



## **Effects and Economics of Processed Tallow (*Detarium microcarpum*, Guill and Sperr) Seed Meal Substituted with Soybean in Broiler Chickens Diet**

**C. O. Obun<sup>1\*</sup>, B. C. Lalabe<sup>1</sup>, P. A. Shinggu<sup>1</sup>, Y. Tor-Agbidye<sup>1</sup> and A. T. Junaidu<sup>1</sup>**

<sup>1</sup>*Department of Animal Production and Health, Faculty of Agriculture and Life Sciences, Federal University, Wukari, P.M.B. 1020, Taraba State, Nigeria.*

### **Authors' contributions**

*All authors contributed in their field of skill. Author COO designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors BCL and ATJ formulated the feed and coordinated data collection. Author YTA managed the analyses of the study. All authors read and approved the final manuscript.*

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### **ABSTRACT**

A feeding experiment was conducted to investigate the effect of soaked-toasted tallow seed meal (STTSM) as replacement for soybean on broiler growth performance, nutrient digestibility, carcass and primal cuts weights and feed cost benefits. The experimental layout was a completely randomized design with three treatments replicated three times. Three hundred and sixty one-day-old Amo broiler chicks were randomly allocated to the three dietary treatments; each treatment had one hundred and twenty (120) chicks and forty chicks per replicate were fed for 56 days. Dietary soybean was replaced by STTSM at 0, 10 and 20% on protein to protein basis. Results of the

\*Corresponding author: E-mail: [obunotu@yahoo.com](mailto:obunotu@yahoo.com);

performance revealed superior ( $P<0.05$ ) final weight, weight gain, total feed intake and feed conversion ratio of birds on 0% STTSM diet compared with those on STTSM based-diets. The daily weight gain and daily feed intake were not significantly ( $P>0.05$ ) different among the treatment groups. The apparent digestibility coefficient (ADC) of dry matter, nitrogen, crude protein, crude fiber, ash, fat, Ca and P were not significantly affected across the treatments. The pre-slaughtered, percentage carcass weights and cut-parts of birds on 0% STTSM diet were significantly ( $P<0.05$ ) superior compared with birds on 10 and 20% STTSM diets. The economic analysis showed that 20% STTSM diet was cheapest ( $P<0.05$ ) to produce 1 kg broiler meat at ₦437.29/kg compared with those on 10% (₦458.8/kg) and 0% (₦476.33/kg) STTSM diets. It is concluded that chicks fed STTSM based-diets depressed growth performance, percentage carcass and cut parts weight but with no adverse effects on ADC. Based on similarity in ADC and lower cost of producing per Kg of feed, feed cost savings (%) and meat produced per Kg. STTSM in diet shows good prospect as an alternative cheap feed substitute for soybean meals and therefore up to 20% level of inclusion in broiler chicks diets is recommended.

**Keywords:** Apparent digestibility coefficient; broiler chicks; Carcass and primal cuts; growth performance; soaked-toasted treatment; tallow seeds.

## 1. INTRODUCTION

Poultry industry is one of the most commercialized sub-sectors of Nigeria Agriculture. Broiler chicken production is among one of the fastest means of producing animal protein because of their short generation interval and quick returns to investment. However, the cost of production of broiler meat has remained high due to high cost of feed. The high cost, scarcity and competition for conventional plant protein ingredients (ground nut cake and Soybean) have necessitated the need for a search for alternative source of protein for the poultry industry [1]. The search for the least-cost formulation is currently exploring the replacement of these expensive feed raw materials with cheaper alternatives in the formulation of poultry ration. [2,3,4] suggested that the alternative plant protein should have comparative nutritive value to or preferably be cheaper than the conventional protein sources. The use of unconventional feed ingredients as alternative in our environment in compounding poultry feed in order to reduce cost of production, cost of meat and animal products is well documented in literature [5,6]. *Detarium microcarpum* tree, a common ornamental plant in the savanna zone of Nigeria known as "Tallow tree or sweet dattock", presently has no human dietary or commercial demand but rather cut down for fuel wood and charcoal production for household use. *Detarium* seeds have been reported to contain anti nutritional factors such as hydrogen cyanide, phytate, tannins, oxalate and saponins [3,7]. Anti-nutritional factors (ANFs) are those substances generated in natural feedstuffs by the normal metabolism of species and by

different mechanisms such as inactivation of some nutrients, interference with the digestive process or metabolic utilization of feed which exert effects contrary to optimum nutrition [8]. These ANFs limit the use of raw *Detarium* seeds in poultry feed although various processing techniques tend to reduce the anti nutritional factors content of the seed. However, most of these toxins are reduced to tolerable levels by simple preparative procedures such as fermentation, germination, roasting, enzyme, soaking in warm water and thorough cooking which usually require high fuel input and prolonged heating [3,9].

Previous studies [3,4,6,10] with broilers fed raw, soaked in water, cooked for 40 minutes and toasting for 25 minutes treatments of *Detarium* seed meals have not yielded satisfactory results. However, these treatments application depressed growth performance, feed intake and feed conversion ratio at 5-20% dietary inclusion levels. The methods of processing the seeds against these anti nutritional factors have been a major challenge to most poultry farmers [11]. It is against this background this research work attempt to evaluate local processing methods of soaked-toasted Tallow seed meal (STTSM) on growth performance, nutrient digestibility, carcass and primal cuts weights and cost of production of broiler chickens.

## 2. MATERIALS AND METHODS

The study was carried out at Aga Livestock Farm Ltd, a commercial farm with standard building for Teaching and Research in Wukari Metropolis,

Taraba State, Nigeria. Wukari is located between Latitude 7°51'N, 9°47'E and Longitude 7°85'N, 9°78'E [12].

Dry Tallow fruits were collected from Wukari and its environs in Taraba State. The fruits were cracked open mechanically to remove the seeds. The raw seeds were cleaned of dirt, soaked in water at room temperature for 24 h, drained, rinsed with fresh water and air dried for three days. The dried seeds were poured into a frying pan mixed with sand in ratio 2:1 under control open fire. Turning was constantly made (to avoid the seeds burning off) until the white endosperm seed turns crispy brown in colour after 30-35 min. The roasted seeds were decorticated and then ground to form soaked-toasted Tallow seed meal (STTSM).

A total of 360 day-old unsexed broiler chicks (Amo) were purchased from a reputable

Hatchery in Ibadan, Oyo State, Nigeria for this study, birds were weighed and randomly assigned to three treatments. Each treatment had three replicates and contained 40 birds each under a completely randomized design. Three diets were formulated to contain soaked-toasted Tallow seed meal (STTSM) at 0, 10 and 20% (starter and finisher phases), respectively replacing soybean in the diets (Table 1). The diets were formulated according to requirements standard recommended by Olomu [13]. The brooder house was thoroughly cleaned, washed, disinfected, allowed to rest for a week before the arrival of chicks and artificial light provided to encourage the birds to eat in the night. Feed and water were provided *ad libitum*. All management procedures recommended for broiler chicks by Olomu [13] were strictly adhered to. The cost per kilogram weight gain was determined based on the feedstuff cost as at the time this research was carried out.

**Table 1. Gross composition of experimental starter and finisher broiler chicks' diets**

Ingredients	% Dietary starter phase			% Dietary finisher phase		
	0%	10%	20%	0%	10%	20%
Maize	51.00	51.00	51.00	52.00	52.00	52.00
Maize bran	10.00	10.00	10.00	15.00	15.00	15.00
Soybean (Fullfat)	30.00	20.00	10.00	25.00	15.00	5.00
STTSM	0.00	10.00	20.00	0.00	10.00	20.00
Fish meal (71%CP)	3.00	3.00	3.00	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00
Lime stone	2.00	2.00	2.00	1.00	1.00	1.00
Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>
<b>Calculated composition (% DM)</b>						
Crude protein	22.89	22.76	22.60	20.40	20.32	20.12
Crude fiber	4.20	4.40	4.70	5.00	4.63	4.60
ME (kcal/kg)	2876.00	2840.60	2832.31	2872.00	2860.00	2854.20
Lysine	1.09	1.07	0.98	1.01	0.93	0.84
Methionine	0.34	0.36	0.38	0.32	0.35	0.36
<b>Analyzed chemical composition (% DM)</b>						
Crude protein	22.00	21.81	21.72	20.13	19.85	19.60
Crude fibre	4.58	4.00	4.20	4.63	4.80	4.94
Fat	4.70	4.56	4.30	4.43	4.36	4.20
Ash	3.41	3.30	3.50	3.32	3.60	3.61
Ca	1.76	1.70	1.68	1.36	1.40	1.42
p	0.60	0.62	0.60	0.60	0.62	0.61

\* To provide the following per Kg of feed: vit-A 100000 IU; vit. D<sub>3</sub>2000 iu; vit. B<sub>1</sub>0.75 mg; nicotinic acid-25 mg; Ca, panthothenate- 12.50 mg; vit.B<sub>12</sub>2.5 mg; vit. K-2.5 mg; vitE-25 mg; Cobalt 0.4 mg Biotin-0.50 mg; Folic acid- 1 mg; Cholin chloride-25 mg; Cu-8.00 mg; Mg-64 mg; Fe-32 mg; Zn 4 mg; Iodine-0.80 mg; Flavomyacin-100 mg; Sapiromycin-5 mg; DL-methionine-50 mg; Selenium- 0.16 mg; 1-lysine 120 mg.  
STTSM: Soaked-toasted Tallow seed meal

The bird's initial weights were recorded at arrival before distribution to pens, and thereafter on weekly basis. Feed served and intake was recorded weekly from which average daily weight gain and feed intake was computed for 56 days. Feed conversion ratio (FCR) was calculated as the ratio of feed intake to weight gain.

On day 56, three birds per replicate whose body weights were closest to the mean of the group were selected and placed in metabolic cages with facilities for individual feeding, watering and collection of droppings for two days adaptation period, followed by 12 hr fasting and four days total collections of droppings. The droppings were collected for 3 days, and sprayed with 1% boric acid to reduce bacterial decomposition of protein. Samples for each bird were bulked, wrapped in aluminium foil and oven dried at 85°C for 24 hr. Representative faecal samples were used for dry matter determination. Apparent nutrient digestibility was calculated using the formula below.

$$\text{Apparent Digestibility Coefficient} = (\text{Nutrient intake} - \text{Nutrient in Excreta} \times 100) / \text{Nutrient intake}$$

At the end of the eight week, five birds were randomly selected per treatment; fasted overnight to reduce their gut contents, weighed and slaughtered manually; birds were scalded using boiled water. The carcass weight, dress weight and weight of the primal cut parts were recorded. The dressed weight and dressing percentage (carcass yield) were computed while Cut-up parts were all weighed and expressed in grammes.

The proximate compositions of dry matter, crude protein, crude fat, crude fibre, ash and Ca and P in the diets and faecal samples were determined according to the Standard Official Methods of Analysis (AOAC) [14] methods.

All data collected were tabulated and subjected to one-way analysis of variance (ANOVA) using the completely randomized design described by Steel and Torrie [15]. Means, where significant were separated by use of the Duncan Multiple Range Test [16].

### 3. RESULTS AND DISCUSSION

The replacement of STTSM in the diets resulted in the decrease in crude protein and ether extract contents (22-18.6 and 6.43-4.25%). Similarly,

there was a corresponding increase in the ash, crude fiber and decrease in energy concentrations with increase in STTSM inclusion levels in the diets (Table 1).

The performance characteristics and nutrient utilization by experimental birds, expressed as means from duplicate pen observations are shown in Table 2. The final live weight and weight gain ranges between 1866.67-1633.33 g and 1827.47-1594 g, respectively. There was a significant difference ( $P < 0.05$ ) among the treatment in terms of final live weight and body weight gain. Also, final and weight gain of broilers fed 10% STTSM based diets were significantly different ( $P < 0.05$ ) from those fed 20% STTSM based diets.

The feed intake of broilers fed STTSM is presented in Table 2. Total feed intake of birds fed 0% STTSM diet was significant lower ( $P < 0.05$ ) compared with those on STTSM based-diets. The total feed intake of birds on 10 and 20% STTSM diet was not statistically ( $P > 0.05$ ) different. Daily feed intake decreased with increased inclusion level of STTSM in the ration. However, no significant difference ( $P > 0.05$ ) was observed among the groups in average daily feed intake. The feed conversion values were best ( $P < 0.05$ ) at 0% STTSM inclusion level (2.39) compared with those on 10% (2.71) and 20% STTSM (2.78) diets, respectively, which was statistically non-significant ( $P > 0.05$ ) between them. The economic analysis of birds fed the experimental diets is presented in Table 2. Dietary inclusion of STTSM reduced cost of producing one kilogram of feed and this reflected in the feed cost savings (%) and feed cost per weight gain (₦/Kg) values were consistent with the dietary levels of STTSM diets.

The Apparent Digestibility Coefficient (ADC) of crude protein, crude fiber, ether extract, ash, nitrogen free extract and N-retention were not significantly different ( $p > 0.05$ ) among the diets. The highest ADC was on birds fed 0% STTSM diet while birds on diet 20% STTSM diet had the least ADC values for all parameters measured Table 3.

Table 4 shows the average pre-slaughtered weight, carcass weight, dressing percentage and primal cut parts of broilers fed different levels of STTSM diets. The inclusion of STTSM based-diets did not significantly ( $P > 0.05$ ) affects the dressed percentage, neck, shank and head across the dietary birds. There was significant

difference ( $P<0.05$ ) in pre-slaughtered weights, carcass yield, thigh, breast, wing and back cuts among the dietary treatments.

### 3.1 Discussion

The proximate analysis and calculated lysine and methionine of the diets are in line with recommended crude protein value ranges of 18-23% lysine values of 1.1-0.80 and methionine

values of 0.33-0.04% for starter chicks and finisher broilers by [17]. The significant better performance of birds on 0% STTSM diet could also probably be attributed to higher CP, EE, ME and lower CF in this diet compared to those formulated on graded levels of 10 and 20% STTSM based-diets. In this study, the mean final body weight varied from 1.63-1.87 kg, which was evidently slightly higher than the recommended live weights of 1.6-1.8 kg for broiler finisher

**Table 2. Performance and economic analysis of birds fed experimental diets**

Parameters	0% STTSM	10% STTSM	20% STTSM	SEM
Mean Initial body weight (g)	39.20	39.10	39.33	0.20
Average final body weight (g)	1866.67 <sup>a</sup>	1683.33 <sup>b</sup>	1633.33 <sup>c</sup>	24.00
Average body weight gain(g)	1827.47 <sup>a</sup>	1644.30 <sup>b</sup>	1594.00 <sup>c</sup>	22.24
Average daily body weight gain (g)	32.60	29.36	28.47	1.11
Mean total feed intake (g)	4358.00 <sup>a</sup>	4451.90 <sup>b</sup>	4430.30 <sup>b</sup>	3.40
Mean daily feed intake (g)	77.82	79.50	79.11	0.76
Feed conversion ratio	2.39 <sup>a</sup>	2.71 <sup>b</sup>	2.78 <sup>c</sup>	0.03
Feed cost (₦/Kg diet)	199.3 <sup>a</sup>	169.30 <sup>b</sup>	157.30 <sup>c</sup>	2.06
Feed cost (₦/Kg) meat produced	476.33 <sup>a</sup>	458.80 <sup>b</sup>	437.29 <sup>c</sup>	6.02
Feed cost savings (%)	-	15.05	21.07	-

*Mean within the same row bearing different superscripts differ significantly ( $P<0.05$ )*

**Table 3. Apparent nutrient digestibility coefficient of finisher broiler chickens fed soaked-toasted tallow seed meal diets (%)**

Parameters	0% STTSM	10% STTSM	20% STTSM	SEM
Dry matter	86.43	87.57	87.57	0.63
Crude protein	80.80	77.40	76.77	0.76
Crude fiber	70.00	62.43	62.23	1.95
Ash	79.93	78.67	78.77	0.70
Ether extract	73.77	78.30	71.70	2.74
Nitrogen Free Extract	71.67	70.50	68.80	1.78
N-retention	80.17	77.60	76.07	2.06
Ca	79.37	78.97	76.10	1.02
P	72.77	70.83	69.80	0.98

**Table 4. Average pre-slaughtered weight, Carcass weight, dressing percentage and primal cuts of broilers fed different level of Tallow seed meal**

Parameters	0% STTSM	10% STTSM	20% STTSM	SEM
Pre-slaughtered weight (g)	1860.00 <sup>a</sup>	1680.10 <sup>b</sup>	1640.30 <sup>c</sup>	11.00
Carcass weight (g)	1451.33 <sup>a</sup>	1311.33 <sup>b</sup>	1252.33 <sup>c</sup>	7.21
Dressed, %	78.03	77.43	76.35	1.95
Thigh (g)	400.09 <sup>a</sup>	357.36 <sup>b</sup>	348.73 <sup>b</sup>	2.67
Breast (g)	306.34 <sup>a</sup>	285.28 <sup>b</sup>	262.61 <sup>c</sup>	1.19
Wing (g)	314.54 <sup>a</sup>	260.08 <sup>b</sup>	252.22 <sup>c</sup>	3.02
Back (g)	270.63 <sup>a</sup>	260.75 <sup>ab</sup>	256.06 <sup>b</sup>	3.70
Neck (g)	70.68	67.37	59.87	0.50
Head (g)	47.06	45.36	39.04	0.36
Shank(g)	47.62	35.28	33.95	1.08

*Mean within the same row bearing different superscripts differ significantly ( $P<0.05$ )*

in the tropics [17]. The better growth performance of birds on soybean based-diet might be due to high feed acceptability and nutrient intake [18] resulting from diet with low fiber and less bulkiness than dietary 10 and 20% STTSM in inclusion levels. Similar findings were also reported by Akinmutimi et al. [19] for sword bean (*Canavalia gladiata*) and Obun et al. [10] for *Detarium microcarpum* seed meal in broilers. The value for daily weight gain (29-33 g/bird) obtained in this study is higher than the values (26-30.5 g/bird/day) reported by Obun et al. [3], respectively. The depression in growth rate, which resulted in inferior FCR among the birds on 10 and 20% STTSM diets, suggest poor utilization of these diets probably due to residual anti nutrients in the treated seeds which presence could not be ruled out completely. Reports from past researchers have also shown that higher inclusion levels of unconventional feedstuff may alter the texture, color, taste and odor of diets [20] due to mallard reactions. Feed consumption and ultimately utilization might be affected by each of the above factors independently or in combination [20,21]. The significantly lower feed intake in birds fed 0% STTSM diets compared to those on 10 and 20% STTSM diets could be attributed to high fat and gross energy (5.52 Kcal/kg content in full fat soybean meal [22] than *Detarium* seed meal (3.70 Kcal/kg) [3].

Adewusi and Matthew [23] reported that increase in dietary fiber content in monogastric diets resulted in a corresponding decrease in conversion rate and nutrient digestibility. The dietary analysis however, showed that the STTSM based-diets had more crude fiber and reduces energy content. These results are in agreement with [24,25,26] who reported that birds consume feed to primarily meet their energy requirement. This is also consistent with [23,24] who suggested that as dietary energy increases; birds satisfy their energy needs by decreasing feed intake. Decreased in feed intake with high energy in diets was supported by Lesson [24] who showed that feed intake decreases linearly as dietary energy increases.

Also the numerical increase in average daily feed intake may be in part, due to the relative decrease in energy level of the diet. It also corroborates the scientific evidence that birds eat to satisfy their energy requirement [27]. The results of the present study are in line with the findings of Obun et al. [3,4,10], who found significant differences in feed intake among the

groups fed diets containing raw and processed *Detarium* (soaked, boiled, and toasted) seed meal. The reduction in feed consumption and growth performance in STTSM based dietary birds may also be in partly attributed to residual effects of anti nutritional factors in the seed meal which could have exerted negatively on growth performance.

The decreased in FCR with increased inclusion level of STTSM could probably be as a result of reduced body weight gain due to decreased nutrient digestibility of birds fed STTSM-based diets. These results agree with previous reports [3,4] who observed poor FCR of broiler chicks with depression in growth rates when fed diet containing raw and toasted *Detarium* seed meal at inclusion levels of 10, 15 and 20% respectively. The FCR obtained in the present study were higher than the values obtained from other studies under the tropical environmental conditions [3,28]. FCR is a good indicator of how well livestock utilize feed intake for weight gain.

Dietary inclusion of STTSM at 10 and 20% levels reduced feed cost/kg which was also reflected in the feed cost savings and meat produced. The lower feed cost/kg and meat produced on the STTSM based-diets suggest that the feed ingredient is economically viable alternative feed materials. The observed significant decrease ( $P < 0.05$ ) in the cost per Kg of feed and meat produced ( $\text{₦}/\text{kg}$ ) as the level of inclusion of STTSM increases in diet in this study confirms earlier reports [5,6,29] that alternative ingredients reduced the cost of poultry production.

The non significant difference ( $P > 0.05$ ) in nutrient digestibility of dry matter, crude protein, crude fibre, ash, ether extract and nitrogen free extract alongside Ca and P across the treatments confirms the efficacy of the soaked-toasted methods on the nutrient value of *Detarium* seeds. The digestibility values obtained in the present study were however lower than 71.41% Nitrogen retention and higher (68%) for crude protein retention previously reported [4,30] when fed broilers raw and toasted tallow seed meal in their separate studies. The decreasing trend of digestibility in STTSM included groups might be due to high CF contents in the diets.

Bonnet et al. [31] reported that a reduction in feed digestibility might contribute to a decrease

in the amount of nutrients available for growth performance. The superior growth performance of experimental soybean based-diets (0%STTSM), suggest that soybean meal is superior to Tallow seed meal.

The reduced carcass yield by birds fed 10 and 20% STTSM diets could be due to decreased in final body weight. The decreased primal cuts (thigh, breast, wing, back, shank, head and neck) yield of birds on 10 and 20% STTSM based-diet compared with those on 0% STTSM diets may have resulted from their small live weight. Breast muscle is one of the main determinants of carcass yield [32] and the breast muscle was better on soybean based-diet (0%) ( $P < 0.05$ ) than the STTSM based diets and this support the earlier assertion of Obun et al. [3] that toasting alone is not a proper method of processing *Detarium* seeds.

The result is in agreement with the finding of Broadbent et al. [33] that surface area and weight determine the amount of feathers and visceral required. The dressing percentage values ranged between 76% and 78% obtained from this study were higher than 65.70 and 70.77%, respectively, reported [34,35] as the ideal dressing percentages for well finished broilers. The results of this study indicate that the diets used were adequate for the birds. The breast and abdominal fat components of finished broilers are very important in assessing quality. Broilers with better developed breast meat are considered superior while heavy deposit of abdominal fat in finished broilers indicates poor finishing. Since carcass yield is an indication of the quality and utilization of the ration [35], it would seem that birds on the 10 and 20% STTSM diets poorly utilized their feed as evidenced by their lower dressed weight, carcass, breast muscle and drum stick.

#### 4. CONCLUSION

It was concluded from this study that STTSM in broiler diets reduced growth performance and carcass and primal cuts weights but without affecting nutrient digestibility. Dietary inclusion of STTSM in diets reduced the cost of feed/kg, feed cost savings and meat produced (N/kg). Based on economics effectiveness of STTSM usage at 20% in broiler diet, 20% STTSM could be recommended and with further investigation on processing methods to improve birds' performance.

#### ETHICAL CONSIDERATION

The study was conducted with permission from the Nigeria Institute of Animal Science welfare and ethics committee (Act No.26 of 2007) in collaboration with the Department of Animal Production and Health, Federal University, Wukari, Taraba State, Nigeria.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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