DOUM PALM (*Hyphaene thebaica*) SEED MEAL AS A NOVEL FEEDSTUFF FOR BROILER CHICKENS: EFFECT ON GROWTH RESPONSE †

[HARINA DE SEMILLAS DE PALMA DOUM (*Hyphaene thebaica*) COMO NUEVO ALIMENTO PARA POLLO DE ENGORDA: EFECTO SOBRE EL CRECIMIENTO]

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SUMMARY

Background. High cost of feed ingredients and increased demand for broiler chicken in many African countries has necessitated the search for alternative feed sources. **Objective.** To evaluate the effects of *Hyphaene thebaica* seed meal (HTSM) as substitute for maize on growth and blood parameters of broiler chickens. **Methodology.** Five experimental diets were formulated for the trial. Diet 1 (0% HTSM) served as the control while diets 2, 3, 4 and 5 contained 5, 10, 15 and 20% HTSM respectively replacing dietary maize in the diets of birds. A total of 225 day-old broiler chicks were randomly allotted into five treatment groups with three replicates of fifteen birds each. Each group was assigned to the five experimental diets in completely randomized design (CRD). Feed and water were supplied *ad libitum* for all treatment groups during the trial. **Result.** Differences ($P<0.05$) were observed in the growth parameters measured except average daily feed intake ($P>0.05$). Feed conversion ratio and average daily weight gain of birds fed 0, 5 and 10% HTSM diets were better ($P<0.05$) compared to those fed 15 and 20 % HTSM diets. Differences ($P<0.05$) were also observed in the blood parameters measured except the packed cell volume (29.08- 31.89%) and mean corpuscular haemoglobin (14.69-15.67pg). The white blood cell (11.45-18.14 x 10^9/l), red blood cell (4.71-6.99 x 10^{12}/l), haemoglobin (6.92-10.05g/dl) and aspartate transaminase (72.95-90.16 IU/l), alanine aminotransaminase (62.84-79.50 IUu/l) and alkaline phosphatase (100.26-108.77 IU/l) increased ($P<0.05$) as the dietary levels of HTSM increased across the treatments. Carcass and organ weights of birds fed 0, 5 and 10% HTSM diets were better ($P<0.05$) than those fed 15 and 20% HTSM diets. **Implication.** Adequate processing of the HTSM is needed to reduce the anti-nutritional factors to a tolerable level before being used in broiler diet. **Conclusion.** Broiler chickens can tolerate up to 10% raw HTSM in their diets without adverse effect on growth performance.

Key words: broiler; performance; haematology; serum.

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RESUMEN

Antecedentes. El alto costo de los ingredientes de los piensos y la mayor demanda de pollos de engorde en muchos países africanos han requerido la búsqueda de fuentes de piensos alternativas. **Objetivo.** Evaluar los efectos de la harina de semillas de *Hyphaene thebaica* (HTSM) como sustituto del maíz sobre el crecimiento y los parámetros sanguíneos de pollos de engorde. **Metodología**. Se formularon cinco dietas experimentales para el ensayo. La dieta 1 (0% HTSM) sirvió como control, mientras que las dietas 2, 3, 4 y 5 contenían 5, 10, 15 y 20% HTSM respectivamente, reemplazando el maíz dietético en las dietas de las aves. Un total de 225 polluelos de engorde de un día de edad se asignaron aleatoriamente en cinco grupos de tratamiento con tres repeticiones de quince aves cada uno. Cada grupo fue asignado a las cinco dietas experimentales en un diseño completamente al azar (CRD). Se suministró alimento y agua *ad libitum* a todos los grupos de tratamiento durante el ensayo. **Resultados**. Se observaron diferencias (P<0.05) en los parámetros de crecimiento medidos, excepto en el consumo diario promedio de alimento (P>0.05). La tasa de conversión alimenticia y el aumento de peso diario promedio de las aves alimentadas con dietas de 0, 5 y 10 % HTSM fueron mejores (P<0.05) en comparación con aquellas alimentadas con dietas de 15 y 20 % HTSM. También se observaron diferencias (P<0.05) en los parámetros sanguíneos medidos, excepto el volumen de células concentradas (29.08-31.89%) y la hemoglobina corpuscular media (14.69-15.67pg). Glóbulos blancos (11.45-18.14 x 109/l), glóbulos rojos (4.71-6.99 x 10^{12}/l), hemoglobina (6.92-10.05 g/dl) y aspartato transaminasa (72.95-90.16 UI/l), alanina aminotransaminasa (62.84-79.50 UI/l) y la fosfatasa alcalina (100.26-108.77 UI/l) aumentaron (P<0.05) a medida que los niveles dietéticos de HTSM aumentaron en todos los tratamientos. Los pesos de las canales y órganos de las aves alimentadas con dietas de 0, 5 y 10% HTSM fueron (P<0.05) mejores que los de aquellas alimentadas con dietas de 15 y 20% HTSM. **Implicaciones.** Es necesario un procesamiento adecuado del HTSM para reducir los factores antinutricionales a un nivel tolerable antes de usarlo en la dieta de los pollos de engorde. **Conclusión.** Los pollos de engorde pueden tolerar hasta un 10% de HTSM crudo en sus dietas sin efectos adversos sobre el crecimiento.

Palabras clave: pollo de engorde; comportamiento productivo; hematología; suero.

INTRODUCTION

There is increasing demand for poultry products globally (USDA, 2012). This is due to the perceived healthiness of poultry being high in beneficial unsaturated fatty acids, has high return over a short period (Makinde *et al.*, 2021), requires low capital for investment, high acceptability in many culinary traditions and increase in human population (Makinde *et al.*, 2021). The demand is expected to be more in developing countries due to increase in human population in the region (Guyomard *et al*., 2013). However, the current state of poultry production in the developing regions is incapable of meeting the current protein needs of the masses let alone of meeting future demand. The major problem facing poultry industry in the developing countries is high cost of conventional feedstuffs due to undue competition for conventional feedstuffs between human and livestock making the poultry business unproductive. The foregoing scenario gives impetus to search for alternative, cheaper and less competitive feedstuff for the poultry industry. Indisputably, there exist various indigenous leguminous plants in tropical countries that could be used as poultry feed (Martens *et al*., 2013). One of such plants that have potential of being inexpensive (Makinde *et al.*, 2018), locally available and nutritionally dense is Doum palm (*Hyphaene thebaica*). It belongs to the family *Arecaceae* commonly known as doum palm, Dum Nut or gingerbread tree. It is found in the Nile valley and in some African countries such as Chad, Senegal, Northern Nigeria, Zaire and Upper Egypt. The leaves of doum palm are largely consumed by livestock while the rind (mesocarp) is also palatable, very sweet with and highly aromatic. Burkill (1997) reported that the mesocarp functions as parasite expellant and vermifuges when consumed. Literature search revealed that the fruit pulp contains some nutrients such as trace minerals, fatty acids especially linoleic acids, vitamins and proteins (Cook *et al.*, 2000). Nwosu *et al.* (2008) reported that the mesocarp of Doum palm fruits contains 8.10% ash, 0.95% ether extract, 0.01% protein, 89.25% carbohydrate while Eissa *et al.* (2008) showed that the fruit pulp contains 4.91% proteins, 4.5% ash, 5.26% fat and 85.33% total carbohydrate. Betty *et al*. (2006) observed a lower blood pressure among rats fed doum palm fruit while Ibe *et al.* (2021) reported that up to 12.5% processed doum palm pulp meal can be included in the diets of broiler chickens without adverse effect on performance indices of chickens. There is however, paucity of information on the nutritional properties of Doum palm (*Hyphaene thebaica*) seed meal and its use in poultry diets. This study aimed at evaluating the effect of different replacement levels of maize with HTSM on the growth response and blood parameters of broiler chickens.

MATERIALS AND METHODS

The site of the experiment was previously described by Makinde *et al.* (2022). The dried *H. thebaica* seeds were purchased from Gashua market, Yobe state, in the North Eastern Nigeria. The dried seeds were crushed with palm kernel machine and the kernels were discarded. The mesocarps were then milled to particle sizes that would pass through a 3 mm sieve, using a hammer mill.

Proximate Analyses and Metabolisable Energy Determination of HTSM

Samples of the meal were taken to the laboratory for proximate analysis using the methods described by AOAC (2006) to determine the following proximate fractions: Moisture content, dry matter (DM), Crude protein (CP), Crude fibre (CF), Ether extract (EE), Ash, Nitrogen free extract (NFE). The metabolisable energy (ME) of the seed meal was calculated, using the methods of Pauzenga (1985).

Metabolizable Energy ME (Kcal/kg) = 37 x % CP + 81.8 x % EE + 35.5 x %NFE

Phytochemical Analysis

The following phytochemicals were determined using the standard procedures (AOAC, 2006): Flavonoids, tannin, oxalate and saponin.

Experimental Diets

Five experimental diets were formulated according to nutrient requirement standards of broilers (NRC, 1994). Diet 1 (0% HTSM) served as the control while diets 2, 3, 4 and 5 contained 5, 10, 15 and 20% HTSM respectively replacing maize in the diets of birds. The gross composition of the experimental diets and their analyzed nutrient contents are presented in Table 1.

Table 1. Gross Composition of the Experimental Diets.

	Dietary levels of *Hyphaene thebaica* seed meal (%)									
	Starter diets					**Finisher diets**				
Ingredients, Kg	**0**	**5**	**10**	**15**	**20**	**0**	**5**	**10**	**15**	**20**
Yellow Maize, 10%	54.00	51.30	48.60	45.90	43.20	56.00	53.20	50.40	47.60	44.80
*HTSM, 6.09%	0.00	2.70	5.40	8.10	10.80	0.00	2.80	5.60	8.40	11.20
Soyabean meal,46%	27.00	27.00	27.00	27.00	27.00	24.00	24.00	24.00	24.00	24.00
Maize offal	5.95	5.95	5.95	5.95	5.95	6.80	6.80	6.80	6.80	6.80
Palm kernel cake	6.00	6.00	6.00	6.00	6.00	5.00	5.00	5.00	5.00	5.00
Fish meal, 48%	2.00	2.00	2.00	2.00	2.00	1.50	1.50	1.50	1.50	1.50
Limestone	0.50	0.50	0.50	0.50	0.50	0.65	0.65	0.65	0.65	0.65
Bonemeal	2.50	2.50	2.50	2.50	2.50	3.00	3.00	3.00	3.00	3.00
Palm oil	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00
Common salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
L-lysine, 95%	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
DL-methionine,58%	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
**Vit/Min Premix	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Total	100	100	100	100	100	100	100	100	100	100
Proximate analysis (%)										
Dry matter	88.24	88.67	87.91	88.34	87.89	89.02	90.15	89.50	88.67	90.00
Crude protein	22.57	21.34	22.09	23.00	22.61	20.04	20.41	20.02	20.11	20.19
Crude fibre	3.76	3.89	3.93	3.98	4.00	3.52	3.70	3.78	3.88	3.97
Ether extract	5.36	4.90	5.21	5.09	4.98	6.12	6.37	6.00	6.04	6.57
Ash	5.62	6.01	6.20	6.09	6.17	5.53	5.86	6.17	6.90	6.14
NFE	62.69	63.86	62.57	61.84	62.24	64.79	63.66	64.03	63.07	63.13

*HTSM=Hyphaene thebiaca seed meal **To provide the following per kilogram of feed: Vit. A, 10,000 iu, Vit. D3, 2000 iu, Vit. E, 5iu; Vit.K, 2mg; Riboflavin, 4.20mg; Vit. B12, 0.01mg; Panthothenic acid, 5mg; Nicotnic acid, 20mg; Folic acid, 0.5mg; choline, 3mg; Mg, 56mg; Fe, 20mg; Cu, 10mg; Zn, 50mg; Co.125mg. NFE: Nitrogen Free Extract =100-(%CP+%CF+%EE+%Ash).

Experimental Birds and Design

A total of two hundred and twenty five (225) day-old broiler chicks were raised on control diet for one week, after which they were randomly assigned into five treatment groups with three replicates of fifteen birds each in a completely randomized design (CRD). Feed and water were provided *ad libitum* for all treatment groups during the 56 d feeding trial with necessary prophylactic medication and vaccination given.

Data collection

Growth performance

Daily feed intake was computed as difference between the feed offered and the left-over while the birds were weighed weekly to obtain weekly weight gain. Feed conversion ratio was computed as a ratio of feed intake/weight gain of each replicate.

Feed consumption was calculated on a daily using the formula:

Feed consumption = amount of feed given (g) – amount of left over (g).

The birds were weighed individually on a weekly basis to determine the weight changes, weight gained was determined by the formula;

$$Daily\ weight\ gained/bird/day = \frac{final\ weight(g) - initial\ weight(g)}{number\ of\ birds\ \times\ number\ of\ days}$$

Feed conversion ratio (FCR) was also calculated as the quantity of feed that will produce 1 kg of weight gain. Using the formula:

$$Feed\ conversion\ ratio\ (FRC) = \frac{total\ feed\ intake}{total\ weight\ gain}$$

Haematological and blood serum analysis

Blood samples were collected for four birds per replicate during the last week of the study. About 5mls of blood was collected from each bird into bottles containing Ethylene Diamine Tetra Acetic Acid (EDTA) for haematological analysis. Blood samples meant for determining biochemical indices (total protein, albumin, globulin, urea, cholesterol and triglyceride) were collected into the plane bottles without EDTA. Haematological parameters and blood chemistry were determined using standard clinical chemistry procedure (Olorede *et al.*, 1996).

Carcass analysis

Three (3) birds per replicate were randomly picked, starved overnight, weighed and slaughtered at the last day of the trial. The birds were allowed to bleed and immersed into a warm water (60 ºC) bath for about 5 minutes before feather-plucked and then, eviscerated. Different cut-parts were weighed and expressed as percentage of dressed weight while the weight of visceral organs were also taken and expressed as percentage of live weight according to Abe *et al.* (1996) procedure. Dressing percentage was calculated using the formula:

$$\text{Dressing percentage (\%)} = \frac{\text{Dressed weight x 100}}{\text{Live weight}}$$

Statistical Analysis

Data generated from the study were analyzed through the use of SAS software (SAS, 2015). Significant means were separated at 5% level of significance.

The statistical model used was as follows:

$Y_{ij} = \mu + TS_i + e_{ij}$

Y_{ij} = Individual observation
μ = population mean
TS_i = effect of i^{th} of HTSM diets
e_{ij} = random error

RESULTS AND DISCUSSION

The proximate fractions (%) obtained on dry matter basis was: crude protein, 6.09; ether extract 1.75 and ash, 6.26. Others were crude fibre, 11.49 and nitrogen free extract, 68.39. The results of the phytochemicals analysed were tannin (0.31%), saponin (1.02%), oxalate (0.67%), phytate (1.13%), and flavonoids (0.78%).

The results of the growth performance of broiler chicks fed HTSM diet from 1 to 4 week is shown in Table 2. Significant differences (P<0.05) were observed in the parameters measured except average daily feed intake (P>0.05). Feed conversion ratio and average daily weight gain of birds fed 0, 5 and 10 % HTSM diets were significantly better (P<0.05) compared to those fed 15 and 20 % HTSM diets. Increasing levels of the HTSM in the broiler's diets resulted in decreased (p<0.05) body weight gain and increased poor feed conversion ratio as observed among birds fed 15 and 20 % HTSM diets. This observation may be attributed to higher amount of phytochemicals and poor feed utilization of the birds fed these two diets compared to diets 1, 2 and 3. Makinde *et al.* (2017) had earlier reported that phytochemicals elicit toxic biological responses with possible physiological implications. These findings corroborate the report of Obun and Adeyemi (2012) who observed reduced weight gain among birds fed increased amount of raw *Daniellia oliveri* seed meal based diets. The negative effects of phytochemicals on the performance of birds cannot be overemphasized. For instance, oxalate exerts negative effect on mineral availability, its presence in food has been reported to cause gut irritation (Ermer *et al.*, 2022) and hinders minerals absorption most especially calcium through formation of insoluble salts with them (Abu Hafsa *et al.*, 2022). Diet with high oxalate content has been reported to increase the risk of renal calcium absorption and may result in kidney stones (Aziz *et al.*, 2022). Similarly, phytate in food is known to form a bond with some essential mineral nutrients in the digestive tract and this will result in mineral deficiencies (Bello *et al.*, 2008). Our observation in this study agreed with Hosseintabar-Ghasemabad *et al.* (2022), who reported that growth rate, feed efficiency and absorption of dietary lipids, cholesterol, bile acids, vitamins A and E were negatively affected when broiler chicks were fed diet containing saponin.

The results of the growth performance of finisher broilers fed HTSM diet from 5 to 8 week is shown in Table 3. Significant differences (P<0.05) were observed in the parameters measured except average daily feed intake (P>0.05). Feed conversion ratio and average daily weight gain of birds fed 0, 5 and 10% HTSM diets were significantly better (P<0.05) than those fed 15 and 20% HTSM diets.

Figure 1 shows the results of haematological parameters of broiler chickens fed HTSM diets. White blood cell (WBC), haemoglobin (Hb) and red blood cell (RBC) increased among birds fed HTSM diets relative to the control diet. The non-significant difference (P>0.05) in PCV as observed in this study implies that the inclusion of HTSM in broilers diet did not pose any effect on the amount of blood cells in comparison with the total blood volume as earlier reported by Islam *et al.* (2022). PCV values obtained (29.08-31.89%) fall within the normal range (22 to 35 %) earlier recorded by Jain (1993) but lower than the range (25 to 45%) observed by Mitruka and Rawnsley (1977). White blood cells ($x10^9$/l) differed significantly (P<0.05) among the treatment groups. Birds fed 20% HTSM diet had the highest value (18.14 $x10^9$/l). An abnormal increase in WBC count may be attributed to microbial infection or the presence of foreign body in the circulatory system. Also, our observation might be associated with the immune system of the birds attempting to detoxify the anti-nutritional factors (ANFs) in the feed. Anti-nutritional factors have been observed to exert negative effects on some haematological parameters. Saponin is known to cause erythrocyte haemolysis and reduction of blood (Cheeke, 1996). The significant increase observed in red blood cells and haemoglobin agreed with the report of Adeyemo and Sanni (2013) and Annongu *et al.* (2017) for broiler chickens fed *Aspergillus niger* treated cassava peel and African star apple (*Chrysophyllum albidum*) kernel meal based diets respectively. Emenalum *et al.* (2009) and Ogbuewu (2008) had earlier reported that

Table 2. Effects of Different Dietary Levels of HTSM on Performance of broiler chicks (1 - 4weeks).

	Dietary levels of *Hyphaene thebaica* seed meal (%)						
Parameters	**0**	**5**	**10**	**15**	**20**	**SEM**	**P-value**
Av. initial body weight (g)	100.05	100.02	100.08	100.05	100.03	0.04	0.7210
Av. daily body weight gain (g)	19.47[a]	21.02[a]	18.81[a]	8.84[b]	7.52[b]	1.71	0.0001
Av. daily feed intake (g)	45.30	47.01	49.49	44.05	50.04	2.99	0.5101
Feed conversion ratio	2.33[a]	2.24[a]	2.09[a]	4.64[b]	6.65[c]	0.76	0.0001

[ab]means in the same row with different superscripts are significantly different (P<0.05). SEM=Standard error of mean.

Table 3. Effects of Different Dietary Levels of HTSM on Performance of finisher broilers (5 - 8weeks).

	Dietary levels of *Hyphaene thebaica* seed meal (%)						
Parameters	**0**	**5**	**10**	**15**	**20**	**SEM**	**P-value**
Av. initial body weight (g)	509.02[a]	541.34[a]	495.16[a]	285.75[b]	257.95[b]	94.46	0.0001
Av. daily body weight gain (g)	28.41[a]	26.80[a]	26.79[a]	21.68[b]	17.14[c]	0.82	0.0001
Av. daily feed intake (g)	66.26	59.17	61.05	62.86	58.46	2.99	0.6010
Feed conversion ratio	2.33[a]	2.21[a]	2.28[a]	2.89[b]	3.41[c]	0.52	0.0001

[ab]means in the same row with different superscripts are significantly different (P<0.05). SEM=Standard error of mean.

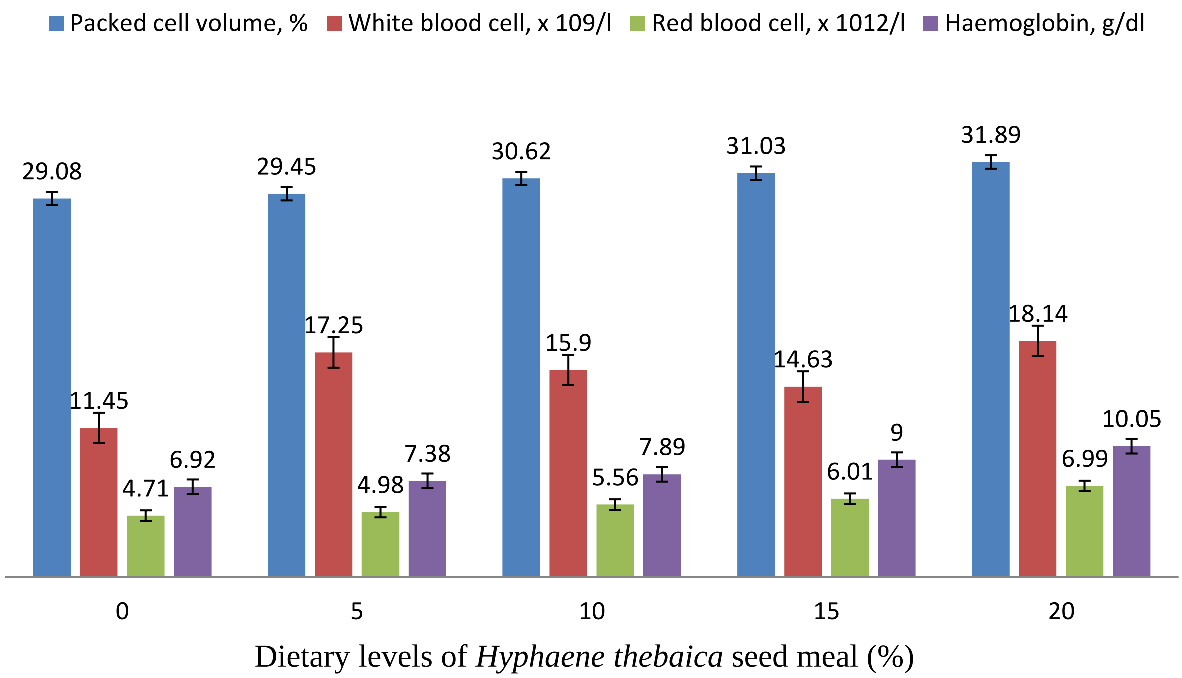

Figure 1. Haematological parameters of Broiler chickens fed FHTSM diets.

the erythrocyte counts of healthy animals is dependent on several factors such as diets, species, sex, age, and clinical conditions of the animal.

The results of the serum enzymes of broiler chickens fed HTSM diets are shown in Figure 2. Aspartate transaminase (AST), alanine transaminase (ALT) and alkaline phosphatase (ALP) increased in response to the increased levels of HTSM in the diets. The increased activity of AST, ALT and ALP as the quantity of HTSM increased in diet ($p<0.05$) may attest to the presence of phytotoxins in the HTSM which led to high enzyme activities in the blood. However, age of birds is also a factor influencing serum biochemical indices of the birds. Oluyemi *et al*. (2002) reported that young chickens (8 – 10 weeks) had significantly greater AST and ALT values than adult (50 – 80 weeks) birds. The slight increase in ALP values in the study might therefore be in response to age (Arslam *et al.*, 2001). The increased activity of ALT suggests the likelihood of liver damage especially among birds fed 15 and 20% HTSM diets.

The results of carcass parameters and organ weights of broiler chickens fed HTSM diet is shown in Table 4. The carcass and organ weights of birds fed 0, 5 and 10% HTSM diets were significantly ($P<0.05$) higher than those fed 15 and 20% HTSM diets. The observed differences in the mean values obtained for the carcass parameters could be attributed to the variation in the final live weights of experimental birds, which was highest among birds fed 0, 5 and 10% HTSM diets. This implies that increasing the levels of HTSM inclusion from 10 to 20% in the diets may lead to a decrease in carcass yield and organ weight. This observation is similar with the report of Jiya *et al*. (2018) who reported a decrease in carcass parameters as the levels of inclusion of tallow seed meal increased in the diets. Similarly, Oloruntola *et al*. (2016) and Makinde *et al.* (2023) observed a decrease in carcass yield of growing rabbits as the level of inclusion of rumen liquor fermented cassava peels and African Star Apple (*Chrysophyllum albidum*) kernel meal, respectively, increased in the diets.

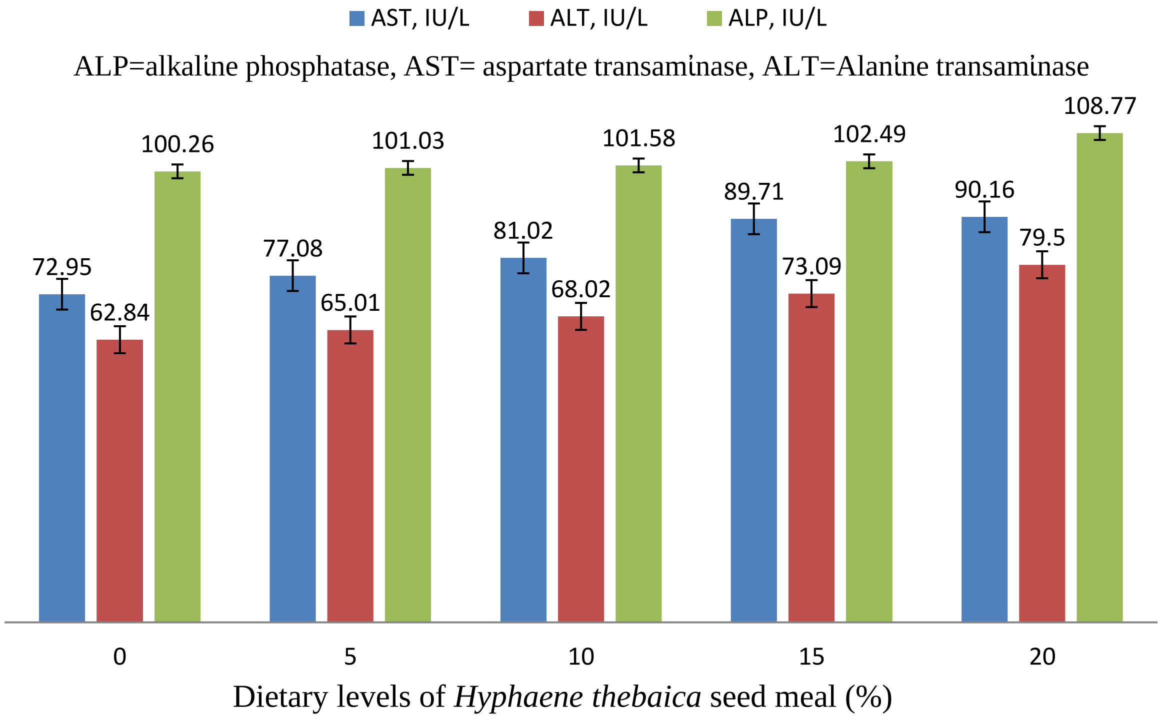

Figure 2. Serum enzymes of Broiler chickens fed HTSM diets.

Table 4. Effects of HTSM on Carcass and Organ weights of Broiler chickens (0-8weeks).

	Dietary levels of *Hyphaene thebaica* seed meal (%)						
Parameters	**0**	**5**	**10**	**15**	**20**	**SEM**	**P-value**
Live weight, g	2100.02[a]	2041.95[a]	1995.68[a]	1500.03[b]	1217.58[c]	121.61	0.0001
Slaughter weight, g	2083.16[a]	1985.72[a]	1923.33[a]	1447.15[b]	1164.29[c]	96.57	0.0001
Dressed weight, g	1688.15[a]	1632.86[a]	1582.07[a]	1092.23[b]	803.65[c]	68.04	0.0001
Dressing %	80.39[a]	79.97[a]	79.27[a]	72.81[b]	66.00[c]	1.87	0.0001
Thigh	22.15[a]	21.04[a]	21.10[a]	17.90[b]	13.99[c]	1.63	0.0001
Drumstick	9.23[a]	8.75[a]	8.00[a]	6.42[b]	5.10[c]	0.83	0.0001
Breast	24.83[a]	24.00[a]	22.97[a]	18.65[b]	14.59[c]	1.71	0.0001
Back	15.61[a]	14.95[a]	13.88[a]	12.89[b]	10.00[c]	1.12	0.0001
Wings	8.92[a]	7.05[a]	7.11[a]	5.14[b]	4.03[c]	0.82	0.0301
Organ weights (%)							
Heart	0.76[a]	0.69[a]	0.65[a]	0.54[b]	0.43[c]	0.06	0.0001
Gizzard	3.01[a]	2.79[a]	2.55[a]	1.74[b]	1.29[c]	0.34	0.0001
Kidney	0.58[a]	0.52[a]	0.49[a]	0.40[b]	0.35[c]	0.05	0.0001
Liver	2.79[a]	2.35[a]	2.01[a]	1.89[b]	1.55[c]	0.25	0.0001
Spleen	0.23[a]	0.21[a]	0.19[a]	0.15[b]	0.10[c]	0.03	0.0301

[ab]Means in the same row with different superscripts are significantly different (P<0.05).

CONCLUSION

The results of this study revealed that broiler chickens would tolerate up to 10% HTSM in their diets with no negative effect on growth response and blood parameters. Also, adequate processing of the seed through different processing methods such as boiling, toasting, fermentation etc is needed to reduce the anti-nutritional factors to a tolerable level before being used in broiler diet.

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