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Effect of Partial Replacement of Dietary Maize with Cassava Peel Meal on Egg Quality Characteristics of Chicken during Storage

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Target Audience: Animal nutritionists, Food technologists, Crop farmers, Poultry scientists, Human nutritionists

Abstract

Effect of dietary cassava peel meal (CPM) inclusion in partial replacement for maize on egg quality characteristics during storage was investigated in this study. In a completely randomized design, ISA brown pullets (n=3,000) aged 20-week were assigned to three dietary treatments. Diets A, B, C contained CPM at 0, 10 and 17.5%, respectively. At week 32, eggs were pooled per treatment (n=180) and assessed for quality attributes in 0, 4, 8, 12, 16 and 20 days of storage (DOS). Results revealed that dietary CPM significantly (p<0.05) lowered albumen height (4.69-0.20mm), albumen weight (37.23-11.55g), yolk height (11.81-4.20mm) and the Haugh unit (63.86-38.32) with increased DOS while yolk weight (25.08-47.45g) and yolk diameter (26.24-48.52mm) increased. The shell thickness, egg length, egg weight, egg width and shape index were not significantly (p>0.05) affected by the treatments. Effect of interactions of CPM inclusion and DOS on albumen height was significantly (p<0.05) different, but for treatments A (81.56mm) and B (80.85mm) (p>0.05) at zero DOS. Yolk colour was highest (9.13) for eggs from C but similar (p>0.05) to those from A (8.78). In conclusion, egg qualities reduction occurred in DOS irrespective of dietary CPM or maize. However, the reduction rate of egg quality in DOS was significantly influenced by the dietary inclusion of CPM.

Keywords: Cassava peel mix, Duration of storage, Haugh unit, Yolk index, Egg quality attributes.

Description of Problem

Maize (*Zea mays*) has been the most commonly used conventional energy source of plant origin in feed formulation for poultry. It is sometimes highly expensive, limited or at times scarce. Also, maize and other cereal grains are highly competed for by animals and humans as food. Therefore, the need for replacing maize with non-conventional energy source requires urgent consideration to minimize cost and maximize poultry production (1, 2). To combat this challenge, alternative ingredients resource was canvassed (3). One of such important alternative ingredients is cassava peel meal. Cassava (*Manihot esculenta*) is a multipurpose plant that thrives well in the tropics, it is a very good energy source widely grown in Nigeria. It has a wide range of adaptability, resistance to drought and tolerance to poor soils (4). Available literature on cassava utilisation in poultry centered on root (5), leaf meal (6) and root sieviate (7). However, there has been suggestion (8) that, it would be preferable to use whole cassava plant to take advantage of the high protein content in the leaves, the bulk in tender stems and the high energy of the tuberous roots.

The level of hydrocyanic acid in cassava limits the use of cassava and its products for livestock feeding (8). Cyanide levels of 100 mg/kg have a negative effect on broiler performance and as low as 25 mg/kg can have a negative effect on layer production, egg quality and hatchability of the eggs (9). However, report indicated that, proper processing techniques would eliminate the hydrocyanic acid potential of cassava based diets (10).

Cassava peel is a waste from cassava root. The peel is obtained by removing the outer cover of cassava root. It could serve as a cheap and alternative source of energy to poultry species, and in ruminant feeding systems, serving either as the main basal diet or as a supplement (11). The peel accounts for between 10–13% of tuber by weight. It contains about 5% crude protein and reasonable amount of minerals (12). In order to increase acceptability and subsequent utilization of cassava peel, the HCN content of fresh cassava peels has to be reduced greatly (13). The inclusion of cassava peel meal up to 30% in the diets of growing pigs did not have any deleterious effect (14). Cassava in animal feed accounts for only 2% of cassava utilization in Africa. Nigeria now ranked as the world's largest producer of cassava with production capacity of 40 million metric tonnes ((15, 16). Various cassava products have been used in feeding livestock (6, 17, 18, 19).

However, there is a paucity of information on the effects of feeding cassava peel based diets on chicken egg quality characteristics. This study was therefore conducted to evaluate the effect of partial replacement of maize by CPM as energy source on the quality characteristics of chicken egg.

Materials and Methods

Test Sample

The fresh cassava peels sourced from villages and Garri Processing Centres in Oyo State were grated. They were then dewatered using hydraulic press and left overnight to ferment. The fermented cake was loosened, sieved and dried. Dried cassava peels were then used in the formulation of experimental diet.

Experimental location and animal allotment

The study was carried out at the Amo Byng Farms Ltd., Awe, Oyo State, Ibadan, South West Nigeria. The measurements were undertaken at the Animal Products and Processing Laboratory, Department of Animal Science, University of Ibadan, Ibadan. Nigeria. Ibadan, lies within the geographical location of longitude 7.25º and latitude 53.4º. In a completely randomized design, Isa Brown layers (n=3000), aged 20-week with proven record of breed, husbandry and health were allotted to three dietary treatments of 1000 birds each. The control group (A) was fed standard maize-soya based diets using conventional ingredients while treatment groups B and C contained CPM at 10 and 17.5%, respectively. Details of the composition of experimental diets fed to the chicken are shown in Table 1.

Table 1. Gross composition (%) of experimental diets fed to laying chickens

	Treatments		
Ingredients	A	B	C
Maize	54.50	44.50	37.0
Cassava peel premix	0.00	10.00	17.5
45% Soyabean Cake	28.20	28.20	28.2
Wheat offal	3.00	3.000	3.00
Lime stone	9.90	9.90	9.90
Salt	0.35	0.35	0.35
DCP	2.20	2.20	2.20
Soya oil	0.70	0.70	0.70
NSP Enzyme	0.01	0.01	0.01
L-Lysine HCL	0.01	0.01	0.01
Toxin binder	0.20	0.20	0.20
Tylozine/Furazolidone	0.01	0.01	0.01
Acidifier	0.20	0.20	0.20
Choline chloride 50% silica	0.15	0.15	0.15
Premix breeder	0.30	0.30	0.30
Vitamin C	0.02	0.02	0.02
DL-Methionine	0.22	0.22	0.22
Zn-Bacitracin ALBAC	0.05	0.05	0.05
Natsel (Vit. E supplement)	0.02	0.02	0.02
Lucantin red	0.001	0.001	0.001
Lucantin yellow	0.003	0.003	0.003
Total	100	100	100
Calculated nutrients			
M.E Kcal/kg	2700	2699	2698
Crude Protein (%)	17.50	17.70	17.80
Crude Fat (%)	4.80	6.00	7.00
Crude Fibre (%)	3.15	4.50	5.60
Available Phosphorus (%)	0.45	0.45	0.45
Calcium (%)	4.00	4.00	4.00
Lysine (%)	0.92	0.95	0.97
Methionine (%)	0.50	0.51	0.52

Treatment A – (Control) 0% cassava peel meal, Treatment B - 10% Cassava peel meal, Treatment C - 17.5% Cassava peel meal, Vit. - Vitamin, ME - Metabolizable Energy, DCP - Dicalcium Phosphate, Zn- Zinc

Birds management and egg sampling

Experimental birds were housed in cages and maintained under standard management practices with free access to feed and water. Also routine medication, vaccination and husbandry practices were administered on them. The design of the experiment was a completely randomized design in a 3 x 5 factorial arrangement.

At week 32, when birds have been fed on experimental diets for 12-week, a total of 540 eggs were sampled made of 180 eggs per treatment. The sampled eggs were stored at room temperature and assessed for quality attributes (both the physical and external characteristics) in 0, 4, 8, 12, 16 and 20 days of storage (DOS).

External egg quality determination

The egg weight is the weight of the whole egg and it was measured with Amput High Precision weighing balance. The length and width were measured using the digital Venier caliper. The egg shells were air dried for 24 hours after careful breaking and their weight were measured using the Amput High Precision weighing balance. Egg thickness was then measured with the micrometer screw guage. This was done by measuring the thickness at three point of the egg shell and their average determined

Internal egg quality determination

Each egg was broken on a flat plate. The albumen height was measured using the tripod micrometer. The yolk was then separated from the albumen and the yolk weight was measured using the Amput High Precision weighing balance. Albumen weight was determined by deducting the egg weight from the yolk and shell weight. Yolk height and width were measured with the digital venier caliper. Yolk colour was determined using the DSM colour fan. The egg yolk that was already separated from the albumen were placed on a plain white surface and examined under normal daylight. The DSM colour fan was placed beside it and the intensity yolk colour that matched the yolk colour number was recorded.

The Haugh was calculated with the formula:

$$HU = 100 \log (h+7.6-1.7w^{0.37})$$

Where, h = observed albumen height in mm

w = observed weight of the egg in g

Egg shape Index

The shape index of an egg was measured for each egg by using the egg width and length and the formula:

$$\text{Shape index} = \frac{\text{egg width}}{\text{egg length}}$$

Yolk index was determined through yolk height and width

$$\text{Yolk index} = \frac{\text{height of the yolk (cm)}}{\text{Diameter of the yolk (cm)}}$$

Statistical Analysis

Data were subjected to regression and analysis of variance using general linear model of SAS (20). Means were separated by Duncan's Multiple Range Test of the same software at $\alpha_{0.05}$

Results and Discussion

Effect of duration of storage on external characteristics of chicken egg is shown in Table 2. The consistent decrease in egg weight with increased DOS is consistent with earlier reports (21, 22). However, for some unexplained reasons, egg weight did not change in the first 10 days of storage (23).

The effect of inclusion of different level of cassava peel mash on external characteristics of egg is shown in Table 2. The shell thickness, egg length, egg weight, egg width and shape index were not significantly affected (p>0.05) by the dietary treatments. Shell thickness, which is a function of calcium and phosphorus levels in layers diet, was not negatively affected. The similarity of shell thickness implied that, all treatments were adequate in calcium, which corroborates earlier findings that cassava based diet did not interfere with calcium metabolism in the laying hen (24). According to reports (25, 26), when eggs are stored for long periods, egg weight can also decrease due to water loss and centralisation of the yolk.

Table 2. Effect of duration of storage on external characteristics of eggs of chicken fed experimental diets

	Duration of Storage (days)						
Parameters	0	4	8	12	16	20	SEM
Egg Length (mm)	58.73	58.18	58.72	57.81	58.65	58.9	0.13
Egg Weight (g)	63.41^{a}	62.55^{a}	62.1^{ab}	60.63^{abc}	59.45^{bc}	58.75^{c}	0.30
Egg Width (mm)	41.65^{a}	39.19^{b}	38.33^{bc}	36.97^{d}	37.62^{cd}	37.89^{cd}	0.13
Shell Thickness (mm)	0.41	0.87	0.37	0.33	0.28	0.36	0.07
Shell Weight (g)	5.12^{c}	5.47^{abc}	5.20^{bc}	5.80^{a}	5.28^{bc}	5.60^{ab}	0.54
Shape Index (%)	70.92	67.36	65.28	63.95	64.14	64.14	0.32

^{a,b,c} means with different superscripts on the same row differ significantly (P<0.05); 0, 4, 8, 12, 16, 20 – duration of storage SEM: Standard Error of Mean

Effect of duration of storage on albumen and yolk characteristics of chicken egg is shown in Table 3. It was observed in this study that, the albumen height, albumen weight, yolk height and the Haugh unit decreased as the duration of storage increased. The yolk weight however increased with duration of storage. The reduction in albumen height as DOS increased conforms to earlier report (27), that, gaseous diffusion of CO_2 and O_2 from the thick albumen during storage resulted to reduced albumen height. The dramatic deterioration observed in albumen height (4.69-0.20mm), Haugh unit (63.86-38.32) and yolk height (11.81-4.20mm) as the DOS increased in this study agreed with the documented observations (22, 23) of significant (p<0.001) egg weight reductions of 2.08 and 3.11%, respectively, within 5 and 10 days of storage at 29°C. A similar weight loss was also reported by other author (28). The decreased yolk index and height observed in this study as the DOS increased supported findings (29, 30), of decreased yolk index and height with increased DOS. The flattening of yolk is primarily due to increased water content caused by osmotic migration from the albumen through the vitelline membrane (29). The higher yolk colour score was observed in eggs from hen fed treatment C (diet with 17.5% CPM). This result contradicted report (31) that reduction in egg yolk colour score of birds fed cassava peel-based diets could be due to less pigmentation of cassava peel. Also, laying hens cannot synthesize egg yolk pigments and egg yolk colour closely depends on the fat soluble pigments mainly xanthophyll, lutein, zeaxanthine and $-cryptoxanthine in the diets fed (32). These pigments provide different colours, light yellow to dark red (33). The general decline in albumen and yolk quality as eggs aged agreed with earlier observations (34, 35, 36) of a decline in albumen and yolk indices with increased storage duration. The effect of interaction of dietary CPM and DOS on yolk weight, yolk height and colour in this study differs significantly ($p<0.05$). The yolk diameter for eggs from hens on treatments A and B were however similar ($p>0.05$).

Table 3. Effects of duration of storage on albumen and yolk characteristics of eggs from chicken fed experimental diets

	Duration of Storage (days)						
Parameters	0	4	8	12	16	20	SEM
Albumen Height (mm)	4.69^{a}	4.31^{ab}	3.68^{b}	3.37^{bc}	3.18^{bc}	2.49^{c}	0.13
Albumen Weight (g)	37.23^{a}	36.65^{a}	36.68^{a}	22.00^{b}	16.34^{bc}	11.55^{c}	0.98
Albumen Diameter (mm)	71.09^{a}	76.94^{a}	62.51^{a}	35.22^{b}	23.74^{bc}	12.69^{c}	2.16
Haugh Unit	63.86	61.04	53.48	50.61	48.76	38.32	
Yolk Weight (g)	25.08^{c}	26.97^{c}	38.78^{b}	42.58^{ab}	43.27^{ab}	47.45^{a}	0.37
Yolk Diameter (mm)	26.24^{c}	36.64^{b}	38.09^{b}	44.57^{ab}	47.89^{a}	48.52^{a}	0.74
Yolk Height (mm)	11.81^{a}	11.41^{a}	11.41^{a}	9.19^{b}	8.23^{b}	4.20^{c}	0.22
Yolk Colour	7.52^{c}	8.58^{b}	8.25^{bc}	9.00^{ab}	8.98^{ab}	9.73^{a}	0.99
Yolk Index	45.1^{a}	31.14^{b}	29.96^{b}	20.62^{c}	17.12^{c}	8.66^{d}	

[a,b,c] means with different superscripts on the same row differs significantly (P<0.05); 0, 4, 8, 12, 16, 20-duration of storage SEM: Standard Error of Mean

Yolk index was related to the DOS (Fig. 1) and the regression equation was: $y= -0.3173x^2-8.8827x+51.69$ (R^2 = 0.9634) ($p<0.01$) (1) This indicated a strong negative and highly significant ($p<0.01$) linear relationship which clearly revealed that yolk index lowered linearly in DOS .

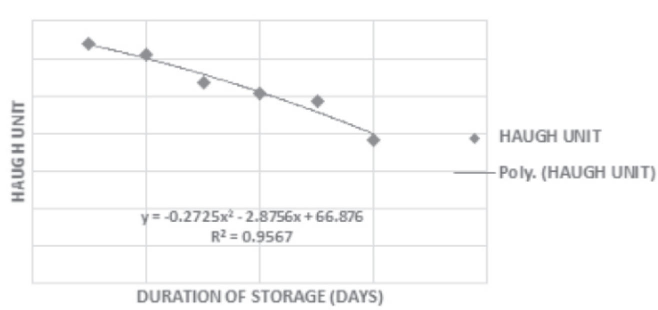

Figure 1. Relationship between Haugh unit and duration of egg storage

Effect of varying dietary inclusion of CPM on internal characteristics of chicken eggs is shown in Table 5. The albumen height (mm) reduced significantly (P<0.05) in eggs from hens on treatment A (2.62) and B (2.75) to 1.99 in C. So also, the albumen diameter (mm) reduced significantly (P<0.05) from 44.57 in eggs from treatment A and B (43.75) to 36.75 in C. However, the yolk colour lowered significantly with the dietary inclusion of CPM in eggs from treatment A (8.78) to 8.13 in treatment B, while the intensity of colouration of 9.13 in eggs from treatment C was similar (P>0.05) with that of those from A. Other indices of internal attributes of eggs were not affected by the treatments.

Table 4. Effect of inclusion of different level of cassava peel meal on external characteristics of eggs of chicken fed experimental diets

	Treatments			
Parameters	A	B	C	SEM
Egg Length (mm)	58.58	58.28	58.63	0.13
Egg Weight (g)	62.16[a]	60.44[b]	60.84[ab]	0.30
Egg Width (mm)	38.71	38.39	38.72	0.13
Shell Thickness (mm)	0.37	0.59	0.34	0.08
Shell Weight (g)	5.10[b]	4.97[b]	6.17[a]	0.05
Shape Index %	66.08	65.87	66.04	0.32

[a, b] means with different superscripts within the same row differ significantly (p<0.05); Treatment A – (Control) 0% cassava peel meal, Treatment B- 10% Cassava peel meal, Treatment C- 17.5% Cassava peel meal SEM: Standard Error of Mean

Table 5. Effect of inclusion of different level of cassava peel meal on internal characteristics of eggs from chicken fed experimental diets.

	Treatments			
Parameters	A	B	C	SEM
Albumen Height (mm)	2.62[a]	2.75[a]	1.99[b]	0.13
Albumen Weight (g)	22.32	21.47	20.77	0.98
Albumen Diameter (mm)	44.57[a]	43.75[ab]	36.77[b]	2.16
Haugh Unit	37.75	41.43	25.93	
Yolk Weight (g)	16.53	16.29	16.24	0.37
Yolk Diameter (mm)	38.82	37.29	36.64	0.74
Yolk Height (mm)	16.53	16.29	16.24	0.22
Yolk Colour	8.78[a]	8.13[b]	9.13[a]	0.99
Yolk Index	42.58	43.68	44.32	0.84

[a, b] means with different superscripts within the same row differ significantly (p<0.05)., Treatment A – (Control) 0% cassava peel meal, Treatment B - 10% Cassava peel meal, Treatment C - 17.5% Cassava peel meal. SEM: Standard Error of Mean

Effects of inclusion of CPM and DOS on external characteristics of chicken eggs are shown in Table 6. Effect of interaction of dietary CPM inclusion and DOS on egg length was not significant (p>0.05). Similarly, effect of interaction of dietary CPM and DOS on egg weight and shell weight were similar (p>0.05) in most DOS. At both four and 20 DOS, no significant difference (p>0.05) existed in egg weight of eggs from treatments A (61.70g), B (62.70g) and C (62.15g). Similarly, there were no significant effect (p>0.05) of the treatments on shell weight of eggs from treatments, A (6.05g), B (6.05g) and C (6.45g) at 12 DOS.

Effect of inclusion of CPM and DOS on albumen characteristics of chicken eggs is shown in Table 7. The Haugh unit at day 0 for eggs from hens on treatments A (73.28) and B (73.28) were similarly (p>0.05) higher. At storage day 8, the effect of interaction of CPM inclusion and DOS on Haugh unit of eggs in treatments A (55.91) and C (50.13) fell in the B specified category (37), The higher the Haugh unit, the better the quality of eggs, Eggs had been classi' ed (37) as AA (100 to 72), A (71 to 60), B (59 to 30) and C (below 29).

Table 6: Effect of interaction of different level of cassava peel meal and duration of storage on external characteristics of the eggs of chicken fed the experimental diets

Treat ments	Duration of Storage (days)	Egg Length (mm)	Egg Weight (g)	Egg Width (mm)	Shell Thickness (mm)	Shell Weight (g)	Shape Index
A	0	58.54	63.68[a]	41.73[ab]	0.46[a]	4.80[de]	71.28
	4	57.87	61.70[ab]	38.34[de]	0.39[bc]	5.55[bcd]	66.25
	8	59.13	63.70[a]	38.70[de]	0.39[bc]	4.80[de]	65.45
	12	57.73	58.50[ab]	36.95[e]	0.35[cdef]	6.05[abc]	64.00
	16	57.16	57.60[b]	37.20[e]	0.29[gh]	4.45[e]	65.08
	20	58.99	58.50[ab]	37.31[e]	0.35[cdef]	5.65[abcd]	63.25
B	0	57.97	62.40[ab]	37.32[e]	0.36[cd]	5.25[cde]	64.38
	4	59.59	62.70[ab]	37.73[e]	0.26[h]	4.95[de]	63.32
	8	58.37	58.80[ab]	38.45[de]	0.36[cd]	5.25[cde]	65.87
	12	58.86	63.29[ab]	42.14[a]	0.33[defg]	6.05[abc]	71.59
	16	58.06	62.45[ab]	39.73[bcd]	0.41[abc]	6.25[ab]	68.43
	20	58.63	61.30[ab]	37.96[de]	0.37[cd]	6.25[ab]	64.75
C	0	58.79	63.24[ab]	41.08[abc]	0.44[ab]	4.50[e]	69.88
	4	58.61	62.15[ab]	39.51[cd]	0.36[cd]	4.60[e]	67.41
	8	58.31	62.65[ab]	38.32[de]	0.35[cde]	4.55[e]	65.72
	12	57.73	57.45[b]	36.62[e]	0.29[gh]	6.10[abc]	63.43
	16	59.19	61.60[ab]	37.95[de]	0.28[gh]	6.45[a]	64.12
	20	59.32	58.95[ab]	37.93[de]	0.37[cd]	5.90[abc]	63.94
	SEM	0.13	0.3	0.13	0.08	0.05	

[a, b, c, d, e] means with different superscripts on the same column differed significantly ($p<0.05$).
Treatment A – (Control) 0% cassava peel meal, Treatment B - 10% Cassava peel meal, Treatment C- 17.5% Cassava peel meal. SEM: Standard Error of Mean

The relationship between yolk index in DOS of eggs is shown in Figure 2. This is represented by the regression equation:

$$y = -0.2725x^2 - 2.8756x + 66.876 \quad (R^2 = 0.9567) \quad (2).$$

The equation 2 above and Figure 2 revealed a strong negative and highly significant ($p<0.01$) linear decline of yolk index in the days of eggs storage.

Effect of interaction of CPM inclusion and internal quality attributes of eggs in DOS is shown in Table 8. Effect of interactions of these two factors on yolk weight, yolk height and colour differs significantly ($p<0.05$). The yolk diameter for eggs collected from hens on treatments A and B were however similar ($p>0.05$).

Table 7: Effects of interaction of different level of cassava peel meal and duration of storage on albumen characteristics of eggs from chicken fed experimental diets

Treatments	Duration of Storage (days)	Albumen Height (mm)	Albumen Weight (g)	Albumen Diameter (mm)	Haugh Unit
A	0	5.71[a]	37.86[a]	81.56[ab]	73.28
	4	3.64[bc]	35.45[a]	71.67[ab]	53.48
	8	3.93[abc]	37.90[a]	66.43[abc]	55.91
	12	1.22[ef]	12.20[bc]	26.72[def]	6.40
	16	0.73[e]	5.00[bcd]	11.95[ef]	-14.71
	20	0.24[e]	1.20[cd]	3.33[f]	-74.76
B	0	1.66[a]	16.00[b]	36.16[cde]	15.03
	4	0.81[b]	6.70[bcd]	17.61[ef]	-25.99
	8	0.00[d]	0.00[d]	0.00[f]	0.00
	12	0.69[c]	36.30[a]	50.86[bcd]	-39.53
	16	0.52[c]	36.65[a]	76.02[ab]	-56.65
	20	0.38[c]	37.10[a]	66.58[abc]	-73.25
C	0	5.69[a]	35.89[a]	80.85[ab]	73.28
	4	5.19[a]	37.85[a]	83.14[a]	69.51
	8	3.43[bc]	36.70[a]	56.51[abcd]	50.13
	12	0.51[e]	4.80[cd]	12.77[ef]	-30.11
	16	0.60[e]	6.30[bcd]	11.67[ef]	-22.92
	20	0.36[e]	3.45[cd]	4.73[ef]	-55.74
	SEM	0.13	0.98	2.16	

[a, b, c, d, e] means with different superscripts on the same column differ significantly ($p<0.05$).,Treatment A – (Control) 0% cassava peel meal, Treatment B - 10% Cassava peel meal, Treatment C - 17.5% Cassava peel meal SEM: Standard Error of Mean.

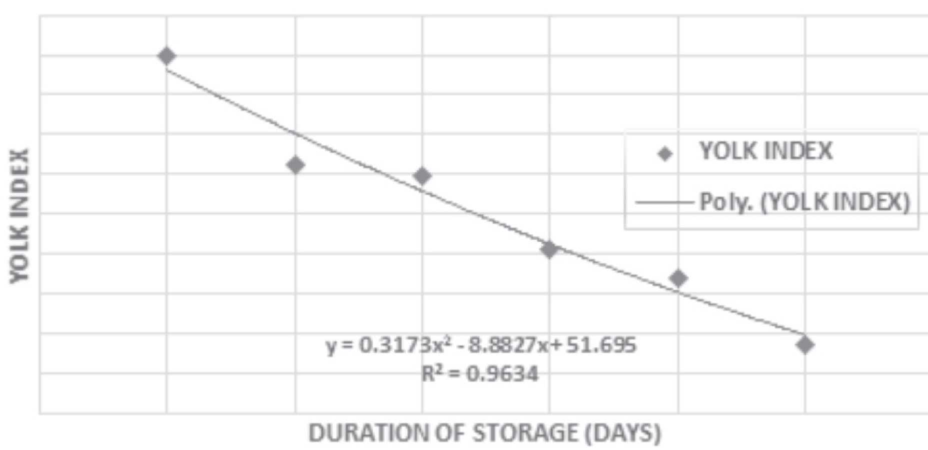

Figure 2. Relationship between yolk index and duration of eggs storage

Table 8: Effects of interaction of different level of cassava peel meal and duration of storage on yolk characteristics of eggs from chickens fed experimental diets

Treatments	Duration of Storage (days)	Yolk Weight (g)	Yolk Diameter (mm)	Yolk Height (mm)	Yolk Colour	Yolk Index
A	0	24.06^{a}	40.91^{ab}	12.00^{ab}	7.30^{de}	29.33
	4	17.70^{b}	41.94^{a}	10.73^{ab}	8.30^{abcde}	25.58
	8	16.75^{b}	38.84^{ab}	12.01^{ab}	8.20^{abcde}	30.92
	12	14.25^{bcd}	36.91^{ab}	8.71^{bc}	8.55^{abcde}	23.60
	16	14.35^{bcd}	39.89^{ab}	8.47^{bc}	8.15^{bcde}	21.91
	20	10.15^{cd}	28.21^{ab}	4.43^{d}	9.70^{ab}	15.70
B	0	13.10^{bcd}	37.28^{ab}	8.96^{bc}	10.10^{a}	24.03
	4	15.75^{bc}	42.74^{a}	9.13^{bc}	9.00^{abcd}	21.36
	8	11.85^{bcd}	31.19^{ab}	4.23^{d}	9.75^{ab}	13.56
	12	25.59^{a}	37.51^{ab}	10.49^{abc}	7.65^{cde}	27.97
	16	16.30^{b}	39.12^{ab}	11.41^{ab}	9.80^{ab}	29.17
	20	17.10^{b}	40.87^{ab}	11.39^{ab}	9.40^{abc}	27.87
C	0	25.59^{a}	39.29^{ab}	12.93^{a}	7.60^{cde}	32.91
	4	16.90^{b}	39.06^{ab}	12.07^{ab}	7.65^{cde}	30.90
	8	16.50^{b}	40.37^{ab}	10.83^{ab}	7.15^{e}	26.83
	12	16.40^{b}	41.52^{a}	9.89^{abc}	8.35^{abcde}	23.82
	16	12.70^{bcd}	34.65^{ab}	7.09^{cd}	9.80^{ab}	20.46
	20	9.35^{d}	26.15^{b}	3.96^{d}	9.75^{ab}	15.14
	SEM	0.37	0.74	0.22	0.99	

$^{a, b, c, d, e}$ *means with different superscripts on the same column differ significantly (p<0.05)., Treatment A – (Control) 0% cassava peel meal, Treatment B - 10% Cassava peel meal, Treatment C- 17.5% Cassava peel meal SEM: Standard Error of Mean.*

Conclusion and Recommendation

Both the dietary treatments and duration of egg storage affected egg quality characteristics. The internal quality attributes of eggs (weight, albumen and yolk height, Haugh unit, albumen and yolk indices) were lowered during egg storage while yolk weight, yolk diameter increased. Egg external characteristics (length and shell thickness) were not affected by DOS. These noted decline in egg quality attributes were irrespective of the dietary maize or CPM.

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