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GROWTH INDICES AND SERUM PROFILE OF BROILER CHICKENS FED DIFFERENT THERMALLY PROCESSED SOYABEAN (GLYCINE MAX) BASED DIETS

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Abstract

An evaluation of growth indices and serum profile of broiler chickens fed different thermally processed soyabean (Glycine max) based diets using 240 days-old Anak broilers that were randomly divided into four (4) experimental groups of three replicates each. Dietary treatments were as follows: T1, T2, T3 and T4 representing extrusion (control), Cooking , toasting and roasting based groups at both starter and finisher phases and the diets were isocaloric and isonitrogenous for both the starter (1- 35 days) and finisher phases (36- 63 days). Cooking and toasting presented significantly (P < 0.05) better Specific Growth Rate (SGR) and Growth Efficiency (GE) when compared to extrusion and roasting at the starter phase. Feed Conversion Ratio (FCR), Protein Efficiency Ratio (PER) and Energy Efficiency Ratio (EER) were significantly affected by dietary treatments (P > 0.05) at both the starter and finisher phases. Variations in urea, creatine, packed cell volume, cholesterol and haemoglobin were significant (P>0.5) among treatments, however cholesterol levels were lowest in cooking (T2) and roasting (4) groups. Cooking process was recognized to preserve nutrients more effectively in this study and therefore provides a more effective mechanism for the improvement in growth indices, PER, EER and reduction in serum cholesterol in broilers.

Key Words: *Broilers, thermal processing, growth indices and serum profile*

1.0 INTRODUCTION

Thermal processing of soyabean is acknowledged to be very successful in enhancing the nutritional value of soyabean and in reducing anti nutritional factors (ANFs). These ANFs in soyabean are mainly heat labile (trypsin inhibitors, lectins, goitrogens, phytates) and heat stable (oligosaccharides) factors, (Feng, 2007; Hosseini *et al*., 2008; Soetan and Oyewole, 2009; Ebrahimi-Mahomoudad and Taghinejad-Roudbaneh, 2011) which adversely affects the efficiency of poultry to convert feed into meat and the overall economics of broiler industry (Ashayerizadeh *et al.*, 2011).
Several thermal and hydro thermal processing techniques of soyabean that are aimed at improving the nutritive values and removing ANFs have been documented. These include: dry heating (Papadopoulos, 1987; ASA, 1993; and Mridula, 2008), toasting (Tiamiyu, 2001), cooking (Kaankuka *et al.* 1996), extrusion (Asiedu, 1989, ASA, 1993), autoclaving (Balogun, 1989) and infrared (Horani, 1987, Ebrahimi-Mahomoudad and Taghinejad-Roudbaneh, 2011; Rathnayaka , 2012 and Ari *et al.*2012). These processes are however affected by many and varied reports on the influence temperature-time combinations on the availability of nutrients from thermally processed soyabeans which ultimately leads to diverse effect on growth indices and serum metabolites of broilers. The lack of standardization of cooking time and temperature regimes and high technology required for either autoclaving, extrusion, micronization, infrared and other thermal based processing methods as well as the energy demand for these processes and the effect of heat on the nutrient content of the full fat soyabeans posed serious challenge to average feed processors and the poultry feed supply chain. This study evaluates the effects of different thermal and hydrothermal processing methods of soyabeans (*Glycine max)* on the growth indices and serum profile of broilers.

MATERIALS AND METHODS

Soyabean Seeds Collection, Processing and Diet Preparation:

Soyabeans seeds *(Glycine max)* were procured from a local market in Lafia metropolis of Nasarawa State, Nigeria. The procured seeds were cleaned by winnowing and hand picking of stones and debris. The raw soyabeans were subjected to thermal and hydrothermal processing methods viz: extrusion, cooking, toasting and roasting -dry heating representing T1, T2, T3 and T4 respectively. The different thermal and hydrothermal processes are described as thus:

Seeds Collection Processing and Experimental Diets:

Soyabeans seeds *(Glycine max)* were procured from a local market in Lafia metropolis of Nasarawa State, Nigeria. The collected seeds were cleaned by winnowing and hand picking of stones and debris. The raw soyabeans seeds were subjected to three thermal and hydrothermal processing methods viz: soyabean cake processed through extrusion treatment as described by ASA (1993), cooking, toasting and roasting (dry heating) as described by Ari *et al.* (2012). Each of these processing methods formed experimental treatment diets D1, D2, D3 and D4 respectively.

Experimental Treatment:

Two hundred and forty (240) days-old Anak broilers were randomly divided into four (4) experimental groups of three replicate each. Dietary treatments were as follows: D1, D2, D3 and D4 representing *soyabean cake* (control), *cooking, toasting and roasting* based groups at both starter and finisher phases using Completely Randomized design having the test ingredients incorporation as the main source of variation.

The starter diets were fed for five (5) weeks (1-35 days) and the finisher diets were fed for four (4) weeks (36- 63 days). Experimental diets were formulated at starter and finisher phases using at least cost feed formulation software ***Feedwin***. Broilers and feed intake were weighed weekly. Energy and protein efficiency ratios and specific growth rate were calculated:

ANALYTICAL PROCEDURES

Chemical Analysis:

Chemical composition of each of the different thermally processed soyabeans seed samples and experimental diets were determined following standard methods (AOAC, 1995) while serum analysis were determined by the methods described by Aletor and Ogunyemi (1988).

Statistics:

Data collected were subjected to one-way analysis of variance (ANOVA), means were separated where there were significant differences using Duncan's Multiple Range Test (Duncan, 1955) using SPSS 16.0.

Results:

The chemical composition of thermal treated soyabean (test ingredient) is presented in Table 1. The dry mater (DM) percentage ranged from 79.00 to 91.25% while crude protein (CP) percentage ranges from 12.51 to 28.34%. The highest value of ether extract (EE) was obtained in cooked soyabeans (19.50%) while the least (9.72%) was obtained in extruded soyabeans. The total ash percentages ranged from 4.27 to 4.46% while nitrogen free extract (NFE) percentage ranged from 13.75 to 26.31%. The highest Ca and P percentage values were 1.08 and 0.33% in roasted and extruded respectively. The chemical composition of thermal processed soyabean based starter and finisher diets are presented in Table 2. DM values ranged from 92.69% to 92.73% and 92.62 to 93.43% in the starter and finisher diets respectively, while CP ranged from 20.53 to 23.47% in the starter diets, the finisher diets had CP range of 20.21 to 22.99%. The lowest crude fibre value in the starter diets was 4.75% (extrusion) and 5.19% (cooked) in the finisher diets. The EE values were highest in cooked soyabean based diets (13.40%) in the starter diets and (14.47%) in toasted soyabeans based finisher diets. Total ash percentage range in the

Table 1: Effect of Thermal processing on the Chemical composition of Soyabean

	Chemical composition (%)							
Thermal methods of Processing	**Dry matter**	**Crude protein**	**Crude Fibre**	**Ether extract**	**Total Ash**	**NFE**	**Ca**	**P**
Extrusion	79.00	40.20	19.50	9.72	4.27	26.31	0.45	0.33
C:ooked	89.83	39.27	12.51	19.27	4.39	24.56	0.56	0.29
Toasted	91.25	35.47	28.34	18.03	4.41	13.75	0.44	0.28
Roasted	90.57	37.53	24.29	16.92	4.46	16.8	1.08	0.29

Source: Ari et al. (2012)

Table 2: Composition of Experimental Diets

Ingredients	**Starter Diets**				**Finisher Diets**			
	T1 (Control)	T2	T3	T4	T1(Control)	T2	T3	T4
Maize	4.00	41.45	44.35	42.25	45.00	41.70	48.60	46.60
Maize Bran	9.05	4.51	3.74	4.00	9.20	10.75	3.00	5.35
Rice Bran	3.00	2.59	0.10	1.00	2.10	2.10	-	0.10
Soya Extrusion	29.50	-	-	-	29.00	-	-	-
Soya Cooking	-	30.50	-	-	-	31.00	-	-
Soya Toasting	-	-	32.10	-	-	-	31.35	-
Soya Roasting	-	-	-	32.00	-	-	-	31.00
Blood Meal	4.00	4.00	4.50	4.00	3.00	2.50	2.75	3.00
Fish Meal	3.50	3.50	3.76	4.00	2.00	2.00	2.25	2.25
Bone Meal	4.50	5.00	4.50	4.00	4.00	4.00	4.50	4.25
Limestone	1.75	2.80	-	1.80	-	-	-	-
Palm Oil	1.75	2.70	4.00	4.00	2.75	3.00	4.50	4.50
L-Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
DL-Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Salt	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Premix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Calculated								
ME/Kcal/kg	3000.26	3000.50	3001.29	3009.0 0	3129.26	3100.00	3042.46	3094. 23
CP%	24.10	24.13	24.00	24.03	22.21	22.00	21.61	22.25

Premix* To Provide the following per 100kg of the diet: 440kg Riboflavin; 72omg Calcium Pantothenate; 2g Niacin, 2.2g Choline chloride; 15mg Folic Acid; 1mg Vit. B_{12}, 15mg Retinol, 165µg Vit. D_2 100mg DL-α- Tocopherol acetate; 1700mg Cu; 200mg Iodine; 3000g Managanese, 5000mg Zinc; 10,000mg Iron.

starter diets was from 12.55% to 15.99% and 9.31% to 9.96% in finisher diets; NFE values also ranged from 34.08 to 40.71% in the starter diets and from 41.62 to 44.22% in the finisher diets. The highest calcium and phosphorous values in the starter diets were 2.92 and 1.43% respectively while 2.24 and 1.68% were the highest calcium and phosphorous values in the finisher diets. Metabolisable energy (ME) values of the starter diets ranged from 3388.13 to 3466.78 Kcal/Kg ME while metabolisable energy value range of the finisher diets was from 3584.03 to 3721.6 Kcal/Kg ME.

The effects of different thermal processing methods on growth indices of broilers are presented in the Table 4. SGR and GE were significantly ($P < 0.05$) affected by treatment, cooking and toasting had higher values of SGR and GE as compared to the control (extruded) and roasted soyabean based diets groups at the starter (1-35 d) of experiment and finisher phases (36 to 63 d).. FCR were significantly ($P<0.05$) different at the starter phase with roasting having the best FCR value of 1.41 whereas no significant ($P<0.05$) difference was observed in the FCR at the finisher phase. Similarly, PER values at both starter and finisher phase were not significant ($P<0.05$) affected with values ranging from 2.56 to 3.50 in the starter phase and 2.05 to 2.66 in the finisher phase. EER showed no significant ($P>0.05$) difference at the starter phase while the finisher phase has significant ($P<0.05$) difference with values ranging from 13.88 to 20.72. Serum and blood profile analysis for broilers fed thermally processed soyabean based diets are presented in Table 5. There were significant ($P<0.05$) variations in all the serum and blood parameters measured. The highest mean values recorded were in extrusion for urea, cholesterol, creatine and haemoglobin while packed cell volume had the highest mean value recorded in the toasting group.

Table 3: Chemical Composition of Thermally Processed Soyabean Based Diets

	Starter Diet				**Finisher Diet**			
Nutrients	**D1**	**D2**	**D3**	**D4**	**D1**	**D2**	**D3**	**D4**
Dry Matter (%)	92.69	92.87	92.73	92.72	93.43	92.95	92.83	92.62
Crude Protein (%)	22.00	21.77	23.47	20.53	20.83	22.99	20.12	20.41
Crude Fibre (%)	4.75	6.40	7.36	7.60	7.15	5.19	6.94	7.26
Ether extract (%)	10.48	13.40	12.72	12.11	12.42	10.59	14.47	13.44
Total Ash (%)	14.75	15.19	15.1	12.55	9.31	9.96	9.68	9.44
NFE (%)	40.71	36.11	34.08	39.93	43.72	44.22	41.62	42.07
Calcium (%)	2.24	2.48	1.76	2.94	0.80	2.24	1.72	1.92
Phosphorus (%)	1.35	1.26	1.26	1.43	0.54	1.68	0.74	0.74
*Energy (Kcal/Kg ME)	3396.6	3466.71	3388.13	3456.98	3647.53	3584.03	3721.6	3657.78

*Calculated using the method reported by Paul and Southgate (1978)

Table 4: Effects of different thermally processed soyabeans on growth indices of broiler chickens

	Starter Phase					**Finisher Phase**				
Growth indices	**D1**	**D2**	**D3**	**D4**	**SEM**	**D1**	**D2**	**D3**	**D4**	**SEM**
SGR(%d^{-1})	14.00±.01c	17.19±0.01a	15.38±0.02b	13.42±0.06d	±0.44	46.99±0.06c	53.05±0.05b	57.67±0.04a	40.38±0.02d	±1.96
GE	4.43±0.10c	7.05±0.11a	6.32±0.01b	4.15±o.13d	±0.37	0.87±0.00a	0.66±0.00c	0.75±0.00b	0.66±0.01d	±0.03
FCR	1.78±0.01a	1.72±0.01b	1.49±0.01c	1.41±0.01d	±0.05	1.81±0.01d	2.13±0.01a	2.05±0.01b	1.97±0.01c	±0.04
Protein Intake(g)	82.28±0.22c	106.77±0.17a	97.51±0.18b	53.47±0.16d	±6.09	175.81±0.21c	207.42±0.20a	179.87±0.00b	132.30±0.18d	±8.11
PER	2.56±0.15d	2.67±0.06c	2.87±0.02b	3.49±0.03a	±0.11	2.65±0.00a	2.05±0.01d	2.43±0.01c	2.55±0.01b	±0.07
Energy Intake	1270.33±3.40c	1700.24±2.64a	1407.59±2.57b	900.36±2.63d	±86.71	3078.52±3.65c	3233.59±3.12b	3327.11±0.00a	2371.05±3.18d	±113.15
EER	16.55±0.12d	16.77±0.03c	19.85±0.09b	20.71±0.15a	±0.55	15.15±0.01a	13.12±0.04c	13.12±0.03d	14.22±0.06b	±0.26

abc Means in the same column with the same superscript are not significantly ($P>0.05$) different

SEM Pooled Standard Error of Means

* Significantly ($P<0.05$) different

±SD Standard Deviation

Table 5: Effect of thermal Processing of Soyabeans on Serum and Blood Profile of Broilers

	Thermal Processing Methods				
Parameters	**D1**	**D2**	**D3**	**D4**	**SEM**
Urea (mmn/1)	3.55[a]	3.33[a]	3.43[a]	2.13[b]	0.17*
Cholesterol (mmn/1)	2.57[b]	2.27[c]	2.83[a]	2.27[c]	0.07*
Creatine (mn/1)	122.67[a]	111.33[b]	122.67[a]	97.33[c]	3.15*
Packed Cell Volume (PCV)	32.67[a]	31.33[a]	32.33[a]	28.33[b]	0.56*
Haemoglobin (Hb) (g/dl)	11.17[a]	10.07[b]	11.27[a]	9.33[c]	0.24*

abc Means in the same column with the same superscript are not significantly (P>0.05) different
SEM Pooled Standard Error of Means

DISCUSSIONS

The results of the proximate and chemical composition of thermally processed soyabeans and formulated soyabeans based diets are consistent with the reports of HNIS (1989) and Ensminger *et al.* (1990) who observed variations in the proximate composition of soyabeans subjected to different processing methods. Similar variations were also reported by Qin *et al.* (1996) and Tiamiyu (2001) for different thermally processed soyabeans. The proximate values obtained in this experiment are within the range reported in NRC (1993) table for heat and mechanical extruded soyabeans and In spite of the variations in the nutrient composition of the thermally processed soyabean based diets, all the diets at both starter and finisher phases were within recommended range for the tropics as reported by Oluyemi and Roberts (1979).

The differences observed between the starter and finisher phases and treatment groups in the growth indices especially SGR,GE FCR, PER, and EER were as a result of dietary nutrient intake and composition of the different thermally processed soyabean diets which were influenced by high variation in TIA reduction (5.44-85.02%) among thermal processing methods as well as age of birds. This was similarly reported by the Ibe (1990), Ayanwale (1999) and Tona *et al.* (2002) among other workers. The reduction in phytic acid may have significantly influenced SGR, GE, FCR, PER, and EER as roasting which had the highest reduction in phytic acid gave the best results in the aforementioned indices. Similarly, variation in serum and blood profile of the experimental birds can therefore attributed to dietary nutrient variations as reported by Aletor and Ogunyemi (1988), Jang *et al.* (1990) and Ari and Ayanwale (2013) which are products of the different processed soyabeans.

CONCLUSION

The utilization value of soyabeans in the diets of broilers has been significantly improved through the thermal processing methods employed in this experiment. The thermal processing methods however showed varied effects on both the chemical parameters measured and the growth indices and serum metabolites of broilers. Cooking (T2) gave the best results when compared with the other thermal methods in the nutrient composition and growth indices, while extrusion and toasting presented better serum profile. It must be noted that the overall best performance recorded in the cooking group is an indication that cooking of soyabeans was the best thermal processing method that will guarantee the preservation of essential nutrients and performance of broilers.

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