

# Effect of Partial Replacement of Soybean (*Glycine max*) Meal with Graded Levels of Boiled *Piliostigma reticulatum* “Kargo” Seed Meal (PRSM) on the Performance of Broiler Starter Chickens Raised Under Deep Litter System

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## Abstract

A 21-day experiment was conducted to determine the effect of partial replacement of soya bean meal (*Glycine max*) with graded levels of boiled *Piliostigma reticulatum* (Kargo) seed meal on the performance of broiler starter chickens. 250 two weeks chicks (Abore acre) were used for the study, the birds were randomly allotted to five different treatment groups and replicated five times with ten birds per replicate in a completely randomized design (CRD). The diets contained *Piliostigma reticulatum* seed meal (PRSM) as a partial replacement to soya bean meal coded as 0%, 5%, 10%, 15%, and 20% in T1, T2, T3, T4, and T5 respectively. The result indicates that *Piliostigma reticulatum* seed meal significantly ( $P < 0.05$ ) affected the performance of broiler starters. There was significant ( $P < 0.05$ ) difference in daily and total weight gains which falls between 27 - 36g/b and 271 - 402g/b. The results showed that T3 (10% inclusion level) recorded significantly higher daily (36g/b) and total weight gains (402g/b) compared to the control and other treatment groups. It was therefore concluded that *Piliostigma reticulatum* seed meal can be used as an alternative protein source to partially replace soya bean meal without adversely affecting performance.

**Keywords:** Broiler Chicken, Graded Levels, *Piliostigma reticulatum* Seed Meal, Soybean Meal.

## Introduction

The high cost of feed ingredients especially the conventional feed ingredients in monogastric nutrition has become an area of concern in poultry industry. The major conventional feed ingredients used as a source of protein (soya bean and groundnut cake) are not just expensive but also not all year round available and affordable in large quantities. Shortages of feed resources in developing countries and Nigeria in particular, has worsened by its competition with humans and growing livestock population in the tropics (Robinson and Singh 2001). The consequence of price increases in conventional feed ingredients has led to a skyrocketing price of animal products making them out of reach of the common man.

In view of the above, it is therefore important to search for and exploit alternatives feed ingredients that are locally available, affordable underutilized, and less competitive for consumption with humans. One such alternative especially non-conventional feed ingredients that can be used to supplement the diet of poultry, reduce the cost of production, and contribute to the increased supply of animal products should be exploited. *Piliostigma reticulatum* (Kargo) is one of the non-conventional feed ingredients that is less exploited as a source of protein in poultry production. Studies have shown that *Piliostigma reticulatum* is a potential alternative and replacement for some conventional feed ingredients for its ability to supply high protein (CP 30.3% undefatted) (Akin *et al.*, 2009). *Piliostigma reticulatum* is one of the non-conventional feed ingredients referred to as browse. Browse forms an important component of plants besides grasses, it is one of the cheapest sources of feed for animals in many parts of the world (Mohd *et al.* 2013). *Piliostigma reticulatum* is a leguminous medium-sized tree that grows wild in the tropics and is one of the commonest species of *Piliostigma* (Hochst) in the north part of Nigeria (Akin *et al.*, 2009) where it is locally known as “Kargo”. It produces a large quantity of pods containing seeds that are not currently utilized for poultry except for ruminant that eats the entire pod. *Piliostigma* seeds contain 20 to 34% crude protein as described by Musa and Bichi (2015). Besides all these, there was little work on the utilization of *Piliostigma* as an alternative non-conventional source of protein in the poultry diets in Nigeria.

In view of the above potentials of *Piliostigma reticulatum* seed (Kargo), the study was therefore, undertaken to determine the effect of replacing soya bean meal with *Piliostigma reticulatum* seed meal (PRSM) on the performance of broiler starter chickens.

## Materials and Methods

### Study Area

The study was conducted at the Teaching and Research Farm of Yobe State University Damaturu Nigeria, located between latitude 11.678° North and longitude 11.946° East. ([www.ysu.edu.ng](http://www.ysu.edu.ng) accessed 12/12/2022).

### Collection and Processing of *Piliostigma reticulatum* (Kargo)

*Piliostigma reticulatum* ‘Kargo’ pods were collected locally from the surroundings of Yobe State University Damaturu and the outskirts of Potiskum town in Yobe Nigeria by engaging assistants. About 130 Kg of dried seeds was obtained after removing the pod (dehusking). The seeds were ground to moderate particle size and kept in a clean container for further feed preparation. Before it was ground after pod removal, about 50 kg of the seeds were boiled for exactly 60 minutes and allowed to dry under the shed for a period of three days. This is done in order to reduce the level of phytochemical properties in *Piliostigma reticulatum* “Kargo” seeds (Osman, 2004 Jerry *et al.*, 2013). The dried ground seeds of *Piliostigma reticulatum* were later used in the preparation of the study diets.

### Experiment Design and Diets

Two hundred and fifty-two weeks old broiler chick (*Abore acre*) obtained from Valentine hatchery Ibadan Nigeria were used for the experiment. After their arrival, birds were checked for any abnormality and later administered with anti-stress supplements. After brooding they were randomly allotted to five different treatment groups and replicated five times with ten birds per replicate in a Completely Randomized Design (CRD). Diets were formulated using “Kargo” *Piliostigma reticulatum* seed meal (PRSM), five study diets were compounded containing graded levels of PRSM at 0%, 5%, 10%, 15%, and 20% for treatment 1, 2, 3, 4, and 5 respectively. The experiment lasted for the period of three weeks. The ingredient composition of broiler starter diets is presented in Table 1.

**Table 1:** Ingredient Composition (%) and Calculated Analysis of the Experimental Broiler Starter Diets

Ingrédients (%)	Diet				
	T1 (0%)	T2 (5%)	T3 (10%)	T4 (15%)	T5 (20%)
Maize	46.0	42.93	41.5	41.77	28.7
Soybeans	35.5	33.57	30.0	24.73	22.8
Wheat offal	10	10	10	10	10
Fish meal	4	4	4	4	4
P R S M	0.0	5.0	10	15	20
Bone meal	1.5	1.5	1.5	1.5	1.5
Lime stone	2.0	2.0	2.0	2.0	2.0
Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
<b>Calculated Values</b>					
Crude Protein %	23	23.5	23.5	23	23.5
ME (Kcal/kg)	2970.00	2843.43	2990.24	2973.7	2972.74
Crude Fiber %	4.0	4.0	4.0	3.9	3.9

Mineral premix/kg the following: Vit A 1500 IU; Vit D3 3000 IU; Vit E; 30 IU; Vit K, 2.5mg; Thiamine B1 3mg; Riboflavin B2 6mg; pyridoxine B6 4mg; Niacin 40mg; Vit B12 0.02mg; pantothenic acid 10mg, Folic acid 1mg; Biotin 0.08g; Chloride 0.125g; Mn 0.096g; Antioxidant 0.125g; Zn 0.06g; Fe 0.024g; Cu 0.006g; Se 0.24g; Co0.240g.

## Data Collection

Data were collected on the birds' performance. Weight gain was determined by a difference between final and initial weight, while feed intake was determined by the difference between feed offered and leftover every day. The feed conversion ratio, which is the ratio of feed intake to weight gain was calculated at the end of the experiment.

## Determination of Phytochemicals and Proximate Analysis

A Sample of *Piliostigma reticulatum* seeds was taken before boiling and another sample after 60 minutes of boiling, the two samples were moderately ground to reduce their particle size and subjected to analyses for the determination of phytochemicals using the method described by A.O.A.C. (1990). In the same vein, the study diets and test diet (*Piliostigma reticulatum* "Kargo") seed boiled and raw were subjected to proximate analyses as described by A. O. A. C, (1990) for the determination of DM, CP, CF, EE, and Ash while M.E was calculated according to Pauzenga, (1984).

## Statistical Analysis

All data generated from the study were subjected to a one-way analysis of variance ANOVA in a Completely Randomize Design according to Steel and Torrie (1980). Treatment means were separated by LSD where significant differences exist using computer software statistic 10.0 version SAS 2010.

## Results and Discussion

### Proximate Composition of Raw and Boiled *Piliostigman reticulatum* Seed

The proximate Composition of raw and boiled *Piliostigman reticulatum* seeds is presented in Table 2. The result of raw *Piliostigma reticulatum* showed that the raw seed sample had less moisture (11.13%) compared to the boiled sample (15.52%). Saulawa *et al.* (2014) reported similar results on baobab seeds. The moisture content (boiled sample 15.52%) in the present study was higher than the one (6.25%) reported by Musa and Bichi, (2015). It was observed that the boiled sample had more moisture than the raw *Piliostigma reticulatum*, this may be attributed to the processing methods that involved boiling for 60 minutes. The percentage crude protein (CP) of *Piliostigma reticulatum* ranges from 26.45 to 28.34 in boiled and raw *Piliostigma reticulatum* respectively. The result showed

the crude protein content was relatively low compared to the result reported by Musa and Bichi (2015). The CP of raw *Piliostigma* was also higher than the CP of raw sunflower seeds (27.02) as reported by Adesina, 2018 and in agreement with 28.53% CP in pumpkin seed meal as reported by Wafar *et al.*, (2017). The boiled *Piliostigma* seed with a CP of 26.45% was in line with the report of Akinmutimi and Okwo (2006) which reported a CP of 21.8% in cooked *Mucuna utilis*. In addition, Auta and Anwa (2007) reported a criterion for a feed ingredient to be regarded as a potential protein source that, its crude protein level must exceed 20% which was in line with the present study and implies that *Piliostigman reticulatum* seed is a potential alternative source of protein in the diets of poultry.

The relatively low CP of (boiled) *Piliostigma reticulatum* could be associated with losses of soluble solids such as hydrolyzed carbohydrates and soluble lipids because of leaching during boiling as thermal treatment has been reported to distort the chemical structure of protein in feed ingredients (Adesina, 2018). Only Soybeans products appear to relatively resist heat treatment (NRC, 1994).

The percentage of crude fiber (CF) content in this study was higher in the raw *Piliostigman reticulatum* seed (30.3) while boiled *Piliostigman reticulatum* seed recorded the lowest (25.98). The CF reported in the present study was higher than the CF of both raw and processed *Piliostigman reticulatum* seed as reported by Musa and Bichi (2015). This may be due to the differences in the variety and location of the study. The result was relatively the same with CF of raw sunflower meal of (26.35) Adesina, (2018) and Pumpkin meal (21.58) as reported by Wafar *et al.*, (2017).

The reduction in CF of raw compared to boiled may be due to the processing (boiling) which results in the removal of some water-soluble oligosaccharides such as raffinose families and the indigestible carbohydrate during boiling processes (Gashaw, 2010).

The gross energy (ME Kcal/Kg) of both raw and boiled *Pliostigma reticulatum* seeds proved to have appreciating values of 3055.74 and 2848.2 Kcal/Kg and this was in agreement with the report of NRC (1994) of 3000 to 3200 Kcal/Kg. the result may be appropriately compared with other seed meals; boiled *Jatropha curcas* seed meal (3120.66 Kcal/Kg) Antyve *et al.* (2017), and sunflower seed meal (2622 Kcal/Kg) reported by Sayda *et al.*, (2011). This may prove the potentiality of the seed as a protein supplement. The above proximate composition was slightly different from the result of Musa and Bichi (2015) and that may be from various factors ranging from geographical location, species difference, and processing methods (Ojewola *et al.*, 2005). Micro and macro environment factors may be responsible for the variation observed.

**Table 2:** Proximate composition of raw and boiled *Piliostigma reticulatum* seeds

Constituents (%)	Raw <i>Piliostigma</i> Seeds	Boiled <i>Piliostigma</i> Seeds
Moisture	11.13	15.52
DM	88.87	84.48
CP	28.34	26.45
EE	3.38	1.81
ASH	12.51	9.27
CF	30.3	25.98
NFE	26.85	30.24
ME Kcal/Kg	3055.74	2848.23

### Determination of Anti-nutritional Factors in *Piliostigman reticulatum* Seed

Lower feed intake in poultry may be attributed to many factors, one of such could be an increase in the level of residual anti-nutritional factors such as saponin, oxalate, phytate, and tannins (Jerry *et al.* 2013). Table 3 revealed some anti-nutritional factors found in *Piliostigma reticulatum* seed before and after processing (raw and boiled). *Piliostigma* seeds were established to contain some anti-nutritional factors. The levels, however, are generally below established toxic levels for most poultry species (Nkafamiya *et al.*, 2007). However, in the present study, as a result of processing (boiling), there was a general reduction in the quantity from (raw to boiled) saponin 0.28 – 0.18, oxalate 0.06 – 0.02, phytate 0.32 – 0.23, and tannin 0.01 – 0.0 (not detected). The present study confirms the report of early studies that reported, a wet heat treatment reduces anti-nutritional factors especially liable anti-nutrients (Udedibie and Carilini 1998, Ewa, 1999, Akinmutuni, 2004 Alexander Zerbo *et al.*, 2010). Duwa *et al.*, 2010 reported a similar finding when they subjected sorrel seed to different processing methods and observed a reduction

in trypsin inhibitors. Though all phytochemicals tested in this study showed a reduction in quantity, however, the processing method (boiling) employed did not completely remove the tested anti-nutritional factors but was observed to be within the recommended threshold. The result agreed with the findings of Obun *et al.* (2008) and Antyev *et al.*, (2017).

**Table 3:** Anti-nutritional factors of raw and boiled *Piliostigma reticulatum* seeds

Anti-nutritional (mg/100)	Concentration	Raw <i>Piliostigma</i> seed	Boiled <i>Piliostigma</i> seed
Saponin	+	0.28	0.18
Oxalate	+	0.06	0.02
Phytate	+	0.32	0.23
Tannins	+	0.01	ND

+ = Moderate Concentration; ND = Not Detected

## Experimental Starter Diet

The experimental diets were formulated and compounded according to the requirement of broiler starter birds NRC 1994. *Piliostigma reticulatum* seed meal (PRSM) was added at graded levels to partially replace soya bean meal at 0, 5, 10, 15, and 20% for treatment T1, T2, T3, T4, and T5 respectively. Five samples were analyzed according to AOAC 2000 and shown in Table 4. The values obtained in the present study were not in agreement with the report of Akinmutini and Okwu (2006) who substituted cooked *Mucuna utilis* for Soya bean meal. However, the result showed that the CP recorded in all the diets are within the recommended values as 22 to 24 by NRC 1994. Though there were slight variations in the numerical mean values of CP among the five experimental diets, this was expected as the diets were not formulated to be iso-nitrogenous but, adequate for normal growth in broiler starter birds. The CF values recorded in the study range from 7.2 to 8.2% thus, slightly higher than the recommended rate of 5 to 7% reported by NRC 1994. The CF reported in the present study was not in agreement with the report of Wafar *et al.* (2017) who reported between 5.12 to 6.37% in a diet supplemented with Pumpkin (*Cucurbita pepo* L.) seed meal in broiler starter. With these values feed intake was not significantly affected. The metabolisable energy (ME) recorded in the present study ranges from 2298 to 2905 Kcal/Kg it is an appreciable energy value and also within the recommended value of 2800 to 3000Kcal/Kg reported by Aduku 1992 for broiler starter birds. It was also slightly different from the recommendation of NRC 1994 of 3200Kcal/Kg but, in agreement with the report of Akinmutuni and Okwo (2006) and Wafar *et al.* (2017) that reported energy values between 2852 – 2897Kcal/Kg and 2710 – 2760Kcal/Kg in broiler starter diets compounded with cooked *Mucuna utilis* seed meal and pumpkin seed meal respectively.

**Table 4:** Proximate Composition of Broiler Starter Diets (23% CP)

Constituents (%)	Diet				
	T1 (0%)	T2 (5%)	T3 (10%)	T4 (15%)	T5 (20%)
Moisture	8.87	9.48	9.64	9.32	9.62
DM	91.13	90.52	90.36	90.68	90.38
CP	25.42	25.0	26.59	24.36	20.9
EE	17.48	16.36	16.13	22.01	17.53
ASH	7.74	8.25	10.34	10.42	8.75
CF	7.25	7.72	8.44	8.24	7.91
NFE	40.98	41.45	39.2	36.07	44.05
ME Kcal/Kg	2783.45	2735.1	2905.18	2682.54	2298.01

## Performance of Broiler Starter Chickens

The effects of feeding graded levels of PRSM on the performance of broiler starters are presented in Table 5. The results obtained showed a non-significant difference ( $P > 0.05$ ) in some of the parameters recorded except in initial weight, final weight, daily weight gain, and total weight gain which were significantly ( $P < 0.05$ ) different. For the initial weight, it was observed that treatment four (T4) 15% inclusion recorded a higher mean value (360 g) and significantly ( $P < 0.05$ ) different when compared to control. In the same vein, there were significant ( $P < 0.05$ ) differences among treatments in final weight and T3 (10% inclusion level) recorded the highest (736.40g) mean value and better performance when compared to other treatment groups (647.40, 655.0, 631.60 and 667.0 in T1, T2,

T4, and T5 respectively). Furthermore, daily weight gain ranges from 27 to 36g/bird, the daily weight gain recorded in the present study was significant ( $P < 0.05$ ) and different across treatments. T3 (10% inclusion) recorded the highest weight gain (36g/b) and was significantly ( $P < 0.05$ ) different when compared to the control and other treatment groups. This was in agreement with the report of Akinmutini and Okwo (2006) who reported a significant ( $P < 0.05$ ) difference in daily weight gain when birds are fed with graded levels of cooked *Mucuna utilis* seed meal. There was no definite pattern across treatment groups but, the numerically similar values across the dietary treatments and the control may therefore be regarded as the confirmation of adequate utilization of feed offered to the broilers across treatment and thus met their physiological requirement. The result of total weight gain at the end of the experiment was also significantly ( $P < 0.05$ ) affected by the partial replacement of PRSM. The values range from 271 to 402g/b with T3 (10% inclusion) recording the highest value (402g/b) and significantly ( $P < 0.05$ ) different when compared to the control and other treatment groups. This may indicate efficient utilization in 10% inclusion level of PRSM.

However, daily feed intake, feed conversion ratio (FCR), and mortality did not differ significantly ( $P > 0.05$ ). Daily feed intake was from (58.1 to 59.6 g), while the feed conversion ratio was between 1.7 and 2.0. The mean values obtained for feed intake were numerically similar but, treatment five (T5) recorded the highest mean value when compared to the control and other treatment groups even though, it was not significant. The uniformity in feed intake may indicate the palatability of the feed. The partial replacement of the soya bean meal with *Piliostigma reticulatum* seed meal did not alter the palatability of the diets. In addition, the boiling of *Piliostigma* seeds may have helped to alleviate the problem of reduced feed intake associated with feeding non-conventional feed ingredients. Furthermore, the result showed that replacing soya beans with graded levels of PRSM up to 20% has no significant ( $P > 0.05$ ) effect on daily feed intake, and feed conversion ratio. Jerry et al. (2013) and Macisaac et al. (2005) reported a similar trend in terms of feed consumption, weight gain, and FCR in broilers fed full-fat soya bean meal. This could be attributed to the balance in nutrient composition and proper metabolism associated with the *Piliostigma reticulatum* seed meal. Wafar and Tarimbuka (2016) reported that imbalances in nutrient composition and improper metabolism of diet are some of the factors affecting muscle development and growth among animals. The control group compared favorably with other treatment groups; this may indicate an efficient utilization of *Piliostigma reticulatum* seed meal as compared to soybean meal. It may also indicate the metabolism requirement of the birds could have been made. A similar study did not observe a performance effect on chicks fed dietary cottonseed meal Gamboa et al. (2001).

FCR did not differ ( $P > 0.05$ ) significantly among treatment groups. The values recorded are within the range of 2.1 – 5.1 reported by Oluyemi and Robert (2000) for broilers in tropical environments. Better FCR was observed in all the treatments, especially T3 (1.7) 10% inclusion level. This could be attributed to proper digestion, absorption, and utilization of nutrients.

Result from the study showed that, no mortality was recorded throughout the experimental period. This may indicate that birds were sourced from a reputable hatchery, and managed adequately well, and also may be due to the suitability of PRSM as a replacement for Soybean meal.

**Table 5:** Performance of Broiler Starter fed *Piliostigma reticulatum* Seed Meal (PRSM) as Replacement for Soybean

Levels of Inclusion Parameters	T1 (0%)	T2 (5%)	T3 (10%)	T4 (15%)	T5 (20%)	SEM
Initial body weight (g)	326.02 <sup>b</sup>	326.02 <sup>b</sup>	354.00 <sup>ab</sup>	360.00 <sup>a</sup>	344.40 <sup>ab</sup>	10.317*
Final weight (g)	647.40 <sup>bc</sup>	647.40 <sup>bc</sup>	756.40 <sup>a</sup>	631.60 <sup>c</sup>	667.00 <sup>b</sup>	11.308*
TFI (g)	1222.9	1222.9	1215.4	1251.6	1246.0	21.347 <sup>NS</sup>
TWG (g)	319.78 <sup>b</sup>	319.78 <sup>b</sup>	402.40 <sup>a</sup>	271.60 <sup>c</sup>	322.60 <sup>b</sup>	13.846*
Daily feed intake (g)	58.240	58.240	57.860	59.620	58.880	1.1118 <sup>NS</sup>
Daily weight gain (g)	28.886 <sup>b</sup>	28.886 <sup>b</sup>	36.780 <sup>a</sup>	27.880 <sup>b</sup>	30.740 <sup>b</sup>	1.1845*
FCR	2.0800	2.0800	1.7600	2.2200	2.0800	0.0888 <sup>NS</sup>
Mortality (Number)	0	0	0	0	0	-

Means on the same row with different superscripts are significantly different\* = ( $P < 0.05$ ) SEM – Standard Error of Mean, NS=Not Significant

## Conclusion

It can therefore be concluded, as indicated by the results of the study, that boiled *Piliostigma reticulatum* seed meal can be used as an alternative non-conventional protein source which can partially replace the conventional protein source of soybean in broiler starter chickens. It can be used up to 20% inclusion level without adversely affecting the performance. Even though, the 10% inclusion level proved to be the most suitable and best in supporting performance.

However, further studies are recommended to determine the suitability for the complete replacement of soybean meal with *Piliostigma reticulatum* seed meal employing different processing methods.

## Contribution by Authors

Equal contribution

## Conflict of Interests

There is no conflict of interest.

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