ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF POULTRY SCIENCE

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International Journal of Poultry Science 4 (3): 289-295, 2006
ISSN 1682-8356

Pigeon Pea (*Cajanus cajan*) Seed Meal as Protein Source for Pullets: 2. Response of Pullets to Higher Inclusion Level and Prolonged Feeding of Raw or Processed Pigeon Pea Seed Meal Diets

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Abstract: One hundred and thirty-five nine week-old black Bovan Nera pullets were used to evaluate the response of pullets to higher level and prolonged feeding of raw or processed pigeon pea seed meal (PSM) diets. The experimental design was completely randomized design (CRD) and comprised pullets fed 10% PSM diet during the chick (0-56 days) stage of life that were fed 20% PSM diets. The diets were isoenergetic and isonitrogenous. The seeds were used as raw, boiled for 30 minutes, toasted for 30 minutes or soaked in water for 24 hours. Each treatment (raw, boiled, toasted, soaked or control diet) was replicated three times. Feed intake, weight gain, feed conversion ratio (FCR), daily feed cost, feed cost per kg weight gain and feed cost of raising a pullet to point of lay (POL) were measured. Results showed that prolonged feeding of raw or processed PSM diets to pullets did not significantly affect live weight at POL, daily weight gain, FCR and average mortality while pullets fed raw PSM diet had significantly ($P<0.05$) lower feed and protein intake than others. Raw PSM diet also significantly reduced daily feed cost and consequently feed cost to POL more than others did. It was concluded that PSM could be a good protein source for pullets from the chick stage to point of lay. PSM could be included as 20% of the grower pullet diet without any adverse effect on performance.

Key words: Diets, grower pullets, pigeon pea, processed seeds

Introduction

The competition between human beings and poultry in Nigeria for cereal and legume grains necessitates the continuation of efforts to search for alternative protein and energy sources for poultry, which will benefit backyard, small-scale and commercial poultry farmers. This need is apparent during periods of acute scarcity of conventional feedstuffs like soybean, groundnut cake and maize occasioned by poor harvests and/ or higher demand from industrial users.

Many legume seeds considered as potential and non-conventional protein sources for poultry contain antinutritional factors (ANFs) that have negative effects on digestion and performance of fowls (Ologhobo, 1992; D'Mello, 1994; Huisman, 1995; Beric *et al*., 1997). The content of ANFs in legume seeds depends on variety and cultivar, as well as climatic and environmental factors (Beric *et al.,* 1997). Most of the ANFs are non-protein amino acids which are generally analogues of the essential amino acids or their derivatives (D'Mello, 1994). The relatively high concentration of these ANFs in seeds is a major factor limiting the exploitation of alternative grain legumes as protein source for poultry and other non-ruminant animals (Udedibie and Nwaiwu, 1987; Ologhobo, 1992; D'Mello, 1994). Simple methods of detoxification that will be easy and affordable to both the rural and small-scale poultry producers and commercial feed millers are needed to solve the problem.

Earlier reports on the feeding of raw or processed pigeon pea seed meal (PSM) diets to poultry have shown that broilers (Amaefule and Obioha, 2001ab) could be fed raw or processed PSM diets from day-old to maturity, pullet chicks (Amaefule and Obioha, 2005) were not adversely affected when fed raw or processed PSM diets from day-old to 56 days of life and also that grower pullets could be fed 20% raw or processed PSM diets from the 9th week of life to point of lay (Amaefule *et al*., 2005). The objective of this study, therefore, was to evaluate the response of pullets to higher inclusion level and prolonged feeding of raw or processed pigeon pea seed meal diets.

Materials and Methods

Processing of seeds: The three processing methods used for the pigeon pea seeds were boiling in water, toasting and soaking in water. Raw seeds were put into boiling water, boiled for 30 minutes and sun dried. Toasting the raw seeds was for 30 minutes with the frying pan normally used in the local frying of cassava flour (*garri*). After toasting, the seeds were poured out on a clean cemented floor and allowed to cool. 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. After 24 hours, the seeds were removed from the container with a basket and sun dried. The raw (unprocessed) or processed pigeon pea seeds were milled to pass through a 2 mm sieve.

Table 1: Composition of raw or processed pigeon pea seed meal fed to pullet diets

Feedstuffs %	Control	Raw	Boiled	Toasted	Soaked
Maize	37.00	36.00	36.00	36.00	36.00
Local Fish meal	1.00	1.00	1.00	1.00	1.00
Spent grain	12.00	5.00	5.00	5.00	5.00
Maize gluten feed	22.50	14.50	14.50	14.50	14.50
Wheat offal	15.00	15.00	15.00	15.00	15.00
Soybean meal	9.00	5.00	5.00	5.00	5.00
Pigeon pea seed meal	0.00	20.00	20.00	20.00	20.00
Bone meal	3.00	3.00	3.00	3.00	3.00
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:					
CP (%)	15.24	15.39	15.55	15.75	15.75
ME (MJ/kg)	12.65	12.65	12.65	12.65	12.52
CF (%)	4.27	4.27	4.27	4.27	3.74
Avail. Ca (%)	1.03	1.03	1.03	1.03	1.05
Avail. P (%)	0.51	0.51	0.51	0.51	0.51

*Composition per 2.5kg: Vitamin A 10000000IU, Vit.D 2000000IU, Vit E 20000IU, Vit K 2250mg, Thiamine 1750mg, Riboflavin 5000mg, Pyridoxine 2750 mg, Niacin 27500mg, Vit B_{12} 15mg, Pantothenic acid 7500mg, Folic acid 7500mg, Biotin 50mg, Choline chloride 400gm, Antioxidant 125g, Manganese 80g, Zinc 50g, Iron 20g, Copper 5g, Iodine 1.2g Selenium 200mg, Cobalt 200mg.

Experimental diets: Five isoenergetic and isonitrogenous diets were formulated with raw, boiled, toasted and soaked pigeon pea seed meal (PSM), and each was included at 20% of the whole diet (Table 1). Lysine and methionine contents were 0.69 and 0.26%, respectively.

Experimental birds and their management: Pullets that were fed 10% raw or processed pigeon pea seed meal diets during the pullet chick (1-56 days) stage of life were used. The raw, boiled, toasted or soaked PSM diets (maize 36%, local fish meal 2%, spent grain 10%, maize gluten feed 8%, wheat offal 6.50%, soybean meal 21%, bone meal 3%, vitamin premix 0.25% and salt 0.25%) contained 20.69% CP, 3.71% CF and 12.87 MJ kg^{-1} ME. The control 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%) had 20.57% CP, 3.70% CF, 1.32% Ca, 0.67% P and 12.97 MJ/kg ME. The lysine and methionine contents of the chick diets were 1.07% and 0.30%, respectively. The pullets were maintained in their respective treatment diet after 56 days, to continue with a 20% PSM diet at the grower stage to point of lay. They were brooded 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. Heat was provided with kerosene stoves under galvanized metal hovers (Amaefule and Obioha, 2005). They were also reared in same poultry house used during the brooding stage.

The birds were vaccinated against Newcastle disease (I/O) at day-old and at the 4th week (Lasota). *Gumboro* disease vaccine was given at the 9th and 21st day, while broad spectrum antibiotics and coccidiostat were administered to the pullets between the ages of 2-3 weeks and 5-6 weeks. Additional medications given to the pullets were piperazine^{R} dewormer, fowl pox vaccine and Newcastle disease vaccine (Komorov) at 9th, 12th and 18th weeks of age, respectively.

Experimental design and data collection: The experimental design was completely randomized design (CRD). There were 27 pullets per treatment, each treatment replicated three times. Each replicate had 9 pullets. Measurements taken were feed intake, weight gain and feed conversion ratio. Feed and water was given to the birds *ad libitum*. Feed intake was determined by subtracting the quantity of feed leftover (unconsumed) from the total quantity offered on a weekly basis. The birds were weighed as replicate groups and the group weight divided by the number of birds to obtain the average live weight per bird. Weighing of the birds was at the beginning of the experiment and subsequently on a weekly basis usually in the morning (8.00 - 9.00 am) hours.

Weight gain was calculated as final live weight minus initial weight, feed conversion ratio (FCR) as feed intake divided by weight gain, and protein efficiency ratio (PER) as weight gain divided by protein intake. Mortality records and other observations were kept throughout the period of study. Feed cost per kg weight gain was calculated as FCR x cost/ kg feed.

Chemical and data analyses: Feed samples were analyzed for proximate composition according to

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

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
Ash (%)	5.50	4.00	6.10	4.00
Nitrogen Free Extract (%)	49.65	47.63	47.98	48.44
Gross Energy (MJ/kg)	16.02	16.52	16.18	16.30

Table 3: Proximate composition of raw or processed pigeon pea seed meal diets fed to pullets (% DM)

Composition	Control	Raw	Boiled	Toasted	Soaked
Dry Matter (%)	87.00	86.00	87.00	87.50	87.50
Crude Protein (%)	15.63	15.40	15.18	15.43	15.20
Ether Extract (%)	2.00	1.00	1.00	1.00	1.00
Crude Fibre (%)	4.60	5.00	4.50	5.00	5.50
Ash (%)	5.50	5.5	9.00	8.00	7.00
Nitrogen Free Extract (%)	59.27	59.10	57.32	58.07	58.80
Gross Energy (MJ/kg)	14.14	16.90	16.90	16.35	14.60

Table 4: Performance of pullets fed raw or processed pigeon pea seed meal diets

Parameters	Control	Raw	Boiled	Toasted	Soaked	SEM
Initial live weight (kg/b)	0.56	0.58	0.53	0.57	0.54	0.02
Final live weight (kg/b)	1.53	1.68	1.65	1.67	1.73	0.08
Daily weight gain (g/b)	9.90	11.22	11.43	11.22	12.14	0.85
Daily feed intake (g/b)	76.50^{ab}	74.26^{b}	79.58^{a}	80.02^{a}	77.44^{ab}	1.24
FCR	7.73	6.62	6.97	7.14	6.40	0.43
Daily protein intake (g/b)	12.05^{ab}	11.70^{b}	12.38^{a}	12.19^{ab}	11.92^{ab}	0.20
PER	0.82^{b}	0.96^{ab}	0.89^{ab}	0.91^{ab}	1.02^{a}	0.06
Mortality (%)	0.0	3.33	0.0	3.33	0.0	1.21

a,b:Means in the same row followed by different superscripts are significantly different (P<0.05). SEM = Standard error of Mean

Table 5: The feed cost of feeding raw or processed PSM diets to pullets

Cost	Control	Raw	Boiled	Toasted	Soaked	SEM
Feed Cost / kg (N)	19.34	18.13	18.33	18.33	18.13	-
Daily Feed Intake (g/b)	76.50^{ab}	74.26^{b}	79.58^{a}	80.08^{a}	77.44^{ab}	1.24
Daily Weight gain (g/b)	9.89	11.31	11.05	11.25	12.19	0.85
Daily feed Cost/b (N)	1.48^{a}	1.35^{b}	1.46^{a}	1.47^{a}	1.40^{ab}	0.02
Cost / kg weight gain (N)	149.88	123.04	132.05	133.07	115.16	7.88
Feed cost to POL (N)	215.07^{a}	190.95^{c}	205.19^{ab}	210.24^{ab}	197.04^{bc}	4.23

a, b, c: Means in the same row with different superscripts are significantly different (P<0.05). SEM = Standard Error of mean. POL = Point of lay. $1.00 = N140.00

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. Data collected were subjected to analysis of variance (ANOVA) while treatment mean separations were by Duncan's Multiple Range Test (Duncan, 1955). All statistical procedures were according to Steel and Torrie (1980).

Results

Growth: The proximate composition of the raw or processed PSM (Table 2) showed no major differences, although boiled PSM had higher numerical values for crude protein, crude fibre and gross energy than raw and toasted PSM, while the proximate composition of the experimental diets is presented in Table 3.

Higher inclusion level and prolonged feeding of pullets with raw or processed PSM diets (Table 4) resulted in no significant differences (P>0.05) among the pullets in final live weight at point of lay (POL), daily weight gain, FCR and average mortality. But significant differences (P<0.05) existed in daily feed and protein intake, and protein efficiency ratio (PER). Despite this non-significant difference in final live weight, pullets fed soaked PSM diet had the highest live weight and those fed control diet the lowest as shown in Fig. 1. Average weekly weight gain of the pullets (Fig. 2) showed weight

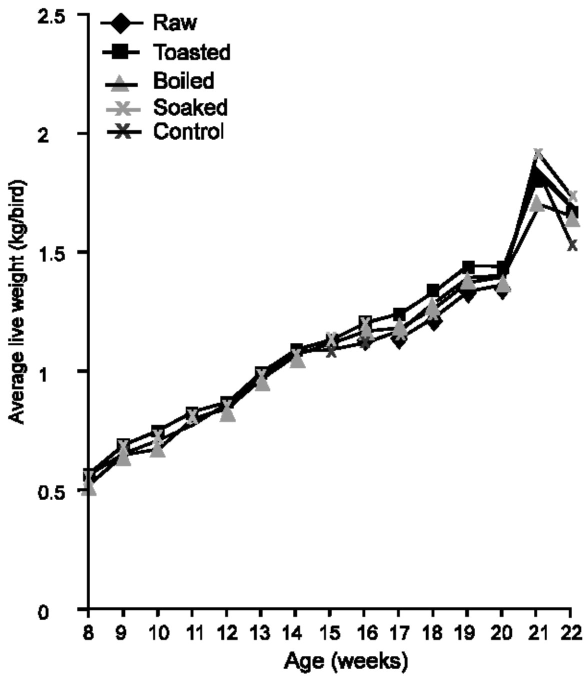

Fig. 1: Average weekly weights (kg/b) of grower pullets fed raw or processed PSM diets from the pullet chick stage to point of lay.

Age (Weeks)	Control	Raw	Boiled	Toasted	Soaked
8	0.564	0.575	0.533	0.574	0.538
9	0.653	0.668	0.642	0.683	0.678
10	0.709	0.719	0.678	0.750	0.721
11	0.775	0.817	0.678	0.835	0.815
12	0872	0.888	0.803	0.872	0.855
13	0.975	0.982	0.850	0.995	0.988
14	1.08	1.08	0.969	1.10	1.06
15	1.09	1.10	1.07	1.13	1.13
16	1.12	1.34	1.12	1.20	1.18
17	1.17	1.15	1.17	1.24	1.16
18	1.28	1.23	1.19	1.34	1.24
19	1.39	1.34	1.27	1.44	1.36
20	1.41	1.37	1.39	1.44	1.39
21	1.85	1.83	1.70	1.82	1.92
22	1.53	1.68	1.65	1.67	1.73

Average weekly weights (kg/b) of grower pullets fed raw or processed PSM diets from the chick pullet stage of life. Microsoft Excel Data for Fig. 1.

losses at weeks 10, 12, 14, 15, 17, 20 and finally at the 22nd week, with a very sharp increase in weight gain between week 20 and 21.The exception was pullets fed soaked PSM diet, which had a different growth curve.
The intake of toasted PSM diet was not significantly different (P>0.05) from that of boiled, soaked and control diets but was significantly higher (P<0.05) than that of raw PSM diet. Also the intake of raw PSM diet was not significantly different (P>0.05) from those of soaked PSM and control diets. Feed intake dropped at week 10, leveled from weeks 11 and 12, and dipped again at weeks 15, 17 and after week 19 (Fig. 3). This feed intake

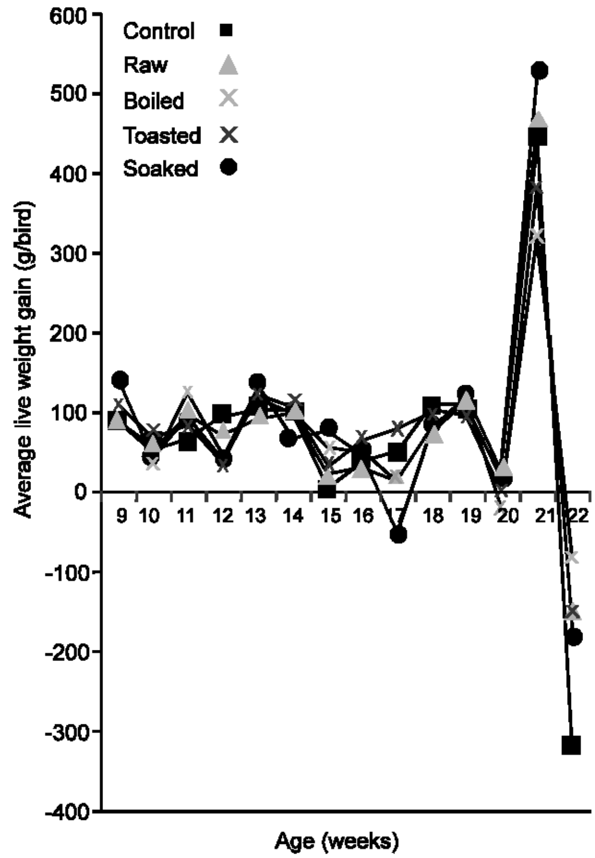

Fig. 2: Average weekly weight gain (kg/b) of grower pullets fed raw or processed PSM diets from the pullet chick stage to point of lay.

Age (Weeks)	Control	Raw	Boiled	Toasted	Soaked
9	89.0	93.0	108	110	140
10	55.3	50.7	36.7	66.7	42.7
11	66.7	98.3	124	85.0	94.0
12	97.0	70.7	47.3	36.7	40.0
13	103	93.7	119	123	133
14	104	98.0	98.0	106	67.0
15	5.33	21.0	55.0	33.0	78.3
16	38.0	31.0	51.7	66.3	46.7
17	50.7	14.0	13.3	79.3	-54.0
18	110	77.0	84.0	102	82.0
19	109	115	115	96.0	120
20	12.0	26.7	-22.0	-3.33	21.3
21	451	467	322	382	531
22	-317	-150	-83.3	-150	-183

Average weekly weight gain (g/b) of grower pullets fed raw or processed PSM diets from the chick pullet stage of life. Microsoft Excel Data for Fig. 2.

pattern followed growth rate pattern. Average daily protein intake followed the same trend as feed intake, except that the daily protein intake of pullets fed boiled PSM diet was not significantly different (P>0.05) from the protein intake of those fed raw PSM diet (Table 4). The

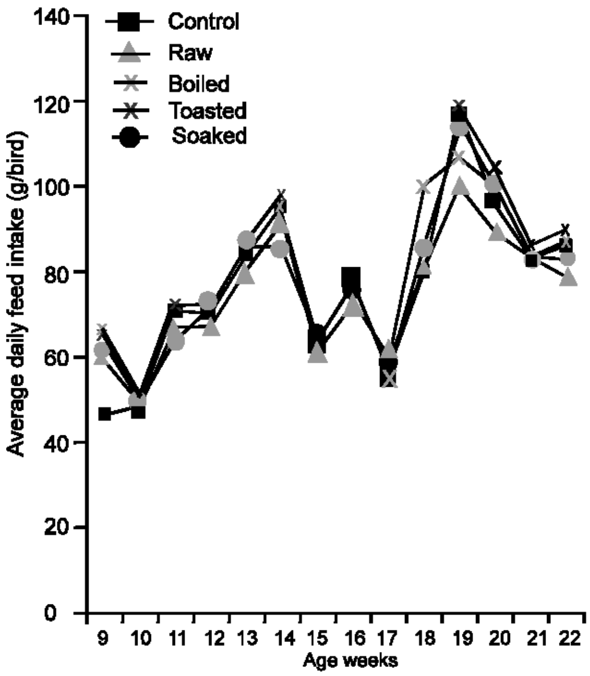

Fig. 3: Average daily feed intake (g/b) of grower pullets fed raw or processed PSM diets from the pullet chick stage to point of lay.

Age (Weeks)	Control	Raw	Boiled	Toasted	Soaked
9	46.2	60.2	66.1	64.6	62.2
10	48.0	49.1	50.0	49.5	50.0
11	70.3	67.1	71.4	71.4	64.3
12	70.3	67.1	71.4	71.4	71.4
13	83.2	80.5	85.7	85.7	85.7
14	94.7	91.0	95.5	97.9	85.7
15	63.3	60.4	64.3	64.3	64.3
16	77.3	72.3	76.7	75.0	77.1
17	56.2	60.4	55.9	57.1	57.1
18	79.8	80.6	100	85.7	85.7
19	117	100	107	119	114
20	96.1	89.2	100	104	100
21	82.9	83.6	82.9	85.9	82.9
22	85.7	78.3	87.1	89.4	83.3

Average daily feed intake (g/b) of grower pullets fed raw or processed PSM diets from the chick pullet stage of life. Microsoft Excel Data for Fig. 3.

protein efficiency ratio (PER) of pullets fed raw, toasted, boiled and soaked PSM diets were not significantly different (P>0.05) from each other; pullets fed boiled diet had PER that was significantly different (P<0.05) from that of pullets fed control diet.

Cost-Benefit: The feeding of raw or processed PSM to pullets at a higher level and for a prolonged period did not result in any significant differences in feed cost and benefit (Table 5). However, daily feed cost (N/b/d) was significantly lower (P<0.05) with the raw PSM diet than others. This trend was similar to and probably a result of the daily feed intake pattern. There were no significant differences (P>0.05) in feed cost/kg weight or cost per kg weight gain. Feed cost to POL was significantly lower (P<0.05) with the raw and soaked diets than with the control diet.

Discussion

Growth: The proximate compositions of the raw and processed PSM were within the range earlier reported (Amaefule and Onwudike, 2000; Amaefule and Obioha, 2001a). The lower ether extract of toasted PSM may have been due to volatilization, while the minor differences between the proximate composition of the raw and processed PSM was attributed to the effect of processing.

The pullets, which had received 10% PSM diets during the pullet chick (0-56 days) stage, had no problems utilizing 20% PSM diet at the grower stage. It was of interest to note that PSM diets either as raw or processed could support the growth and development of pullets up to point of lay against earlier report by Ologhobo (1992) that care should be taken when feeding pigeon pea seed meal to poultry over a long period. Also the control diet had no obvious advantage over the PSM diets in the performance of pullets.

Interestingly, pullets fed raw PSM diet had no inferior growth performance when compared to pullets fed boiled, toasted or soaked PSM diets. This performance of pullets fed raw PSM diet is inconsistent with the presence of protease inhibitors in the seeds (D'Mello, 1995a) and thus confirms the report of D'Mello (1995b) that diet composition and feeding method may modulate animal responses to the toxic components of legume seeds.

The average weekly weight gain of the pullets was uniform, especially during the last two weeks, which could be a carry-over effect from the pullet chick stage (Amaefule and Obioha, 2005). It could also be that the pullets adapted well to higher levels of PSM in the diets over the prolonged period of feeding. The increase in weight gain at the 20th week may have been due to the preparation of the pullets for egg lay. Morris (2004) had stated that the rapid increase in weight observed in the two weeks before lay commences is due to growth of the ovary, oviduct and comb and the storage of yolk precursors in the liver and calcium phosphate in the medullary bone.

Feed consumption by pullets in this study dropped after the 14th week, which according to Hocking *et al.* (1989), corresponds to the time when the ovary of birds fed *ad libitum* began to show follicular development. This may have been the reason why the weight gain was unsteady and the extension of the sexual maturity period of the pullets to 22 weeks, which was in line with the report of Hocking (1993). The significantly higher intake of toasted

PSM diet could be that the pullets increased the consumption of the diet to meet their nutrient requirement from a diet that contained some level of antinutritional substances. This is in agreement with the report of D'Mello (1995a) that dry heating is less effective than moist heating method for the elimination of ANFs in legume seeds. The feed intake trend, which followed pattern of growth rate, may have been in response to nutrient requirements for growth and development.
The CP level (15.50%) and ME (12.76 MJ/kg) of the diets used in this experiment were slightly higher than the recommendations of Elzubeir and Mohammed (1993) due to the fact that higher CP and ME levels are needed to meet nutrient requirements from plant ingredients in many Third World countries, especially where crystalline amino acid are not used as supplements (Musharaf and Latshaw, 1999).

Cost-benefit: The continued feeding of raw or processed PSM and at higher inclusion level did not affect cost per kg feed due to the fact that the composition of the diets was the same, except the control diets. The little difference in feed cost between heat treated (boiled and toasted) and non-heat treated (raw and soaked) PSM diets was the cost of generating the heat. The difference between the diets in daily feed cost was due to the differences in the daily feed intake, although this did not result in significant differences in cost per kg weight gain of the pullets fed the diets. Apart from feed intake, heating as a processing method also contributed to the differences in the daily feed cost as shown by the higher cost of toasted and boiled PSM diets. The highest feed cost to point of lay (POL) of pullets fed control diet resulted from the higher cost per kg feed and higher daily feed cost, which when translated in economic terms for a poultry farmer, means a lot of money relative to PSM diets. The lower feed cost to POL of pullets fed raw PSM diet was due to lower daily feed cost and lower cost per kg weight gain. The economic implication of these to a poultry farmer is that he needs less amount of money to feed his pullets to point of lay using raw or processed PSM diets than feeding control (conventional) diet.

Conclusion: Pullets earlier fed 10% raw or processed pigeon pea seed meal (PSM) diet at chick stage of life, could continue with a 20% PSM diet up to point of lay without any adverse affect on growth performance.

Acknowledgement

We are grateful for the financial and material grant (B/2590-1) from International Foundation for Science (IFS), Sweden that made this study possible. Michael Okpara University of Agriculture, Umudike provided Poultry houses and some other facilities.

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