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Original Contribution

EFFECTS OF ALKALI TREATMENT OF SOYABEAN ON CARCASS TRAITS, INTESTINAL MORPHOLOGY AND COOKING YIELD OF BROILERS

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ABSTRACT

The effects of different alkali treatment of soyabeans on carcass traits, intestinal morphology and cooking yield of broilers was evaluated using 240 Anak broilers day-old chicks that were allocated into four (4) treatments of three (3) replicates as thus: Soaking in water (H_20)- T1, sodium carbonate(Na_2CO_3) –T2, potash (K_2CO_3) –T3 and sodium hydroxide (NaOH) -T4 based groups. Five birds were selected from each group and fasted for 8 h prior to carcass evaluation. Plucked weight percentage did not vary significantly ($P>0.05$) among processed broilers, but significant ($P<0.05$) differences were recorded in the eviscerated weights. Neck, breast and primal cut-up parts varied significantly ($P<0.05$). No significant ($P>0.05$) differences were observed in the values for head, wing and shank. Intestinal weight and organs like lungs, liver, gizzard, heart, kidney spleen and abdominal fat deposition significantly ($P<0.05$) varied. Cooking yield was significantly ($P<0.05$) reduced in 1% NaOH. The best percentages for the fleshy primal cuts parts and the meat/bone ratio were 9.20% of breast in 1% Potash; 5.20% of thighs and 4.93% of drumstick all recorded in 1% Potash group and so also 4.35 ratio of meat to bone was recorded in 1% K_2CO_3. Alkaline treatment of soyabeans with 1% $K_2CO_3$is recommended for improved carcass yield in broilers.

Key words: Alkaline treatment, Broilers, Carcass traits, cooking yield, and Organ morphology

INTRODUCTION

Soya bean meal remains the most commonly used source of supplementary protein for poultry on accounts of its consistently high quality product (1, 2). It is however limited in utilization for usage in the feed industry by the presence of antinutritional factors (ANFs).

The use of alkali in the removal of anti nutritional factors and the nutritional improvement of feedstuff for poultry and livestock utilization has been reported (3, 4, 5, 6). The application of sodium sesquicarbonate (trona) in improving the nutritive values of soyabeans by removal of polyphenols and destroying the trypsin inhibition factor was reported by (3, 7). Sodium hydroxide and sodium hypochloride was also evaluated in the detoxification of a toxic variety of *Jatropha curcas* (8, 9). The use of sodium bicarbonate solution, distilled water and potassium hydroxide in the removal of trypsin inhibitor activity in oilseeds and soyabeans has also reported by (10, 11, 6).

(12, 3) however observed that alkaline treatment of soyabeans is dependent on the concentration levels of the alkaline used, as treatment of soyabeans with strong alkaline resulted in decreased protein quality, loss of amino acids and the formation of amino acids lysinealanine complex, which reduce lysine availability (13). Assessment of feed quality by evaluating the meat yield and composition of broilers was earlier reported (7). Similarly, carcass characteristics and organoleptic qualities of

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broilers and other monogastrics were affected by differences in feed nutrient utilization (14, 15, 2, 16, 17, 18) reported the use of some morphological measurements such as gizzard weight, liver weight, ceacum length and gut-gizzard length in the assessment of feed nutrients quality and anti-nutritional factors in broilers feeds. This study was therefore conducted to evaluate carcass traits, intestinal morphology and meat yield of broilers fed different alkaline treated soyabean meal based diets.

MATERIALS AND METHODS

Soyabean Collection, Processing and Diet Preparation:

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 were subjected to three alkali treatment viz: sodium carbonate (Na_2CO_3)- T2, potash (K_2CO_3) –T3 and sodium hydroxide (NaOH) -T4. Each of these alkaline solutions that served as experimental treatment groups were compared with controlled soaking in water (T1) which served as experimental control. The different alkali treatments are described as thus:

Soaking in Water- (H_2O) T1 (control)

The cleaned raw soyabeans were poured into a plastic container of cold water according to the methods reported by (3) and adopted by (19). The soyabeans were allowed to soak by immersing the soyabeans in water at room temperature for 24 hours, this represents 0% alkaline. The soaked grains were drained, and sun dried by spreading on jute bags. The sun dried samples were milled and bagged.

Soyabeans Processed with Sodium Carbonate (Na_2CO_3) –T2

The method reported by (3) and adopted by (19) was used. The cleaned sample grains were soaked in 1% solution of sodium carbonate

The soyabeans sample was allowed to soak by immersing in the aqueous alkaline solution at room temperature for 24 h. The soaked grains were drained and sun dried by spreading on jute bags until stable weight was attained. The sun dried products were milled and bagged.

Soyabeans Processed with Potash –T3

The method reported by (3) and adopted by (19) for alkali treatment of soyabeans was applied. The cleaned sample grains were soaked in 1% solution of potash. The potash used was procured from local market in Lafia. The soyabean samples were allowed to soak by immersing the soyabeans in the aqueous solution at room temperature for 24 h. The soaked grains were drained and sun dried by spreading on jute bags until stable weight was attained. The sun dried samples were milled and bagged.

Soyabeans Processing with Sodium Hydroxide (K_2CO_3) T4

. The cleaned samples grains were soaked in 1% solution of sodium hydroxide. The method reported by (3) and adopted by (19) for alkali treatment of soyabeans was applied. The sodium hydroxide used was manufactured by Fisher Scientific Comp., New Jersey USA. The soyabeans samples were soaked in the aqueous solution of NaOH at room temperature for 24 h. The soaked and wet grains were drained, and sun dried by spreading on jute bags until stable weight was attained. The sun dried samples were milled and bagged.

Experimental treatment:

A total of 240 Anak broilers day-old were randomly divided into4 experimental groups of three replicate each. Dietary treatments were as follows: T1, T2, T3 and T4 were representing *soyabeans processing by Soaking in water, with sodium carbonate, with potash; and with sodium hydroxide* based groups at both starter and finisher phases using Randomized Complete Block design, having the test ingredients incorporation as the main source of variation.

The starter diets were fed for 5 weeks (1- 35 days) and the finisher diets were fed for 4 weeks (36- 63 days). Experimental diets were formulated to be *isocaloric* and *isonitrogenous* diets having 3,000 cal, 24% CP at starter stage and 3,100 Kcal, 22% at finisher level. The experimental feeds were formulated using at least cost feed formulation software ***Feedwin***.

Carcass Evaluation and Gut Morphology*:*

A total of 5 birds were randomly selected from each of the replicate groups and fasted (no limitation of water access) for 8 h prior to complete carcass evaluation according to the

methods described by (3). The selected birds from each replicate group were weighed and each selected bird was slaughtered by cutting the jugular vein with a sharp knife. The weights of the slaughtered birds, dressed birds, eviscerated parts, cut up parts and organs were recorded and expressed as percentage of their respective plucked weights. The gut morphology of the processed birds were obtained by weighing and measurements of organs and the gastro intestinal tract according to the methods described by (16)

Meat to Bone Ratio

The determination of the meat to bone ratio was conducted after other carcass parameters have been measured in the process of carcass evaluation. The bones of the birds were manually separated from the meat. The weights of the meat and the bones then were determined. The ratio of meat to bone was calculated as:
Meat bone ratio = weight of meat/weight of bone

Cooking Losses and Yields

The total cooking losses were determined by pre and post-weight measurement during heat processing according to the method described by (20) and adopted by (21,19).The samples were placed in a pot of boiling water and thereafter allowed to cook for fifteen minutes. The samples were then blotted with tissues paper and weighed. The difference between the pre and post-cooking weights constituted the cooking losses. These values were then expressed as the percentage of the pre-cooked weights of the samples to get the cooking loss percentage. The cooking yield percentages were obtained by subtracting the cooking loss percentage from 100.

Chemical Analysis

Chemical composition of each of the fermented soyabeans samples and experimental diets were determined following standard methods (22). Crude protein (N × 6.25) was determined by the Kjeldahl method after acid digestion. Crude lipid analysis without acid hydrolysis was determined by the ether-extraction method using a Soxtec System. Moisture was determined by oven drying at 105 ◦C until a constant weight was achieved. Ash content was estimated by incinerating the samples in a muffle furnace at 600 ◦C for 6 h. Total carbohydrates (NFE) was determined by difference and Calculated as thus: 100% - % (CP+ Ash + Crude Fat + Moisture).

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 (23) using SPSS 16.0.

RESULTS AND DISCUSSION

The composition of that alkali treated soya beans based diets and the anti nutritional profile of the test soya beans are presented in **Tables 1 and 2**, while **Table 3** presents the effect of alkaline treated soyabeans on the carcass characteristics of the experimental birds. There were significant ($P<0.05$) differences in the live weight and plucked weight, while plucked weight percentage did not vary significantly ($P>0.05$) among processed broilers. Significant ($P<0.05$) differences were recorded in the eviscerated weight of broilers fed alkaline treated soyabeans. Other cut-up parts that vary significantly ($P<0.05$) include; neck, wings and the primal cuts (breast, thighs, drumstick and back). No significant ($P>0.05$) differences were however observed between the mean values for head and shank. The best percentages for the fleshy primal cuts parts and the meat/bone ratio were 9.20% of breast in 1% potash, 5.20% of thighs and 4.93% of drumstick all recorded in 1% potash group while 4.35 ratio of meat to bone was recorded in 1% potash.

The morphology of internal organs of experimental broilers fed alkaline treated soyabean based diets is presented as measured parameters in **Table 4**. There were significant ($P<0.05$) variations in intestinal weight and organs like lungs, liver, heart, gizzard, gall bladder and abdominal fat deposition while kidney and spleen did not vary ($P<0.05$) significantly between treatment groups.

Gastro-intestinal measurement indicated no significant ($P>0.05$) differences between treatment groups in the following parameters; duodenum width and ceacum length while all other intestinal measurement showed significant ($P<0.05$) differenc

Table 1. *Composition of Experimental Diets*

	Starting phase				Finishing phase			
Ingredients	T1	T2	T3	T4	T1	T2	T3	T4
Maize	38	38	37	38	46.55	46	46	46.3
Maize Bran	10.25	10	10.25	10.5	8	8	9.3	8
Rice Bran	2.5	2.25	2.8	2.55	1.25	1.25	1.75	1.5
Soya 0% Alkaline	32	-	-	-	31.5	-	-	-
Soya 1% Na_2Co_3	-	33.25	-	-	-	32.55	-	-
Soya 1% Potash	-	-	33	-	-	-	31	-
Soya 1% NaOH	-	-	-	33.25	-	-	-	31.5
Blood Meal	3.5	3.5	3.25	3.25	3	3	3	3
Fish Meal	3.5	3.5	3.25	3.25	1	1	1	1
Bone Meal	3.5	3.5	3.5	3.5	3	3	3	3
Limestone	0.8	1.05	2	0.75	-	-	-	-
Palm Oil	3	2	2	2	2.75	2.25	2	2.75
L-Lysine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
DL-Methionine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Salt	2.5	0.25	2.5	2.5	2.5	2.5	2.5	2.5
Premix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100
****Calculated**								
ME/Kcal/kg	3009.85	3007.13	3009.17	3003.74	3061.75	3088.23	3107.94	3108.37
CP%	24	24	24.14	24.11	21.99	21.92	22.07	21.97
Determined analysis								
D M (%)	92.1	92.1	91.3	92.42	91.81	92.12	92.73	91.99
CP (%)	21.14	21.86	23.36	23.36	20.44	23.63	20.56	20.62
CF (%)	7.15	6.58	6.88	6.24	7.06	7.01	7.41	6.8
EE (%)	11.75	9.52	10.32	8.86	12.45	11.16	13.52	11.93
T Ash (%)	11.49	10.55	11.2	11.25	5.72	6.8	14.03	7.76
NFE (%)	37.57	43.59	39.49	42.71	46.14	43.52	37.21	44.88

*Premix to provide the following per KG of diet: Vitamin A, 9,000 IU; Vitamin D3, 2,000,IU; vitamin E, 18 IU; vitamin B1, 1.8 mg; vitamin B2, 6.6 mg B2,; vitamin B3, 10 mg; vitamin B5, 30 mg; vitaminB6, 3.0 mg; vitamin B9, 1 mg; vitamin

Table 2. *Effect of Alkaline Treatments on the Value of Anti-Nutritional Factors of Soyabeans*

Parameters	Raw Soya	0% Alkaline	1% Na_2CO_3	1% K_2CO_3	1% NaOH
Trypsin Inhibitor Activity TIA (mg/k)	15.35	9.40	0.90	1.20	1.15
Reduction in TIA (%)	0.00	38.76	94.14	92.18	92.51
Phytic Acid (mg/100g)	345.00	325.00	66.00	48.8	48.6
Reduction in PA (%)	0.00	5.80	80.87	85.86	85.91
Urease Assay (ΔpH)	0.03	0.07	0.09	0.03	0.04
Protein Solubility Index PSI (%)	85.74	81.95	76.44	76.65	74.6

Source: Ari *et al*. (2012)

Table 3. *Effect of Alkaline Treatment of Soyabeans on Carcass Characteristics of Broilers*

Parameters	Alkaline Treatments				
	0% Alkaline	1% Na_2CO_3	1% K_2CO_3	1% NaOH	SEM
Live Weight (g)	160.00^{c}	195.00^{b}	226.67^{a}	190.00^{b}	8.36*
Pluck Weight (g)	189.67^{b}	156.00^{c}	220.67^{a}	185.00^{bc}	8.37*
Pluck Percentage (g)	97.20	97.57	97.23	97.36	0.31NS
Eviscerated Weight (g)	163.67^{ab}	125.00^{bc}	186.67^{a}	116.67^{c}	10.13*
Head (%)	1.50	0.96	1.02	0.93	0.14NS
Neck (%)	2.01^{a}	1.67^{ab}	1.80^{ab}	1.38^{b}	0.09*
Wing (%)	3.35^{a}	3.17^{a}	3.29^{a}	2.10^{b}	0.19*
Breast (%)	9.17^{a}	9.17^{a}	9.20^{a}	7.00^{b}	0.32*
Thighs (%)	4.05^{b}	5.20^{a}	3.99^{b}	3.66^{b}	0.21*
Drumstick (%)	3.08^{bc}	493.^{a}	3.52^{b}	2.36^{c}	0.30*
Back (%)	4.61^{ab}	5.29^{a}	4.64^{ab}	3.94^{b}	0.17*
Shank (%)	1.49	1.24	1.55	1.18	0.07NS
Meat/Bone Ratio	1.24^{c}	3.72^{ab}	4.35^{a}	3.13^{b}	0.37*

abc Means in the same column with the same superscript are not significant (P>0.05) different
SEM Pooled Standard Error of Means
* Significantly (P<0.05) different
NS Not Significant
±SD Standard Deviation
% Percentages are with respect to plucked weight.

Table 4. *Effects of Different Treatment of Soyabeans on Organs Morphology of Broilers*

Parameters	**Alkaline Treatments**				
	0% Alkaline	**1% Na_2CO_3**	**1% K_2CO_3**	**1% NaOH**	**SEM**
Intestine (g)	2.22^{b}	3.15^{a}	2.55^{b}	2.29^{b}	0.13*
Lungs (g)	0.11^{b}	0.11^{b}	0.18^{a}	0.10^{b}	0.01*
Liver (g)	0.92^{a}	0.65^{b}	0.73^{b}	0.63^{b}	0.04*
Hearts (g)	0.27^{a}	0.15^{b}	0.23^{ab}	0.18^{ab}	0.02*
Kidney (g)	0.03	0.01	0.02	0.02	0.00NS
Spleen (g)	0.03	0.01	0.02	0.02	0.00NS
Gizzard (g)	1.94^{b}	1.10^{a}	1.21^{a}	1.88^{b}	0.16*
Gall Bladder (g)	0.11^{b}	0. 10^{a}	0.19^{b}	0.04^{b}	0.11*
Abdominal Fat (g)	0.96^{a}	0.25^{b}	0.85^{a}	0.36^{b}	0.10*
Crop Oesophagus (g)	12.30^{a}	7.83^{d}	10.67^{b}	9.43^{c}	0.51*
Proventiculus (g)	0.50^{a}	0. 57^{c}	0.39^{ab}	0.30^{bc}	0.04*
Duodenum Fold Length (cm)	14.67^{a}	9.17^{c}	13.67^{b}	13.67^{b}	0.66*
Duodenum Width (cm)	3.50	2.63	2.97	5.90	0.79NS
Jejunum Width (cm)	3.40^{a}	2.13^{b}	2.73^{ab}	2.30^{b}	0.18*
Ileum Length (cm)	1.09^{d}	1.76^{b}	1.63^{c}	1.91^{a}	0.09*
Ceacum Length (cm)	21.00	19.00	18.67	21.00	0.43NS
Ceacum Width (cm)	4.33^{a}	3.73^{c}	3.38^{b}	2.43^{c}	0.31*
Small Intestine (cm)	25.00^{a}	9.50^{b}	11.83^{b}	10.00^{b}	2.02*
Colo-Recticulum Length (cm)	11.00^{a}	7.33^{d}	13.00^{a}	9.33^{c}	0.65*
Colo-Recticulum Width (cm)	2.33^{b}	2.10^{a}	2.17^{b}	2.67^{d}	2.04*
Colo-Gizzard Length (cm)	22.37^{b}	20.50^{c}	19.07^{d}	23.50^{a}	0.52*

abcd 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
NS Not Significant
±SD Standard Deviation

Table 5 shows that cooking yield was significantly (P<0.05) reduced in 1% NaOH compared to 0% alkaline, 1% Na_2CO_3 and 1% potash groups. Similar trend was observed in the levels of meat cooking loss.

Table 5. *Means Sensory Values of Cooking Yield and Cooking Loss of Broilers Fed Alkaline Treated Soyabeans Based Diets (%)*

	Alkaline Treatments				
Parameters	**0% Alkaline**	**1% Na_2CO_3**	**1% K_2CO_3**	**1% NaOH**	**SEM**
Cooking yield	53.63a	53.59a	53.05a	51.32b	± 0.33*
Cooking Loss	46.37a	46.41a	46.95a	48.68b	± 0.33*

ab	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
NS	Not Significant
±SD	Standard Deviation

The variations in the nutrient composition of the alkaline treated soyabean base diets at both starter and finisher phases were within recommended range for the tropics as reported by (24).

Even though (3) observed no significant (P>0.05) differences in carcass characteristics of broilers fed different concentration levels of alkaline treated soyabeans, differences were observed between broilers fed different alkaline salts treated soyabeans in this study. Changes observed in some gut measurements and organ weights in response to dietary treatments were similar to the observation of (17). Similar observation on the effect of feed treatment on organ weights was reported by (25,26). The observed differences in carcass characteristics were as a result of differences in the removal of Trypsin Inhibition Activity (TIA) and phytic acid through the various alkaline treatments and type of alkaline salts used as these factors affect nutrient composition and absorption.0% alkaline recorded the lowest organs when compared with other alkaline treatments that supported the removal of ANFs. Variations in organ weight in response to anti-nutritional factors levels in broiler feeds were also reported by (16)

CONCLUSIONS

The use of alkaline solutions in the treatment of soyabeans was found to be advantageous in the nutritional improvement of soyabeans for utilization in the diets of broilers as observed in the findings of this experiment. The alkaline treatment methods showed varied effect on both the chemical parameters measured and the carcass characteristics and organ morphology of the experimental broilers.

The use of Na_2CO_3 and 1% K_2CO_3 in the processing of soyabean recorded greater improvement in the removal of ANFs and preservation of nutrient quality which resulted in better carcass characteristics and meat yield of broilers The relative poor results associated with the sodium hydroxide treatment of soyabeans was an indication that the type of alkaline salt used in the treatment of soyabean for broiler feds significantly affected these performance indicators in broilers.

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