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Prosopis Africana (African Mesquite) Oil Supplemented Feed for Broiler Chickens: Growth Performance and Nutrient Digestibility

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Abstract: *The aim of this experiment was to investigate the effects of Prosopis africana (African mesquite) oil supplemented feed for broiler chickens: growth performance and nutrient digestibility. 300 1-day old broiler chicks (Ross 307) of mixed sex with an initial body weight of 48.10 ± 0.2 g were used for this experiment. Birds were randomly distributed into five groups of sixty birds each in a completely randomized design. Experimental (basal) diet was formulated to meet the requirements of broilers according to NRC (1994). Clean water and feed were offered ad libitum and the experiment lasted for fifty six days. Diet 1 (D1) consists of basal diet with 2.5 g/kg Oxytetracycline, D2, D3, D4 and D5 were fed basal diet supplemented with Prosopis africana oil at 600 mg, 800 mg, 1000 mg and 1200 mg/kg. Final body weight, average daily weight gain and feed intake of broilers fed diet 3, 4 and 5 were similar (P>0.05) but significantly higher than diet 1 and 2. Feed conversion ratio of birds in diet 4 were similar (P>0.05) to those fed diet 5, but significantly higher than those in diet 1, 2 and 3. Mortality were higher (P<0.05) in T1 (2.06 %) and lowest in T2 (1.00 %), however, none was recorded in the other group. Dry matter, crude protein, crude fibre, nitrogen free extract and ether extract digestibility were significantly (P<0.05) influenced by dietary supplementation of Prosopis africana oil. In conclusion, Prosopis africana oil contains several bioactive compounds with therapeutic properties and can be supplemented up to 1200 mg in the diet of broiler chickens without posing any negative effect on the performance of birds.*

Keywords: *Prosopis africana, phytogenics, phytochemicals, broilers, growth.*

Introduction

Antibiotics are effective ways to control intestinal health in chickens. However, when utilized for medical purposes in animals, the usage of antibiotics might lead to antibiotic resistance, which reduces their efficacy (Catherine, 2022). Through the potential transfer of resistance from non-pathogenic to harmful bacteria and vice versa, they can also select for non-pathogenic microorganisms (Wang et al., 2005). The worldwide prohibition of antibiotic usage in animal agriculture is in favor of the use of phytogenic feed additives, which have been shown to be safe, efficient, and environmentally benign, is one way to prevent the emergence of new resistance (Oluwafemi et al., 2021; Viljeon et al., 2003).

Essential oils and other volatile molecules from plants with complex chemical compositions are examples of phytogenic feed additions (Olafeadehan et al., 2020; Lius, 2022). Flowers, stems, leaves, seeds, bark, buds, and other plant elements found in nature can all be used to extract essential oils (Lius, 2022). The bioactive components in essential oils are influenced by a variety of factors, including age, climate, plant species, and extraction methods (Agubosi et al., 2022). Animals have been shown to benefit from essential oils, particularly those derived from *Prosopis* *africana* oil. These qualities include antioxidant, antiviral, antifungal, antimicrobial, immune-stimulatory, hepatoprotective, and anti-helminthic activities (Alagbe et al., 2019; Villasenor et al., 2002). *Prosopis africana* oil's antibacterial properties against *Streptococcus epidermidis, Staphylococus aureus*, *Pseudomonas aeruginosa*, *and Microsporum canis* (Alagbe, 2019).

According to earlier research by Alagbe et al. (2022), feeding broiler chickens 600 mg/kg of prosopis oil as a dietary supplement has a growth-promoting impact by favorably affecting the morphology of their gastrointestinal tracts. The same authors have also reported positive results in the blood parameters of broilers given 800 mg/kg of *Prosopis africana* oil. Thus, it is necessary to determine the proper dosage for birds as well as the relationship between in vitro and field dosages.

Therefore, the aim of this experiment was to determine the effect of *Prosopis africana* (African mesquite) oil supplemented feed for broiler chickens: growth performance and nutrient digestibility.

Materials and methods

Research site and ethical consent

The study was carried out at the Poultry unit, University of Abuja Reasearch Farms, Gwagwalada located between latitude 8º57′ and 8º5′N and longitude 7º05′ and 7º06′E. The temperature of Gwagwalada ranges from 28-33 °C in the day time and 22-25°C in the night (NPC, 2006).The experiment was conducted according to the rules and specifications of protocols approved by research ethic committee of the department of Animal Science, University of Abuja Nigeria (Abj/ASN/2022). Research was carried between September to November, 2023.

Apparatus required for *Prosopis africana* extraction

Clevenger apparatus (N-shaped), aluminum medium size steam generator, round bottom flask (500 mL), beaker (glass), Grahams' condenser, safety tube, seperatory funnel and a digital thermometer.

Prosopis africana oil extraction (Steam distillation method)

Fresh *Prosopis africana* seeds were purchased from a local market in Gwagwalada, Nigeria and it was sent to the Department of Biological Science at the University of Abuja, Gwagwalada for detailed identification and authentication by a qualified taxonomist where a voucher specimen number (AS/09D/2023) was deposited at the school's herbarium. Seeds were sorted mechanically to remove the damaged ones, air dried for 11 days and pulverized before they are sent to the lab for extraction. Steam extraction technique was adopted, 200 g of pulverized samples were soaked into a round bottom flask containing 400 mL water and connected to the steam generator by a delivery tube which has an inlet and outlet. The inlet is connected to a thermometer while the outlet was attached to a condenser and heated to 80 ºC for 45 minutes. The steam that was produced passes through the grahams' condenser. Distillate was collected into a beaker and immediately transferred into a seperatory funnel to get pure *Prospopis africana* essential oil.

Animal care, housing, feeding and experimental arrangement

300 1-day old broiler chicks (Ross 307) of mixed sex with an initial body weight of 48.10 ± 0.2 g were brought from a reputable farm in Kwara State, Nigeria and transferred to the University of Abuja poultry section. Two weeks before to the start of the experiment, galvanized battery cages individually measuring 280 cm x 100 cm x 50 cm (length x width x height) and 100 cm above the ground in a semi-housed open pens were thoroughly washed and disinfected using Izal® (5 mL to 5 liters of water). After offloading the chicks from the carton, they were administered glucose (2 g to 5 liters of water) and water soluble vitamins (2 g to 5 liters of water) mixed together. In a completely randomized design, chicks were distributed to 5 groups of 3 replicates consisting of 20 birds each. Experimental diets were compounded according to the nutritional requirements for birds containing all appropriate nutrients according to (Nutritional Research Council, 1984). Feed and

clean water was supplied daily *ad libitum* and the total experimental period was fifty six days. Birds in treatment 1 was fed experimental (basal) diet with 2.5 g Oxytetracycline/kg while treatment 2, 3, 4 and 5 were fed basal diet with *Prosopis africana* oil at 600 mg, 800 mg, 1000 mg and 1200 mg/kg correspondingly.

Data collected during the experiment

Feed intake was determined by subtracting the weight of the left over feed from the weight of the feed offered the previous day. Weight gain was calculated as the difference between final body weight minus initial body weight. Average daily weight gain was calculated as weight gain divided by the number of experimental days. Similarly, average daily feed intake was estimated as the total feed intake divided by the number of experimental days. Feed conversion ratio was calculated by dividing the average daily feed intake by the average daily weight gain.

On the eighth week of the experiment, a nutrient digestibility study was conducted; five birds were chosen from each replication pen, for a total of 15 birds per treatment. The birds were kept in battery cages that had wire bottoms to make it simple to collect their waste. Throughout the seven days of the trial, the birds received clean water and a predetermined amount of food. Feed consumption was calculated by daily subtracting the amount of feed supplied from the weight of the leftover feed. Before being transported to the lab for additional analysis, samples were collected over the course of five days, dried, and bulked together. The following formula was used to determine the digestibility of nutrient.

$$\% \text{ Nutrient digestibility (DM)} = \frac{\text{Nutrient intake} - \text{Nutrient output in the excreta}}{\text{Nutrient intake}} \times 100$$

Determination of phytochemicals in *Prosopis africana*

Total tannins concentration was measured using the Folin-Ciocalteau method as earlier described by Biswas et al. (2020), total phenolic acid was evaluated using Folin-Ciocalteau method described by Otles and Yalcin (2012), saponin was measured using the vanillin and concentrated sulfuric acid colourimetric method as outlined by He et al. (2012). Total flavonoids (Odebiyi and Sofowora (1978) while alkaloids was estimated following the procedures described by Boham and Kocipai (1974), steroids and oxalates (Harbone, 1973).

Experimental diet analysis

Analysis of experimental diet was carried out using automated near infra-red kit (Antaris) Model XM009F, Netherlands. The equipment was adjusted to a temperature of 104°F and humidity of 80 % and operated at an photometric range of 20 µAu and wave length of 0.005 nm before result was generated in 60 seconds via the visual display unit.

Statistical analysis

Data were subjected to analysis of variance in a completely randomized design using the SPSS (21.0). Duncan multiple range test of the same software was used to test the significant difference between the means at P≤0.05 level of significance.

Table 1: Chemical composition of the diet (in dry matter)

Feed ingredients	Starter phase (day: 0 - 28)	Finisher phase (day: 29 - 42)
Yellow maize	54.00	59.00
Maize bran	0.00	1.00
Soya meal	35.00	30.00
Fish meal (Imported)	4.00	2.00

Oyster shell	2.00	2.50
Bone meal	4.00	5.00
Methionine	0.20	2.50
Lysine	0.25	0.25
*Premix	0.25	0.25
Salt	0.30	0.35
**Toxin binder	0.10	0.10
Total	100.00	100.00
Determined analysis		
Crude protein	23.16	20.90
Crude fibre	3.94	4.02
Ether extracts	4.08	4.30
Energy (kcal/kg)	2911.6	3009.7

*Each 2.5 kg of premix contains: vitamin A (10,000, 000.00 iu), vitamin D3 (2,000,000.00 iu), vitamin E (23,000.00 mg), vitamin K3 (2,000.00 mg), vitamin B1 (1,800.00 mg), vitamin B2 (5,500.00 mg), niacin (27, 500.00 mg), pantothenic acid (7, 500.00 mg), vitamin B6 (3,000.00 mg), vitamin B12 (15.00 mg), folic acid (750.00 mg), biotin (60.00 mg), choline chloride (300,000.00 mg), cobalt (200.00 mg), copper (3,000.00 mg), iodine (1,000.00 mg), iron (20,000.00 mg), manganese (40, 000.00 mg), selenium (200.00 mg), zinc (30,000.00 mg) and antioxidant (1,250.00 mg).

**Each 1 kg toxin binder contains: charcoal (5g), fomic acid (5.0 g), acetic acid (5.0 g), propionic acid (5.0 g), citric acid (5.0 g), lactic acid (400 g), copper (20 g) and yeast cell walls (2500 mg)

Phytochemical composition

Phyto-constituents in *Prosopis africana* seed is presented in Table 2 shows that flavonoids had the highest concentration (77.92 g/kg) while oxalates had the lowest concentration (2.60 g/kg). Other compounds; phenols (52.80 g/kg), alkaloids (40.83 g/kg), tannins (35.70 g/kg), steroids (21.35 g/kg) and saponins (13.16 g/kg). Essential chemical components with pharmacological qualities are found in medicinal plants (Alagbe, 2021). Numerous of these metabolites have medicinal qualities, and the primary criterion for assessing the quality and therapeutic efficacy of a particular herb is thought to be its concentration in the plant tissues (Woldemichael et al., 2003; Wills et al., 2000). According to Bez et al. (2003) and Böhme et al. (2014), the presence of flavonoids implies that prosopis seed possesses antioxidant and antibacterial activity against both gram-positive and gram-negative bacteria (Dewick, 2002). Because of their overall toxicity and deterrent effect, alkaloids are thought to serve as defense components against predators, particularly mammals (Harborne, 1998; Robert et al., 2002). Additionally, strong antimalarial action has been observed for them (Abdin et al., 2003; Alagbe, 2023). Phenolic chemicals may stop oxidative stress and provide biological benefits such as anti-inflammatory, anti-carcinogenic, and antioxidant qualities (Park et al., 2001; Böhme et al., 2014). Steroids have been demonstrated pharmacologically to have anti-inflammatory and hormone effects. They serve as androgenic, anabolic, and contraceptive agents. In addition, they have antiviral, antifungal, antibacterial, and hypolipidemic properties (Saeidnia et al., 2014).

Table 2: Phyto-constituents in *Prosopis africana* seed

Components	Concentrations (g/kg)
Tannins	35.70
Saponins	13.16
Flavonoids	77.92
Alkaloids	40.83
Phenols	52.80
Steroids	21.35
Oxalates	2.60

Table 3: Effects of *Prosopis africana* oil on the growth performance of broiler chickens

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SEM
Strain: Ross 307						-
Number of birds	60	60	60	60	60	-
Initial body weight (g/bird)	48.10	48.05	48.00	47.90	47.85	0.04
Final body weight (g/bird)	1963.5^{c}	2338.1^{b}	2390.0^{a}	2601.1^{a}	2574.5^{a}	43.80
Weight gain (g/bird)	1915.4^{c}	2290.1^{b}	2342.0^{b}	2553.2^{a}	2574.5^{a}	36.62
Av. daily weight gain (g/b)	34.20^{c}	40.89^{b}	41.82^{b}	45.59^{a}	45.97^{a}	3.91
Total feed intake (g/bird)	3800.0^{b}	3900.2^{b}	3910.5^{a}	3912.5^{a}	3915.0^{a}	54.02
Av. daily feed intake (g/b)	67.85^{b}	69.65^{b}	69.83^{a}	69.87^{a}	69.91^{a}	5.08
Feed conversion ratio	1.98^{a}	1.70^{b}	1.67^{b}	1.53^{c}	1.52^{c}	0.03
Mortality (%)	2.06^{a}	1.00^{b}	-	-	-	0.01

^{a,b,c} -Means in the same row with different superscripts are significantly different (P< 0.05); diet 1: basal diet plus 2.5g Oxytetracycline/kilogram; diet 2, 3, 4 and 5: basal diet plus *Prosopis africana* oil at 600 mg, 800 mg, 1000 mg and 1200 mg/kg; SEM: standard error of mean.

Table 4: Effects of *Prosopis africana* oil on the nutrient digestibility of broiler chicken

Parameters (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SEM
Dry matter	76.90^{c}	81.55^{b}	82.01^{b}	85.96^{a}	86.02^{a}	0.06
Crude protein	69.15^{c}	73.00^{b}	73.70^{b}	78.00^{a}	78.16^{a}	0.04
Crude fibre	48.62^{a}	45s.66^{b}	45.50^{b}	45.27^{b}	45.20^{b}	0.02
Ether extract	50.03^{c}	55.80^{b}	55.73^{b}	59.00^{a}	59.06^{a}	0.02
Nitrogen free extract	69.10^{b}	70.03^{a}	70.80^{a}	71.22^{a}	71.83^{a}	0.05

^{a,b,c} -Means in the same row with different superscripts are significantly different (P< 0.05); diet 1: basal diet plus 2.5g Oxytetracycline/kilogram; diet 2, 3, 4 and 5: basal diet plus *Prosopis africana* oil at 600 mg, 800 mg, 1000 mg and 1200 mg/kg; SEM: standard error of mean.

Growth performance and nutrient digestibility

The effects of *Prosopis africana* oil on the growth performance of broiler chickens is displayed in Table 3. The growth performance indices were significantly (P<0.05) influenced by dietary supplementation of *Prosopis africana* oil. Final body weight, average daily weight gain and feed intake of broilers fed diet 3, 4 and 5 were similar (P>0.05) but significantly higher than diet 1 and 2. Feed conversion ratio of birds in diet 4 were similar (P>0.05) to those fed diet 5, but significantly higher than those in diet 1, 2 and 3. Mortality were higher (P<0.05) in T1 (2.06 %) and lowest in T2 (1.00 %), however, none was recorded in the other group. The significant increase in growth rate recorded among birds in diet 3 (800 mg), diet 4 (1000 mg) and diet 5 (1200 mg/kg) *Prosopis africana* oil in this experiment suggests that the oil can promote growth due to the presence of phytochemicals or bioactive compounds especially flavonoids and phenols. *Prosopis africana* oil has also proven to exert stimulatory actions on the secretion of broiler's digestive endogenous enzymes and at the same time slightly reduce the digesta transit time. Both effects allow more enzymatic action on the ingredients, breaking them down to nutrients and a little more time is available for the enzymatic processes to be more effective (Sandra, 2022). The aforementioned dietary supplements also had a significant effect on the feed conversion ratio, broilers fed diet 3, 4 and 5. The best feed conversion ratio was reported among birds fed 800 mg, 1000 mg and 1200 mg this result indicates the capacity of broilers to transform the ingested feed into body mass gain.

Dry matter, ether extract, crude fibre, crude protein and nitrogen free extract values were significantly ($P<0.05$) influenced by the dietary supplementation of *Prosopis africana* oil. Crude protein, ether extract and nitrogen free extract were higher in diet 5 relative to the other groups. According to Manu (2021), phytochemicals in essential oils are capable of increasing the permeability of the gut wall leading to the improved absorption of nutrients. Mortality was higher in birds fed diet 1 relative to the other groups which reflects antimicrobial capacity of *Prosopis africana* oil. It can also prevent dysbiosis favoring the proliferation of beneficial bacteria (Inge and Thilla, 2022). The result obtained corroborates with the findings of Alagbe et al. (2023) when *Prosopis africana* oil was supplemented at 600 mg/kg in broiler chickens. These result agrees with the findings by Mohebodini et al. (2021) where increased body weight gain, feed intake, dry matter, crude protein and ether extract was reported in broiler chickens fed *Eucalyptus globulus* essential oil.

Conclusion

In conclusion, *Prosopis africana* oil has positive impact on growth, secretion of digestive juices and nutrient absorption of broilers due to the presence of bioactive compounds which has multiple therapeutic properties. The oil can be supplemented up to 1200 mg/kg in diet of broiler chickens without having any deleterious or negative effect on the general performance of birds.

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