conversion efficiency declined progressively as the proportion of alkali-treated pito mash in the diets increased. What it means then is that the chickens fed with the treated based diets were been more efficient in utilizing feed than the control. The control group exhibited the highest feed conversion ratio (2.65), though not significant, makes it the least efficient in feed conversion. This is in agreement with El-Deek *et al.* (2009) who reported that chickens fed with 15% alkali-treated Guava-by products improved feed conversion ratio compared to 5 and 10%. One of the four common dates used for computing early egg production, is the age of flock when first egg is laid (Donald and North, 1990). This study has shown that there was a significant ($p<0.05$) difference in age at the onset of egg laying among the dietary treatments (Table 3). However there were noticeable but not significant differences in body weight of birds fed different dietary treatments, with the control group registering the lowest body weight of (1.36 kg, Table 3) at the onset of egg laying. These values though fell within the recommended body weight standard for medium size pullet at 1.36-1.68 kg (Donald and North, 1990). The present findings seem to agree with Hocking and Whitehead (1990) who reported that there is a linear relationship between the number of yellow follicles and body weights in broiler breeders, turkeys and ducks which have been fed throughout the rearing period to achieve different proportions of body weights.

In another development Sahota and Bhati (2001) observed a reduction in feed intake and body weight of pullets thereby reflecting on delayed age of sexual maturity and subsequent delay of age at onset of egg laying. This to some extent disagree with the present findings, in that though, the control group recorded the lowest feed intake of 98.80 g, however registered the earliest age at the onset of egg (Table 3). This could be due to variation of feed utilization for growth as Barber *et al.* (1957) intimated that faster growth rate of animals on diet, were due to improved feed utilization rather than increased feed consumption. This is supported by Bornstein and Levi (1984) In: Etalem *et al.* (2009) who observed that birds can start egg laying if higher body weight is attained at earlier ages. This compares favourably with the present findings. It could therefore mean that the experimental diets were adequate in terms of nutrient compositions to initiate and sustain early age and body weights at the onset of egg laying for all the experimental chickens especially the control, which even though, consumed the least feed, but started egg laying at earliest age of 20.5 weeks. The body weight at the onset of egg laying and weight of first egg laid increased steadily as the level of alkali-treated pito mash in the experimental diets was increased from 5-15 percent. Bornstein and Levi (1984) In: Etalem *et al.* (2009) noted that the initial similarity of sexual maturity plot for birds fed in different regimes might be due to a similar number of chickens in both feeding regimes having already reached the necessary body weight or body composition threshold for reproductive development. This seemed to agree with the present results, in that the control recorded the lowest body weight (1.36 kg) and the earliest age at the onset of egg laying (20.5 weeks) though, these values fall within the recommended values from literature, weight of the first egg laid was the lowest among the treatment groups (39.2 g, Table 3). This could be attributed to the fact that as the age of sexual maturity is delayed, egg size increases particularly for those eggs produced at the beginning of the laying cycle.

The study showed that there were noticeable but not significant ($p>0.05$) beneficial effects of experimental diets on shell thickness. Although chickens fed 10 and 15% alkali-treated pito mash inclusion diets had better values than the control and the 5% groups (Table 3). This could mean that the 5% alkali treated pito mash inclusion in the diet is insignificant in terms of quantity to elicit any meaningful change in nutrient composition. As the level of the treated pito mash was increased in the T3 and T4 diets, a slight improvement in the shell thickness was noticed. These observations were similar to the effects previously noted by El-Deek *et al.* (2009) that chickens fed on alkali-treated guava by-product did not show any significant ($p>0.05$) difference in shell thickness. It is quite true from literature that, providing feed *ad lib* could promote adequate daily intake of specific mineral components and other nutrients required by chickens for optimum growth and egg quality characteristics. It could be said that since, feed were made available to chickens at all times, all the chickens in the various treatment might have accumulated adequate amount of Ca and P for later mobilization for shell development. The analysis of the mineral composition of treated and untreated pito mash indicated a significant reduction of Ca contents from 1.72-0.82% and a slight increase of phosphorus from 0.34-0.51%. The overall Ca and P content in the treatment diets were adequate enough to strengthen the egg shell of the egg laid by the experimental chickens. This might have impacted positively in the reduced number of egg broken for all the treatment groups.

This study has shown that yolk colour scores were significantly ($p<0.05$) influenced by the dietary treatments. The value ranged from 4-6 with 10 and 15% alkali treated pito mash inclusion level recording the highest value of 6 (Table 3). This result is in agreement with Odunsi *et al.* (2002) that chickens fed with diets containing 5, 10 and 15% Gliricida sepium leaf meal registered increased yolk colour score. However Etalem *et al.* (2009) and Oladunjoye *et al.* (2010) noted reduction in yolk colour score of chickens fed with alkali-treated cassava peel-based diets in their respectively findings. The increased in the egg yolk colour values of eggs laid by chickens fed alkali-treated pito mash base-diets in this study, could be due to more pigmentation of the treated pito mash diet compared with the control. This might have been supported by the addition of palm oil to the experiment diets at increasing levels, caused essentially by increased alkali-treated pito mash levels in the diets (Table 3), indicating the presence of carotene in available form. Thus supporting the findings that apart from the fatty acids, the major constituent of palm oil is the carotenoids and value will dictate the degree of pigmentation (Opeke, 1987; Odunsi *et al*., 2002). Yolk diameter significantly ($p<0.05$) differed among chickens and 15% alkali-treated pito mash based diets (T4) consistently performed better among the treatment groups (Table 3). Etalem *et al*. (2009) are of the view that higher yolk diameter impact positively in the subsequent performance of the laying hen in terms of egg weight. This is consistence with the present findings, in that as the level of the treated pito mash was increased in the diets, corresponding increase in the yolk diameter was noted and this reflected in the subsequent performance of the egg laid in term of weight across the treatments. According to North and Donald (1972) increasing the linoleic acid in chicken diets could increase the deposition of polyunsaturated fatty acid in the egg yolk from a basic level of about 5 to approximately 28%. Since palm oil according to Opeke (1987) contains 9.60% linoleic acid, the quantity might have gone up in the diets as the quantity of palm oil was increased as a result of increased levels of the alkali-treated pito mash. This might have raised the deposition of the polyunsaturated fatty acids in the egg yolk thereby increasing the yolk diameter.

The average Haugh unit ranged from 77-78.65 among the treatment groups. Alkali treated pito mash inclusion at all levels improved Haughunit compared to the control. In agreement with the present results, El-Deek *et al*. (2009) found that inclusion of alkali-treated guava by-product significantly ($p<0.05$) enhanced Haugh unit compared to the control. Contrarily, to this view, Etalem *et al*. (2009) noted that Haugh unit did not significantly ($p<0.05$) differ among treatments.

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