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Biochemical evaluation of *Gmelina arborea* fruit meal as a swine feedstuff

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Abstract

An experiment was conducted to evaluate the influence of *Gmelina arborea* fruits (GAF) meal on haematology and certain biochemical parameters including blood enzyme profile of wean pigs. 16-piglets, 8-males and 8-females averaging 12.41 ± 0.59 kg live weight from Hampshire commercial breed were allotted to four dietary treatment groups each consisting of four piglets per treatment group in a completely randomised design. The diets formulated on iso-nitrogenous and iso-energetic basis had Diet 1 containing 30% processed GAF meal and was taken as a reference Diet while Diets 2, 3 and 4 contained 10, 20 and 30% raw GAF meal respectively. The experimental diets and water were supplied to appetite in a feeding trial which lasted for 28 days. There were no statistically significant differences in haematological parameters ($p > 0.05$) except lymphocytes and neutrophils of the leucocytes differential count ($p < 0.05$). There were also no significant differences in the selected blood enzymes and serum biochemical parameters of the trial animal models ($p > 0.05$). Urine analyses similarly showed no significant difference in urea and creatinine excretions except that there was a significant difference in uric acid produced ($p < 0.05$). An overall assessment of the study indicated that values of some parameters measured tended to decrease (in case of blood indices and serum constituents) and increase (with regards to blood urea nitrogen, creatinine in blood and urine and uric acids) though not significantly as the dietary inclusion level of raw GAF meal increased. It was therefore concluded that GAF when processed or incorporated at lower levels has no adverse effect on animals.

Keywords: *Gmelina arborea,* diets, pig

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INTRODUCTION

The measurement of nutritional, excretory and functional substances in blood and urine serve as good parameters for evaluating the nutritional status of the body. Haematological analysis, for instance, is significant in nutritional studies because blood, the metabolites and their concentrations provide information for indirect nutritional assessment due to the fact that food or feed components affect body constituents (Harper et al., 1979). Urinary excretion levels, on the other part, reflect immediate storage quantities more than the blood circulating levels. Functional substances such as enzyme activities provide more sensitive indications of nutritional status. It is against this background that blood indices, urine analysis, sero-biochemical and enzyme determinations were considered. Developing and underdeveloped countries including Nigeria, are facing serious increase in competition between mankind and animals for the available conventional foodstuffs especially the monogastric animals (Qureshi, 1980). This problem has exacerbated the high cost of feeding, and consequently, of the animal products (Adeleye and Adebiyi, 1990). The increased competition for and scarcity of food have drawn the attention of nutritionists, scientists and agriculturists to the need for research into the use of unconventional feedstuffs that are not a staple for man, to meet the nutritional needs of the livestock. *Gmelina arborea* fruits, GAF proposed for the present study is one of such novel feedstuffs. Little or no work has been done on the utilization of *Gmelina arborea* fruits in the nutrition of monogastrics. The study is therefore designed to make use of *Gmelina arborea* fruit based on its nutritional quality which include high crude protein (16.2%), high caloric value (gross energy value of 106.7kcal/kg), 35% ether extract, ADF, NDF and hemicellulose values of 57.5, 78.9 and 26.4% respectively, with a total Ash of 2.5% and 1.0% NFE (Ogundun, 2001: The physical parameters and nutritional value of Gmelina arborea fruits, B.Sc. Agric., A. B. U. Zaria, Nigeria). Besides, the study was carried out to find ways of preventing the wastage that occurs annually from tons of the fruits from the Gmelina trees widely grown all over Nigeria.

MATERIALS AND METHODS

Gmelina arborea fruits used were collected from the University of Ilorin campus premises from the months of December and January of the year. The ripened, yellow succulent fruits were sun-dried to enable easy grinding before milling into flour using an attrition miller (Model YL112M-4, No.98100315; Manufactured by: Viking Exclusive Joncod, Britain). The desired quantity of the meal was subjected to anaerobic fermentation, followed by lyle treatment. Lyle preparation was carried out by burning the husks from *Parkia filicoides* to ash. Parkia usually gives an unconventional alkali, lyle, of high pH from its ash. 10kg ash was dissolved in 100litres of tap water and allowed to extract for a week. The resulting lyle was filtered using a muslin cloth producing a 10% alkali solution with a pH of 11.5. Anaerobic fermentation was conducted by soaking some GAF flour in tap water for an hour. The dough was subsequently removed, packed in doubled-layered polythene bags and tied to exclude air. The bags were stored in a 200-litre empty steel drum and sealed up to ensure an airtight system. At the end of one week, the fermented stuff was removed. The fermented material was then soaked in the lyle for 48hrs after which it was strained with a cloth and sun-dried to constant weight prior to incorporation into the experimental diets. The resulting lyle so

formed was filtered via a muslin producing an alkali solution of high pH. The fermented material was then soaked in the lyle for 48hrs after which it was strained and sun-dried to constant weight prior to incorporation in the experimental diets.

Four iso-nitrogenous and iso-energetic diets were formulated containing 10, 20 and 30% graded levels of raw GAF meal and 30% fermented-lyle treated GAF meal. The diet containing fermented-lyle treated GAF meal served as a negative reference diet (1).

The experiment was designed as a one way classification model. There were four treatments each replicated four times. 16-Hampshire breed of piglets, 8-male and 8-female (from a standard piggery farm in Ilorin), weighing on average 12.40 +\-0.5kg, were used for the feeding trial.

The piglets were randomly allotted into four treatment groups and placed in individual stalls and fed the experimental diets presented in Table 1. The piglets were gruel-fed twice daily at 800 and 1600hrs. Gruel-feeding was adopted because the pigs tended to consume more feed when fed in this way than when dry-fed (Erickson et al., 1978). Both feed and water were supplied to appetite in a feeding trial which lasted for 28 days.

Sample collection and preparation

At the end of the experiment, blood samples were taken from each pig by ear-vein procedure (Blood et al., 1979) for the analysis of blood cell corpuscles, packed cell volume (PCV), red blood cells (RBC), white blood cells (WBC), haemoglobin (Hb) including mean corpuscle haemoglobin concentration, corpuscle volume, neutrophils and lymphocytes. Blood for the analysis of corpuscles and differential counts was collected in test tubes containing ethylene diamine tetracetic dipotassium salt (EDTA) while the samples for the analysis of tissue soluble enzymes, blood glucose, total protein, albumin, total lipid, blood urea nitrogen (BUN) and creatinine were taken in test tubes, allowed to stand for sometime before centrifuging at 92.6g relative centrifugal force for 15min to obtain clear sera.

Serum was used for the analysis of activities of the enzymes aspartate amino transferase (AST., EC 2.6.1.1), alanine amino transferees (ALT., EC 2.6.1.2) and alkaline phosphatase (AP., EC 3.1.3.1).

Urine collection was made by placing a container with 5ml hydrochloric acid (as preservative) underneath the metabolic cage of each animal. 100ml urine was taken from the total collection from each animal and preserved in a deep freezer for subsequent analysis.

Chemical analysis

The experimental diets (Table 1), *Gmelina arborea* fruits meal both raw and treated (Table 2) were analysed for proximate composition following the outlined standard procedures (4). Analyses of blood samples were carried out as described by the current conventional methods (Adewuyi and Olatunji, 1995) while urine samples, enzymes and serum constituents were carried out following the outlined procedures (Singh, 1990).

Statistical analysis

All data collected were subjected to analysis of variance, ANOVA appropriate of the experimental design and where significant differences existed, treatment means were compared using Duncan`s Multiple Range Test (Duncan, 1955) at 5% level of probability.

RESULTS

Table 3 shows the effects of diet containing raw and processed GAF meal on haematological indices in wean pigs. There

Table 1: Composition of experimental diets (%)

Ingredients	DIETS			
	1	2	3	4
Maize	42.03	57.03	50.03	42.03
GAF meal	30.00	10	20	30
Soybean meal	24.90	29.00	26.90	
Lysine	1.01	1.01	1.01	1.01
Dicalcium phosphate	0.71	0.71	0.71	0.71
Ground limestone	0.90	0.90	0.90	0.90
Sodium chloride	0.25	0.25	0.25	0.25
Mineral-vitamin premix	0.10	0.10	0.10	0.10
Anti-microbial premix*	0.10	0.10	0.10	0.10
TOTAL	**100**	**100**	**100**	**100**
Analysed nutrient content of the experimental diets				
Dry matter	89.99	81.59	81.13	79.10
Crude protein	20.82	20.86	20.64	20.82
Crude fibre	23.91	10.30	16.73	23.40
Ash	3.78	3.63	3.15	2.95
Ether extract	20.40	21.03	21.70	23.85
Nitrogen free extract	13.08	25.17	18.91	8.08

**Antimicrobial premix, Furazolidone (Pfizer product).*

was no statistically significant difference in blood corpuscles between pigs fed diets containing raw and processed GAF meal (p >0.05), neither was there significant difference in mean corpuscle haemoglobin or corpuscle volume. However, significant difference was recorded in percent neutrophils

Table 2: Proximate composition of raw and procesed *Gmelina arborea* fruits meal

Parameters	Raw GAF meal	Treated GAF meal
Dry matter	78.10±1.30	83.31±0.40
Crude protein	17.56±0.33	18.41±0.43
Crude fibre	68.18±0.41	69.88±0.47
Ether extract	22.90±0.45	18.60±0.15
Ash	3.63±0.07	10.68±0.05
Nitrogen free extract	15.83±0.41	18.60±0.15

GAF = *Gmelina arborea* fruits meal (average of 3-trials).

and lymphocytes in pigs receiving diets with raw and treated GAF meal ($p < 0.05$). There was no significant difference in the measured sero-biochemical parameters of blood glucose, serum total protein, albumin and serum total triglycerides ($p > 0.05$) though values of these parameters tended to decrease with increasing level of raw GAF meal in diets (Table 4). Similarly, no significant difference was recorded in the metabolites, blood urea nitrogen, BUN or creatinine but values of these parameters on diet with treated GAF meal (30%) and the diets containing low levels of raw GAF meal were seemingly lower than those on the diet with high level of raw Gmelina meal (30%). There were no significant differences in the activities of aspartate and alanine amino transferases or alkaline phosphatase ($p > 0.05$) in pigs offered raw or processed GAF meal diets (Table 5).

Table 3: Haematological indices of pigs fed raw and processed GAF based diets.

Diets	PCV (%)	RBC ($x10^{12/L}$)	WBC ($x10^{9/L}$)	HB (g/dl)	Mean corp. Hb conc.	Mean corp. volume	Neutrophils (%) *	Lympho-cytes (%) *
1	36.50±1.30	3.88±1.00	14.28±4.74	14.13±1.72	34.00±1.30	86.75±7.72	$21.00^{ab \pm 5.32}$	$90.00^{b \pm 5.72}$
2	31.75±2.36	3.73±0.47	12.45±5.58	13.70±0.63	33.75±2.10	84.25±5.32	$20.50^{ab \pm 7.12}$	$79.50^{a \pm 6.80}$
3	31.75±3.10	3.71±0.30	10.93±5.16	10.58±1.24	33.50±1.00	82.00±2.63	$20.00^{b \pm 4.24}$	$78.00^{a \pm 3.77}$
4	29.50±3.10	3.71±0.55	8.28±6.65	10.00±1.00	33.00±1.41	80.50±2.87	$9.75^{a \pm 6.24}$	$77.75^{a \pm 5.59}$

Means in the same column not sharing common letters differed significantly ($p < 0.05$)

Table 4: Serum glucose and other metabolic indices of pigs fed raw and processed GAF based diets.

Diet	Blood glucose (mmol/L)	Total protein (mmol/L)	Total triglycerides (mmol/L)	Albumin (mmol/L)	BUN* (mmol/L)	Creatinine (mmol/L)
1	4.88±1.26	74.75±5.19	1.08±0.29	54.75±5.12	0.65±0.49	113.00±0.86
2	4.87±0.98	74.00±5.97	1.00±0.28	54.74±5.59	0.90±0.22	115.25±0.51
3	4.65±0.99	68.75±3.69	0.97±0.10	56.80±4.04	0.95±0.06	127.25±0.73
4	4.45±0.97	68.50±5.87	0.88±0.33	51.75±4.35	1.05±0.31	131.00±0.55

**BUN, blood urea nitrogen.*

Table 5: Serum aminotransferases and alkaline phosphatase levels in pigs fed raw and processed GAF based diets.

Diet	AST (IU/L)	ALT (IU/L)	AP (IU/L)
1	37.00±17.57	23.50±8.37	31.20±8.43
2	47.75±14.91	27.25±7.40	33.50±7.58
3	55.50±17.97	31.00±5.45	34.25±5.84
4	57.75±11.25	34.50±6.60	41.50±7.50

AST, aspartate amino transferase., ALT, alanine Amino-ransferase., AP, alkaline phosphatase.

Table 6: Urinary urea, urate and creatinine levels in pigs fed raw and processed GAF based diets

Diet	Urea (mmol/l)	Uric acid (mmol/l) *	Creatinine (mmol/l)
1	12.35±0.19	$0.30^{a \pm 0.01}$	163.50±0.45
2	13.08±029	$0.35^{a \pm 0.02}$	181.00±1.10
3	13.75±0.33	$0.47^{b \pm 0.05}$	203.50±0.22
4	14.00±0.08	$0.50^{b \pm 0.02}$	322.25±0.17

**Means in the same column not sharing common letters differed significantly ($p < 0.05$).*

DISCUSSION

The haematological parameters investigated showed that neutrophils and lymphcytes in pigs fed raw and processed GAF meal in diets differed significantly. Low count or reduction in values was recorded on these two blood fractions with increasing raw GAF meal in diets probably due to one or a combination of the raw GAF phytotxins namely tannins, tartaric acids or benzoic and butyric acids (Little, 1983). The improved leucocytes, lymphocytes and neutrophils count in pigs fed processed GAF meal diet serve to indicate an improvement in the nutritive value of the treated Gmelina meal based diet. Observations in blood corpuscles and differential counts in this study tallied with past works (Orji et al., 1992) who reported similar results in guinea fowls fed test diets containing pigeon pea. The improved lymphocytes count in pigs fed treated GAF meal diet might serve to indicate an improvement in the nutritive value of the processed Gmelina meal based diet. The blood glucose level, total lipid, serum total protein and albumin values were not significantly different on all the test diets though groups of pigs maintained on the treated GAF meal diet, control containing 30% treated GAF meal and the group on the diet with 10% raw GAF meal gave high values for the parameters determined indicating that the two diets (30 and 10% treated and raw GAF respectively) had no adverse effects on the test animals. The metabolites, blood urea nitrogen and creatinine as well as enzyme activities followed a trend similar to blood glucose, lipid, protein and albumin. However, blood urea nitrogen and creatinine values on the diet with 30% treated GAF meal and 10% raw meal diets appeared to be low. Analyses of urea, uric acid and creatinine from urine samples showed that only uric acid was significantly influenced by increasing level of raw GAF meal in diets. Uric acid is a primary metabolic product of protein metabolism (Eggum et al., 1982). Increase in uric acid values in pigs maintained on diets containing 20 and 30% raw GAF meal (compared to the 30% treated) reflects the

poor or low protein nature of the diets in question.

In summary, the pigs fed diets containing graded levels of *Gmelina arborea* fruits meal performed well considering the parameters investigated whereas pigs fed treated GAF meal diet, 30% and low raw GAF meal diet, 10% exhibited better performance and, likewise results of enzyme profile and blood parameters indicated that GAF is relatively non-toxic to pigs and leading to the conclusion that GAF, when anti-nutritional factors are removed or when fed raw at low inclusion level of 10%, may serve a useful alternative feedstuff for animals.

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