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Prosopis Aficana Stem Bark as an Alternative to Antibiotic Feed Additives in Broiler Chicken Diets: Performance And Carcass Characteristics

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Abstract: The aim of the present study was to examine Prosopis aficana stem bark (PASB) as an alternative to antibiotic feed additives in broiler chicken diets: performance and carcass and organ weight. A total of two hundred and fifty (250) one-day old broiler chicks of Arbo-acres strain of mixed sex were allotted into five (5) treatments of 5 replicates consisting of 10 birds each in a completely randomized design. Feed and water were given ad libitum and all necessary management practices were strictly observed throughout the experiment which lasted for 56 days. The dietary treatments include a control diet (T1) with no Prosopis aficana stem bark. PASB was included at 200 g, 400g, 600g and 800g in Treatment 2, 3, 4 and 5 respectively. Results obtained were used to evaluate the growth performance (weight gain, feed intake, feed conversion ratio and mortality), carcass and organ weights. Weight gains (WG), average daily feed intake (ADFI) and feed conversion ratio (FCR) were significantly different ($P<0.05$) among the treatments. However, increasing the level of Prosopis aficana stem bark from 200g to 800g tended to increase ADWG and ADFI. Highest mortality was recorded in T1 (1.8 %); none was recorded in the other treatments ($P < 0.05$). Dressing percentage and organ weights were significantly ($P < 0.05$) influenced by the different inclusions of PASB. No noticeable inflammation was observed in the internal organs (liver, heart, lungs, spleen and gizzard). It was concluded that PASB is rich in phytochemicals and also has significant therapeutic effects in animals and can be safely included in the diets of birds up to 800 g without any negative effect on the general performance of broiler chicks.

Keywords: broiler chicks, Prosopis aficana, phytochemicals, performance, nutrients.

INTRODUCTION

The indiscriminate use of antibiotics, its residues in animal products as well as the dangers posed to human health has led to a research for alternatives that are less toxic, safe, efficient and cheap (Olafadehan et al., 2020). Among the new alternatives is the use of herbs or medicinal plants because the presence of some nutrients and phytochemicals which posses pharmacological properties like chemo preventive and cytotoxic effects (Oluwafemi et al., 2020), Prosopis africana is one of the numerous underexplored medicinal plant with abundant bioactive chemicals and nutrients.

Prosopis aficana belongs to the family Fabaceae, sub-family Mimosoideae is a multipurpose trees and shrubs native to Africa/Asia (Orwa et al., 2009). The plant consists of about 44 species and it is popularly known all over the world as mesquite (Yarkwan, 2020). It is a tree with very hard wood and characterized with a deep, fast–growing tap root, probable phreatophyte with very dark and scaly bark which is orange to red brown with white streaks when slashed. The branches and twigs are thornless, leaves alternate with bipinnate leaflets in 9 – 16 pairs, oblong lanceolate (12 – 30 mm) and shortly pubescent (Burkart, 1976; Agboola, 2004). The plant grows best in areas where the mean annual temperature falls within the range 22 - 35°c, but can tolerate 18 - 40°c (Weber et al., 2008; Agboola, 2004). Prosopis aficana has vast social, economic, cultural, medicinal and agricultural values. It is widely used and consumed in the entire country and beyond. It is very popular for its seeds, highly priced food condiment or seasoning, rich in

protein, fatty acids and other vital nutrients and minerals (Ayanwuyi et al., 2010; Amusa et al., 2010; Barminas and Marina, 1998).

According to Alagbe (2021), Prosopis aficana stem bark (PASB) contains 8.35 % moisture, 91.62 % dry matter, 4.87 % crude protein, 45.60 % crude fibre, 0.81 % ether extract, 11.52 % ash and 28.25 % carbohydrates and several bioactive chemicals such as: alkaloids, flavonoids, hydrolysable tannins, condensed tannins, oxalates, terpenoids, saponins and phenols (Anyanwuyi et al., 2010; Olorunmaiye, 2019). Scientific reports have shown that PASB has significant therapeutic effects such as: anti-bacterial (Kolapo et al., 2009; Akintayo and Alagbe, 2020), antiviral (Ajiboye et al., 2013), antioxidant (Singh, 2010), antifungal (Shruthi et al., 2010; Lersten and Horner, 2000; Oluwafemi et al., 2020), immunomodulatory (Vautier and Schmidt, 2007; Ahmadi et al., 2006), hepatoprotective (Pal and Manoj, 2011), cytotoxic (Khan et al., 2013), antispasmodic and neuroprotective (Prakash et al., 2002) and hypolipidemic activities (Miller et al., 2002; Prakash and Gupta, 2009).

The leaves, stem and roots of Prosopis aficana are used in traditional and folk medicine in the treatment of malaria, stomach ache, rheumatism, tooth ache, bronchitis, arthritis and several inflammatory conditions (Ayanwuyi et al., 2010)

In view of these abundant potential, an experiment was designed to evaluate Prosopis aficana stem bark as an alternative to antibiotic feed additives in broiler chicken diets: performance, carcass and organ characteristics.

MATERIALS AND METHODS

STUDY AREA

The experiment was carried out at Division of Animal Nutrition, Sumitra Research Institute, Gujarat, India during the month of April to June, 2020.

SOURCE, COLLECTION AND PREPARATION OF PROSOPIS AFICANA STEM BARK (PASB)

The stem of Prosopis aficana stems were obtained from different plants in Gujarat, India and authenticated by a certified crop taxonomist in the institute. The stem bark were cut into pieces and thoroughly washed with distilled water, air dried under the shade for 12 days to maintain the bioactive chemicals in the test material. The dried samples were pulverized into powder using a laboratory electric blender (Panasonic: Model HD-03RL) and stored in a well labeled air tight container for further analysis.

PRE-EXPERIMENTAL PROCEDURES

A deep litter housing system used for the experiment was fumigated two weeks prior to the commencement of the study, the surrounding environment was also cleaned, plastic feeders and drinkers were thoroughly washed. Foot bath was prepared at the entrance of the pen to ensure proper biosecurity.

EXPERIMENTAL ANIMALS AND MANAGEMENT

Two hundred and fifty (250) one-day old Arbo acres broiler chicks with mixed sex were used for this experiment. The birds were purchased from a commercial hatchery in India and weighed on arrival on the farm to obtain their initial body weight and thereafter weekly. Animals were divided to five treatments with five replicates consisting of ten (10) birds each in a completely randomized design. Electric brooders were used to supply heat and wood shavings serve as the litter material.

Vaccines were administered according to the prevailing disease condition in the environment and all other management practices were strictly adhered throughout the experiment which lasted for 56 days.

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RATION FORMULATION

Three (3) basal diets were formulated at different stages of production to meet up with the requirements of birds according to NRC (1994). Broiler starter's mash (0-21 days), growers mash (22-35 days) and finishers mash (36-56 days).

Treatment 1: diet contained 2.5g oxytetracycline in 100 kg feed
Treatment 2: diet contained 200g PASB per 100 kg feed
Treatment 3: diet contained 400g PASB per 100 kg feed
Treatment 4: diet contained 600g PASB per 100 kg feed
Treatment 5: diet contained 800g PASB per 100 kg feed

DATA OBTAINED

Weight gain (g) = final weight (FW) – initial weight (IW)
Feed intake (g) = Amount of feed consumed – remaining feed
Average daily gain (ADG) = Final body weight – Initial body weight/Total days of the experiment
Feed conversion ratio (FCR) = feed intake (g)/weight gain (g)
% mortality = number of dead birds/total number of birds × 100

CARCASS EVALUATION

At the end of the experiment (56 days), two (2) birds were randomly selected per replicate for carcass evaluation; the birds were feed starved overnight, weighed, slaughtered and manually de-feathered. Weights of internal organs (liver, lungs, spleen, gizzard, heart and intestine) were recorded and the parameters below were estimated:

Dressing % = dress weight/live weight × 100
% organ/ primal cut parts = weight of primal cut or organ/live weight × 100

STATISTICAL ANALYSIS

All data were subjected to one -way analysis of variance (ANOVA) using SPSS (23.0) and significant means were separated using Duncan multiple range tests (Duncan, 1955). Significant was declared if $P \leq 0.05$.

Table 1: Chemical composition of experimental diets

Materials	Starter (1-21 days)	Grower (22-35 days)	Finisher (36-56 days)
Maize	50.00	58.00	60.00
Wheat offal	8.00	8.00	8.45
Soya meal	38.30	30.40	28.00
Fish meal	2.00	2.00	2.00
Bone meal	0.40	0.40	0.40
Limestone	0.25	0.25	0.20
Lysine	0.20	0.20	0.20
Methionine	0.25	0.20	0.20
Premix	0.25	0.25	0.25
Salt	0.35	0.30	0.30
TOTAL	100.0	100.0	100.0
Calculated analysis (%)			
Crude protein	23.59	21.93	19.37
Ether extract	5.11	5.00	4.28
Crude fibre	3.01	3.67	3.42
Calcium	1.02	1.08	1.10
Phosphorus	0.53	0.61	0.65
Lysine	1.17	1.29	1.60
Meth +Cyst	0.87	0.82	0.51
ME (Kcal/kg)	2944	3007.9	3200.2

*Premix supplied per kg diet: - vit A, 10,000 I.U; 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.

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Table 2: Vaccination schedule for birds

Vaccine	Day/week	Route of administration
1st ND Lasota	Day 5	Drinking water
1st IBD (Gumboro)	Day 8	Drinking water
Immucox vaccine (Coccidial vaccine)	Day 10	Drinking water
2nd ND Lasota	Day 15	Drinking water
2nd IBD (Gumboro)	Day 21	Drinking water
3rd ND Lasota	Day 28	Drinking water
3rd IBD (Gumboro)	Day 33	Drinking water

Table 3: Proximate composition of PASB

Parameters	% composition
Moisture (%)	8.35
Dry matter (%)	91.62
Crude protein (%)	4.87
Crude fibre (%)	45.60
Ether extract (%)	0.81
Ash (%)	11.52
Energy (Kcal/kg)	1783.8

Table 4: Phytochemical analysis of PASB

Parameters	Composition (%)
Hydrolysable tannins	3.33
Condensed tannins	0.17
Alkaloids	5.45
Flavonoids	9.83
Terpenoids	2.10
Saponins	1.82
Phenols	4.02
Phytic acid	0.78

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Table 5: Performance characteristic of broiler chicks fed different levels of PASB

Parameters	T1	T2	T3	T4	T5	SEM
IW (g)	41.06	41.00	41.02	40.96	41.00	0.06
FW (g)	1945.2^{c}	2101.0^{b}	2200.2^{b}	2400.1^{a}	2471.5^{a}	3.88
WG (g)	1904.1^{c}	2060.0^{b}	2159.2^{a}	2359.1^{a}	2430.5^{a}	7.09
ADWG (g)	34.00^{b}	36.79^{b}	38.55^{b}	42.13^{a}	43.40^{a}	1.02
F.I (g)	3900.4^{b}	4200.0^{a}	4200.1^{a}	4200.3^{a}	4200.5^{a}	6.60
ADFI (g)	68.43^{b}	70.66^{a}	70.64^{a}	70.45^{a}	70.29^{a}	0.42
FCR	2.10^{a}	1.94^{b}	1.85^{b}	1.70^{c}	1.65^{c}	0.17
Mortality	1.80	-	-	-	-	0.01

Means in the same row with different superscripts differ significantly (P<0.05)
IW: initial weight; FW: final weight; WG: weight gain; ADWG: average daily weight gain; F.I: feed intake; ADFI: average daily feed intake

Table 6: Carcass and organ characteristics of broiler chicks fed different levels of PASB

Parameters	T1	T2	T3	T4	T5	SEM
Live weight (g)	1900.3^{c}	2005.1^{b}	2218.0^{b}	2300.1^{a}	2390.7^{a}	8.11
Dressed weight (g)	1485.6^{c}	1700.1^{b}	1833.3^{b}	1966.1^{a}	1989.0^{a}	10.19
Dressed %	78.10^{b}	84.80^{a}	83.00^{a}	86.00^{a}	83.10^{a}	2.95
Head (%)	1.51^{b}	2.08^{a}	2.03^{a}	2.66^{a}	2.06^{a}	0.43
Neck (%)	2.94^{c}	3.19^{b}	3.20^{b}	4.71^{a}	3.11^{b}	0.04
Thigh (%)	8.22^{b}	11.02^{a}	11.08^{a}	11.23^{a}	11.84^{a}	2.07
Back (%)	14.11^{c}	19.18^{b}	21.04^{a}	22.18^{a}	21.38^{a}	3.27
Shank (%)	3.10^{b}	6.11^{a}	6.28^{a}	6.87^{a}	6.54^{a}	1.94
Breast muscle (%)	19.80^{c}	24.19^{b}	24.00^{b}	24.10^{b}	26.08^{a}	4.04
Wings (%)	5.05^{c}	9.11^{b}	10.59^{a}	10.89^{a}	11.20^{a}	1.22
Organ performance (%)						
Liver	1.97^{b}	2.11^{b}	2.74^{b}	3.44^{a}	2.63^{b}	0.16
Heart	0.40^{c}	0.52^{b}	0.71^{a}	0.88^{a}	0.58^{b}	0.23
Lungs	0.57^{c}	0.66^{b}	0.85^{a}	0.87^{a}	0.71^{a}	0.47
Spleen	0.09^{b}	0.12^{a}	0.17^{a}	0.13^{a}	0.10^{a}	0.08
Gizzard	2.88^{b}	3.00^{a}	3.18^{a}	3.13^{a}	3.45^{a}	0.02

Means in the same row with different superscripts differ significantly (P<0.05)

RESULTS AND DISCUSSION

Table 1 revealed the chemical composition of experimental diet. The feeding was in 3 phases which consists of starter mash (0-21 weeks) and it contained 23.59 % crude protein, 3.01 % crude fibre, 5.11 % ether extract, 1.02 % calcium, 0.53 % phosphorus and 2944.0 kcal/kg energy while growers mash was fed between 22-35 days and it contained 21.93 % crude protein, 5.00 % ether extract, 3.67 % crude fibre, 1.08 % calcium, 0.51 % phosphorus and 3007.9 kcal/kg (energy). Finishers mash (36-56 days) contained 9.37 crude protein, ether extract (4.28 %), crude fibre (3.42 %), calcium (1.10 %), phosphorus (0.65 %) and energy (3200.2 Kcal/kg) respectively. The crude protein, crude fibre and ether extracts in all the diets conforms to the findings of Musa et al. (2020); Olafadehan et al., 2020; Aduku, 2004 in feeding broilers. The calcium and phosphorus is in line with the recommended range by NRC (1994). The energy values obtained in this study are in agreement with the values obtained by Oluwafemi et al. (2020) who examined the effect of supplementing neem oil (Azadirachtin indica) in the diets of broiler chicken. Vaccines were administered according to the prevailing vaccination schedule in the environment; all the vaccines (ND and IBD) were given to birds orally as presented in Table 2.

The proximate composition of PASB is presented in Table 3.Prosopis aficana stem bark (PASB) contains moisture (8.35 %), dry matter (91.92 %), crude protein (4.87 %), crude fibre (45.60 %), ether extract (0.81 %), ash (11.35 %) and energy (1783.8 kcal/kg) respectively. The result obtained in this study is in agreement with the reports of Alagbe (2021) who examined the proximate, phytochemical and vitamin composition PASB. This result suggests that PASB is low in protein, thus it cannot be used as a protein supplement in livestock diets especially broilers that require high protein in their feed, and this result is in conformity with the findings of NRC (1994). Similarly, the sample contained low energy content which is contrary to the reports of Madubuike and Ekenyem (2006); Shittu et al. (2019); Alagbe (2019). The crude fibre and ether extract values obtained are lower than the values reported by Olanipekun et al. (2016) for Morinda lucida stem bark (53.49 %). Higher ash content in PASB is an indication that the sample is abundant in minerals. Adequate dietary intake in animals enhances several biochemical reaction, physiological functioning of the body as well as enzyme activation (Ojewuyi et al., 2014; Alagbe, 2020).

The proximate composition of Prosopis aficana stem bark is presented in Table 4. Phytochemical analysis revealed the presence of hydrolysable tannins (3.33 %), condensed tannins (0.17 %), alkaloids (5.45 %), flavonoids (9.83 %), terpenoids (2.10 %), saponins (1.82 %), phenols (4.02 %), phytic acid (0.78 %) and oxalates (0.85 %) respectively. In order of abundance flavonoids > alkaloids > phenols > hydrolysable tannins > terpenoids > saponins > oxalates > phytic acid > condensed tannins. The result obtained in this study in accordance with the findings of Ezike et al. (2010); Shittu et al. (2020); Olueafemi et al. (2020). Phytochemical are bioactive chemicals which enable plants to perform multiple biological activities (antimicrobial, antiviral, antioxidant, antifungal etc.) and have physiological actions on the body (Olowokudejo et al., 2008; Okigbo et al., 2008), their concentrations depends on differences in plant species, plant parts (seeds, leaf, root and stem bark), age of plants, methods of extraction, soil type and seasons (Newton, 1994; Chandralega et al., 2015).

Performance characteristics of broiler chicks of broiler chicks fed different levels of Prosopis aficana stem bark (PASB) is presented in Table 5. The initial body weight (IW), final weight (FW), weight gain (WG), average daily weight gain (ADWG) and feed intake (FI) ranged between 40.96 – 41.06 g, 1945.2 – 2471.5 g, 1904.1 – 2430.5, 34.00 – 43.40 g and 3900 g – 4200.5 g respectively. FW, WG, ADWG and FI were significantly different ($P < 0.05$) among the treatments, the values obtained in this study follow similar pattern and were highest in T4 and T5, intermediate in T2 and T3 and lowest in T1 ($P < 0.05$). Body weight gain and feed conversion ratio were significantly influenced when PASB was added to the diets at 600 g and 800 g respectively; it could possibly be attributed to the presence of some phytochemicals in PASB as earlier reported by Alagbe (2021). This result obtained is in agreement with the findings of Khattak et al. (2014) who examined the effect of natural blend of essential oil in the diet of broiler chickens. Increasing

PASB in the diet of birds increased feed intake by improving palatability of diet possibly due to enhanced flavor and odor (Omokore and Alagbe, 2019; Huyghebaert et al., 2011). Highest mortality was recorded in T1 (1.80 %) and none were recorded in the other treatments ($P<0.05$). The presence of flavonoids in high concentration in PASB could confer it the ability to act as anti-inflammatory and antioxidant activities, thus scavenging free radicals, thus preventing infections (Okwu and Josiah, 2006; Sexena et al., 2012; Oluwafemi et al., 2020). The test material is also capable of modulating the gut of the animals and prevents the entry of pathogenic bacteria (Gopi et al., 2014; Farag et al., 2016).

Table 6 reveals the carcass and organ characteristics of broiler chicks fed different level of PASB. Dress (%), head, neck, thigh, back, shank, breast muscle and wings ranged between 78.10 – 83.10 %, 1.51 – 2.66 %, 8.22 – 11.84 %, 14.11 – 22.18 %, 19.80 – 26.08 % and 5.05 – 11.20 % respectively. Weights of the liver, heart, lungs, spleen and gizzard ranged between 1.97 – 2.63 %, 0.40 – 0.88 %, 0.57 – 0.87 %, 0.09 – 0.10 % and 2.88 – 3.45 % respectively. All the parameters were significantly different ($P< 0.05$) among the treatments. No noticeable inflammations were observed in the organs, which is an indication that anti-nutrients in PASB were below lethal levels reported by Alagbe and Oluwafemi (2019). According to Shittu et al. (2017) organ weight 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 is in agreement with the 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.

CONCLUSION

One of the ways of ensuring food safety, increasing healthy poultry production to meet the growing demand globally and reduce the high cases of antibiotic resistance diagnosed in human and animals is the use of medicinal plants. They are effective with no side effects; Prosopis africana stem bark has proven to be effective in livestock feed due to the presence of bioactive chemicals and it can be included up to 800g in the diet of broiler chicks without any negative effect on the general performance of the animal.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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