Nig. J. Anim. Prod. 2010, 37(1):13 - 24

The Effect of Duration of Cooking Pigeon Pea *(Cajanus Cajan)* Seeds on the Performance and Carcass Characteristics of Broiler Chicks

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Abstract

Two hundred and seventy (270) one-week old broiler chicks of Abor Acre breed were fed diets containing pigeon pea seeds boiled for 0, 30, 40, 50 and 60 minutes or a control diet containing full fat soybean. Birds were randomly assigned to pens and treatments in a completely randomised design trial. There were 3 replications of the 6 treatments and 15 birds per pen. 23% crude protein (CP) diets were fed during the starter phase and 20% CP diets during the finisher phase. Feed and water were supplied ad libitum throughout the 8-week trial period. At the end of the feeding trial, 2 birds were selected from each pen and slaughtered for carcass evaluation. During the starter and finisher phases, feed intake of birds were similar across treatments. The final weight gain of birds fed the control diet were significantly better than those of birds fed the raw or boiled pigeon pea during the 2 phases. Birds fed pigeon pea seeds boiled for 30, 40, 50 or 60 minutes had better (P<0.05) gain and final weights compared to those fed raw pigeon pea. Slaughter weights of birds fed the control diet and diets with pigeon pea cooked for 30, 40, 50 or 60 minutes were similar and significantly (P<0.05) better than those of birds fed raw pigeon pea diet.

Keywords: Pigeon pea, performance, broiler chicks.

Introduction

The production of conventional protein and energy sources is still grossly inadequate in most of the developing countries of the world and oftentimes demand exceeds supply. With the increasing human population in these countries of the world, there is always a very stiff competition between man and livestock for the available feed resources. The livestock industry is worst hit as the needs for humans takes priority over those of livestock. Hence, feed producers and animal scientists are always looking or searching for alternative feed resources that can substitute for or partially replace the conventional feedstuffs. Besides, once an alternative feed resource is discovered the price becomes high or out of reach of livestock producers. Hence, the search for alternative feed resources appears to be an unending one in the developing countries of the world if more meat must be made available for the teeming human population.

Pigeon pea is one of such alternative feed resources that grows well under dry conditions. Pigeon pea contains 18 to 30% crude protein (Siegel and Fawcett, 1976). Pigeon pea meal has not been extensively used as an alternative livestock feed in Nigeria. Amaefule and Obioha 2001, investigated the performance of broiler starters fed differently processed pigeon pea diets. Most legumes require one form of processing or the other before they can be incorporated in animal feeds owing to the presence of some anti-nutrients. Anti-nutrients impair the utilization of important feed nutrients like protein, minerals etc. Kaankuka *et al* (1996) observed that time and temperature were important in the processing of full-fat soybean. Bawa *et al* (2003), reported that cooking of lablab seeds for 45 minutes significantly decreased trypsin inhibitor activity, phytic acid, tannin and cyanide. The present trial aims at determining the effect of feeding pigeon pea subjected to varying duration of cooking on the performance and carcass weights of broiler chickens.

Materials and Methods

The objective of this study was to determine the optimum duration of cooking that will render raw pigeon pea seeds safe for inclusion in broiler diets. Pigeon pea seeds were cooked for 30, 40, 50 and 60 minutes. Seventy-Five (75) litres of cold clean water was first brought to boiling point in a 200 litre drum. A batch of 30kg raw pigeon pea seeds was then poured into the boiling water and covered. The specified time for the cooking was taken from that moment. At the end of the specified period of cooking, water was drained off and the cooked seeds sun-dried for 4 days, before being milled and bagged.

Experimental Birds and Design

Aborica breed of broiler chicks were used for the study. Prior to the beginning of the trial, the chicks were fed a common diet for seven days. The birds were then weighed and allotted into deep litter floored pens.

Two hundred and seventy (270) one-week old broiler chicks were used for both the starter phase (1-4 weeks) and finisher phase (5-9 weeks) of the trial.

There were Fifteen (15) birds per pen and three (3) replications of the 6 treatments randomly assigned to pens in a completely randomised design trial. The diets were iso-nitrogenous and had similar metabolizable energy (Tables 1 and 2) and were formulated to meet the recommended nutrient requirements (NRC, 1988). The starter and finisher rations contained 23% and 20% crude protein (CP) respectively. Diet 1 formulated with soybean seeds (full-fat) as the main vegetable protein source served as the control. Diets 3 to 6 were formulated with pigeon pea seeds cooked at 100°C for 30, 40, 50 and 60 minutes respectively, while diet 2 contained raw pigeon pea seeds, all included at 30% of the diet. Feed and fresh water were supplied *ad libitum* throughout the eight (8) weeks of trial. Routine vaccines and drugs were administered as necessary.

Table 1. Composition of Broiler Starter Diets Based on Soybean Meal and Raw Pigeon Pea Seeds cooked at 100°C for Varying Time Period.

Calculated Nutrient Analysis

Ingredients	TREATMENTS 1	2	3	4	5	6
	Duration of Cooking Pigeon Pea Seed (Minutes)					
	(SBM)	0	30	40	50	60
Maize	53.00	38.00	38.00	38.00	38.00	38.00
Soybean (HFT)	15.00	-	-	-	-	-
Pigeon Pea Seed Meal	-	30.00	30.00	30.00	30.00	30.00
Ground Nut Cake	12.25	12.00	12.00	12.00	12.00	12.00
Blood Meal	5.00	5.00	5.00	5.00	5.00	5.00
Rice Meal	2.00	2.00	2.00	2.00	2.00	2.00
Wheat Offal	8.25	8.25	8.25	8.25	8.25	8.25
Bone Meal	3.00	3.00	3.00	3.00	3.00	3.00
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Methionine	0.20	0.20	0.20	0.20	0.20	0.20
Vit. Premix	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00
Metabolizable energy (Kcal/kg)	3,017.59	2,941.64	2,941.64	2,941.54	2,941.57	2,941.64
Crude protein (%)	23.38	23.08	23.08	23.08	23.08	23.08
Calcium (%)	1.26	1.26	1.26	1.26	1.25	1.26
Phosphorus (%)	0.51	0.88	0.83	0.83	0.53	0.83
Fibre (%)	3.63	4.06	4.09	4.09	4.09	4.09
Lysine (%)	1.25	1.28	1.28	1.28	1.28	1.28
Methionine (%)	0.35	0.59	0.59	0.59	0.59	0.59
Cysteine (%)	0.30	0.31	0.31	0.31	0.31	0.31
Cost/Kg of Diet (N)	51.78	40.25	42.25	42.75	43.75	41.75

[illegible]

Table 2: Composition of Broiler Finisher Diets Based on Soybean Meal and Raw Pigeon Pea Seeds cooked at 100°C for Varying Time Period

Ingredients	TREATMENTS					
	1	2	3	4	5	6
		Duration of Cooking (Minutes)				
	(SBM)	0	30	40	50	60
Maize	58.00	43.00	43.00	43.00	43.00	43.00
Soybean Meal	[illegible]	-	-	-	-	-
Pigeon Pea Seed Meal	-	30.00	30.00	30.00	30.00	30.00
Ground Nut Cake	9.30	9.80	9.80	9.80	9.80	9.80
Blood Meal	4.00	4.00	4.00	4.00	4.00	4.00
Wheat Offal	9.60	9.10	9.10	9.10	9.10	9.10
Bone Meal	2.20	3.20	3.20	3.20	3.20	3.20
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Methionine	0.35	0.35	0.35	0.35	0.35	0.35
Vit. Premix	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Nutrient Analysis						
Metabolizable energy (Kcal/Kg)	3,053.80	2,957.56	2,967.85	2,950.80	2,951.85	[illegible]
Crude protein (%)	20.1	20.14	20.12	20.11	20.41	[illegible]
Calcium (%)	1.27	1.27	1.27	1.27	1.27	1.27
Phosphorus (%)	0.88	0.80	0.80	0.80	0.80	0.80
Fibre (%)	2.94	4.75	4.75	4.75	[illegible]	[illegible]
Lysine (%)	1.36	1.10	1.10	1.10	1.10	1.10
Methionine (%)	0.56	0.65	0.65	0.65	0.65	0.65
Cystine (%)	0.36	0.27	0.27	0.27	0.27	0.27
Cost/Kg of Diet (₦)	49.96	[illegible]	[illegible]	41.09	[illegible]	[illegible]

Vitamin Mineral Premix provide per kg of diet: Vit A, 12,500 iu; Vit D3 2,500 iu; Vit E 15 iu; Vit K 2.00 mg; Calcium pantothenate 10.68mg; Vit B12 0.022mg; Folic acid 1.088mg; Choline Chloride 400mg; Chlortetracycline 26.08mg; Manganese 133.34mg; Iron 66.67mg; Zinc 53.34mg; Copper 3.2mg; Iodine 1.50mg; Cobalt 0.28mg; Selenium 0.108mg

Data Collection and Analysis

At weekly intervals, feed consumption, weight gain and feed to gain ratio were calculated. At the end of the trial, birds were weighed to obtain their final weights after which 6 birds per treatment (two birds per pen) were selected for carcass analysis. All data collected from the study were statistically analyzed using general linear model of SAS (S.A.S., 1995) and the differences among the means were separated using the Duncan's Multiple Range Test (Steel and Torrie, 1980).

Results and Discussion

Starter phase

At the end of the starter phase, birds fed the full-fat soybean based diet had final body weights which were significantly (P<0.05) higher than those of birds fed raw pigeon pea seed meal diet or pigeon pea seed cooked for 30, 40, 50 and 60 minutes (Table 3). The final weights of birds fed pigeon pea seed meal cooked for 30, 40, 50 and 60 minutes were similar (P>0.05), though there was a slight increase as the cooking time increased. Birds fed raw pigeon pea seed meal diet were significantly smaller (P<0.05) compared to those on cooked pigeon pea seed meal diets. This result agreed with the work of Ogundipe (1980) who reported that broilers fed boiled soybean performed better than those fed raw soybean diets. De Castro *et al.* (1992) also reported that feeding raw legumes to chickens generally resulted in lower growth rate and reduced feed efficiency compared to those fed soybean seed meal or processed legumes.

Duration of cooking had significant (P<0.05) effect on the average final weight, weight gain, feed to gain ratio and feed cost/kg gain during the starter phase, while the feed consumption was not significantly affected by the duration of cooking (Table 3). However, treatment 6 (pigeon pea seeds cooked for 60 minutes) gave the best results for most of the parameters, which were not significantly (P>0.05) different from those of 30, 40, and 50 minutes cooking time, but significantly (P<0.05) different from those of birds fed raw pigeon pea seed meal. The weight gain of birds fed full-fat soybean based diet was significantly (P<0.05) higher than those of birds fed raw or pigeon pea seeds cooked for 30, 40, 50 and 60 minutes. The weight gain of birds fed pigeon pea seeds cooked for 30-60 minutes were similar, but was significantly better (P<0.05) when compared to that of the birds on raw pigeon pea seed diet. Bawa (2003) reported a slight increase in the final weight of finished pigs as the duration of cooking lablab increased from 0 to 45 minutes. He also reported that pigs fed soybean meal diet had significant better final live weight than those fed diets containing raw lablab seeds and lablab seeds cooked for 15 minutes.

The feed to gain ratio of the birds fed the control diet containing soybean was the best and was significantly different (P<0.05) from those of other treatments. The feed to gain ratio of birds on treatments 3 to 6 were similar (P>0.05) and significantly (P<0.05) better than those on treatment 2.

Feed cost per kg gain showed that cooking pigeon pea seeds before inclusion ~~in broiler~~ diets was more cost effective than when fed in the raw state. The significantly higher (P<0.05) feed cost per kg weight gain observed on birds fed the raw pigeon pea seed diet compared to those fed the

Table 3: Effect of Duration of Cooking of Pigeon Pea Seeds on the Performance of Starter Broiler Chicks

Parameters	TREATMENTS Duration of Cooking (Minutes) 1 (SBSM)	2 0	3 30	4 40	5 50	6 60	SEM	Level of Significance
Initial body weight (g)	69.00	69.00	68.00	68.00	67.00	68.00	-	-
Final body weight (g)	1200.3^{a}	902.3^{c}	993.0^{b}	1005.0^{c}	1017.0^{b}	1062.7^{b}	20.36	*
Feed consumption (g)	2022.0	1905.0	1959.1	1973.0	1943.3	1938.0	35.11	NS
Weight gain (g)	1131.3^{a}	833.3^{c}	925.0^{c}	937.0^{b}	950.0^{d}	964.7^{b}	19.02	*
Feed / Gain ratio	1.79^{d}	2.30^{a}	2.12^{b}	2.11^{b}	2.05^{bc}	2.01^{c}	0.021	*
Feed cost / Kg gain (N)	90.90^{c}	93.73^{a}	89.57^{ab}	90.20^{ab}	88.60^{bc}	87.94^{c}	0.807	-
Mortality (%)	0.00	2.22	0.00	0.00	0.00	0.00	-	-

a, b, c: Means within the same row bearing different superscripts are significantly different (P≤0.05)
* = significant difference (P≤0.05);
SBSM = Soybean seed meal
SEM = Standard error of mean

Table 4: Effect of Duration of Cooking Pigeon Pea on the Performance of Broiler Finisher

Parameters	TREATMENTS Duration of Cooking (Minutes) (SBSM)	0	30	40	50	60	SEM	Level of Significance
Initial body weight (g)	1200.3	902.3	993.0^{c}	1005.0^{c}	1017.0^{c}	1063.7	25.35	*
Final body weight (g)	2926.0	2229.7^{c}	2400.0^{b}	2425.0^{b}	2470.7	2518.7^{b}	33.05	*
Feed consumption (g)	4622.7	4645.3	4640.0	4655.1	4553.3	4647.3	32.39	NS
Weight gain (g)	1725.67^{a}	1325.13^{c}	1407.00^{bc}	1420.00^{bc}	1453.7^{b}	1486.0^{b}	26.83	*
Feed / Gain ratio	2.65^{c}	3.51^{a}	3.30^{ab}	3.28^{b}	3.20^{b}	3.13^{b}	0.10	*
Feed cost / Kg gain (N)	133.73	127.23	133.93	134.78	133.00	131.74	1.87	NS
Mortality (%)	0.00	2.22	0.00	0.00	0.00	0.00	-	-

a, b, c: Row means with different superscripts differ significantly (P≤0.05)
* = significant difference (P≤0.05)

control or cooked pigeon pea seed diets could be attributed to the poor rate of conversion of pigeon pea seed protein in the raw state into body tissue. The cost per kg gain for treatment 6 (60 minutes cooking time) was the lowest. This could be as a result of the reduced cost per kg diet of diets containing pigeon pea as Amaefule and Obioha (2001) had earlier reported decreased feed cost with increasing level of pigeon pea in diet of broilers.

Finish phase:

The final weight for birds fed the control diet during the finisher phase was significantly (P<0.05) higher than those of other dietary treatments (Table 4). The final weight increased from treatment 3-6 which were not significantly different (P>0.05). The final weight of birds fed cooked pigeon pea seed meal was significantly (P<0.05) higher than the final weight of birds fed the raw pigeon pea seed meal diet, which had the least final weight, possibly due to the presence of anti-nutritional factors especially trypsin inhibitor. Feed intakes of broilers were similar on all treatments during this phase. This is line with the report of Amaefule and Obioha (2001) who reported that broiler finishers tolerated raw pigeon pea seed meal up to 30% of the whole ration, although there was a depression in growth rate compared with broilers fed processed pigeon pea seed meal. The depression in growth rate observed in birds fed raw pigeon pea seed meal relative to boiled or cooked pigeon pea diets could be as a result of the trypsin inhibiter activity that affected the utilization of feed nutrients for growth. With cooking, most feed nutrients were available for utilization by the birds as reported by Liener and Kakade (1980). Significant (P<0.05) differences were observed for weight gain with the control having the highest. The weight gain for treatment 6 (60 minutes cooking time) was the next, followed by 50 minutes, 40 minutes and 30 minutes but they were not significantly different (P>0.05) from one another. These were significantly different (P<0.05) from gain of birds fed raw pigeon pea seed meal diet which gave the lowest weight gain. The feed to gain ratio followed the same trend with treatment 1 (control) being the best, which was significantly (P<0.05) better than those of the other treatments. The feed to gain ratio for treatment 6 (60 minutes cooking time) was also significantly (P<0.05) better than those for birds fed raw pigeon pea seed meal diet. The feed to gain ratio for treatments 3-5 (30, 40, and 50 minutes cooking time) were similar to that of treatment 2 (raw pigeon pea based diet) (P<0.05). This observation is in line with the report of Ologhobo (1987) and Kaankuka *et al* (2001) who reported that raw or improperly heated legume seeds fed as the main source of protein in diets for monogastrics can depress growth and efficiency of feed utilization. The feed cost/kg gain were similar for all treatments during the finisher phase indicating that the effect of protease inhibiter was more pronounced in the younger birds.

The result of this study revealed a poor feed conversion efficiency ratio for birds fed raw pigeon pea meal diet compared to those fed boiled pigeon pea meal diets. This could be attributed to the fact that raw pigeon pea seeds like other legumes contain some anti-nutritional factors which inhibit the utilization of protein, hence reduced weight and increased feed to gain ratio (Igbasan and Guenter, 1996). Onwe (1996) reported that cooking of legume seeds for about 30 minutes resulted in the destruction of their anti-nutritional factors such as trypsin inhibitor, haemagglutinins, phytic acid, goitrogen and hence improved the nutrient availability for better performance of poultry.

During the entire life of broilers, duration of cooking had significant ($P<0.05$) effect on the average final weight, weight gain, feed to gain ratio and feed cost /kg gain (Table 5). Birds on the control ration had the best final weight, weight gain and better feed to gain ratio ($P<0.05$) compared to other treatments. This could be due to the good amino acid profile of soybean. The final weight and weight gain increased non-significantly ($P>0.05$) from treatments 3 to 6 (30 to 60 minutes cooking duration). These were significantly ($P<0.05$) different from those fed raw pigeon pea seed meal diet. The general improvement in weight gain as the duration of cooking of pigeon pea seeds increased in the present study also agreed with the reports of Amaefule and Obioha (2001), Amaefule *et al* (1997), Onigbinde (1989) and Emenalom *et al* (2011). The feed to gain ratio also became better with increased duration of cooking. Feed to gain ratio for treatments 3-6 were similar but different ($P<0.05$) from those of treatments 1 and 2 with birds fed soybean seed based diet having the best, while those fed raw pigeon pea based diet had the poorest. This agreed with the reports of Ratliff *et al* (1987). Fashina-Bombata and Tewe (1995) also observed a significant ($P<0.05$) depression in feed efficiency of pigs fed raw soybean meal diet compared to those fed cooked soybean diets.

The feed cost/kg gain of birds fed raw pigeon pea seed diet (Table 5) was significantly ($P<0.05$) higher than those of treatments 1, 3, 4, 5 and 6. Those of treatments 1, 3, 4, 5 were not significantly ($P>0.05$) different from each other, but the control, raw and pigeon pea boiled for 30 and 40 minutes were significantly different ($P<0.05$) from those of treatment 6 (60 minutes cooking time) which was the lowest ($P<0.05$). This could be attributed to the slightly improved gain of broilers on treatment 6 coupled with the reduced feed intake on that diet.

The data on carcass characteristics (Table 6) shows that birds fed the control diet had similar ($P>0.05$) live weight, slaughter weight and plucked weight with birds fed pigeon pea seed meal diets cooked for 30, 40, 50 and 60 minutes. These were significantly ($P<0.05$) higher than those of birds fed raw pigeon pea seed meal diet. The result revealed that duration of cooking pigeon pea seeds had significant ($P<0.05$) effect on the live weight, slaughter weight and plucked weight. Birds fed full-fat soy control diet were heaviest at slaughter. The dressed weight for treatments 1, 3, 4, 5 and 6 were similar, but the values for treatment 1 were significantly ($P<0.05$) higher than those of treatment 2 (raw pigeon pea seed diet). The dressing percentage for birds fed pigeon pea seed based diet cooked for 30 minutes was the highest, but was similar to those of treatments 1, 4, 5 and 6, and this was significantly ($P<0.05$) higher than that of treatment 2 (raw pigeon pea seed meal diet).

Birds in treatment 1 (control) had the highest percentages of breast and abdominal fat which were significantly (P<0.05) different from those of other treatments. The breast and abdominal fat percentages for birds fed raw and boiled pigeon pea diets were similar. This could be due to the high fat content of soybean with excess fat laid down. The higher percentage breast also indicates better protein utilization by the birds on the control diet.

The weight of the gizzard (full) for birds fed raw pigeon pea seed meal was significantly (P<0.05) higher than those fed the control diet, but was not different (P>0.05) from those fed pigeon pea seed meal diet boiled for 30, 40, 50 and 60 minutes. It was observed that the duration of cooking of pigeon pea seeds had significant (P<0.05) effect on the liver which was significantly different from that of control birds. The raw pigeon pea seed based diet resulted in enlarged liver which was significantly different from that of the control birds. The enlargement of this organ could be due to increased metabolic activities of the liver in trying to make up for reduced availability of proteins from the raw pigeon pea seeds due to the presence of anti-nutritional factors (Omeje, 1999; Marty and Chavez, 1993). The weight of intestine (full) and intestinal length for birds fed raw pigeon pea seed meal diet was significantly (P<0.05) different from those fed the control diet but was similar to those of treatments 3-6, though higher. Pigeon pea seeds have hard seed coats that are not easily digested. Heavier weight of organs could be an indication of hypertrophy (Koong *et al.* and Pond *et al.* (1989).

Table 4: Effect of Duration of Cooking Pigeon Pea on the Performance of Broiler Chicks

	TREATMENTS							
	1	2	3	4	5	6		
		Duration of Cooking (Minutes)						
Parameters	(SBSM)	0	30	40	50	60	SEM	Level of Sig.
Initial weight (g)	69.00	66.00	68.00	68.00	67.00	68.00	-	-
Final weight (g)	2926.30	2226.66[c]	2400.00[b]	2425.00[b]	2422.67[b]	2513.67[b]	34.95	*
Feed consumption (g)	5649.00	6536.30	6599.00	6628.00	6597.00	6583.30	71.21	NS
Weight gain (g)	2857[a]	2159.66[c]	2332.00[b]	2357.00[b]	2403.67[b]	2445.67[b]	26.15	*
Feed : Gain ratio	2.33[c]	3.03[a]	2.83[b]	2.81[b]	2.74[b]	2.59[b]	0.05	*
Feed cost/Kg gain (N)	117.29[c]	130.96[a]	117.22[c]	127.30[b]	126.33[b]	115.25[c]	0.30	*
Mortality (%)	0.00	2.22	0.00	0.00	0.0	0.00		-

a, b, c: Means within a row with different superscripts are significantly different (P<0.05).
* = significant difference (P<0.05).
SBSM = soybean seed meal
SEM = Standard error of mean

Table 6: Carcass weights of Broiler Chicks Fed Soybean Seed Meal Based Diet and Pigeon Pea Seed Meal Boiled for Different Durations (1 - 9 weeks).

Parameter	1	2	3	4	5	6	SEM	Level of Sig.
				TREATMENTS Duration of Cooking (Minutes)				
	(SBSM)	0	30	40	50	60		
Live weight (kg)	2.82	2.25^{f}	2.45^{e}	2.54^{cd}	2.58^{c}	2.74^{b}	0.099	*
Slaughter weight (kg)	2.70^{f}	2.12^{e}	2.37^{de}	2.41^{d}	2.50^{cd}	2.62^{c}	0.098	*
Plucked weight (kg)	2.53^{a}	1.98^{b}	2.25^{ab}	2.22^{ac}	2.32^{f}	2.48^{c}	0.099	*
Dressed weight (kg)	1.95^{e}	1.45^{e}	1.74^{d}	1.69^{cb}	1.79^{c}	1.91^{b}	0.082	*
Dressing (%)	69.23^{b}	64.65^{b}	71.01^{a}	66.58^{ab}	69.07^{ab}	69.39^{ab}	1.206	*
Breast (%)	20.52^{a}	17.12^{b}	17.09^{b}	17.37^{c}	17.90^{b}	18.21^{ab}	0.753	*
Back (%)	15.09	15.23	14.80	15.31	15.68	15.83	0.567	NS
Thigh (%)	21.41	23.98	22.42	22.76	24.37	23.79	0.744	NS
Wing (%)	8.15	8.48	8.61	8.63	9.00	8.02	0.598	NS
Neck (%)	5.30	4.89	4.91	4.85	5.12	5.41	0.299	NS
Abdominal fat (%)	3.20^{a}	1.41^{b}	1.32^{b}	1.62^{b}	1.89^{b}	1.87^{b}	0.339	*
Head (%)	2.76^{b}	2.80^{a}	2.55^{ab}	2.55^{ab}	2.92^{a}	2.50^{c}	0.122	*
Feet (%)	3.52^{c}	4.54^{b}	3.92^{ab}	3.86^{ab}	3.24^{c}	4.13^{a}	0.378	*
Gizzard (full) %	2.10^{c}	2.36^{a}	2.63^{ab}	2.40^{b}	2.41^{b}	2.42^{ab}	0.141	*
Heart (%)	0.51	0.54	0.52	0.47	0.49	0.49	0.048	NS
Liver (%)	2.08^{d}	2.58^{a}	2.42^{b}	2.32^{b}	2.29^{c}	2.29^{c}	0.142	*
Kidney (%)	0.13	0.15	0.16	0.16	0.18	0.15	0.017	NS
Lungs (%)	0.59	0.59	0.63	0.59	0.52	0.60	0.065	NS
Intestine (full) %	4.88^{b}	6.92^{a}	5.54^{ab}	6.07^{ab}	5.17^{b}	5.52^{b}	0.530	*
Intestinal length (cm)	258.00^{c}	259.00^{a}	254.50^{bc}	272.20^{c}	256.00^{bc}	267.80^{b}	0.410	*

a, b, c: Means with different superscripts on the same row are significantly different (P<0.05)

* = significant difference (P<0.05)

SBSM – Soybean seed meal

SEM – Standard error of means

Conclusion

Based on the response of the birds on measurements of criteria such as feed intake, weight gain, feed conversion ratio and the cost of producing a unit of weight gain; the optimum duration of cooking pigeon pea seeds for inclusion in broiler diets, appears to be 30 minutes.

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(Received 7[th] Sept. 2007; Accepted 1[st] June 2009).