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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: 2. Laying Performance and Egg Quality Characteristics of Pullets Fed Raw or Processed Pigeon Pea Seed Meal Diets During Grower and Layer Stages of Life

*K.U. Amaefule, U.K. Oke and F.C. Obioha[1]
College of Animal Science and Animal Health, Michael Okpara University of Agriculture, Umudike, PMB 7267, Umuahia, Abia State, Nigeria
[1]Department of Animal Science, University of Nigeria, Nsukka, Nigeria

Abstract: Laying performance and egg quality characteristics of grower pullets fed raw or processed pigeon pea seed meal diets during grower and layer stages of life were determined with 135 black Bovan Nera grower (126 days old) pullets. Each raw or processed (toasted for 30 minutes, boiled for 30 minutes, or soaked in water for 24 hours) seeds, which constituted a treatment, were milled. Each treatment had three replicates and nine birds per replicate in a completely randomized design (CRD). The experimental diets were isoenergetic and isonitrogenous. Live weight, feed intake, live weight gain, egg production, mortality, external and internal egg quality characteristics were measured. Results showed that there were non-significant (P>0.05) differences among the layers fed PSM diets in all the egg production parameters measured, except daily feed intake and feed conversion ratio (FCR). However, layers fed boiled PSM diet had the highest hen-day production (67.64%), feed intake (105.57 g/b/d) and hen-housed production (78.71%). Layers fed soaked PSM diet had the lowest hen-housed production (66.30%), hen-day production (58.38%), egg mass production (1083.16 g), poorest FCR, and highest number of cracked eggs. The conclusion was that raw, boiled or toasted PSM included as 30% of the diet could be fed to layers that had received 20% PSM diet during the grower stage of life without adverse effects on egg production, external and internal egg quality characteristics. It should be expected that soaked PSM diet could adversely affect egg production as well as external and internal egg qualities.

Key words: Processed pigeon pea seed meal, laying performance, layer diets, egg quality

Introduction

Pigeon pea seeds are best known as human food in the Middle Belt of Nigeria during periods of scarcity of the popular cowpea (Amaefule and Obioha, 1998) and as *dhal* in India (Van Den Beldt, 1988). Apart from the fairly high CP content of the raw and processed seeds (23-25%) as reported by Amaefule *et al.* (2003), Amaefule and Nwagbara (2004) and Amaefule *et al.* (2006a) the seeds have good contents of vitamins A (470 mg/100 g) and C (25 mg/100 g) as indicated by Faris *et al.* (1987) and Olomu (1995).

In an earlier study, Amaefule *et al.* (2006b) fed raw or processed (boiled, toasted and soaked) pigeon pea seed meal (PSM) diets to 9-week old black Bovan Nera pullets to point of lay and reported that pullets fed 20% boiled PSM diet had significantly (P<0.05) higher daily protein intake and live weight at point of lay than others. The conclusion from that study was that PSM could be a good protein and energy source for grower pullets, which could be incorporated into the diet at 20% of the whole diet. This present study, which is a continuation of the earlier reported one, was aimed at determining the laying performance and egg quality characteristics of pullets fed raw or processed pigeon pea seed meal diets during grower and layer stages of life.

Materials and Methods

Processing of seeds: The pigeon pea seeds (brown coloured) were used raw, boiled, toasted or soaked in water. Boiling was for 30 minutes with a big cooking pot heated with a gas stove. Soaking of raw seeds in water was for 24 hours 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 with a local milling machine powered by a 2.0 hp diesel Lister engine to pass through a 2 mm sieve. The processing of the seeds had been described by Amaefule and Nwagbara (2004), Amaefule and Obioha (2005) and Amaefule *et al.* (2006b).

Experimental diets: Five isoenergetic and isonitrogenous layer diets were formulated with raw, boiled, toasted and soaked PSM. Each was included at 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 birds and their management: Point of lay black Bovan Nera pullets that were fed PSM diets during the grower stage (56-126 days) of life were used for the

Table 1: Percentage composition of raw or processed pigeon pea seed diets to layers

Feedstuffs %	Control	Raw	Boiled	Toasted	Soaked
Yellow maize	36.00	28.50	28.50	28.50	28.50
Local fish meal	3.00	3.00	3.00	3.00	3.00
Spent grain	8.00	-	-	-	-
Maize gluten feed	15.00	5.00	5.00	5.00	5.00
Wheat offal	10.00	10.00	10.00	10.00	10.00
Soybean meal	18.50	14.00	14.00	14.00	14.00
Pigeon pea seed meal	0.00	30.00	30.00	30.00	30.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Oyster shell meal	6.00	6.00	6.00	6.00	6.00
Vitamin Premix*	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total (%)	100	100	100	100	100
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

*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.

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 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 salt 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. At the grower stage (56-126 days), pullets of the control group were fed 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% salt. The CP, CF, 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. Pullets fed pigeon pea seed meal (PSM) received diets composed of maize 36%, local fish meal 1%, spent grain 5%, maize gluten meal 14.50%, wheat offal 15%, soybean meal 5%, bone meal 3%, vitamin premix 0.25%, salt 0.25% and 20% raw, boiled, toasted or soaked PSM.

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 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 x 42 cm x 40 cm) contained two layers. The ambient temperature of the experimental poultry house measured with three thermometers hung above, and at various sections of the cages ranged between 23 and 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 16 weeks of age.

The feeder troughs were demarcated with specially constructed flat aluminum sheets to prevent feed from one replicate or treatment mixing with another. This also prevented birds from one replicate feeding from another. The layers were fed 2 times daily (7.00-7.30 am and 1.00-1.30 pm, local time) with a feed allowance of 120 g per layer per day. Drinking water was provided *ad libitum*.

Experimental design and data collection: The experimental design was completely randomized design (CRD). There were five treatments, and each replicated three times. There were nine birds per replicate. The number of eggs laid per replicate was collected and recorded twice daily (10.30 am and 4.00 pm local time) while egg weight, shell weight and thickness, shape index, albumen and yolk weight, yolk index and Haugh unit were determined monthly, usually at the middle of each laying month. The layers were weighed individually and on a monthly basis. Egg mass was calculated as number of eggs x egg weight, percent hen-day production as number of eggs produced divided by the number of hen-days x 100% and percent hen-housed production as number of eggs produced divided by (number of hens housed x number of days) x 100%. Record of number of cracked eggs and mortality were maintained for each replicate throughout the period of

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

Table 3: Proximate composition of raw or processed layer diets (% DM Basis)

Composition	Control	Raw	Boiled	Toasted	Soaked
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
Energy ($MJkg^{-1}$)	15.43	14.43	15.31	16.23	15.60

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 egg width.

Chemical and data analyses: Feed samples were analyzed for proximate composition according to methods of A.O.A.C. (1990). The gross energy (GE) 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). Arcsine transformation was carried out for percent hen-day and hen-housed production before ANOVA. Differences among treatment means were separated using Duncan's Multiple Range Test (Duncan, 1955).

Results

Performance: The performance of layers fed raw or processed PSM diets during the grower and layer stages of life is presented in Table 4. The intake of the raw PSM diet by layers was not significantly ($P>0.05$) different from that of control diet; both were significantly ($P<0.05$) lower than those of toasted, boiled and soaked PSM diets. The intake of boiled and soaked PSM diets by layers were not significantly ($P>0.05$) different from each other, although each was higher than the intake of the toasted diet.

Layers fed control diet had a significantly ($P<0.05$) lower FCR than those fed toasted or soaked PSM diet. There was no significant ($P>0.05$) difference among layers fed raw, toasted, boiled and soaked PSM diets in FCR. Age at first egg lay, percent hen-day production, hen-housed production, average number of cracked eggs produced and mortality did not show significant ($P>0.05$) differences among the layers fed the control, raw or processed PSM diets.

Layers fed boiled PSM diet consistently gave the highest hen-housed (Table 4) and hen-day production (Fig. 1). Conversely, the toasted diet supported the least production in the two parameters. Hen-day production showed peaks at the 3rd month and troughs at the 6 th month.

External egg quality: The effect of feeding raw or processed PSM diets to layers during grower and layer stages of life on the external egg quality characteristics is presented in Table 5. The weight and width of eggs laid by all the birds were not affected by treatment diets consumed. However, the length of eggs laid by birds fed toasted PSM diet was significantly ($P<0.05$) higher than that of birds fed boiled PSM diet only. At the same time, eggs laid by birds fed toasted PSM diet had significantly ($P<0.05$) lower shape index than the rest. The shell weight of eggs laid by birds fed raw, boiled PSM and control diets were not significantly ($P>0.05$) different from each other, but were significantly ($P<0.05$) lower than the shell weight of eggs laid by birds fed toasted PSM diet, which was in turn significantly ($P<0.05$) lower than that by birds fed soaked PSM diet. The eggs laid by layers fed soaked PSM diet had a significantly ($P<0.05$) thicker shell than those laid by birds fed control diet only. There was no significant ($P>0.05$) difference in shell thickness among eggs laid by birds fed raw, toasted and boiled PSM diets.

Internal egg quality: The layers fed raw or processed PSM diets laid eggs that had significant ($P<0.05$) differences in all their internal quality parameters except yolk weight (Table 6). Layers fed soaked PSM diet laid eggs with significantly ($P<0.05$) higher albumen height than that of eggs laid by layers fed raw PSM diet only. But yolk height of eggs laid by birds fed raw PSM diet, which was not significantly ($P>0.05$) different from the yolk height of eggs produced by layers fed toasted or soaked PSM diets, was significantly ($P<0.05$) lower than that of eggs laid by birds fed boiled and control diets. Albumen

Table 4: Performance of layers fed raw or processed pigeon pea seed meal diets during the grower and laying stages of life

Parameters	Control	Raw	Boiled	Toasted	Soaked	SEM
Hen-housed production (%)	76. 31	68.16	78.71	68.00	66. 30	3. 80
Hen-day production (%)	65.56	58.57	67.64	58.44	56.98	3.29
Daily feed intake (g/b)	88.15^{c}	90.38^{c}	105.57^{a}	98.69^{b}	100. 07^{a}	6.69
No. of cracked eggs	0.67	1.00	1.33	1.00	1.67	0. 82
Average mortality (%)	0.00	0.00	3.33	1.00	3.33	1.54
Feed conversion ratio	3.17^{ab}	3.76^{ab}	3.66^{ab}	4.12^{a}	4.12^{a}	0. 20
Egg mass prod. (g)	1200.07	1103.04	1232.82	1100.88	1083.16	342.42
Age at 1st egg (days)	155.33	160.33	153.33	153.33	159. 67	1.76
Age at 25% production (days)	158.33	166.00	162.67	164.00	165.00	2.03
Age at 50% production (days)	165.00	174.67	166.67	169.00	174.67	2.99
Initial live weight (kg/b)	1.53^{b}	1.60^{ab}	1.75^{a}	1.60^{ab}	1.73^{a}	0.05
Final live weight (kg/b)	1.90	2.10	1.88	1.90	2.10	0.21

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

Table 5: External quality characteristics of eggs laid by layers fed raw or processed pigeon pea seed meal diets during grower and laying stages of life

Parameters	Control	Raw	Boiled	Toasted	Soaked	SEM
Egg weight (g)	61.01	62.78	60.76	62.80	63.38	1.48
Egg width (cm)	4.30	4.29	4.31	4.23	4.27	0.03
Egg length (cm)	5.80^{ab}	5.76^{ab}	5.67^{b}	5.90^{a}	5.75^{ab}	0.06
Shape index	0.74^{a}	0.75^{a}	0.76^{a}	0.72^{b}	0.74^{a}	0.01
Shell weight (g)	4.63^{c}	4.65^{c}	4.50^{c}	5.45^{b}	6.47^{a}	0.18
Shell as % of egg weight	8.08	8.87	8.11	14.14	11.57	-
Shell thickness (mm)	0.37^{c}	0.42^{ab}	0.39^{bc}	0.43^{a}	0.44^{a}	0.01

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

weight was of the same trend as albumen height except that the albumen height of eggs laid by layers fed raw PSM diet was not significantly (P>0.05) different from that of eggs by birds fed toasted PSM diets. Yolk weight of eggs produced by layers fed the various PSM diets and control was not significantly (P>0.05) different from each other. Yolk index of eggs laid by birds fed raw PSM diet was significantly (P<0.05) lower than those of birds fed toasted, boiled or control diets, which were in turn significantly (P<0.05) lower than that of eggs from soaked PSM diet. Albumen + yolk weight was of the same trend as albumen weight. Haugh unit of eggs produced by layers fed raw PSM diets was significantly (P<0.05) lower than that of eggs laid by layers fed other treatment diets.

Discussion

Performance: The feeding of raw or processed PSM diets to layers from the pullet grower stage influenced only daily feed intake and FCR. Average percent hen-housed and percent hen-day production of layers fed boiled PSM diet were comparable to that of layers fed control diet but better than those of layers fed raw, toasted and soaked PSM diets, showing that boiling was a better processing method that could have effectively removed antinutritional substances from the pigeon pea seeds (D'Mello, 1995). The result obtained in this study is in agreement with that of Udedibie and Igwe (1989) using 30% raw pigeon pea seed meal diet but higher than that of Agwunobi (2000) with 55% raw seed diet. Generally, these results are in line with those of Obioha *et al.* (1984); Obioha *et al.* (1985) and Summers *et al.* (1991). The drop in egg production between 3rd and 6th month in lay could be as a result of change of soybean meal from imported to locally produced one. Boiled PSM diet fed to layers resulted in increased daily feed intake probably as a result of the higher percent hen-housed and percent hen-day production, while the increase in feed intake due to soaked PSM diet could be attributed to the presence of autinutritional substances, which may have caused the birds to increase feed intake to meet nutrient requirement. The feed intake figures obtained agree with those of Udedibie and Igwe (1989) but were higher than those of Agwunobi (2000) obtained with 55% raw PSM in layer ration. The values also agree with those obtained using fermented *Thevetia* cake (Adeyemi and Adeyemi, 2000), wild sun-flower leaf meal (Odunsi *et al.*, 1996), supplemented low protein diet (Summers *et al.*, 1991) but were lower than the feed intake values obtained using sun-flower seed meal (Okonkwo and Oketola, 1996). The differences in the FCR of the layers fed raw or processed PSM diets, especially those fed toasted and soaked PSM diets, could be attributed to lower egg production and higher feed intake. Age at sexual maturity was generally lower than that of layers fed PSM diet from point of lay (POL) stage of life (Amaefule *et al.*, 2006a), but still fell within the range (142-160 days) regarded as normal (Shanawany, 1983; Odunsi and Gbadamosi, 2001). Just like the birds fed PSM diets from POL (Amaefule *et al.*, 2006a), birds fed raw PSM diet during the grower and layer stages attained age at 25 and 50% eggs production almost at

Table 6: Internal quality characteristics of eggs laid by layers fed raw or processed pigeon pea seed meal diets during the grower and laying stages of life

Parameters	Control	Raw	Boiled	Toasted	Soaked	SEM
Albumen height (mm)	9.78^{ab}	9.18^{b}	9.85^{ab}	10.50^{a}	10.28^{a}	0.32
Yolk height (mm)	19.12^{ab}	17.54^{c}	19.48^{a}	18.12^{c}	18.43^{bc}	0.29
Albumen weight (g)	36.65^{a}	33.33^{ab}	33.63^{ab}	28.67^{b}	35.97^{a}	1.66
Yolk weight (g)	14.25	13.67	12.87	13.67	13.15	0.46
Yolk diameter (mm)	42.53^{a}	42. 10^{a}	42. 27^{a}	40. 23^{b}	37. 60^{c}	0.45
Yolk index	0.45^{b}	0. 42^{c}	0. 46^{b}	0. 45^{b}	0. 49^{a}	0.01
Albumen+ Yolk height (g)	50.88^{a}	47.00^{ab}	46.50^{ab}	42.33^{b}	49.12^{ab}	2.18
Haugh Unit	98.73^{ab}	97.27^{b}	99.40^{ab}	102.37^{a}	101.23^{ab}	1.28
USDA Quality Score	AA	AA	AA	AA	AA	-

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

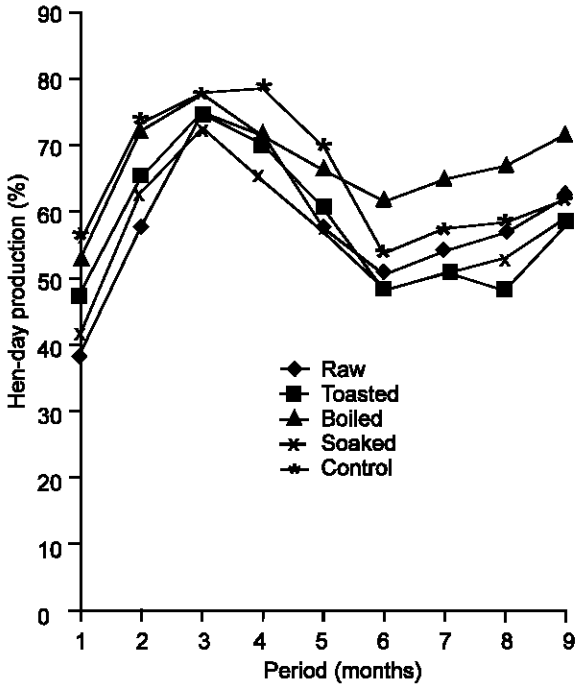

Fig. 1: Average percent hen-day production of layers fed raw or processed PSM diets during the grower and layer stages of life

the same time with those layers fed other PSM and control diets, the later parameter depending on the first. On the average, the period (6.80 days) between age at 25 and 50% egg production recorded by layers fed PSM and control diets is below 11.50 days estimated by Shanawany (1983) and also the average of 17 days report by Elzubeir and Mohammed (1993).

External egg quality: The feeding of 30% PSM diets to layers previously fed 20% PSM diets during the grower stage of life could not affect egg weight and egg width but rather affected egg length, shape index, shell weight and thickness. Average egg weight increased from about 45 g from the first month to about 60 g in the 2nd month, dropped slightly before maintaining a level average of about 60 g between 4th and 9th month (Fig. 2). This pattern of egg weight increase with increase in hen's age is supported by the earlier report of Fletcher *et al.* (1981). The egg weight from this study compare favourably with those obtained with yellow peas - *Pisum sativum L. var. Miranda* (Ivusic *et al.*, 1994), but was higher than those obtained with sheabutter cake (Olorede and Longe, 2000), autoclaved pigeon pea and soybean seed meal (Agwunobi, 2000), commercial diets (Ayanwale and Gado, 2001) and raw pigeon pea grain meal (Udedibie and Igwe, 1989). Toasted PSM diet increased egg length more than boiled PSM diet did, which eventually resulted in a significantly lower shape index. The shell weight differences could be due to unknown factors associated with the physiology of egg formation but generally fell within the range (3.10-7.00 g) reported by Oguike (1994) for domestic fowl kept in the warm humid tropics. The egg shell weights also fell within the range (4.37-5.88 g) reported by Awosanya *et al.* (1998) for flock having the laying age of 25-78 weeks, an average range adequately covered by our own experimental period (22-85 weeks). Shell weight as percentage of egg weight was also in line with the report of Awosanya *et al.* (1998), except the shell weight of eggs laid by birds fed soaked PSM diet that was higher. We could not explain the higher shell weight and shell thickness of eggs laid by birds fed soaked PSM diet in this experiment, especially when the Ca level in the diets was the same. However, overall external egg quality results suggest that any antinutritional substances in raw, toasted or soaked PSM diets may either not have adversely affected external egg quality parameters measured over the prolonged period of feeding the PSM diets or their effect was modulated by diet ingredient composition.

Internal egg quality: The raw or processed PSM in layer diets influenced all internal egg quality measurements except yolk weight. Raw PSM diet fed to layers reduced albumen height but not more than the control diet did, while toasted and soaked PSM diets increased it. Yolk height was highest with boiled seed diet, while raw and toasted diets produced the lowest yolk heights. These parameters, which are related to the entire egg size, translated to the observed differences in the albumen +

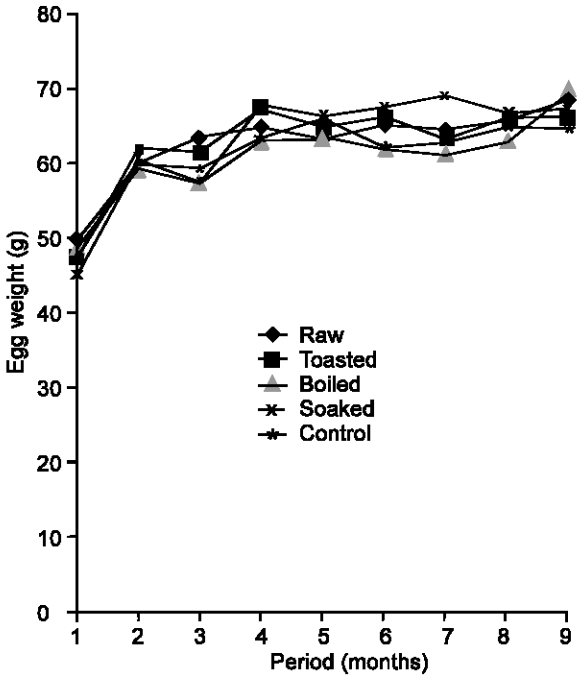

Fig. 2: Average weight of eggs laid by layers raw or processed PSM diets during the grower and layer stages life

yolk weight where eggs of toasted diet had the least value. The albumen and yolk weights obtained were lower than those reported by Ayanwale and Gado (2001) obtained from eggs of layers fed commercial diets. Values of Haugh unit differed among eggs of raw and toasted PSM diets due to differences in their albumen height. Due to earlier stated reasons, the Haugh unit in this study were also higher than those reported by Awosanya *et al.* (1998); Olerede and Longe (2000) and Ayanwale and Gado (2001). These differences, apart from dietary treatments, may also have arisen from differences in the hybrid of pullets used in the studies.

Conclusion: Raw, boiled or toasted PSM included as 30% of the diet could be fed to layers that had received 20% PSM diets during the grower stage of life without adverse effects on egg production, external and internal egg quality characteristics. It should be expected that soaked PSM diet could adversely affect egg production as well as external and internal egg qualities.

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