ADAN J. Agric. 2024, 5: 132-141 **DOI:10.36108/adanja/4202.50.0141**

ISSN 2736-0385

Carcass characteristics and blood profile of broiler chickens fed diets containing different inclusion levels of *Prosapis africana* essential oil

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Abstract

This study was carried out to investigate the effect of Prosopis africana (African mesquite) oil as feed additive on the carcass and blood profile of broiler chicken. Two hundred and twenty-five-day-old (arbor acre) broiler chicks were sourced from a reputable hatchery in Ibadan. A feeding trial which lasted for eight weeks, was carried out on the birds, which were randomly divided into five dietary treatments each with three replications of 15 chicks in a Completely Randomized Design (CRD). Dietary treatments were as follows: Treatment 1 (T1): Basal diet with no Prosopis africana oil; T2: Basal diet + 0.06% Prosopis oil while T3, T4, and T5 had 0.08%, 0.1% and 0.12% Prosopis africana oil respectively. Parameters evaluated among others included carcass and organs weight such as dressed, eviscerated, head, breast, thigh, drumsticks, wings, back, neck, spleen, heart, livers, gizzard and kidney, haematological indices including: Packed Cell Volume (PVC); Haemoglobin (Hb); Red Blood Cell (RBC); White Blood Cell (WBC); Mean Corpuscular Volume (MCV); Mean Corpuscular Haemoglobin (MCH); Mean Corpuscular Haemoglobin Concentration (MCHC) and Serum parameters including; Total Protein (TP); Albumin(ALB); Globulin(GLO); Glucose(GLU); Cholesterol(CHO); It was concluded that the dietary inclusion of Prosopis africana oil up to 0.12% in broiler chickens does not have any negative effects on the carcass, organs and blood profiles of the experimental animals, rather, a positive effects on carcass quality, haematology and serum parameters as well as reduction of free radicals. The study recommends increase awareness about the potential benefits of Propospis africana oil and the need for further research towards sustainable livestock development.

Keywords: *Essential oil, carcass, blood profile, broiler.*

Introduction

The poultry industry in Nigeria is facing some challenges, one of which is increase in the cost of feed because of high prices of protein, energy sources, diseases, high cost of livestock drugs as well as its indiscriminate use (Musa *et al*., 2020). The use of antibiotics in livestock production practices especially in poultry production continues with little or no consideration for its negative effects on human health and even animals. Hence, the need for more work on the search for alternative antibiotics in poultry production. Several compounds such as enzymes, organic acids, probiotics, prebiotics and phytogenic are used to improve the performance. There is therefore the need for an alternate solution to enhance productive performance without any resistance of antibiotic in poultry and harmful residues in meat. Recently aromatic plants and their associated essential oils or extracts are being evaluated as potential growth promoters. (Dieumou *et al*., 2009).

Phytogenics are substances derived from plants, including essential oils, herbs, spices, and other plant extracts.

Phytogenic compounds exhibit a variety of biological effects, including immune-stimulatory, hepato-protective, antibacterial, antifungal, and antioxidant properties (Singh *et al.,* 2021). Phytogenic feed supplements like the essential oils, are suitable alternatives in broiler chicken production for improving growth performance and the characteristic properties of meat products. One of the many alternatives to antibiotics is *Prosopis africana* extract, which includes stem bark, leaves, roots, and their essential oils. Antioxidant, antibacterial, antifungal, anti-helminthic, antiviral, hepatoprotective, immune-stimulatory, and antimicrobial properties are among the many pharmacological activity of *P. africana* preparations. They are also an abundant supplier of vital minerals and amino acids that support enzyme function and provide defense against the effects of oxidative stress. Oluwafemi, *et al*. (2024), observed that *Prosopis africana* oil has positive impact on growth, secretion of digestive juices and nutrient absorption by broilers due to the presence of bioactive compounds which has multiple therapeutic properties, of which 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.

Namdeo, *et al*. (2020), stated that essential oils are complex mixtures of fragrant volatile compounds of plant origin, which are isolated through various methods such as fermentation, extraction and steam distillation. They are distinguished by their potent aroma and diverse characteristic makeup. Alagbe, *et al*. (2023), found that the dietary supplementation of *Prosapis africana* essential oil up to 800 mg/kg in broiler chickens could arouse its appetite translating to higher weight gain, increased secretion of enzymes in the gastro intestinal tract as well as reduction of free radicals. Nevertheless, despite its reported use, scientific knowledge is scarce regarding how integrating the essential oil into the broiler diet affects their blood profile, and carcass composition. Hence, the reason for this study.

Materials and Methods

This experiment was carried out at the Teaching and Research Farm Unit, Department of Animal Science, Faculty of Agriculture, University of Abuja, Main Campus, along Airport Road, Gwagwalada, Abuja, Nigeria. Gwagwalada is the headquarters of the Gwagwalada Area Council; located between latitudes $8^{0}57^{1}$ and $8^{o}55^{1}$N and longitude $7^{o}05^{1}$ and $7^{o}06^{1}$E. *Prosopis africana* was obtained from a market in Kano, recognized and authenticated at the Department of Biological Sciences, University of Abuja, Nigeria, and granted a voucher number. The seeds were extracted from the pods by breaking them, and then the seeds were shade-dried for 13 days to get a consistent weight. A laboratory blender (Pansonic, Model: 15GT-045F, Japan) was used to crush the seeds into a powder. LYZX18, a cold press machine, was used to extract *Prosopis africana* oil. A new type of low temperature screw oil expeller called a cold press expeller is particularly well suited for mechanically processing seeds. Its dimensions are 3176 × 1850 × 2600 mm, and it can function at low temperatures (10 – 15 degrees) with a total power of 27.2 kW. *Prosopis africana* powder that has been ground up was added to the machine's feeder funnel. A stainless valve keeps the sample safe from contamination. *Prosopis africana* oil (PAO) was collected

via the squeeze cage (output) and placed in a clean, clearly labeled container for additional examination after the machine ran for ten minutes.

Experimental diets

Treatment 1: Basal diet without PAO
Treatment 2: Basal diet plus 0.06% PAO
Treatment 3: Basal diet plus 0.08% PAO
Treatment 4: Basal diet plus 0.1% PAO
Treatment 5: Basal diet plus 0.12% PAO

Table 1: Ingredient composition of the experimental diets

Components (kg)	Starter's mash (0-4 weeks)	Finisher's mash (5-8 weeks)
Maize	52.00	60.00
Wheat offal	2.50	5.00
Soya bean meal	30.00	23.50
Groundnut cake	8.00	4.00
Fish meal (72%)	2.00	2.00
Limestone	1.50	1.50
Bone meal	3.00	3.00
Lysine	0.20	0.20
Methionine	0.20	0.20
*Premix	0.25	0.25
Salt	0.30	0.30
Toxin binder	0.05	0.05
Total	**100.0**	**100.0**
Calculated analysis (%)		
Crude protein	23.30	21.40
Crude fibre	4.18	5.01
Ether extract	3.93	4.07
Calcium	1.50	1.60
Phosphorus	0.78	0.89
Energy (Kcal/kg)	2900.3	3100.8

***Premix supplied per kg diet: - vit A, 13,000 I.96U; vit E, 5mg; vit D3, 3000I.U, vit K, 3mg; vit B2, 5.5mg; Niacin, 25mg; vit B12, 16mg; choline chloride, 120mg; Mn, 5.2mg; Zn, 25mg; Cu, 2.6g; folic acid, 2mg; Fe, 5g; pantothenic acid, 10mg; biotin, 30.5g; antioxidant, 56mg (starter's mash)*

***Premix supplied per kg diet: - vit A, 9,000 I.U; vit E, 10mg; vit D3, 1500I.U, vit K, 3.8mg; vit B2, 10 mg; Niacin, 15mg; vit B12, 10mg; choline chloride, 250mg; Mn, 5.0mg; Zn, 56mg; Cu, 1.6g; folic acid, 2.8mg; Fe, 5.1g; pantothenic acid, 10mg; biotin, 30.5g; antioxidant, 56mg (finisher's mash)*

Experimental design and statistical analysis

All data was subjected to one-way analysis of variance (ANOVA) with SPSS (18.0), means were separated using software of the same statistical package. Where $P \leq 0.05$ was declared significant.

Results and Discussion

Phytochemical composition of *Prosopis africana* oil

Table 2 revealed the phytochemical constituents of *Prosopis africana* oil. Phenols were the most abundant (10.18%), whereas oxalate was the least abundant (0.02%). Phenols > Flavonoids > Terpenoids > Tannins > Steroids > Alkaloids > Oxalate. Phytochemicals in plants exhibit antimicrobial, antioxidant, antibacterial, immunostimulatory, hepatoprotective, antifungal, antiviral, and analgesic effects (Agubosi *et al.,* 2021). *Prosopis africana* oil has a higher concentration of phenolic components, which indicates that it has active antibacterial and antioxidant properties. (Olafadehan *et al.,* 2021)

Alkaloids and tannins have analgesic and antimicrobial properties (Oluwafemi *et al.,* 2021). Alagbe *et al.*, (2022) state that a number of variables including the extraction method, plant age, species, and geographic location, might affect the phytochemical content of plants. On the other hand, the *Prosopis africana* oil composition revealed in this study fell within the safe range recommended by Kumar and Amit (2000) for birds.

Table 2: Phytochemical composition of *Prosopis africana* oil

Parameters	Concentration (%)	Tolerable level (%)
Tannins	2.88	1.50 - 6.62
Flavonoids	5.07	2.00 – 18.00
Terpenoids	3.96	1.52 – 10.00
Alkaloids	1.60	1.00 - 5.57
Phenols	10.18	2.00 – 16.00
Steroids	2.57	0.06 – 4.00
Oxalate	0.02	0.01 – 0.09

Carcass and organ characteristics of broiler chickens fed different levels of P*rosopis africana* oil

The results of the carcass and organ characteristics of the experimental birds were presented in Table 3. The live weight, dressed weight, eviscerated weight, dressing, head, breast, thigh, drumsticks, wings, back, neck, spleen, heart, livers, gizzard and kidney values ranges between 2481.90 – 1996.30g, 1896.30 – 2380.10g, 1496.30 – 1900.60g, 74.95 – 77.19g, 58.10– 65.00g, 566.30 – 685.70g, 218.60 – 380.60g, 196.50 – 271.20g, 200.20 – 323.70g, 188.40 – 302.20g, 71.60 – 87.18g, 0.01 – 1.20g, 10.80 – 12.80g, 20.15 – 20.45g, 30.92 – 45.00g and 4.62 – 5.25g respectively. All the parameters evaluated (live weight, dressed weight, eviscerated weight, dressing, head, breast, thigh, drumsticks, wings, back, neck, shank, heart, spleen, livers and gizzard) under this study were significantly ($P < 0.05$) different across the treatments. No noticeable inflammations were observed in the organs, which is an indication that anti-nutrients in *Prosopis africana* oil were below the threshold levels. Presence of anti-nutritional factors is associated with enlargements of internal organs like liver, kidney, pancreas and spleen. According to Shittu *et al*. (2021) organ weights are influenced by age of birds, sex, breed as well as presence of toxic substance in feed (nutrition). However, the result obtained in this study confirmed the earlier reports of Soltan *et al*. (2008); Jamoz *et al*. (2003) who evaluated the influence of phytogenic extracts on performance, nutrient digestibility and carcass characteristics of broiler chickens. This finding also confirmed the report of Oluwafemi *et al*. (2021) who evaluated the effects of dietary inclusion of ginger (*Zingiber officinale*) and garlic (*Allium sativum*) oil mixtures on carcass characteristics and sensory evaluation of broiler chickens.

Table 3: Carcass and organ characteristics of broiler chicken fed different level of *Prosopis africana* oil

Parameters	$T_{1\,(g)}$	$T_{2\,(g)}$	$T_{3\,(g)}$	$T_{4\,(g)}$	$T_{5\,(g)}$	SEM
Live weight	1996.3^{c}	2300.0^{b}	2315.1^{b}	2400.2^{a}	2481.9^{a}	42.4
Dressed weight	1896.3^{c}	2189.3^{b}	2198.3^{b}	2300.1^{a}	2380.1^{a}	40.55
Eviscerated weight	1496.3^{b}	1789.3^{b}	1778.3^{b}	1870.1^{a}	1900.6^{a}	38.92
Dressing (%)	74.95^{b}	77.80^{a}	76.81^{a}	77.19^{a}	76.57^{a}	6.15
Head	58.10^{c}	61.33^{b}	61.91^{b}	64.02^{a}	65.00^{a}	5.06
Breast	566.3^{d}	615.7^{c}	655.9^{b}	680.1^{a}	685.7^{a}	11.2
Thigh	218.6^{c}	330.6^{b}	339.5^{b}	371.4^{a}	380.6^{a}	6.63
Drumsticks	196.5^{d}	225.1^{c}	246.0^{b}	266.3^{a}	271.2^{a}	5.02
Wings	200.2^{b}	291.6^{b}	308.5^{a}	311.5^{a}	323.7^{a}	4.95
Back	188.4^{c}	255.6^{b}	260.9^{b}	300.6^{a}	302.0^{a}	4.04
Neck	71.60^{d}	82.93^{c}	85.00^{b}	87.16^{a}	87.18^{a}	3.8
Spleen	0.01^{b}	1.22^{b}	1.20^{a}	1.21^{a}	1.20^{a}	0.01
Heart	10.80^{b}	10.92^{b}	12.05^{a}	12.11^{a}	12.80^{a}	0.06
Liver	20.15^{b}	28.02^{a}	28.40^{a}	28.42^{a}	28.45^{a}	0.08
Gizzard	30.92^{c}	41.65^{b}	42.06^{b}	42.11^{b}	45.00^{a}	0.05
Kidney	4.62^{c}	5.05^{b}	5.18^{a}	5.20^{a}	5.25^{a}	0.01

^{abc} Means in the same row with different superscripts differ significantly ($P<0.05$)
SEM: standard error of mean

The effect of *Prosopis africana* oil on the haematological parameters of broiler chickens

Results of the experimental ingredient on the experimental birdsare shown in Table 4. The values obtained ranged from: PCV (30.90 – 36.02 %), Hb (10.61 – 13.61 g/dL), RBC (2.97 – 3.97 ($\times 10^{12}$ /L), MCVC (35.12 – 44.80 fl), MCH (33.65 – 42.00 pg), MCHC (28.90 – 34.06 g/dL), lymphocytes (61.82 – 75.12 %), WBC (17.61 – 22.91 10^{9} /L), heterophil (28.63 – 35.10 %), monocytes (2.00 – 3.00 %), eosinophils (1.82 – 2.15%) and basophils (1.00 – 1.00). The treatments had a significant ($P \leq 0.05$) effect on all of the parameters measured. The values of PCV, Hb, RBC, WBC, monocytes, and lymphocytes increased as the level of PAO increased during the treatment. However, all results were within the normal physiological range as reported by Livingston *et al.,* (2020); Talebi *et al.,* (2005) for healthy birds. PCV (30.90-36.02%) and Hb (10.61-13.61 g/dL) levels are within the ranges reported by Abdi-Hachesoo *et al.,* (2011) and Islam *et al*., (2004). Normal haematological findings in this study might be attributed to proper dietary intake as well as PAO's safety level. Abnormalities in hematological parameters may suggest anemia, liver injury, poor nutrition, or parasite infestation (Olabanji *et al.*, 2007). High WBC counts in T3-T5 may cause the immune system to become aware and sensitive to any infection or disease (Nse Abasi *et al.,* 2014; Isaac *et al.,* 2013). Eosinophils have been shown to be important in the prevention of endo and ectoparasites, as well as in the regulation of allergic processes in animals (Dellmann and Brown, 1987).

Table 4: Effect of *Prosopis africana* oil on the haematological parameters of broiler chicks

Parameters	T1	T2	T3	T4	T5	SEM
PCV (%)	30.90^{c}	34.02^{b}	34.10^{b}	36.00^{a}	36.02^{a}	2.58
Hb (g/dL)	10.61^{b}	12.88^{a}	12.96^{a}	13.09^{a}	13.61^{a}	0.32
RBC($\times 310^{12}$/L)	2.97^{c}	3.63^{b}	3.67^{b}	3.90^{a}	3.97^{a}	0.11
MCVC (fl)	35.12^{c}	40.26^{b}	44.53^{a}	44.61^{a}	44.80^{a}	2.03
MCH (pg)	33.65^{b}	40.80^{a}	41.80^{a}	41.87^{a}	42.00^{a}	2.63
MCHC (%)	28.90^{b}	33.42^{a}	33.50^{a}	34.00^{a}	34.06^{a}	2.50
WBC($\times 10^{9}$/L)	17.61^{c}	20.05^{b}	20.11^{b}	22.06^{a}	22.91^{a}	1.41
LYM (%)	61.81^{c}	70.00^{b}	70.60^{b}	74.50^{a}	75.12^{a}	5.06
HET (%)	28.63^{b}	30.80^{ab}	30.92^{ab}	35.08^{a}	35.10^{a}	2.00
MON (%)	2.00^{c}	2.60^{b}	2.66^{b}	2.98^{a}	3.00^{a}	0.12
EOS (%)	1.82^{c}	1.93^{c}	2.02^{b}	2.11^{a}	2.15^{a}	0.11
BAS (%)	1.00	1.01	1.02	1.00	1.00	0.01

Means within rows with different letters are significantly different ($p<0.05$); PCV: packed cell volume; Hb: haemoglobin; RBC: red blood cell; WBC: white blood cell; MCV: mean corpuscular volume; MCH: mean corpuscular haemoglobin; MCHC: mean corpuscular haemoglobin concentration; LYM: lymphocytes; MON: monocytes; BAS: basophils; HET: heterophils; EOS: eosinophils; SEM: standard error of mean; T1: basal diet + 0 % Prosopis africana oil; T2: basal diet + 600kg/mg PAO ; T3: basal diet + 800kg/mg PAO; T4: basal diet + 1000kg/mg PAO; T5: basal diet + 1200kg/mg PAO.

Effect of *Prosopis africana* oil on the serum biochemical indices of broiler chickens

The above results are shown in Table 5. Total protein values, albumin, globulin, glucose, cholesterol, creatinine and uric acid ranged from 5.81 – 6.50 g/dL, 3.00 – 3.50 g/dL, 2.80 – 3.00 g/dL, 118.3 – 135.1 mg/dL, 83.10 – 71.20 mg/dL, 0.87 – 0.85 mg/dL and 2.16 – 2.00 mg/dL respectively. Total protein, albumin, globulin, glucose, and cholesterol levels differed significantly ($P<0.05$) between treatments. Albumin and globulin levels are effective markers of the quality of dietary protein (Gauche *et al.*, 1991). However, it was discovered that birds in T3 - T5 had the highest total protein value, with T2 being intermediate and T1 having the lowest. According to Mitruka and Rawnsley (1977), a reduced serum protein value could be caused by infection, a weakened immune system, or malnutrition. Lower cholesterol levels in birds fed PAO indicate that the test material can perform a hypolipidemic function, lowering the risk of cardiovascular disease and increasing meat shelf life (Mahipal *et al.*, 2015). Stress, animal age, and blood collection method all have an effect on glucose levels (Ozkan *et al.*, 2003).

However, the glucose level range found in this experiment validates previous reports by Jang *et al.*, (2007) and Basmacioglu *et al.*, (2010). Uric acid and creatinine levels did not differ substantially ($P>0.05$) across treatments. The amounts of uric acid and creatinine recorded in the study had no harmful effect on the function of the liver and kidney, resulting in the death of the birds (Olafadehan *et al.*, 2020). Alanine amino transferase and aspartate amino transferase levels were between 31.27 and 30.82 (IU/L) and 87.02 and 89.15 (1U/L), respectively. The treatment had a significant ($P <0.05$) influence on the values. Elevated levels of these enzymes may indicate a liver problem or the presence of a toxic chemical in the blood (Obajuluwa *et al.*, 2020). Birds' normal biological status is dependent on electrolytes, and a lack of electrolytes in the

blood may result in animal death (Malahubban and Aziz, 2016). The amounts of Ca, bicarbonate, P, and Cl were significantly increased ($p<0.05$) by different PAO treatments. Calcium and phosphorus are necessary for appropriate bone formation and nerve impulse transmission in birds (Vasudevan *et al.*, 2007). According to Gupta *et al.*, (2005), Bicarbonate is a critical component of pH homeostasis and is employed by a variety of transporters to carry other ions and organic substrates across cell membranes. Ca, P, and bicarbonate levels in the current study were all within the normal ranges observed by (Subhadarsini, *et al.*, 2020). Sodium helps to regulate P, osmotic pressure, water balance, nerve impulse transmission, and the active transport of glucose and amino acids (Edeoga *et al.*, 2005).

Table 5: Effect of *Prosopis africana* oil on the serum biochemical indices of broiler chickens

Parameters	T1	T2	T3	T4	T5	SEM
T.P (g/dL)	5.81[b]	6.20[a]	6.35[a]	6.40[a]	6.50[a]	0.10
ALB (g/Dl)	3.00[b]	3.20[a]	3.35[a]	3.40[a]	3.50[a]	0.11
GLO (g/dL)	2.80[b]	3.00[a]	3.00[a]	3.00[a]	3.00[a]	0.09
GLU (mg/dL)	118.3[c]	121.6[b]	125.0[b]	133.8[a]	135.1[a]	4.83
CHO (mg/dL)	83.10[a]	71.60[b]	71.43[b]	71.29[b]	71.20[b]	3.81
Uric Acid (mg/dL)	2.16	2.10	2.05	2.03	2.00	0.01
CRT (mg/dL)	0.87	0.85	0.88	0.80	0.85	0.01
Alanine amino transferase (IU/L)	31.27	31.16	31.05	30.92	30.82	2.02
Aspartate transferase (IU/L)	87.02	88.38	88.57	89.02	89.15	3.15
Calcium (mmol/L)	1.33	1.35	1.30	1.31	1.32	0.01
Phosphorus(mmol/L)	2.05	2.33	2.50	2.67	2.80	0.11
Bicarbonate (mmol/L)	1.91[b]	1.97[b]	2.10[a]	2.11[a]	2.13[a]	0.10
Sodium (mmol/L)	104.2	118.5	120.5	120.8	122.5	5.40
Chloride (mmol/L)	1.00	1.06	1.02	1.03	1.31	0.11

Means within rows with different letters are significantly different ($p<0.05$); TP: total protein; ALB: albumin; GLO: globulin; GLU: glucose; CHO: cholesterol; CRT: creatinine; alanine phosphatase; alanine serum transaminase; alanine transferase; SEM: standard error of mean; T1: basal diet + 0 % Prosopis africana oil; T2: basal diet + 600kg/mg PAO ; T3: basal diet + 800kg/mg PAO; T4: basal diet + 1000kg/mg PAO; T5: basal diet + 1200kg/mg PAO.

Conclusion

Prosopis africana essential oil (PAO) was found to have a wider range of effects on broiler performance than standard antibiotics. This is due to the presence of several phytochemicals with therapeutic values, which are effective, safe, and ecologically friendly. It could bridge the productivity gap between livestock and food safety. This study showed that broiler chickens can receive up to 1200 mg/kg of PAO in their feed without experiencing any negative effect on their carcass quality and their blood biochemical and haematological parameters.

Acknowledgment

The authors are grateful for the invaluable support the Tertiary Education Trust Fund (TETFund) provided through the Institution Based Research (IBR) Grant for this research. The facilities and resources offered were beneficial and have been instrumental in completing this research project successfully

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