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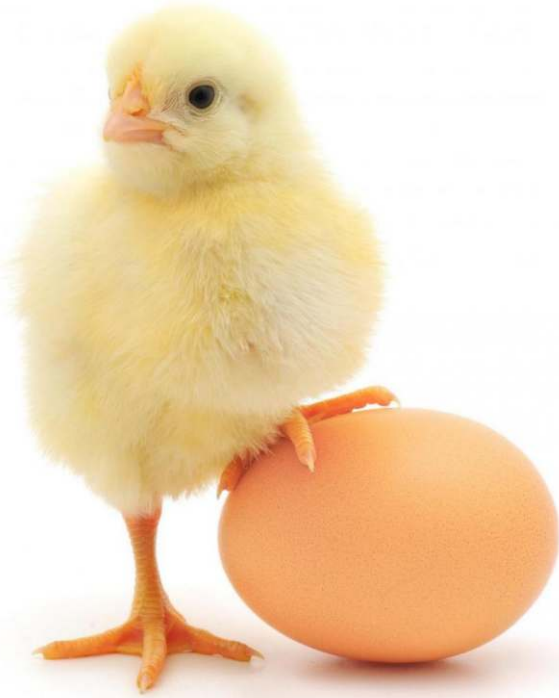

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ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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Pigeon Pea [*Cajanus cajan* (L.) Millsp.] Seed Meal in Layer Diets: 3. Effect of Higher Inclusion Level and Prolonged Feeding of Raw or Processed Pigeon Pea Seed Meal Diets from Pullet Chick Stage on the Laying Performance of Pullets

*K.U. Amaefule, M.A. Oguike, M.O. Ironkwe[1] and F.C. Obioha[2]
College of Animal Science and Animal Production, Michael Okpara University of Agriculture, Umudike, PMB 7267, Umuahia, Abia State, Nigeria
[1]Department of Animal Science and Fisheries, Faculty of Agriculture, University of Port Harcourt, Choba, Rivers State, Nigeria
[2]Department of Animal Science, University of Nigeria, Nsukka, Nigeria

Abstract: Black Bovan Nera pullets at point of lay (19 weeks old) that were fed pigeon Pea Seed Meal (PSM) diets during the pullet chick and grower stages of life were used to determine the effect of higher inclusion level and prolonged feeding of raw or processed PSM diets from the pullet chick stage on the laying performance of pullets. Brown colored pigeon pea seeds were used as raw, boiled for 30 min, toasted for 30 min, or soaked in water for 24 h, all of which were milled to pass through a 2 mm sieve. Each diet had three replications; each replicate had eight birds in a Completely Randomized Design (CRD). Parameters measured were feed intake, live weight, hen-day production, age at 1st, 25 and 50% egg production, external and internal egg quality characteristics. Results showed that layers fed boiled PSM diet had significantly ($P<0.05$) higher hen-day production (67.04%), egg weight (57.63 g), shell weight (6.50 g) while those fed raw PSM diet had the lowest (55.07%) hen-day production. It was concluded that raw or processed pigeon Pea Seed Meal (PSM) could be included as 30% of the whole diet of layers that had received 10 and 20% PSM based diets during their pullet chick and grower stages of life, respectively. Boiled PSM diet would improve hen-day egg production, toasted PSM diet would increase feed intake of layers while PSM diets will have no regular effects on external and internal egg quality characteristics of eggs laid by layers fed PSM diets.

Key words: Pigeon pea seed meal, layers, diet, eggs, pullets

Introduction

Conventional production of hen eggs and at low cost too is expected to help achieve sustainable and rapid production of high quality animal protein to meet increasing demands in Nigeria. The realization of this expectation is still being threatened by high cost and at times unavailability of maize and soybean meal, which are the two major feedstuffs in poultry diets.

Pigeon pea seeds (*Cajanus cajan*) have shown to possess good nutritive attributes as an alternative plant protein and energy source for broilers (Amaefule *et al.*, 2003; Onu and Okongwu, 2006), pullets (Amaefule and Obioha, 2005; Amaefule *et al.*, 2006a,b) and layers (Agwunobi, 2000; Amaefule *et al.*, 2006c). Previous study has indicated that pullet chicks could be fed 10% pigeon Pea Seed Meal (PSM) diets without adverse effect on performance (Amaefule and Obioha, 2005). The PSM could be included in the diets as raw, boiled for 30 min, toasted or soaked in water for 24 h. Amaefule *et al.* (2006a) have reported that nine week old pullets could be fed 20% raw, boiled, toasted or soaked PSM diets to point of lay without adverse effect on growth performance. Another report has also shown that pullets fed 10% PSM diet during the pullet chick stage of life could be fed 20% PSM diet from the grower stage to point of lay (Amaefule *et al.*, 2006b). There are other reports that pointed out that raw or processed pigeon pea seed meal could constitute 30% of the whole diet of point of lay pullets receiving PSM diet for the first time (Amaefule *et al.*, 2006c) while raw, boiled, toasted or soaked PSM included as 30% of the whole diet could be fed to layers that had received 20% PSM diet during the grower stage of life without any adverse effect on egg production and egg quality characteristics (Amaefule *et al.*, 2006d).

Due to the fact that the laying performance of hens could be affected by the diet and management received during the pullet chick and grower stages of life, the objective of the present study was to determine the effect of higher inclusion level and prolonged feeding of raw or processed pigeon Pea Seed Meal (PSM) diets from the pullet chick stage on the laying performance of pullets.

Materials and Methods

Processing of pigeon pea seeds: Brown colored pigeon pea seeds were used in the study as raw, boiled, toasted or soaked in water. Boiling in water was for 30 min with a big cooking pot heated with a gas stove. Soaking of raw seeds in water was for 24 h in a 200 litre capacity plastic container. The seed: water ratio was 30 kg per 100 litre water. The raw (unprocessed) or processed pigeon pea seeds were milled to pass

Table 1: Composition of raw or processed pigeon pea seed meal diets fed to layers (g kg^{-1})

Feedstuffs	Control	Raw	Boiled	Toasted	Soaked
White maize	360.00	285.00	285.00	285.00	285.00
Local fish meal	30.00	30.00	30.00	30.00	30.00
Spent grain	80.00	0.00	0.00	0.00	0.00
Maize gluten feed	150.00	50.00	50.00	50.00	50.00
Wheat offal	100.00	100.00	100.00	100.00	100.00
Soybean meal	185.00	140.00	140.00	140.00	140.00
Pigeon pea seed meal	0.00	300.00	300.00	300.00	300.00
Bone meal	30.00	3.00	3.00	3.00	3.00
Oyster shell meal	60.00	60.00	60.00	60.00	60.00
Vitamin premix*	2.50	2.50	2.50	2.50	2.50
NaCl	2.50	2.50	2.50	2.50	2.50
Total (g)	1000.00	1000.00	1000.00	1000.00	1000.00
Calculated composition:					
CP (%)	18.26	18.50	18.50	18.50	18.50
ME ($MJkg^{-1}$)	12.30	12.77	12.77	12.77	12.77
CF (%)	6.20	5.51	5.40	4.31	5.40
Ca (%)	3.40	3.40	3.40	3.40	3.40
Avail. P (%)	0.54	0.54	0.54	0.54	0.54
Lysine (%)	1.05	1.23	1.23	1.23	1.23
Methionine (%)	0.34	0.34	0.34	0.34	0.34
Analyzed composition+:					
Dry matter (%)	86.50	87.50	85.20	85.00	82.50
Crude protein (%)	18.32	18.18	18.37	18.06	18.40
Ether extract (%)	2.00	1.00	1.00	2.00	1.00
Crude fibre (%)	3.50	4.00	4.09	6.00	4.50
Crude ash (%)	15.50	13.00	17.50	15.50	18.00
Nitrogen free extract (%)	47.18	51.32	44.24	43.44	40.60
Gross Energy ($MJkg^{-1}$)	15.43	14.43	15.31	16.23	15.60

*Premix supplied Vitamin A 200000 IU, Vit. D_3 400000 IU, Vit. E 8.00 g, Vit. K_3 0.40 g, Vit. B_{12} 0.32 g, Vit. B_2 0.96 g, Vit B_6 0.56 g, Vit. C 2400 mg, Vit. B_{12} 400 mg, Folic acid 0.16 g, Biotin 8.00 mg, Choline 48.00 g, Ca Pantothionate, 1.60 g, Mn 16.00 mg, Fe 8.00 mg, Zinc 7.20 g, Copper 0.32 g, Iodine 0.25 mg, Cobalt 36.00 mg, Selenium 16.00 mg, BHT 32.00 g. + DM Basis

Table 2: Proximate composition of raw or processed pigeon pea seed meals (% DM Basis)

Composition	Raw	Boiled	Toasted	Soaked
Dry matter (%)	88.50	88.50	87.00	89.00
Crude protein (%)	26.25	27.34	25.37	27.12
Ether extract (%)	2.10	2.03	1.05	1.94
Crude fibre (%)	5.00	7.50	6.50	7.50
Crude ash (%)	5.50	4.00	6.10	4.00
Nitrogen free extract (%)	49.65	47.63	47.98	48.44
Gross Energy ($MJkg^{-1}$)	16.02	16.52	16.18	16.30

through a 2 mm sieve. The processing of the seeds had earlier been described by Amaefule and Obioha (2005) and Amaefule *et al.* (2006a).

Experimental diets: Five layers diets were formulated with raw, boiled, toasted or soaked PSM. Each was included as 30% of the whole diet. The control diet had 0% PSM (Table 1). The raw or processed PSM replaced part of soybean meal and maize in the diets.

Experimental pullets and their management: Black Bovan Nera pullets at point of lay (19 weeks old) that were fed PSM diets during the pullet chick and grower stages of life were used for the study. The pullets in each replicate were brooded and reared in a deep litter (wood shavings) pen of a tropical-type, open-sided poultry house whose sides and demarcations between pens were covered with wire-gauze (Amaefule and Obioha, 2005).

The pullets of the control group were fed a chick diet (maize 45%, soybean meal 25%, maize gluten feed 8%, local fish meal 2%, spent grain 10%, wheat offal 6.50%, bone meal 3% vitamin premix 0.25% and Nacl 0.25%) that contained 20.57% CP, 3.70% CF, 1.32% Ca, 0.67% P, 1.07% lysine, 0.30% methionine and 12.97 $MJkg^{-1}$ ME at the pullet chick (0-56 days) stage and a grower diet containing 37% maize, 1% local fish meal, 12% spent grain, 22.50% maize gluten feed, 15% wheat offal, 9% soybean meal, 3% bone meal, 0.25% vitamin premix and 0.25% Nacl during the grower stage (56-126 days). The CP, crude fibre, Ca, P, lysine, methionine and ME contents were 15.24, 4.27, 1.03, 0.51, 0.69, 0.26% and 12.65 $MJkg^{-1}$, respectively.

The groups that were fed raw, boiled, toasted or soaked PSM diets received 10% raw or processed PSM diets that also contained 36% maize, 2% local fish meal, 10% spent grain, 8% maize gluten feed, 21% soybean meal and 6.50% wheat offal during the pullet chick stage (Amaefule and Obioha, 2005). They were also fed 20% raw, boiled, toasted or soaked PSM diets containing maize 36%, local fish meal 1%, spent grain 5%, maize gluten feed 14.50%, soybean meal 5% and wheat offal 15% during the grower stage (Amaefule *et al.*, 2006a,b).

Table 3: Performance of Layers fed raw or processed pigeon pea seed meal diets from pullet chick stage of life

Parameters	Control	Raw	Boiled	Toasted	Soaked	SEM
Hen-day Production (%)	65.56^{ab}	55. 07^{b}	67.04^{a}	64.43^{ab}	62.50^{ab}	3.12
Daily feed intake (g/b)	88.17^{b}	89.10^{b}	99. 37^{ab}	104.74^{a}	94.47^{ab}	4. 3 4
No. of cracked eggs per bird	4. 00^{a}	4. 33^{a}	0. 00^{b}	4. 33^{a}	4. 67^{a}	1. 1 3
Mortality (%)	0.00	3. 67	3. 33	3. 33	3. 33	0.42
F C R	3. 17	4. 36	3. 42	3. 92	3. 63	0.41
Egg Mass Produced (kg/b)	1.20	1.11	1.26	1.17	1.14	0.27
Age at 1st egg (days)	155. 33	157.00	153. 67	153. 00	154. 67	1.92
Age at 25% Production (days)	158.33	167.00	158.33	158.33	164.33	2.57
Age at 50% production (days)	165.00	172.33	167.33	169.00	169.00	1.82
Final live weight (kg/b)	1.90	1.96	1.89	2.10	2.03	0.20

a,b Means in the same row followed by different superscripts are significantly different (P<0. 05). SEM = Standard Error of mean

All the diets were fortified with 3% bone meal, 0.25% vitamin premix and 0.25% Nacl. The CP and ME of the grower diets were 15.39% and 12.65 $MJkg^{-1}$, respectively.

The layers were housed in a 2-tier battery cage located in an open-sided poultry house covered with wire gauze but roofed with corrugated iron sheets. The battery cages were equipped with open (manual) feeder troughs and nipple drinkers. Water supply to the nipple drinkers was from an over-head 500 litre water tank. Each cage cell (60 cm×42 cm×40 cm) contained two layers. The ambient temperature of the experimental poultry house measured with a thermometer hung above the cages ranged from 23 to 25°C (average 24°C) throughout the period of the experiment. The layers were vaccinated against Newcastle (I/O, *Lasota, Kamorov*), *Gumboro* and fowl pox diseases during the rearing period. They were not de-beaked but were de-wormed at 18 weeks of age.

The feeder troughs were demarcated with flat aluminum sheets to prevent feed from one replicate or treatment mixing with another and this also prevented birds from one replicate feeding from another. Feed was introduced into the feeders 2 times daily (7.00-7.30 am and 1.00-1.30 pm), with a feed allowance of 120 g per layer per day. Water was provided *ad libitum*.

Experimental design and data collection: The experimental design was Completely Randomized Design (CRD). There were five treatments, each replicated three times and eight birds per replicate. The number of eggs laid per replicate was recorded and collected twice daily (10.30 am and 4.30 pm) while egg weight, shell weight and thickness, shape index, albumen and yolk weight, yolk index and Haugh unit were determined monthly. The layers were weighed individually and on a monthly (middle of each laying month) basis. Egg mass was calculated as number of eggs×egg weight, percent hen-day production as number of eggs produced divided by the number of hen-days×100%. Record of number of cracked eggs and mortality were maintained for each replicate throughout the period of the experiment. Feed efficiency was calculated as the number of eggs laid per kg feed consumed.

Egg quality measurements: The average weight of eggs laid by birds in each replicate was determined monthly (mid-month of lay) using an Acculab electronic (0.1g) weighing scale. The length and diameter of the eggs were measured with a Venier Caliper. Shell thickness was determined using Ames micrometer screw gauge (Ames 25M5), albumen and yolk heights with Ames (S-6428, 0.1mm) Tripod thickness measure, yolk diameter with Venier Caliper, while albumen and yolk weights were measured with Acculab electronic scale. Yolk index was calculated as yolk height divided by yolk diameter. Haugh unit was determined using interior quality calculator for eggs (USDA Chart for scoring broken-out eggs, Catalog 4-4200 American Instrument Co. Inc. Silver Spring, MD.) while shape index was calculated as egg length divided by the width.

Chemical and data analyses: Feed samples were analyzed for proximate composition according to methods of A.O.A.C. (1990). The gross energy of PSM and experimental diets were determined using Adiabatic Oxygen Bomb Calorimeter (1241 Adiabatic Calorimeter, PARR Instrument Co., Illinois, USA) technique. All data collected were subjected to analysis of variance (ANOVA) and differences among treatment means were separated using Duncan's Multiple Range Test (Duncan, 1955). All statistical procedures were according to Steel and Torrie (1980).

Results

The performance of layers fed raw or processed PSM diets from the pullet chick stage of life is presented in Table 3. There were no significant differences (P>0. 05) among the layers fed raw, toasted, boiled, soaked or control diets in Feed Conversion Ratio (FCR), egg mass, age at first egg lay, age at 25 and 50% egg production, final live weight and mortality. Layers fed toasted PSM diet had a significantly (P<0.05) higher daily feed intake than those fed raw PSM and control diets, while the number of cracked eggs produced by layers fed boiled PSM diet was significantly (P<0.05) lower than those fed other diets. The percent hen-day production of layers fed boiled PSM diet was significantly (P<0.05)

Table 4: The Effect of Feeding raw or processed PSM diets to layers from chick stage on external egg quality

Parameters	Control	Raw	Boiled	Toasted	Soaked	SEM
Egg Weight (g)	57.35^{a}	54.42^{ab}	57.63^{a}	53.25^{b}	50.98^{b}	1.12
Egg Width (cm)	4.30^{ab}	4.21^{c}	4.36^{a}	4.25^{bc}	4.20^{c}	0.03
Egg Length (cm)	5.80^{ab}	5.82^{a}	5.88^{a}	5.65^{b}	5.49^{c}	0.05
Shape Index	0.74^{bc}	0.72^{c}	0.74^{bc}	0.75^{ab}	0.77^{a}	0.01
Shell as % of egg weight	8.07	9.19	9.54	9.90	9.81	-
Shell Weight (g)	4.63^{c}	5.00^{bc}	6.50^{a}	5.27^{b}	5.00^{bc}	0.14
Shell Thickness (mm)	0.37	0.38	0.38	0.40	0.41	0. 01

a,b Means in the same row followed by different superscripts are significantly different (P<0. 05), SEM = Standard Error of mean

Table 5: Effect of feeding raw or processed PSM based diets to layers from the chick stage on internal egg quality

Parameters	Control	Raw	Boiled	Toasted	Soaked	SEM
Albumen height (mm)	9.78^{ab}	10.19^{a}	10.11^{a}	9.18^{b}	9.60^{ab}	0.24
Yolk height (mm)	19.13^{a}	18.02^{b}	18.67^{ab}	18.52^{ab}	18.55^{ab}	0.31
Albumen weight (g)	36.65^{a}	33.20^{b}	37.42^{a}	33.20^{b}	33.13^{b}	0.69
Yolk weight (g)	14.25^{a}	15.17^{a}	13.72^{ab}	14.40^{a}	12.45^{b}	0.52
Yolk diameter (mm)	42. 53^{a}	40. 13^{bc}	39. 50^{c}	40. 90^{b}	37. 73^{d}	0.42
Yolk index	0. 45	0. 61	0. 47	0. 45	0. 49	-
Albumen + yolk weight (g)	50.88^{a}	48.37^{b}	51.03^{a}	47.60^{bc}	45.58^{c}	0.73
Haugh unit	98.73^{ab}	101.13^{a}	99.1^{ab}	96.87^{b}	99.40^{ab}	1.27
USDA Quality score	AA	AA	AA	AA	AA	-

a,b Means in the same row followed by different superscripts are significantly different (P<0. 05). SEM = Standard Error of mean

higher than that of birds fed raw diet but not significantly (P>0.05) different from the rest of other PSM and control diets. Percent hen-day production (Fig. 1) peaked at about 85% at the 3rd month and dropped sharply to about 50-55% between the 4th and 6th months in all the PSM diet groups. The exception were layers fed the control diet, which maintained a plateau between the 3rd and 4th months, while the average hen-day production of layers fed toasted PSM diet dropped to below 40% at the 7th month before rising sharply again.

External egg quality: The effect of feeding raw or processed PSM diets to layers from pullet chick stage of life on external egg qualities (Table 4) showed that the average weight of eggs laid by birds fed control, boiled and raw PSM diets were not significantly (P>0.05) different from each other. Eggs laid by layers fed toasted and soaked PSM diets were significantly (P<0.05) lower in weight than eggs laid by layers fed boiled PSM diet. Layers fed boiled PSM also laid eggs of significantly (P<0.05) higher length than those fed toasted or soaked PSM diet and also a significantly (P>0.05) higher egg width than eggs from toasted, or soaked PSM diets. The Shape Index (SI) of eggs from layers fed boiled, raw PSM and control diets were not significantly (P>0.05) different from each other but were significantly (P<0.05) lower than the S1 of eggs laid by birds fed soaked diets. Shell weight of the control group, although not significantly (P>0.05) different from those of raw and soaked, was the lowest. Shell thickness was not significantly affected by feeding raw or processed PSM diets to the layers.

Internal egg quality: All internal egg quality parameters measured (Table 5) were significantly (P<0.05) affected by raw, toasted, boiled, soaked PSM or control diets fed to layers from pullet chick stage except yolk index. Layers fed boiled PSM diet had a significant (P<0.05) higher albumen height than those of eggs laid by layers fed toasted PSM diet. Albumen height did not significantly (P>0.05) differ among eggs laid by layers fed raw, boiled soaked PSM and control diets. Raw PSM diet produced an average yolk height that was significantly (P<0.05) lower than that of control, but did not significantly (P>0.05) differ from that of other PSM diets. Albumen weight followed the same trend as yolk height, while yolk weight of eggs laid by birds fed control diet was only significantly (P<0.05) higher than those of eggs laid by layers fed soaked PSM diet. The albumen+yolk weight of eggs laid by birds fed boiled PSM and control diets were similar. However, they were significantly (P<0.05) higher than that of eggs laid by layers fed raw PSM diets, which in turn was significantly (P<0.05) higher than the albumen+yolk weight of eggs laid by birds fed soaked PSM diet. The Haugh unit followed the same trend as the albumen height.

Discussion

Boiled PSM diet significantly improved percent hen-day production of layers over that of the raw PSM or control diet. The superiority of boiled PSM diet over raw could be attributed to the elimination or significant reduction (Onu and Okongwu, 2006) of protease and other antinutritional substances from boiled PSM by boiling in water and the presence of these substances in the raw PSM (D'Mello, 1995). This could equally explain the higher numerical values obtained in all performance measurements taken from layers fed boiled PSM diet when compared to layers fed other processed or raw PSM diets. This result is in agreement with the report of Tangtaweewipat and Elliott (1989) and Udedibie and

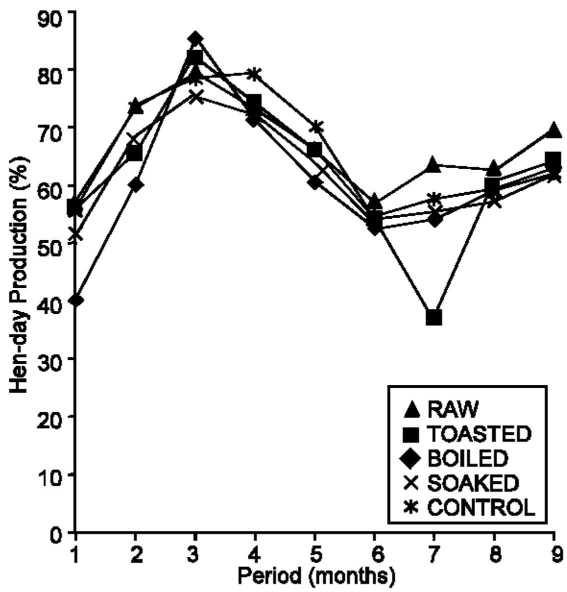

Fig. 1: Average percent hen-day production of layers fed raw or processed PSM diets from the pullet chick (day-old) stage of life

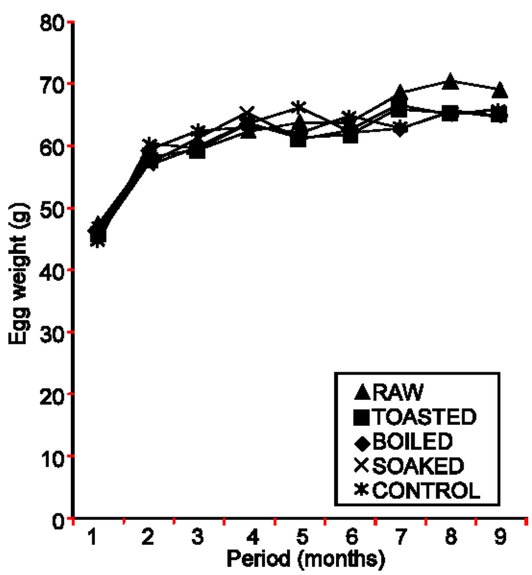

Fig. 2: Average weight of eggs laid by layers fed raw or processed PSM diets from the pullet chick (day-old) stage of life

Igwe (1989) that higher rates of inclusion (300-400 gkg^{-1} diet) of raw PSM depressed egg production and feed efficiency, especially when there was no supplementation with oil or methionine as was the case in this study.

The uniform hen-day production of the layers fed raw or processed PSM diets from pullet chick stage could be due to the prolonged period of feeding in which the birds adapted to the PSM diets. The sharp drop in egg production from 3rd to 6th month of lay (Fig. 1) corresponds to the period in which soybean meal was temporally replaced with full fat soybean meal due to the non-availability of soybean meal in the market and subsequent adaptation to the diet. Sexual maturity (age at first egg lay) recorded in this study for layers fed raw, processed PSM and control diets could have been due to feed restriction practiced during the pullet growing period (Hocking *et al.*, 1989; Hocking, 1992; Hocking, 1993; Sharma and Sharda, 1993). The age range (153-175 d) is considered normal and agrees with 142-160 days of Shanawany (1983) and 148-158 days of Odunsi and Gbadamosi (2001). Layers fed raw PSM diet reached sexual maturity 2-4 days later than those fed processed PSM and control diets; and this could be attributed to the presence of antinutritional substances in the raw PSM. Also layers fed raw PSM diet reached 25 and 50% eggs production at a later age than those fed other diets, which could be a carry-over from the age at sexual maturity. Generally, layers fed raw PSM or control diets attained 25 and 50% egg production at an age comparable to that reported by Shanawany (1983) and Elzubeir and Mohammed (1993). The significantly higher consumption of the toasted PSM diet may have been an attempt by the birds to meet their nutrient requirement from a diet that may have contained some levels of antinutritional substances, thus confirming that toasting (dry heating) is less effective in removing antinutritional substances from tropical legumes seeds (D'Mello, 1995; Onu and Okongwu, 2006). However, overall feed intake and performance of the birds are in line with earlier reports of Agwunobi (2000), Amaefule *et al.* (2006c,d). The lack of cracked eggs produced by layers fed boiled PSM diet and no mortality among birds fed control diet could not be explained in this study but showed the superiority of these two diets over raw, toasted and soaked PSM diets.

External egg quality: Raw or processed PSM diets as well as control diet fed to pullets from pullet chick, through the grower stage of life, resulted in an increase in the weight of eggs laid with increase in age (Fig. 2) of the layers. This is in agreement with the reports of Fletcher *et al.* (1981) and Awosanya *et al.* (1998) that egg weight increases with increase in age of laying hens. The higher egg weight laid by birds fed boiled PSM diet occurred from the 7th month (Fig. 2), which was due mainly to the significant increase in shell weight (Table 4) and albumen weight (Table 5). Generally, the egg weights recorded in this study were in line with those reported by Obioha *et al.* (1985) Olerede and Longe (2000) and Ayanwale and Gado (2001), but lower than that by Awosanya *et al.* (1998) and Agwunobi (2000). The difference among eggs laid by layers fed

boiled and soaked PSM diets in shape index may have resulted from differences in egg width and length while the egg shape indices of eggs laid by birds fed PSM and control diets were similar to those reported by Olerede and Longe (2000), but slightly lower than that recorded by Awosanya *et al.* (1998). Variations in shape index associated with increase in egg weight (Fletcher *et al.*, 1981) were also observed in this study.
Boiled PSM diet increased egg shell weight more than any other PSM diet, while the control diet decreased it. However, the decrease in the shell weight as a percentage of the total egg weight as egg weight increased suggested that the quantity of shell deposited on the egg remained constant irrespective of egg size (Jackson *et al.*, 1987). Egg shell thickness was not affected by raw or processed PSM diets fed to the layers and the values obtained, which compared favourably with those reported by Oguike (1994), Awosanya *et al.* (1998), Agwunobi (2000), Olerede and Longe (2000), clearly showed that layers capable of laying larger eggs are also capable of laying stronger eggs with normal shell thickness (Jackson *et al.*, 1987). Egg shell thickness obtained in this study was higher than that obtained when layers were fed commercial diets (Ayanwale and Gado, 2001) and this could have been due to the higher Ca content of our diets (3.40%) compared to 1.04-1.88% in the commercial diet they used.

Internal egg quality: The feeding of raw or processed PSM diets to pullets from the pullet chick stage influenced all the internal egg parameters measured. Boiled PSM diet increased albumen height, weight and albumen+yolk weight, toasted PSM diet significantly reduced albumen height, while raw PSM diet reduced yolk height. These differences in internal egg qualities were attributed to differences in egg size and weight as a result of feeding raw or processed PSM diets to the layers. Layers fed soaked PSM diet produced eggs with smallest albumen+yolk weight suggesting that the greater proportion of the egg was made up of the shell. The only significant difference in Haugh unit was between eggs laid by birds fed raw and toasted PSM diets, which was related to differences in albumen height. The Haugh unit values were generally higher than those obtained with 55% autoclaved pigeon pea seed meal (Agwunobi, 2000), yellow peas (Ivusic *et al.*, 1994), she abutter cake (Olerede and Longe, 2000) and commercial diets (Ayanwale and Gado, 2001), which may have been due to the effect of PSM diets on egg size and other quality characteristics. Apart from these, the eggs in this study were evaluated for these internal quality parameters as fresh eggs collected almost immediately after lay. The evaluation lasted for about six hours, which left no opportunity for moisture loss or other changes associated with egg storage that subsequently affects internal constituents of eggs. The eggs laid by the layers fed the raw or processed PSM diets scored ‘AA’ judging by USDA quality or fresh measurement.

Conclusion: Raw or processed pigeon Pea Seed Meal (PSM) could be included as 30% of the whole diet of layers that had received 10 and 20% PSM based diets in during their pullet chick and grower stages of life, respectively. Boiled PSM diet would improve hen-day egg production and result in no cracked eggs. The expectation will be that toasted PSM diet could increase feed intake of layers while there could be no regular effect on external and internal egg quality characteristics of eggs laid by layers fed PSM diets.

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