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Alagbe Olujimi John *

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Research Article

Doum Palm Meal (Hyphaene Thebaica) and Partial Maize Substitution: Impact on The Blood Biochemical Indicators of Weaned Pigs

Alagbe Olujimi John

Sumitra Research Institute, Gujarat, India; Department of Animal Nutrition and Biochemistry.

***Corresponding author:** Alagbe Olujimi John, Sumitra Research Institute, Gujarat, India; Department of Animal Nutrition and Biochemistry.

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Abstract:

This study looked at how weaned pigs' blood biochemical indicators were affected when doum palm meal (DPM) was used in part lieu of maize. After being weaned at 28 days of age and weighing 7.40 ± 0.09 kg at birth, fifty Landrace × Duroc crossbred pigs were divided into divisions based on their body weights and given five distinct experimental diets. Over the course of a ninety-day fully randomized design experiment. Diets 1, 2, 3, 4, and 5 were fed 0 %, 5 %, 10 %, 15 %, and 20 % DPM in place of maize. The NRC (2012) states that the experimental diet satisfied the pigs' needs, and clean water was provided daily and at will. DPM had the following elements: manganese (0.91 mg/100g), zinc (0.72 mg/100g), copper (0.35 mg/100g), iron (5.60 mg/100g), calcium (371.20 mg/100g), potassium (966.31 mg/100g), phosphorus (206.19 mg/100g), magnesium (150.67 mg/100g), and zinc. The values of total serum protein, albumin, globulin, creatinine, alanine phosphatase, aspartate transaminase, sodium, potassium, calcium, phosphorus, and bicarbonate were not affected (P>0.05) by the treatments, with the exception of the glucose level, which was higher (P<0.05) in D1 than in the other treatments. It has been shown that DPM can partially replace up to 20% of maize without causing metabolic problems or adversely influencing the health of the animals.

Key words: swine; doum palm; maize; serum; minerals; phytochemicals

Introduction

The high cost of other high-energy concentrate feed and the scarcity of grain make swine feed expensive in underdeveloped nations [1]. [2] states that 70–80 % of the overall cost of producing livestock is spent on feed, with a significant portion of this cost being attributable to the high price of maize on the market [3]. A common staple grain in many parts of the world, including Asia, Latin America, and Africa, is maize (Zea mays L.). A common feed grain and energy source for cattle, maize is fed to them as part of their diets [3]. When estimating the nutritional worth of other grains, especially their energy content, maize is usually compared to them [4, 5].

Maize is a common cereal grain in Nigeria that is fed to chickens and consumed by humans alike. However, given its increased demand for various processing industries, maize availability in Nigeria both now and in the future is in doubt. The use of cereal grains, especially maize, as a source of starch industry appears to justify the ongoing price increases of standard chicken feeds [6,7]. Given the circumstances, it is necessary to assess additional locally accessible non-conventional feed sources and include the most promising ones into the diets of chickens.

One potential replacement is the doum palm fruit (Hyphaene thebaica), which is abundant in essential minerals like potassium, salt, calcium, magnesium, phosphorus, and other nutrients [8]. The plant belongs to the Arecaceae family and is endemic to Egypt, sub-Saharan Africa, and west India, especially Gujarat [9]. The tree is dichotomous and arborescent in nature, and it has been called one of the world's useful plants [10]. Although the leafy stem is used for construction, the foliage is used to make hats, mats, ropes, and baskets [11]. The doum palm is used to treat bilharziasis and its fruit is sometimes chewed to decrease high blood pressure [12, 13]. [14] reported that the doum palm fruit pulp's proximate composition included the following: protein (2.86%), fat (0.92%), ash (6.24%), crude fiber (12.87%), moisture (8.64%), and carbohydrates (68.47%). Similar findings were made by [9] who recorded a crude protein of 2.92 percentage, ether extract (0.49 percentage), crude fiber (15.14 percentage), and metabolizable energy (2254.5 kcal/kg) for DPM. A wealth of information exists regarding the impact of partially substituting doum palm with maize on the serum biochemical indices of weaned piglets, despite the fact that there are numerous papers on the use of doum palm fruit in poutry. Timely assessment is essential to minimize feed costs, boost animal protein, and optimize the use of the test item.

Determining the impact of doum palm meal on the serum biochemical indicators of the weaned piglets was the aim of this investigation.

Methodology

Site of investigation and ethical criteria

The animals division of Sumitra Research Institute, situated in Gujarat, India at 23° 13' N and 72° 41' E, is where the experiment was carried out from March to June, 2023. Every part of management was carried out with the institute's ethical standard (ASF/08A/2023).

Acquiring and preparing dry doum palm meal (DPM)

The doum palm's ripe fruits were gathered from Gujarat's Sumitra Research Farm and arranged in tidy, level iron trays. It was identified and sent to the same institute's Department of Crop Production. To separate the outer part from the kernel, the dried fruits were seperated in a mortar and pestle. Each sample was then collected into a separate, sterile plastic bucket. After being further ground into tiny particles in a hammer mill, the mesocarp was kept in an airtight container with a clearly marked label. Before samples were were taken to the lab for chemical analysis.

Animal treatment, feed, and design of experiments

At 28 days, 50 Landrace × Duroc piglets, weighing an average of 7.40 ± 0.09 kg at birth, were weaned and relocated to sterile nursery cages from Sumitra Teaching and Research Farm. During a 14-day quarantine, the animals received treatment with Oxytrox® (long-acting antibiotics) at the recommended dosage as well as injections of Ivermecin®, which fights ecto and endo parasites. After the acclimation phase, the pigs were divided into five treatments of ten pigs each, all of whom were housed individually in 1.7-square-meter pens with open sides measuring 10 m × 5-m × 5-m. The pigs were grouped according to their body weight. The pens that each held an animal measured. Five experimental diets were created using different amounts of Doum palm meal (DPM) to substitute maize on a dry matter basis (Table 2). Diet 1 (D1) included no DPM, while diet 2 (5%), diet 3 (10%), diet 4 (15%), and diet 5 (20%) DPM levels. Diets were developed based on the National Research Council's [15] guidelines for pig needs.

Three feeding times a day were arranged: at 7:00, 12:00, and 17:00. Daily, limitless access to clean water was provided. The weight of the feed supplied the day before was subtracted from the weight of the leftover feed to establish the amount consumed.

Chemical evaluation

The Lionat® near-infrared feed analyzer (Model: CF-007HSD, China) was used to perform a chemical evaluation on DPM and trial diets. After inserting 200 grams of each sample into the sample cap or entry channel, thereafter the cap is placed on the metallic lid of the machine’s tray, pressing the scan button allows you to examine the results just in time (1 minutes).

Analysis of minerals was carried out using Labocon atomic absorption spectrophotometer LAAS - 100 series which offer superior baseline stability of 0.002 A/30 minutes with advanced optical system to ensure fast and reliable results. The machine has the following general specification; resolution (< 30 %), baseline stability (0.005 A/30 minutes).

Phytochemical analysis of doum palm meal was evaluated adopting standard laboratory procedures outlined by [23].

Statistical analysis used in the experiment

Using the Statistical Analysis System Software (SAS), all collected on serum biochemical parameters underwent a one-way analysis of variance. The SAS Turkey test was used to separate the means, and significant differences were identified at P<0.05.

Feedstuffs	D1 (0 %)	D2 (5 %)	D3 (10 %)	D4 (15 %)	D5 (20 %)
Yellow maize	53.00	48.00	43.00	38.00	33.00
doum palm meal (DPM)	0.00	5.00	10.00	15.00	20.00
Rice bran	10.00	10.00	10.00	10.00	10.00
S/cake	14.00	14.00	14.00	14.00	14.00
GNM	17.50	17.50	17.50	17.50	17.50
B/meal	3.00	3.00	3.00	3.00	3.00
O/shell	1.55	1.55	1.55	1.55	1.55
Lysine	0.20	0.20	0.20	0.20	0.20
Methionine	0.30	0.30	0.30	0.30	0.30
Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.35	0.35	0.35	0.35	0.35
Total	100.00	100.00	100.00	100.00	100.00
Determined analysis					
Crude protein (%)	18.77	18.67	18.30	18.25	18.20
Energy (Kcal/kg)	2788.5	2700.0	2695.4	2690.0	268.0

Mineral/Vitamin premix supplied per kg diet: - vit A, 8,500 I.U; vit E, 10.91 mg; vit D3, 2500I.U, vit K, 3.2mg; vit B2, 5.0mg; Niacin, 40 mg; vit B12, 25 mg; choline chloride, 100 mg; Mn, 5.0 mg; Zn, 35.1mg; Cu, 2.0g; folic acid, 2.5mg; Fe, 5.8g; pantothenic acid, 10mg; biotin, 30.5g; antioxidant, 56mg; S/cake: soya cake; GNM: groundnut meal; B/meal: bone meal; O/shell: Oyster shell

Table 1(T1): Diet composition chemical analysis

Results and Discussion

Chemical evaluation of DPM

In Table 2, the chemical evaluation of DPM reveals that ether extract and crude protein values of 5.35 % and 1.90 % were less than the 6.09 % and 1.75 % reported by [16]. Because the sample's crude protein concentration is low (less than 30 %) and it cannot be used to replace protein sources in the diet of monogastric according to [15]. The study's 13.51% crude fiber content was more than the 12.87 % reported by [14]. The experimentally reported ash content is consistent with the results of [17], whereas the reported energy level is consistent with those of [18].

Constituents	Composition (percentage)
C/ protein	5.35
C/ fibre	13.51
E/extract	1.10
Ash content	7.83
Metabolizable energy (kcal/kilogram)	2610.7

C/protein: crude protein; C/fibre: crude fibre; E/extract: ether extract

Table 2: Chemical evaluation of DPM

Copper had the lowest concentration (0.35 mg/100g) and potassium had the highest concentration (966.31 mg/100g) in the mineral composition of doum palm meal (Table 3). Calcium, potassium, phosphorus, sodium, magnesium, iron, manganese, zinc, and copper are listed in order of abundance. The results of this experiment showed greater values for calcium (371.20 mg/100g), phosphorus (206.19 mg/100g), and iron (5.60 mg/100g) than those reported by [19] (336.00 mg/100g, 200.8 mg/100g, and 4.86 mg/100g). The potassium (966.31) value for fresh doum meal was less than that of the reports made by [18]. These differences might result from the test ingredients' species or processing technique [20, 21].

Constituents	Concentrations (mg/100g)
Calcium	371.20
Potassium	966.31
Phosphorus	206.19
Magnesium	150.67
Manganese	0.91
Zinc	0.72
Copper	0.35
Sodium	177.52
Iron	5.60

Table 3: Mineral composition of doum palm meal

Phytochemical composition of doum palm meal is presented in Table 4. Flavonoids had the highest concentration (2705.1 mg/100g) while saponins had the lowest concentration (0.66 mg/100g). These bioactive compounds have therapeutic properties and their concentration in the plant tissues is considered as the main factor to evaluate the therapeutic value and quality of a given herb [22]. For instance, alkaloids are believed to function as defensive elements against predators, especially mammals because of their general toxicity and deterrence capability [23]. Phenolic compounds have antioxidant, anti-inflammatory, anti-carcinogenic and other biological properties and may prevent oxidative stress [24].

Table 4 displays the phytochemical composition of doum palm meal. Flavonoids had the highest concentration (2705.1 mg/100g), whereas saponins had the lowest content (0.66 mg/100g). These bioactive compounds have therapeutic properties, and it is believed that a herb's concentration in the plant tissues is the main factor determining its quality and therapeutic efficacy [22]. For instance, alkaloids are believed to function as defensive elements against predators, especially mammals, due to their general toxicity and deterring impact [23]. Per [24], phenolic compounds have biological properties that include anti-inflammatory, anti-carcinogenic, antioxidant, and they may help prevent oxidative stress. Pharmacological evidence has revealed the hepatoprotective, antioxidant, and anti-inflammatory effects of terpenoids and flavonoids [25]. Tannins also have antibacterial, antifungal, and immune-stimulating qualities. According to [26], saponins are used as adjuvants in vaccines against the herpes simplex virus (HSV), influenza, and HIV.

Parameters	Concentration (mg/100g)
Alkaloid	1218.3
Flavonoids	2705.1
Saponins	0.66
Tannins	175.8
Terpenoids	2.64
Phenols	561.1

Table 4: Phytochemical components of doum palm meal

Serum biochemical indices of weaned pigs fed DPM

The dietary treatments did not influence ($P>0.05$) total protein, albumin/globulin ratio, creatinine, alanine transaminase and alkaline phosphatase except glucose levels ($P<0.05$) in Table 5. However, all values were within the normal levels for disease free pigs by [27]. Measurements of total protein can reveal nutritional status related to liver or renal disease as well as other medical disorders [28]. Many hydrophobic compounds in the blood, including metals, non-esterified fatty acids, steroids, and thyroxine, are carried by albumin [29]. According to [30], the pigs' normal range of globulin levels indicates that the doum palm meal did not cause any serious health problems. Nutritional and immunological function can be understood by the albumin/globulin ratio (A/G ratio) [31]. According to [32] it is also an index for screening chronic disorders, including kidney diseases. Diarrhea or extreme dehydration may be the cause of a high A/G ratio [33]. Glycine, arginine, and methionine are the amino acids that are transaminated in the liver, pancreas, and kidneys to produce creatinine [34]. It can also be used as a renal function indicator and is made from creatine and phosphocreatine [35]. T1 had higher ($P<0.05$) glucose levels than the other groups. According to [36], the glucose readings in this trial (100–121.64 mmol/L) fell within the normal range. Stress, inadequate diet, and poor management are all linked to elevated glucose levels (Clack and Coffer, 2008). The study's reported ranges for aspartate transaminase (AST) and alanine phosphatase (ALP) are within the optimal range [37] at 55.79 - 56.50 IU/L and 143.09 - 148.40 IU/L, respectively. According to [38], low levels of ALP may indicate malnourishment, magnesium and zinc deficiencies, whereas high levels may be indicative of bacterial infections and liver blockage in animals [39]. Elevated AST levels can be a sign of pancreatitis, cirrhosis, and cardiovascular disorders [40].

Components	D1	D2	D3	D4	D5	SEM	Ref. value
TPP (g/dL)	4.78	4.75	4.73	4.71	4.70	0.13	4.00 - 5.80
ALB (g/dL)	3.15	3.13	3.12	3.11	3.10	0.10	3.10 - 4.80
GLB (g/dL)	1.63	1.62	1.61	1.60	1.60	0.02	0.30 - 1.70
A/G ratio (g/dL)	1.93	1.93	1.94	1.94	1.94	0.01	0.90 - 2.00
Creatinine (mmol/L)	0.95	0.90	0.96	0.90	0.92	0.01	0.50 - 1.10
Glucose (mmol/L)	121.64 ^{a}	100.70 ^{b}	100.62 ^{b}	100.34 ^{b}	100.00 ^{b}	1.56	75.0 - 136.0
AST (IU/L)	56.17	56.50	56.01	55.93	55.79	0.75	13.0 - 110.0
ALP (IU/L)	148.40	146.50	143.31	143.84	143.09	9.12	130.0 - 513

a,bwith different superscripts in the same row ($P<0.05$) ; diet 1 (D1); with no DPM, D2 (5 %), D3 (10 %), D4 (15 %) and D5 (20 %) inclusion levels of DPM; TPP: total protein ; ALB: albumin; GLB: globulin

Table 5: Serum biochemical indices of DPM

Serum minerals of weaned pigs fed DPM

Pigs given doum palm meal did not differ in serum concentrations of sodium (Na), potassium (P), chloride (Cl-), bicarbonate, calcium (Ca), and phosphorus ($P>0.05$) (Table 6). All readings, however, fell within the optimal ranges for pigs as reported by [41], indicating that there is no metabolic disease or health issue with the animals. The outcome is consistent with the research conducted by [42], which found no variations in the calcium, bicarbonate, and sodium levels of weaner pigs fed [41, 43]. According to [44, 45], potassium is essential for heart, neuron, and muscle function. Sodium reflect a part of kidney function and elevated levels of sodium chloride, bicarbonate suggests a metabolic disorder or acidosis [46.47]. Phosphorus helps to regulate chemical reactions in the body [48].

Variables	D1	D2	D3	D4	D5	SEM	Ref. value
Sodium (mmol/L)	146.8	140.5	142.1	143.5	141.9	9.05	131 - 151
Potassium (mmol/L)	3.81	3.93	3.90	3.91	3.95	0.18	3.70 - 6.10
Chloride (mmol/L)	95.67	96.02	96.11	96.72	96.18	1.67	93.0 - 108.0
Bicarbonate (mmol/L)	18.65	18.06	19.10	19.15	19.74	0.92	19.0 - 31.0
Calcium (mmol/L)	10.98	10.95	11.22	11.20	11.27	0.51	9.50 - 12.5
Phosphorus (mmol/L)	6.57	6.54	6.63	6.67	7.00	0.11	6.30 - 11.50

Diet 1 (D1); with no DPM, diet 2 (D2) [5 % DPM]; diet 3 (D3) [10 % DPM], diet 4 (D4) [15 % DPM] and diet 5 (D5) [20 % DPM]

Table 6: Serum minerals of DPM

Conclusion

In conclusion, doum palm meal doesn't have any detrimental effects on pigs' serum parameters, making it safe to use as a feed ingredient in swine feed. DPM can also be used to replace up to 20 % of maize without having an impact on the pigs' health.

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