INFLUENCE OF DIETARY SOYA BEAN POMACE ON SERUM TESTOSTERONE, REPRODUCTIVE TRAIT DEVELOPMENT, GROWTH PERFORMANCE AND CARCASS QUALITY CHARACTERISTICS OF BROILER ROOSTERS

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ABSTRACT

This study examines the effects of the use of agro by-product soya bean pomace to substitute some plant protein ingredients in the diet of male broilers on its serum testosterone, reproductive trait development, growth performance and carcass quality characteristics. 90 four weeks old male broilers were used in this study. Birds were allocated randomly into three treatment groups A (0 % soya bean pomace, soya bean meal), B (15 % soya bean pomace inclusion, 10 % soya bean meal) and C (25 % soya bean pomace, 0 % soya bean meal). Each group was distributed into 3 replicates with 10 birds per replicate. All the birds were fed for a period of twelve weeks. At the end of 12 weeks of feeding trial, the reproductive performance parameters, serum testosterone, growth performance and carcass quality characteristic were determined. The analysis of serum testosterone level showed that diet C had positive influence on the serum testosterone level which was not significantly different from the other two treatments, there were slight significant differences (p<0.05) in the reproductive performance parameters, their growth performance while carcass quality characteristics demonstrated no significant differences (p>0.05). Economic returns of the diet C had the least cost per weight gain. Diet C would be most economical to feed to animals. The study concluded that inclusion of soya bean pomace in rooster diets helped in their reproductive performance, enhancement of serum testosterone, growth performance as well as their carcass quality characteristics.

Keywords: Dietary substitution, Soya bean pomace, Serum testosterone, Reproductive trait development, Broiler roosters

INTRODUCTION

Most agricultural wastes and some industrial wastes are alternative feed resources available to replace or supplement the active nutrient ingredients in animal feeds due to their cheaper costs and nutritional constituents (Ravindran and Blair, 1992). Grains and cereals which are the main ingredients in animal feeds are becoming too expensive to use to formulate highly nutritious and economic feeds that can maximize profit because of their many competitive uses (Aguilera, 1989). The high costs of these main ingredients have made it difficult for farmers to feed their animals adequately and this has led to production of malnourished animals for the market (Makkar, 2016). Soya bean is a member of Fabaceae, it is a species of legume native to east Asia. It is an annual plant that has been used in China for 5000 years as a food and a component of drugs (Smýkal *et al.*, 2015).

Soya contains significant amount of all the essential amino acids for humans, and animals so is a good source of protein. Soya bean is one of the active ingredients in animal feed. It accounts for about 25 – 30 % of the total feed produced nowadays. The use of soybean meal has improved the growth performance and body composition of animals. Soya bean meal costs about three hundred dollars per tonne at the international market and it is relatively scarce to get sufficient quantity of soya in Africa.

The use of agro waste from soya bean will provide a good quality animal feed resource which will not compromise essential nutrients that are needed for growth, development and reproduction (Makkar, 2016). Soya bean pomace is a waste that is obtained from soya bean after extraction of pulp in the process of making milk or cheese from the soya bean. Soybean pomace has always been treated as waste product from soybean milk or cheese production despite its high nutrient profile. It is in this view; a feeding trial was conducted to evaluate the nutritional quality of soya bean pomace which could serve as an alternative feed resource for soya bean meal in the diet of male broilers. The use of soya bean pomace could as well maximize the use of soya bean after extraction of milk, production of cheese and cake from the same bean. This will also serve as a clean way of getting rid of potential pollution from the environment by converting them to animal feeds to feed broilers or ruminant animals (Makkar, 2016).

Roosters are male chicken known for their masculine superiority among the poultry herd. Care of the rooster has recently gained importance because of their roles in reproduction. Roosters play important physiological roles which cannot be underestimated in poultry reproduction and production (Duncan *et al.,* 1990). As far as fertilization is concerned, keeping a rooster is necessary to hatch chicks or produce fertile eggs for the kitchen. Other reasons for keeping roosters on the farm include rooster crow at the break of the dawn and all through the day, they also possess colourful feathers which distinguish them (Astiningsih and Rogers, 1996). Testosterone is a hormone found in male animals. It plays important roles in bone calcification and muscle mass building, fat storage, production of red blood cells, which determines the activity levels of an organism, sexual and physical health (Finkelstein *et al*., 2013). Decrease in testosterone level could lead to difficulty in achieving erection, loss of body hair or feather, decrease in muscle strength, sleep disturbances, fatigue and depression. Little information is available concerning the phyto-testosterone effects of some of our plant based agro waste that are quite rich in dietary protein, energy and fibre on the development and growth of male broiler chicken (Modaresi *et al*., 2011).

This study was targeted towards obtaining relevant information on the influence of the dietary inclusion of soya bean pomace on the development of reproductive traits, serum testosterone levels, growth performance and carcass quality of broiler roosters.

MATERIALS AND METHODS

Experimental Site and Pen Management: The study was carried out between March – May, 2019 at the Poultry Pen, Wesley University Mini-Zoo, Ondo, Ondo State, Nigeria. The pens were washed and disinfected prior to the chicks' arrival. On arrival of the chicks, their initial weights were measured individually. The already weighed chicks were then distributed to the already prepared pens. The birds used for this study were raised under similar conditions that involved an intensive production system (in a closed confinement). The birds were raised on deep litter.

Processing of the Test Ingredient: Soya bean pomace was obtained as a waste product from the soya beans. The soya bean pomace was sun dried to decrease the moisture content and soya bean pomace ground into powder. The grounded soya bean pomace was oven dried in a hot air oven at 100^oC for 15 minutes to breakdown the anti-nutritional factors (trypsin inhibitors and lectins) (Makkar *et al*., 2011). After oven drying, the soya bean pomace was kept at room temperature until it was mixed with the basal diet.

Formulation of the Experimental Diets: Three isocaloric and isonitrogenous experimental diets were formulated. Soya bean pomace was substituted for soya bean meal in diets two and three at ratio 15 and 25 % respectively (Ranjhan, 1993) (Table 1).

Proximate Analyses of the Test Ingredient and the Experimental Diets: Samples of the test ingredient and the experimental diets were analysed for dry matter, energy content, crude protein level, crude fat, crude fibre, total ash and metabolizable energy using methods according to the AOAC (2005).

Experimental Birds and Experimental Design: The broilers used for the experiment were purchased from hatchery Agric-Tech Farm, Oluyole Estate, Ibadan, Oyo State, Nigeria. The approval for the study was granted by the ethical committee on animal experimentation of the Wesley University, Ondo, Nigeria. Ninety (90) four week old male broilers were used in this study. The broilers were allocated randomly into three treatment groups with each group replicated thrice with 10 birds per replicate. All birds were fed a starter diet from age 1 – 28 days, followed by a finisher diet (formulated as in Table 1) from age 29 – 84 days. The basal diet was based on corn and soybean meal and was balanced to meet the nutrient requirements for broiler chickens according to NRC (1994). The birds were reared on concrete flooring covered with wood shavings as litter material. Feeding was carried out twice daily between the hours of 08.00 – 09.00 am and 05.30 – 06.30 pm. Water was provided *ad libitum*. All routine vaccination and management practices related to broiler production were observed.

Determination of the Serum Testosterone of Male Broilers Reared: Blood samples were obtained from the male broilers after 12 weeks of feeding. The blood samples collected were centrifuged at 3000 rpm for 15 minutes to obtain serum for hormonal analysis. Enzyme-Linked Immunosorbent Assay (ELISA) Quantitative Test Kit (PREFERMED, USA) was used and was based on a solid phase enzyme-linked immunosorbent assay. The assay system utilized one anti-testosterone antibody for solid phase (microtiter wells) immobilization and another mouse monoclonal testosterone antibody in the antibody-enzyme conjugate solution (Sakamoto *et al*., 2018). The test sample was allowed to react simultaneously with the antibodies resulting in the testosterone molecules being sandwiched between the solid phase and enzyme-linked antibodies. After 60 minutes of incubation at room temperature the wells were washed with water to unbound labelled antibodies. A solution of TMB was added and incubated for 20 minutes resulting in the development of a blue colour. The colour development was stopped with the addition of 2N HCl and the colour was changed to yellow and measured spectrophotometrically at 450 nm. The concentration of testosterone was directly proportional to the colour intensity of the sample (Sakamoto *et al*., 2018).

Measurement of Reproductive Traits Development: At the end of 12 weeks of feeding trial, the following reproductive performance parameters were determined: (i) hepatosomatic index (HSI) as the weight (g) of the liver over that of the body, (ii) gonadosomatic index (GSI) as the weight (g) of the testis over that of the body, (iii) comb colour, (iv) comb length (cm), (vii) length of the neck (cm), (viii) wattle size and colour and (ix) size of the testes (cm). They are reflections of maturity and puberty in male birds (Bilcik *et al.,* 2005).

Measurement of the Growth Performance parameters: The broilers were fed for 12 weeks after which their growth performance parameters were measured: initial weight (IW), final body weight (FBW), daily feed intake (DFI, estimated as the amount of feed offered per day), cumulative feed intake (CFI, calculated as the total amount of feed offered throughout the rearing period), body weight gain (BWG, final body weight minus initial weight), daily weight gain (DWG, taken as body weight gain divided by the rearing period), feed conversion ratio (FCR, calculated as the amount of feed offered divided by weight gain) and specific growth rate (SGR, estimated as (final body weight – initial body weight)/(number of trial days) x 100) (Adeleke *et al.,* 2011).

Table 1: Formulated experimental diets with soya bean meal substituted for soya bean pomace fed to broiler roosters

Dietary ingredients (%)	Experimental Diets Percentage (%) Composition		
	Treatment A	Treatment B	Treatment C
Maize	55.00	55.00	55.00
Wheat offal	14.43	14.43	14.43
Soya bean meal	25.00	10.00	0.00
Soya bean pomace	0.00	15.00	25.00
Fish meal	2.00	2.00	2.00
Bone meal	2.50	2.50	2.50
Premix*	0.25	0.25	0.25
Oyster shell	0.50	0.50	0.50
Salt	0.25	0.25	0.25
Methionine	0.07	0.07	0.07
Lysine	0.15	0.15	0.15
Proximate composition of the experimental diets			
Moisture (%)	10.90	10.40	9.19
Crude protein (%)	17.53	18.53	17.41
Crude fat (%)	3.17	5.38	5.01
Crude fibre (%)	3.31	4.64	3.57
Total ash (%)	3.88	4.65	4.39
Carbohydrate (%)	61.21	58.10	60.47
Metabolized energy (Kcal/Kg)	3025.35	3044.85	3151.65

**Supplied per kg diet: Vit. A, 8×10^6 IU; Vit. D_3 1.2×10^6 IU; Vit. E 7×10^3 mg; Vit. 1.5×10^3 mg; Vit.B_1 2000 mg; Vit.B_2 2.5 mg; Niacin 15 g; Pantothenic acid, 5.5 g; Vit.B_6 2 g; Vit.B_{12} 10 mg; Folic acid 500 mg ; Biotin 500 mg; Choline chloride 175 g; Cobalt 200 mg; Copper 3 g; Iodine 1 g; Fe 21 g; Mn 40 g; Selenium 200 mg; Zinc 31 g*

Measurement of the Carcass Quality Characteristics: After 12 weeks of feeding, the carcass quality characteristics determined were: live weight, dressing weight, breast weight, head weight, shank weight and length, drum stick length, wing length, thighs length, neck length, liver weight, heart weight, gizzard weight, empty gizzard weight and intestinal length (Adenowo and Omoniyi, 2004).

Determination of Economic Returns on Investment: The under listed parameters were used to determine the economic returns of male broilers fed dietary inclusion of soya bean pomace in comparison with the control diet. They are: feed cost per gain (FCG), net profit return (NPR), return on investment (ROI) and salable net return (SNR). FCG is a ratio of the amount of feed fed divided by amount of weight gain or a ratio of average daily feed intake per average daily weight gain (Lokaewmanee, 2017). NPR is the profitable ratio that measures the percentage of net income to sales (Lokaewmanee, 2017). ROI measures the gain or loss generated on an investment relative to the amount of money invested. ROI is usually expressed as a percentage and is typically used for personal financial decisions, to compare the efficiency of different investments. SNR is the amount that is put up for sales minus the cost price (Nishanthini and Nimalathasan, 2013; Lokaewmanee, 2017).

Data Analysis: The data were analyzed using one-way analysis of variance (ANOVA) at $p<0.05$. Means were compared using Duncan's New Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Soya Beans: Soya bean pomace had high crude protein level (31.57 %) and high metabolizable energy (3636.15 kcal/Kg) while soya bean meal had 42.00 % crude protein level and metabolizable energy of 2492.00 Kcal/kg (Table 2).

Table 2: Proximate composition of soya bean pomace and soya bean meal use in formulation of diets for broiler roosters

Ingredient	Crude protein (%)	Crude fat (%)	Crude fibre (%)	Total ash (%)	Carbohydrate (%)	Metabolizable energy (Kcal/Kg)
Soya bean pomace	31.57	17.08	6.16	5.75	30.84	3636.15
Soya bean meal	42.00	3.50	3.50	6.00	31.35	2492.00

Soya bean pomace can be said to be a protein supplement because of its high protein content which is higher than 20 % and could be a good replacement for soya bean meal. Soya bean pomace could be a good replacement for soya bean meal (Idahor, 2013).

Experimental Diets: Isonitrogenous and isocaloric diets were formulated to balance the nutrients in the three experimental diets (Table 1). The crude protein levels were between 17.41 % and 18.53 % and the metabolizable energy was between 3025.35 kcal/kg and 3151.65 kcal/kg. Idahor (2013) reported that protein: energy ratio within the observed ranges was adequate for broilers.

Effect of Dietary Inclusion of Soya Bean Pomace on Serum Testosterone Levels: There were no significant differences (p>0.05) in the serum of levels of testosterone of birds in groups A, B and C. 25 % inclusion of soya bean pomace had highest amount of serum testosterone which was not significantly different (p>0.05) from the other treatment (Table 3).

Table 3: **Serum testosterone levels of broiler roosters fed diets having soya bean meal substituted with soya bean pomace**

Treatment	Serum testosterone level (µg/mL)
A	0.43 ± 0.03^{a}
B	0.33 ± 0.05^{a}
C	0.53 ± 0.01^{a}

Means with the same superscripts are not significantly different at p<0.05

In a similar study on the effects of replacing meat protein in the diet with a soyabean product, tofu, on blood concentrations of testosterone, dihydrotestosterone and androstane, the blood concentrations of sex hormones did not differ after the two diets, but the mean testosterone: oestradiol value was 10% higher (Habito *et al.*, 2000).

Effects Dietary Inclusion of Soya Bean Pomace on Reproductive Trait Development: There were significant differences (p<0.05) in HIS, GSI, neck length and testis size between the control group (A) and the two other groups (B and C), while there were no significant differences (p>0.05) in comb length and wattle size in all the three treatments (Table 4). There was no significant difference (p>0.05) in treatments B and C that had soya bean pomace included in them. In another study, processed soya bean meal in broilers led to significantly increased feed conversion rates and body weight gain. Increase feed conversion may be responsible for the observed reproductive trait development (Masey O'Neill *et al.*, 2018).

Effect of Dietary Inclusion of Soya Bean Pomace on the Comb and Wattle Colour: Figure 1 presents the comb colour for treatment A, B and C birds. The birds in treatment A had the darkest red colour comb and wattle. The birds in treatment B had lighter red colour comb and wattle. The birds in treatment C had the lightest red colour comb and wattle. The intensity of the colour of the comb and wattle is a reflection of blood flow to them which depends on the level of absorption of nutrients into the blood (Navara *et al.*, 2012)

Effects of Dietary Inclusion of Soya Bean Pomace on Growth Performance: There was no significant difference (p>0.05) in their final body weight but numerical differences were observed in their weight gain, daily weight gain, feed conversion ratio and specific growth rate of birds in treatments A, B and C (Table 5).

Table 4: Effects of dietary substitution of soya bean meal with soya bean pomace on the development of reproductive traits in broiler roosters

Treatment	HIS ($x10^{-4}$)	GSI ($x10^{-5}$)	Comb length (cm)
A	6.47 ± 2.10^b	4.30 ± 2.50^b	8.20 ± 1.34^a
B	5.81 ± 1.20^a	3.68 ± 0.56^a	8.00 ± 0.33^a
C	6.14 ± 0.91^a	3.39 ± 0.76^a	7.80 ± 0.34^a
	Neck length (cm)	**Wattle size (cm)**	**Testis size (cm)**
A	9.00 ± 2.10^b	4.40 ± 0.55^b	0.14 ± 0.02^b
B	8.50 ± 1.05^a	4.20 ± 0.21^{ab}	0.11 ± 0.03^a
C	8.00 ± 1.55^a	3.80 ± 0.20^a	0.10 ± 0.02^a

Means with the same superscripts are not significantly different at p<0.05, HIS = Hepatosomatic index, GSI = Gonadosomatic index

Figure 1: Photographs of roosters' combs arising from the substitution of soya bean meal for soya bean pomace in diets fed to broiler roosters

Table 5: Growth performance of male broilers fed diets with dietary substitution of soya bean meal with soya bean pomace

Treatment	Initial weight (g)	Final weight (g)	Body weight gain (g)	Daily weight gain (g)
A	610.00 ± 2.34^a	3180.00 ± 15.10^a	2570.00 ± 23.20^b	45.89 ± 5.30^b
B	630.00 ± 3.00^a	3010.00 ± 12.50^a	2380.00 ± 20.10^{ab}	42.50 ± 3.20^{ab}
C	640.00 ± 2.15^a	2800.00 ± 13.20^a	2160.00 ± 18.30^a	38.57 ± 4.30^a
	Daily feed intake (g)	**Feed conversion ratio**	**Specific growth rate (g)**	
A	107.10 ± 2.20^a	2.39 ± 0.40^a	1.27 ± 0.05^b	
B	107.10 ± 3.30^a	2.56 ± 0.60^{ab}	1.22 ± 0.03^{ab}	
C	107.10 ± 2.00^a	2.86 ± 0.03^b	1.14 ± 0.03^a	

Means with the same superscripts are not significantly different at p<0.05

This may be as a result similar protein: energy ratio in the three diets (Durosaro *et al.,* 2013; Idahor, 2013). The feed conversation ratio of birds in treatment C was higher than that of the other treatments with slight significant difference (p<0.05) from FCR of birds in treatment A. In another study on the effect of feeding differently processed soya bean on performance, protein utilization, relative organ weights, carcass traits and economics of producing broiler-chickens, feed efficiency was best in chicks fed roasted soya bean (Aletor and Olonimoyo, 1992).

Effects of Dietary Inclusion of Soya Bean Pomace on Carcass Quality Characteristics: There were no significant differences (p>0.05) in the dressing weight carcass, breast weight, shank weight, shank length, drumstick weight, drumstick length, wing weight, wing length, but there were some slight significant differences (p<0.05) in the thigh weight, thigh length and the back carcass of birds in treatments A, B and C. Inclusion of soya bean pomace did not affect the carcass qualities as there were no significant differences (p>0.05) in the dressing weight, breast weight, shank weight, shank length, drumstick weight, drumstick length, wing weight and wing length when compared with treatment A which had soya bean meal (Table 6). Payne *et al.* (2001) in their experiment on the effect of soy isoflavones (ISF) on growth and carcass traits of commercial broilers reported that the performance and carcass traits were not affected.

Effects of Dietary Inclusion of Soya Bean Pomace on Visceral Organs: There were no significant differences (p>0.05) in the liver weight, heart weight, gizzard weight, empty gizzard weight, testes weight and the intestinal length of birds in treatments A, B and C. The inclusion of soya bean pomace had no statistical significance (p>0.05) on the visceral organs (Table 7).

Table 6: Carcass quality characteristics of male broiler fed diets with dietary substitution of soya bean meal with soya bean pomace

Treatment	Dressing weight carcass (g)	Breast weight (g)	Shank weight (g)
A	3205.00 ± 22.65[c]	23.31 ± 5.22[b]	3.93 ± 0.56[a]
B	2550.00 ± 20.16[b]	26.25 ± 3.55[c]	4.80 ± 0.44[b]
C	2150.00 ± 21.62[a]	15.23 ± 4.44[a]	3.93 ± 0.35[a]
	Wing length (cm)	**Thigh weight (g)**	**Thigh length (cm)**
A	35.50 ± 6.99[c]	16.23 ± 2.50[b]	13.65 ± 3.20[b]
B	32.25 ± 5.53[b]	15.24 ± 1.70[b]	13.35 ± 3.10[b]
C	29.50 ± 5.76[a]	6.57 ± 1.20[a]	12.25 ± 3.70[a]
	Shank length (cm)	**Drumstick weight (g)**	**Drumstick length (cm)**
A	17.90 ± 0.23[a]	17.02 ± 0.23[c]	15.75 ± 1.20[a]
B	17.40 ± 0.33[a]	13.77 ± 0.32[b]	13.25 ± 2.20[a]
C	16.75 ± 0.35[a]	9.54 ± 3.14[a]	14.25 ± 2.40[a]
	Back carcass	**Wing weight (g)**	
A	21.62 ± 2.20[b]	10.91 ± 0.22[a]	
B	17.06 ± 2.40[ab]	8.84 ± 0.23[a]	
C	14.33 ± 3.80[a]	7.89 ± 0.21[a]	

Means with the same superscripts are not significantly different p<0.05

Table 7: Effects of dietary substitution of soya bean meal with soya pomace on some visceral organs weight or length of rooster broiler

Treatment	Liver weight (g)	Heart weight (g)	Gizzard weight (g)
A	2.06 ± 0.00[b]	0.47 ± 0.00[c]	2.89 ± 0.03[a]
B	1.75 ± 0.00[a]	0.41 ± 0.00[b]	2.59 ± 0.03[a]
C	1.72 ± 0.00[a]	0.31 ± 0.00[a]	2.46 ± 0.04[a]
	Empty gizzard weight (g)	**Testes weight (g)**	**Intestinal length (cm)**
A	1.86 ± 0.00[c]	0.14 ± 0.00[a]	247.50 ± 22.40[a]
B	1.72 ± 0.00[b]	0.11 ± 0.00[a]	238.50 ± 21.20[a]
C	1.46 ± 0.00[a]	0.10 ± 0.00[a]	257.00 ± 26.80[a]

Means with the same superscripts are not significantly different p<0.05

The intestinal length was longest in absolute value and this was as a result of the soya bean pomace which was richer in crude fibre. The feed tends to stay longer in the intestine than the other experimental diets which later resulted into increased length of the intestine (Farhoomand and Dadvend, 2007). In a similar study, except for the small intestine and pancreas, increasing the level of raw soya bean meal in the diets of broilers had no influence on the weight of other internal organs, including the gizzard and proventriculus liver, heart, bursa, and spleen (Erdaw *et al.*, 2017).

Economic Returns of Dietary Inclusion of Soya Bean Pomace: Birds in treatment C had the least FCG, SNR, NPR and ROI, while treatment A birds had the highest FCG, SNR, NPR and ROI. Treatment C birds fed 25 % inclusion of soya bean pomace had the least cost per weight gain, indicating that diet C would be the most economical to feed for the birds (Table 8).

Table 8: Economic returns of rooster broiler birds fed dietary substitution of soya bean meal with soya bean pomace

Treatment	FCG (₦)	SNR (₦)
A	3.93 ± 0.50[b]	29.20 ± 2.40[b]
B	3.39 ± 0.60[b]	27.05 ± 2.70[b]
C	3.01 ± 0.20[a]	24.55 ± 1.40[a]
	NPR (₦)	**ROI (₦)**
A	18.92 ± 3.40[b]	27700.00 ± 23.50[b]
B	17.55 ± 3.20[b]	24800.00 ± 24.50[b]
C	15.94 ± 2.20[a]	21600.00 ± 15.50[a]

Means with the same superscripts are not significantly different p<0.05, ₦ = Naira, FCG = feed cost per gain, SNR = salable net return, NPR = net profit return and ROI = return on investment

Treatment A birds had highest SNR, NPR and ROI because of their superior performance which was as a result of the use of conventional feed ingredients in diets formulated for birds in treatment A. Lokaewmanee (2017) had reported that the feed cost per gain (FCG) and net profits return (NPR) per bird in the birds fed mao pomace substituted diets were significantly higher than those of the control group. Furthermore, he reported that the return of investment (ROI) for birds fed mao pomace substituted diets when compared with the control group ROI was significantly lower.

Conclusion: The use of soya bean pomace is a good alternative feed ingredient to soya bean meal in case of scarcity and because of its many competitive uses. It can be concluded that inclusion of Soya bean pomace in rooster diets helps in their growth performance as well as their carcass quality characteristics. Soya bean pomace as an agro industrial waste can be used to substitute for any other source of plant protein based ingredients. Fifteen percent inclusion could be the most appropriate. It is recommended that Farm/poultry industries should start using the agro industrial waste products so as to enhance the productivity of the poultry production and as well reduce the cost of feed.

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