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Performance and nutrients digestibility of young pigs fed dietary raw and processed *Gmelina arborea* fruits

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Abstract

A feeding trial to study the effects of dietary *Gmelina arborea* fruit (GAF) meal on performance and nutrients digestibility of young piglets, was conducted. 16 male piglets averaging 12.40 ± 0.55kg were randomly allotted to four dietary treatments designated as 30% treated *Gmelina arborea* fruit based diet (negative control diet 1) and three other diets containing 10, 20 and 30% raw *Gmelina arborea* fruit meal. Feeding and water supply were given to appetite during a 42-day feeding experiment. Significant difference was observed in body weight gain ($P < 0.05$). There were significant differences in apparent digestibility of dry matter, daily intake and metabolizable energy ($P < 0.05$). Statistically significant differences were recorded on nitrogen intake, faecal nitrogen excretion, daily-retained nitrogen and the corresponding nitrogen retention coefficient ($P< 0.05$). Both performance and digestibility parameters were high and showed improvement on 30% treated or diet containing low inclusion of raw GAF meal (10%). It was concluded that *Gmelina arborea* fruits when processed or included raw at low levels from 10% in diets has no adverse effects on the performance and nutrients utilization in livestock.

Key words: *Gmelina arborea fruits, piglets, performance, nutrients digestibility.*

INTRODUCTION

The need for the production of animals/animal products cannot be overemphasized because animal products supply proteins and other nutrients of high quality to man.

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In Nigeria and other developing countries, a large percentage of the population subsists mainly on grains, roots and tuber crops, which supply proteins that are inferior to those of animal origin. This being the case, animal protein is becoming one of the most limiting nutrients in diets of the countries in question [1]. Available data [2] showed that the 68g animal protein intake per head per day recommended for maintenance is yet a dream with Nigeria consuming about 18.7g [3] against the minimum recommendation of 35g [4] while the recommended 85.9g protein intake for growth and development is a mirage in many countries. For these reasons, it is necessary to find means of increasing livestock production so as to make adequate protein supply a reality.

The problems that crop up in developing countries when increase in animal production is considered are scarcity of conventional feedstuffs and competition between man and animal especially the monogastric animals reared on intensive system which share similar foods with man. Thus, the increased competition and dearth of feed have necessitated research into unconventional feedstuffs not consumed by man to meet the nutritional requirements of animals. The Federal Government of Nigeria set up a Presidential Task Force (PTF) on Alternative Formulations of Livestock Feeds in response to the situation of the livestock feed industry. The experiment on the use of *Gmelina arborea* fruits therefore aims at sourcing non-conventional and locally available feed materials to be used as alternatives in place of the conventional ones. This work would also supply data on the nutritive value of such novel feed materials for subsequent uses. Early studies [5] demonstrated that *Gmelina* foliage and bark are eaten by cattle while the seeds and foliage are consumed by rabbits and deer. Further works [6] revealed that *Gmelina* leaves are harvested for fodder for animals and silkworms and that humans once consumed the bittersweet fruits.

MATERIALS AND METHODS

Source and treatment of test feedstuff

Gmelina arborea fruits (GAF) used for this study were collected from the University of Ilorin campus premises. The ripened, yellow succulent fruits were sun-dried to enable proper grinding into flour. The meal was soaked in tap water for two hours and the dough packed in double-layered polythene bags and tied to exclude air. The bags were placed in a 200-litre empty drum and sealed up to ensure an airtight system. At the end of 7-days, the fermented stuff was removed and soaked in *lyle* (unconventional alkali) prepared with *Parkia filicoides* pods ash. *Parkia filicoides* pod was chosen for this purpose because of its generation of exceptionally high alkalinity. 10kg ash was dissolved in 100 litres of tap water and allowed to extract for a week. The resulting mixture was filtered using a muslin cloth producing an alkaline (*lyle*) solution. 1kg/litre (w/v) GAF dough was soaked in the *lyle* for 48hrs after which it was strained, sun-dried prior to incorporation in diet.

Diets preparation, animals and feeding trial

Four iso-nitrogenous (20%) and iso-caloric diets were formulated containing 10, 20 and 30% levels of raw GAF meal and one of the diets contained 30% treated meal. Raw GAF meal was prepared by sun-drying the ripened yellow fruits, which were then ground into flour. The diet with 30% treated GAF meal was considered as a negative control diet (since the performance of livestock on the standard ration has already been established). Sixteen young male pigs (average live weight of 12.40 ± 0.55kg) were used for the trial.

Pigs were randomly allotted to four treatments of 4 pigs per treatment in a complete randomised design [7] and housed in separate metabolic cages during the first week of adjustment period. The pigs were fed the test feedstuff in diet to flush out any existing foreign material in the gastro-intestinal tract (GIT) and to enable them adjust to the environment. After the one week of adjustment, the experimental diets shown in Table 1 were fed to the piglets for 2-weeks to collect data on digestibility experiment. The pigs were gruel-fed twice daily at 8.00hr and 16.00hr respectively.

After the two weeks of feeding to collect data on digestibility, the pigs were kept in individual pens and given the experimental diets for another 4-weeks period for the collection of data on the performance. Both feed and water were supplied to appetite during the trial period. Response criteria considered for the digestibility trial were the digestibility of organic and dry matter, nitrogen and energy including digestible and metabolizable energies. Digestible and metabolizable energies were conducted by recording data during the feeding trial on feed consumption, faecal output and urine. The collection of faeces and urine were carried out by placing the individual piglet on a particular diet in a metabolic cage built with facilities for faeces and urine collection. Faeces were collected daily for four days a week after the commencement of the experiment from the groups of animals on the four experimental diets. The faecal samples were oven-dried between 60-70^{0}C to constant weight and the weights taken. Urine from each animal was collected by placing a container under the metabolic cage containing 5ml concentrated hydrochloric acid as preservative and the total urine collected was recorded on a daily basis for four days. 100ml of the total urine volume pooled from each animal was taken in plastic bottles and stored in a deep freezer at -4^0C for subsequent chemical analysis. For the determination of performance, data was collected on feed intake, growth rate, feed efficiency and the survival rate.

Chemical analysis

The proximate composition of the experimental diets (Table 1), treated and raw GAF meals and the faecal samples were analysed following the standard procedures outlined by AOAC [8]. Samples were analysed for dry matter, crude protein, ether extract, crude fibre and ash while nitrogen free extract was obtained by difference. The determination of digestibility, gross energy, digestible energy, metabolizable energy and other indices were mathematically calculated following the laid down formulae [9] as follows: metabolizable energy (ME) = 53 + 38(%CP) + 2.2(%EE) + 1.1(%NFE) + 0.22 (%CF).

Statistical analysis

Data obtained were subjected to analysis of variance (ANOVA) and where statistical significant differences were observed, treatment means were compared using the Duncan`s multiple range test [10].

RESULTS

Table 2 shows the proximate composition of raw and treated *Gmelina arborea* fruit (GAF) meal. Treatments increased the nutrients (dry matter, crude protein, fibre, fat, mineral matter and nitrogen free extract) contents of the test feed material compared to the untreated GAF. Table 3 presents the performance data of pigs fed raw and processed GAF meal in diets. There was no significant difference in feed intake among the four treatments ($P > 0.05$). Animals fed 30% unprocessed *Gmelina* based diet (diet 4), seemed to consume less of feed compared with the groups receiving 30% treated and 10% untreated *Gmelina* meal diets. However, growth rate was significantly different among the treatments ($P < 0.05$). Pigs on diets with 30% treated GAF and 10% level of untreated *Gmelina* meal gained weight faster than those fed 20 and 30% untreated *Gmelina* meal. There was no significant difference ($P > 0.05$) in feed conversion ratio though animals offered 30% treated *Gmelina* meal in the diet had seemingly better feed efficiency compared to the other diets.

Table 1: **Composition of the experimental diets on as-fed basis (%).**

	DIETS			
	1	2	3	4
Treatments	30% treated GAF	10% raw GAF	20% raw GAF	30% raw GAF
Ingredients				
Maize	42.04	57.74	50.00	42.00
Gmelina meal	30.00	10.00	20.00	30.00
Soybean meal	24.90	29.00	26.90	24.74
Lysine	1.00	1.20	1.30	1.40
Dicalcium phosphate	0.71	0.71	0.45	0.51
Ground limestone	0.90	0.90	0.90	0.90
Sodium chloride	0.25	0.25	0.25	0.25
Min.-Vit. Premix	0.10	0.10	0.10	0.10
*Antimicrobial premix	0.10	0.10	0.10	0.10
Total	100	100	100	100
Analysed nutrients content				
Dry matter	91.99	90.59	91.13	90.10
Crude protein	20.82	19.86	20.64	20.82
Crude fibre	20.91	14.30	16.73	23.40
Ether extract	23.40	27.03	28.70	25.85
Ash	3.78	3.23	3.15	2.95
Nitrogen free extract	23.08	26.17	21.91	17.08

*Antimicrobial premix, Furazolidone.

Table 2: **The chemical analysis of raw and treated *Gmelina arborea* fruits, GAF meal.**

Nutrients	Raw GAF meal	Treated GAF meal
Dry matter	78.10 ± 2.70	83.31 ± 1.00
Crude protein	17.56 ± 0.80	18.41 ± 0.50
Crude fibre	34.01± 1.84	35.61 ± 0.70
Ether extract	21.90 ± 1.16	22.60 ± 0.25
Ash	3.63 ± 0.37	4.68± 0.56
Nitrogen free extract	15.83 ± 0.49	18.60 ± 1.08

Each value in the table is derived from the average of 3 experimental diets.

Table 3: **Effects of raw and treated GAF meal based diets on the performance of young pigs.**

	DIETS				
	1	2	3	4	SEM
Parameters	30% treated GAF	10% raw GAF	20% raw GAF	30% raw GAF	
Mean daily feed intake (g/p/d)	1000.50	998.50	996.00	979.75	2.3
Mean daily weight gain (g/p/d)	341.25[a]	321.75[a]	262.00[b]	259.25[b]	4.8
Feed conversion ratio	2.94	3.16	3.84	3.95	0.63
Survival (%)	100	100	100	100	

a-b means in the same row not sharing common letters differed significantly from the control ($P < 0.05$).

There was no death recorded throughout the study period and the animals maintained good health throughout the 42-day feeding trial. Table 4 shows the apparent digestibility of the GAF- based diets by pigs. There were significant differences ($P < 0.05$) in digestibility of nutrients namely dry matter, protein and fibre ($P < 0.05$), but no significant difference was recorded for fat digestion ($P > 0.05$). There were significant differences in dry matter intake, daily absorbed and metabolizable energy ($P < 0.05$). No significant differences ($P > 0.05$) were observed on gross energy intake, digestible energy or daily-retained energy.

Table 5 shows the nitrogen balance of the pigs offered GAF in the experimental diets. There were significant differences ($P < 0.05$) in the daily nitrogen intake, daily faecal nitrogen output, daily retained and apparent nitrogen digestibility as well as the corresponding nitrogen retention coefficients.

DISCUSSION

Subjecting GAF to fermentation and *lyle* treatments increased its nutritional value as the nutrients present in it were observed to increase. This increment in nutritional value following treatment is of nutritional advantage to the animals offered the treated GAF in diet. Weight gain on the control with 30% treated and the diet containing 10% untreated GAF meal was improved relative to that on diets with 20 and 30% raw GAF meal. The poor growth rate observed on diets containing untreated *Gmelina* meal could be attributed to many factors. These are the high fibre found in the GAF and the anti-nutritional principles present in the native GAF namely high fibre (since pigs being monogastrics could not utilize high fibre [11] and the presence of chemical anti-nutrients in GAF like benzoic and butyric acids, tannins, tartaric acids which might have hindered increase in weight [6]. The absence of mortality on the experimental diets suggest that *Gmelina arborea* fruits are less or non-toxic to pigs and also might serve to buttress the claim that pigs may respond differently to toxicants in some raw feedstuffs than their counterparts [12].

There were significant differences in digestibility of dry matter, protein and fibre. Dietary GAF also influenced metabolizable energy as well as daily energy absorbed/retained. Values on these parameters decreased with increasing level of raw GAF meal in diets. Conversely, there was improvement in the digestibility of these nutrients following GAF treatments or when low level of raw GAF was fed incorporation raw at a low level. Results of this work also agreed with the past findings on the use of fibrous feedstuffs [13, 14] which showed that treatment of high fibre feedstuffs with alkali could assist in breaking ligno-cellulose complex walls releasing nutrients and enhancing digestibility.

Results on nitrogen balance followed a trend similar to the other nutrients discussed. High nitrogen utilization on the 30% treated and 10% raw GAF meals suggested improved or better nutritional value of the test feedstuff treated or included at low levels.

Pigs fed 30% treated or 10% unprocessed GAF meal diet showed improved performance and nutrients digestibility than those fed high levels of untreated GAF meal in diets. For GAF to serve as an alternative feedstuff for livestock, it has to be treated or included at low levels from 10% in diets.

Table 4: **Effects of diets containing raw and treated GAF meal on apparent digestibility of nutrients in the experimental pigs (%)**

	DIETS				
	1	2	3	4	SEM
Parameters	30% treated GAF	10% raw GAF	20% raw GAF	30% raw GAF	
Dry matter	88.95[a]	85.49[a]	82.20[a]	72.27[b]	1.4
Crude protein	92.86[a]	90.18[a]	85.79[b]	84.25[b]	2.1
Crude fibre	83.68[a]	67.09[b]	62.39[c]	58.71[d]	22.8
Crude fat	96.62	95.39	95.16	94.00	1.8

a, b, c, d means in the same row not sharing common letters differed significantly from the control ($P < 0.05$).

Table 5: **Effects of diets containing raw and treated GAF meal on comparative energy utilization in young pigs**

	DIETS				
	1	2	3	4	SEM
Parameters	30% treated GAF	10% raw GAF	20% raw GAF	30% raw GAF	
Dry matter intake g/p/d	816.62[a]	814.68[a]	811.30[a]	771.53b	3.7
Gross energy intake Mcal/kg	3.81	3.81	3.82	3.66	0.18
Energy digestibility (%)	90.28	87.84	85.07	80.97	0.75
Daily absorbed energy Kcal/kg	3435.38[a]	3349.20[a]	3250.80[b]	2967.15c	8.7
Digestible energy (Kcal/kg)DM	61.30	61.30	60.91	57.93	1.0
Daily retained energy Kcal/kg	3434.37	3347.92	3249.69	2966.47	4.15
Metabolizable energy MJ/kg) DM	50.27[a]	50.27[a]	49.95[b]	47.51b	0.5

a, b, c, means in the same row not sharing common letters differed significantly ($P < 0.05$).

Table 6: **Effects of diets containing raw and processed GAF meal on nitrogen balance values in young pigs.**

	DIETS				
	1	2	3	4	SEM
Parameters	30% treated GAF	10% raw GAF	20% raw GAF	30% raw GAF	
Nitrogen intake g/p/d	29.19[a]	27.20[a]	26.79[b]	25.70[b]	0.3
Faecal nitrogen output (g/p/d)	1.94[a]	2.67[b]	3.65[c]	4.22[d]	0.2
Daily retained nitrogen (g/p/d)	27.25[a]	24.53[a]	23.14[b]	21.50[b]	0.4
Apparent nitrogen digestibility (%)	92.87[a]	90.18[a]	85.80[b]	84.25[b]	1.0
Nitrogen retention coefficient	0.933[a]	0.901[a]	0.863[b]	0.840[b]	0.1

a, b, c, d means in the same row not sharing common letters differed significantly from the control ($P < 0.05$).

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