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Effect of processed doum palm (*Hyphaene thebaica)* pulp meal on growth performance, nutrient digestibility, carcass characteristics and haematological indices of broilers

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ABSTRACT: The increase in human population, particularly in the developing countries like Nigeria and the demand for animal protein intake has necessitated different approaches of solving protein shortage. A 28-day study was carried out to determine the performance of finishers fed on different hourly soaked doum palm (*Hyphaene thebaica)* pulp meal (DPPM) diets. Two hundred and sixteen (216) finishers (4 week-old) were randomly allotted to six dietary treatments. Each treatment consisted of 36 birds with three replicates (12 birds per replicate) in a completely randomized design (CRD). Six experimental diets were formulated and designed as follows: T_1 (Control) contained 0% DPPM while T_2, T_3, T_4, T_5 and T_6 contained 12.5% each of 2, 4, 6, 8 and 10 hours soaked DPPM as substitute for maize, respectively. Feeds and water were provided *ad libitum* for all treatment groups. The average body weight gain (40.44- 42.71 g/b/d), average feed intake (87.52-96.73 g/b/d) and feed conversion ratio (2.14-2.34) were non-significant ($p>0.05$) regardless of the dietary treatments. Statistical differences ($p<0.05$) were observed in some carcass parameters such as thigh (13.40-14.98%), neck (5.32-6.55%), shank (3.81-5.2 %), wing (9.80-11.41%), head (2.43-3.74%) and two haematological indices; white blood cell (160.67-189.53 X 10^3/mm^3) and eosinophils (0.33-2.00%) across the treatment groups. The processed DPPM could serve as a rich energy source in broiler feeds with the raw doum palm pulp containing 2987.45 kcal/kg. Also, soaking the pulp for 2 to 10 hours before been included in broiler diet improved the nutritional content, acceptability, palatability and utilization of the feed by the broilers. Thus, up to 12.5% processed DPPM can be included in the diets of broiler chickens without adverse effect on growth performance, nutrient digestibility, carcass characteristics and haematological indices of chickens.

Keywords: Broilers, digestibility, doum palm pulp, performance, processing, soaking.

INTRODUCTION

In Nigeria, maize is the most commonly used source of energy for poultry which usually constitutes about 40 to 60% of industrially formulated poultry diets (Heise et al., 2015). The high cost of maize and other cereals is due to the competition between man and farm animals and their seasonal production. Many unconventional tropical feed resources and their by-products which have potential for use as alternative sources of feed for poultry, could be exploited to reduce cost and limit the dependence on maize (Kudu et al., 2008; Annongu, et al., 2017; Makinde et al., 2021). Many developing countries of the world have protein deficiency gap, especially that of high quality animal protein. This low animal protein intake has very serious implications on the health status and well-being of the citizenry (Ayanwale et al., 2006). There is need to search for non-conventional feedstuffs such as doum palm

(*Hyphaene thebaica*) pulp which might reduce cost of poultry feed, meat and animal products. Abdulsalam et al. (2018) reported that boiled doum palm pulp was found to contain 6.25% ash, 89.25% carbohydrate, 0.95% oil, 316 mg/g glucose, 6.09% protein but high calorific values of 3234 kcal/kg while Makinde et al. (2018) reported the values of 93.08% dry matter, 6.09% crude protein, 1.75% ether extract, 6.26% ash, 11.49% crude fibre, 68.39% nitrogen free extract and 2796.33 kcal/kg metabolizable energy for raw doum palm pulp. Apart from the studies conducted by Abdulsalam et al. (2018) and Makinde et al. (2018) to assess the effect of doum palm pulp meal on growth performance of broiler chickens, all other studies were focused on its pharmacological and phytochemical activities in experimental rats (Auwal et al., 2013; Shehu et al., 2017; Nisreen and Heba, 2020). Thus, this study determined the performance characteristics of finisher broilers fed different hourly soaked doum palm (*Hyphaene thebaica)* pulp meal (DPPM) diets.

MATERIALS AND METHODS

The study was carried out at the Teaching and Research Farm of the Department of Animal Production, School of Agriculture and Agricultural Technology, Federal University of Technology Minna, Bosso Campus Niger State, Nigeria. The mature ripe doum palm (*Hyphaene thebaica*) fruits were sourced from Mashi Local Government, Katsina State, Nigeria. The fruits were divided into 5 batches and soaked in tap water at the ratio of 1 kilogram fruit to 5 litres of water at room temperature for 2, 4, 6, 8 and 10 hours respectively following the method earlier described by Nafiseh et al. (2013). The water was drained and the soaked fruit mesocarps were removed with knife and air-dried at 25^{o}C for 72 hours. Samples from the five batches were ground to pass through a 3 mm hammer and taken to the laboratory for chemical analysis.

Management of experimental animals

A total of 216 day-old Ross 308 broilers were randomly allotted to six treatments. Each treatment consisted of 36 birds (12 per replication) in a completely randomized design (CRD). Feeds and water were provided *ad libitum.* Data were collected on average weight gain, feed intake and feed conversion ratio.

Experimental diets

Six experimental diets containing differently soaked DPPM were formulated as follows: T_1 (Control) contained 0% DPPM while T_2, T_3, T_4, T_5 and T_6 contained 2, 4, 6, 8 and 10 hourly soaked DPPM respectively. Proximate compositions of raw and different hourly soaked DPPM is shown in Table 1 while gross composition of experimental diets is presented in Table 2.

Carcass and organs weight determination

Three chickens per replicate were selected at random and starved for about 12 hours to empty the crops. They were then slaughtered, scalded, plucked and eviscerated. The carcass and cut parts were expressed as percentage of dressed weight while the viscerals (liver, heart, kidney, gizzard and intestines) were removed, weighed and expressed as a percentage of live weight.

Blood collection and analysis

A 5 ml of blood was collected from 15 chickens per treatment through the wing vein and put into bottles containing Ethylene Diaminetetra- acetic Acid (EDTA) to determine the haematological indices including the differential counts. All the analysis was done at the University Research Laboratory according to the methods described by Kohn and Allen (1995) and Peters et al. (1982).

Statistical analysis

Data collected were subjected to analysis of variance using SAS software (SAS, 2015). Significant means were separated with Duncan multiple range test at 5% level of significance.

RESULTS

The growth performance and apparent nutrient digestibility of broiler chickens fed on different hourly soaked doum palm pulp meal diets are presented in Tables 3 and 4, respectively. There were non-significant ($p>0.05$) differences across treatment means for all the parameters measured.

The results of the carcass characteristics and organs weight are shown in Tables 5 and 6, respectively. There were non-significant ($p>0.05$) differences in the parameters measured except thigh, neck, shank, wing and head weights ($p<0.05$). Also, liver, spleen, intestine length and abdominal fat were significantly ($p<0.05$) different across the treatment groups.

Table 7 shows the results of haematological indices of broiler chickens fed on different hourly soaked doum palm pulp meal diets**.** Of all the parameters analyzed, only white blood cell and eosinophils were significantly ($p<0.05$) different across the treatment groups.

Table 1. Proximate composition of raw and different hourly soaked doum palm pulp meal.

Nutrients (%)	T_1	T_2	T_3	T_4	T_5	T_6
Dry matter	95.96	95.50	95.59	95.36	95.41	94.85
Crude Protein	8.26	8.03	8.00	7.98	7.87	7.70
Crude fibre	14.62	15.73	15.50	14.92	14.69	14.30
Ether extract	5.98	4.34	4.09	4.49	4.58	4.54
Ash	5.20	6.50	6.02	7.26	6.69	6.02
Nitrogen free extract	61.90	60.90	61.98	60.71	61.58	62.29
Energy (Kcal/kg)	2987.45	2819.60	2821.91	2814.155	2848.26	2863..93

NFE=100-(%CP+%CF+%EE+%Ash). T_1 = (0 hour soaked); T_2 to T_6 = 2, 4, 6, 8 and 10 hours soaked DPPM.

Table 2. Gross composition of experimental diets.

Ingredients (%)	T_1	T_2	T_3	T_4	T_5	T_6
Maize	57.00	49.87	49.87	49.87	49.87	49.87
Doum palm meal	0.00	7.13	7.13	7.13	7.13	7.13
Maize offal	5.00	5.00	5.00	5.00	5.00	5.00
GNC	15.00	15.00	15.00	15.00	15.00	15.00
Soya cake	16.00	16.00	16.00	16.00	16.00	16.00
Fish meal	2.00	2.00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00	1.00
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00
Palm oil	1.00	1.00	1.00	1.00	1.00	1.00
*Vitamin Premix	0.25	0.25	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25	0.25	0.25
L-lysine	0.25	0.25	0.25	0.25	0.25	0.25
Dl-methionine	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100
Calculated nutrients (%)						
ME (Kcal/kg)	3055.83	3055.39	3035.39	3004.55	3018.81	3035.19
Crude protein	20.05	20.04	20.09	20.07	20.08	20.08
Ether extract	5.81	5.66	5.66	5.66	5.66	5.66
Crude fibre	5.40	5.42	5.42	5.42	5.42	5.42
Calcium	1.19	1.20	1.20	1.20	1.20	1.20
Phosphorus	0.63	0.64	0.64	0.64	0.64	0.64
Lysine	1.14	1.14	1.14	1.14	1.14	1.14
Methionine	0.64	0.64	0.64	0.64	0.64	0.64

ME= Metabolizable Energy, T_1 = (0 hour soaked); T_2 to T_6 = 2, 4, 6, 8 and 10 hours soaked doum palm pulp meal diets.

Table 3. Growth performance of broiler chickens fed different hourly soaked doum palm pulp meal diets.

Parameters	T_1	T_2	T_3	T_4	T_5	T_6	SEM	P-value
Initial weight (g/b)	751.67	698.83	751.67	777.33	747.50	787.33	44.14	0.3938
Final weight (g/b)	1933.33	1831.11	1899.99	1950.00	1914.66	1983.33	65.27	0.6722
Daily body weight gain (g/b/d)	42.20	40.44	41.01	41.88	41.69	42.71	2.330	0.6725
Daily feed intake (g/b/d)	96.73	87.52	95.96	89.19	91.07	94.24	3.79	0.1565
Feed conversion ratio	2.30	2.17	2.34	2.12	2.19	2.20	0.15	0.7710
Protein efficiency ratio	2.07	2.19	2.02	2.22	2.17	2.15	0.12	0.3128
Energy efficiency ratio (EER)	0.02	0.02	0.02	0.02	0.02	0.02	0.00	0.8234

SEM: standard error of mean. ^{abcd} Means on the same row with different superscripts are significantly ($p<0.05$) different. T_1 = (0 hour soaked); T_2 to T_6 = 2, 4, 6, 8 and 10 hours soaked doum palm pulp meal diets.

Table 4. Apparent nutrient digestibility of broilers fed different hourly soaked doum palm pulp meal diets.

Parameters (%)	T_1	T_2	T_3	T_4	T_5	T_6	SEM	P-value
Dry matter	90.58	91.18	92.08	91.24	92.27	92.27	0.03	0.3384
Crude protein	90.63	86.70	89.81	89.33	88.72	88.99	1.96	0.5703
Crude fibre	80.47	85.51	81.81	78.67	77.82	78.93	0.91	0.4141
Ether extract	95.16	93.98	94.57	94.41	94.58	95.52	0.45	0.9891
Ash	85.47	90.69	92.76	92.80	92.88	92.94	0.41	0.6731
NFE	86.07	78.79	79.47	82.46	83.12	82.18	0.40	0.0860

SEM: standard error of mean. ^{abcd} Means on the same row with different superscripts are significantly ($p<0.05$) different. NFE: Nitrogen Free Extract. T_1 = (0 hour soaked); T_2 to T_6 = 2, 4, 6, 8 and 10 hours soaked doum palm pulp meal diets.

Table 5. Carcass characteristics of broilers fed different hourly soaked doum palm pulp meal diets.

Parameters	T_1	T_2	T_3	T_4	T_5	T_6	SEM	P-value
Average live weight (g)	1833.33	1883.33	1900.00	1950.00	1916.67	1983.33	65.26	0.0820
Slaughter weight (g)	1783.33	1833.33	1850.00	1866.67	1800.00	1933.33	69.39	0.1413
Dressed weight (g)	1658.33	1683.33	1700.00	1666.67	1700.00	1791.67	74.22	0.4054
Dressing percent (%)	73.64	79.65	76.60	78.67	76.63	78.40	5.07	0.4936
Carcass weight (g)	1350.00	1500.00	1458.33	1533.33	1466.67	1550.00	97.53	0.4204
Breast weight (%)	19.38	19.54	19.60	21.40	19.39	19.31	0.68	0.0629
Thigh weight (%)	13.40^{c}	13.86^{c}	14.69^{ab}	14.98^{a}	14.50^{b}	14.50^{b}	0.19	0.0317
Back weight (%)	12.77	13.58	14.11	15.47	13.79	13.55	0.88	0.1421
Neck weight (%)	5.78^{bc}	5.37^{bc}	6.55^{a}	6.19^{ab}	5.77^{b}	5.32^{c}	0.32	0.0174
Drumstick (%)	9.35	9.83	9.92	11.09	10.21	10.44	0.30	0.1045
Shank weight (%)	4.01^{c}	4.39^{bc}	3.81^{c}	5.24^{a}	4.96^{ab}	5.07^{a}	0.29	0.0012
Wing weight (%)	10.08^{bc}	11.41^{a}	10.13^{bc}	10.60^{b}	9.80^{c}	10.59^{b}	0.35	0.0084
Head weight (%)	2.43^{d}	3.18^{b}	2.66^{c}	3.74^{a}	3.33^{b}	3.56^{a}	0.10	<0.0001
Proventriculus (%)	0.52	0.56	0.61	0.55	0.59	0.60	0.08	0.0820

SEM: standard error of mean; ^{abcd} Means on the same row with different superscripts are significantly ($P<0.05$) different; T_1 = (0 hour soaked); T_2 to T_6 = 2, 4, 6, 8 and 10 hours soaked doum palm pulp meal diets.

Table 6. Organs weight of broilers fed differently soaked doum palm pulp meal diets.

Parameters	T_1	T_2	T_3	T_4	T_5	T_6	SEM	P-value
Heart weight (%)	0.41	0.38	0.47	0.48	0.46	0.50	0.04	0.0862
Crop weight (%)	0.80	0.67	1.07	1.28	1.45	1.00	0.29	0.1383
Liver weight (%)	1.70^{bc}	2.09^{ab}	1.62^{c}	2.50^{a}	2.06^{b}	2.11^{a}	0.20	0.0129
Lungs weight (%)	0.43	0.52	0.63	0.50	0.56	0.49	0.07	0.1297
Spleen weight (%)	0.10^{b}	0.11^{b}	0.10^{b}	0.11^{b}	1.37^{a}	1.38^{a}	0.51	0.0435
Gizzard weight (%)	1.67	1.71	1.90	1.70	1.70	2.02	0.15	0.3683
Intestine weight (g)	7.30	6.26	5.86	6.63	7.11	6.70	0.51	0.1626
Intestine length (cm)	12.47^{a}	12.19^{a}	10.84^{b}	10.73^{b}	10.92^{b}	11.09^{b}	0.32	0.0005
Abdominal fat (%)	2.56^{a}	2.35^{a}	2.13^{ab}	1.07^{b}	0.84^{c}	0.93^{c}	0.54	0.0203
Gall bladder (%)	0.13	0.11	0.10	0.11	0.12	0.10	0.05	0.6220

SEM: standard error of mean; ^{abcd} Means on the same row with different superscripts are significantly ($p<0.05$) different; T_1 = (0 hour soaked); T_2 to T_6 = 2, 4, 6, 8 and 10 hours soaked doum palm pulp meal diets.

DISCUSSION

The similarity observed in the results of growth performance and apparent nutrient digestibility implied that soaking of doum palm pulp between 2 to 10 hours before been included in broiler diet improved the nutritional content of the diets and that there was acceptability and palatability as well as utilization of the feed by the chickens.

Table 7. Haematological indices of broiler chickens fed different hourly soaked doum palm pulp meal diets.

Parameters (%)	T_1	T_2	T_3	T_4	T_5	T_6	SEM	P-value
Haemoglobin (g/dl)	8.33	7.97	8.00	7.87	7.93	8.07	0.25	0.5115
Packed cell volume (%)	25.33	24.00	24.00	24.00	23.67	23.67	1.17	0.7238
Red blood cell count (X 10^6/mm^3)	3.07	3.00	3.00	3.03	2.93	3.066	0.13	0.9036
Mean cell volume (fl)	82.63	79.99	80.09	79.14	80.79	77.09	2.58	0.4540
Mean cell haemoglobin (pg)	27.17	26.55	26.70	25.97	27.10	26.31	0.71	0.9285
Mean cell haemoglobin conc. (%)	32.89	33.19	33.34	32.80	33.54	34.41	1.62	0.5470
White blood cell count (X 10^3/mm^3)	188.67^a	160.67^c	189.83^a	168.63^{ab}	178.57^{ab}	189.53^a	5.95	0.0011
Heterophils (%)	33.00	30.00	31.33	31.00	30.00	29.33	1.88	0.4702
Lymphocytes (%)	63.67	68.33	66.33	68.33	68.67	69.33	1.82	0.0768
Monocytes (%)	1.33	1.00	1.00	0.33	1.00	0.67	0.47	0.4253
Eosinophils (%)	2.00^a	0.67^b	1.33^{ab}	0.67^b	0.33^c	0.67^b	0.43	0.0221

SEM: standard error of mean; ^{abcd} Means on the same row with different superscripts are significantly ($P<0.05$) different; T_1 = (0 hour soaked); T_2 to T_6 = 2, 4, 6, 8 and 10 hours soaked doum palm pulp meal diets.

Several authors had earlier reported that raw doum palm pulp contains some anti-nutritional factors such as tannin, saponin, oxalate and phytate which limit its use as feed for monogastric animals (Auwal et al., 2013; Shehu et al., 2017; Makinde et al., 2018). The negative effect of these anti-nutritional factors on growth performance might be responsible for the differences observed in results of this study and the report of Makinde et al. (2018) who fed broiler chickens with diets containing raw doum palm pulp meal. The authors observed that increasing levels of the raw doum palm pulp meal in broiler's diets from 10 to 20% resulted in decreased body weight gain and poor feed conversion ratio among the birds. However, Abdulsalam et al. (2018) reported that inclusion of 10% boiled doum palm pulp meal in broiler diets does not impair feed intake, weight gain, feed conversion ratio and economic characteristics of broiler chickens. The current result of apparent nutrient digestibility compared favourably with the report of Tamburawa et al. (2017) who fed broiler chickens with diets containing soaked and fermented African locust bean (*Parkia biglobosa*) seed meal. Similarly, carcass parameters measured across the treatment groups is a true reflection of the body weight performance indices and that of tissue development. This implied that the nutrients supplied by different hourly soaked doum palm pulp diets were adequate and met the nutrients required by broilers for efficient meat production that were similar. The significant differences observed in few of the organs measured does not implied any effect of toxicity of the diets since all the organs were within the normal range earlier reported by Ibe and Makinde (2014) and Makinde et al. (2017) for broilers fed on diets containing white guinea corn (*Sorghum bicolor*, Linn.) as a replacement for dietary maize.

The significant difference observed in white blood cell and eosinophils among other parameters implied that different hourly soaked doum palm pulp diets had no detrimental effect on health status of chickens. The decrease observed in white blood cells among birds fed T_2 and T_4 diets agrees with the findings of Annongu et al. (2017) who reported a significant decrease in white blood cell of broiler chickens fed raw African star apple (*Chrysophyllum albidum*) kernel meal based diets. Makinde et al. (2018) also observed a significant difference in white blood cell when broiler chickens were fed on diets containing raw doum palm (*Hyphaene thebiaca*) as a replacement for dietary maize.

Conclusion

This study revealed that processed DPPM could serve as a rich energy source in broiler feeds with the raw doum palm pulp containing 3020.57 kcal/kg. Also, soaking the pulp for 2 to 10 hours before being included in broiler diet improved the nutritional content, acceptability, palatability and utilization of the feed by the chickens. It can therefore be concluded that up to 12.5% processed DPPM can be included in the diets of broiler chickens without adverse effect on growth performance, nutrient digestibility, carcass characteristics and haematological indices of chickens.

CONFLICTING INTERESTS

The authors declared no conflicts of interest with respect to the research, authorship, and/or publication of this article.

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