MEDWIN PUBLISHERS
Committed to Create Value for Researchers

Bioequivalence & Bioavailability International Journal
ISSN: 2578-4803

Prosopis Africana Extracts as Potential Natural Alternatives to Synthetic Antibiotics and a Key for Sustainable Broiler Production: A Review

John AO*

Department of Animal Nutrition and Biochemistry, Sumitra Research Institute, India

***Corresponding author:** Alagbe Olujimi John, Department of Animal Nutrition and Biochemistry, Sumitra Research Institute, Gujarat, India, Email: dralagbe@outlook.com

Review Article

Volume 8 Issue 1

Received Date: February 05, 2024

Published Date: March 06, 2024

DOI: 10.23880/beba-16000227

Abstract

The chicken sector is more vulnerable to antimicrobial resistance, the buildup of toxic or dangerous residues in meat and eggs, and environmental contamination as a result of the widespread and careless use of antibiotics in most nations. Natural solutions, such as medicinal plants, are required to address these issues. These plants have been shown to contain a variety of phytochemicals, including phenols, flavonoids, terpenoids, tannins, alkaloids, and saponins. These chemicals endow plants with a multitude of medicinal qualities. 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. Using extracts from Prosopis africana is the way forward for effective chicken production, environmental sustainability and food hygiene.

Keywords: Prosopis Africana; Medicinal Plants; Phytochemicals; Food Safety; Antibiotics

Introduction

Public concern over potential antibiotic resistance risks related to human health has driven interest in poultry nutrition and adoption of antibiotic free feeding systems. This has led to the development of feed additives such as Prosopis africana extracts that can be used as in-feed antibiotic alternatives in livestock feeding strategies. The extracts have a wide range of potential benefits all targeting the enhancement of performance of livestock.

The medium-sized, annual savannah tree Prosopis africana is a member of the fabaceae family. The majority of Asia and Africa (both East and West Africa) are home to the plant [1]. There are roughly forty-five species of it, and it can reach heights of 4 to 20 meters. It has a thick tap root that expands quickly and deeply into the earth. The plant's leaves range in size from 12 mm to 30 mm and are bipinnate, with 9–16 oblong leaf pairs. When dried, the seeds of Prosopis africana can open freely inside a yellow-intermeshed pod. According to Kolapo, et al. [1], the plants' seeds, leaves, roots, and stem bark have lots in phytochemicals and are typically used to treat bronchitis, fever, gonorrhea, toothache, stomachache, dysentery, and body aches.

The variances in plant extract effectiveness can be attributed to a variety of factors, including climate, location, harvest stage, and storage conditions, as well as variations

in the chemical content of the extracts made from *Prosopis africana* (Jan, 2020). Numerous phytochemicals found in *P. africana* extracts have been shown to have a variety of pharmacological effects, including anti-inflammatory, anti-helminthic, antioxidant, antimicrobial, immune-stimulatory, anti-fungal, and hepatoprotective qualities.

Essential minerals like potassium, phosphorus, calcium, manganese, magnesium, zinc, and copper are present in *Prosopis africana* [2]. According to Yanwuyi, et al. [3], these minerals are critical for the activation of essential enzymes and for protecting against a state of oxidative stress. Additionally, P. africana contains the amino acids methionine, lysine, threonine, leucine, alanine, phenyl alanine, cysteine, and proline, as well as vitamins A, B2, B5, B6, B9, and B12. These nutrients are essential for reducing cellular damage, scavenging free radicals, promoting collagen formation, and further enhancing antioxidant activities [4].

Considering the wealth of potential found in Prosopis africana and the growing awareness of the need to offer natural antibiotic substitutes instead of manufactured ones. This review summarizes earlier research and emphasizes the need of advancing food safety and sustainable livestock practices.

The Phytochemical Makeupof Extracts from Prosopis Africana

Phenols

Due to their antioxidant and free-radical scavenging qualities, phenolic compounds help keep animals healthy [5]. Phenols work by depriving bacteria of their substrate, which causes fragmentation of the bacterial cytoplasm [6]. In their investigations, Cushnie and Lamb [7]and Davies, et al. [8] found that the inhibition of enzymes by oxidized substrate was the cause of phenols' potency against bacteria.

Alkaloids

According to Nath, et al. and Singh [9], alkaloids are naturally occurring organic molecules that have a nitrogen heteroatom in their framework. According to Ayushi, et al. and Wink, alkaloids may have a variety of medicinal effects on birds, including antibacterial, analgesic, and antioxidant qualities. It has been found that alkaloids prevent the synthesis of proteins and RNA.

Flavonoids

According to Cowan [6], the carbonyl group of flavonoids has hydroxyl groups at positions 3 and 7. Moreover, it has been proposed that they possess antioxidant and antibacterial qualities. Additionally, they may attach to bacterial cell proteins, inhibiting and deactivating enzymes [7].

Tannins

Every portion of a plant, including the stem, bark, roots, leaves, fruits, and flowers, contains tannins. The capacity of tannins to form complexes with proteins and polysaccharides via covalent and hydrogen bonding is one of their primary characteristics. Enzyme inactivation results from tannins' capacity to bind to surface proteins and form complexes that do so.

Enzyme inactivation results from tannins' capacity to bind to surface proteins and form groups that do so. According to Lim, et al. it also causes membrane rupture and substrate restriction as a result of complex formation.

Saponins

A class of phytochemicals known as saponins is one of the main defense mechanisms plants have against microbial, fungal, and insect invasion. Whilst the quantity and concentration of saponins in plants differ from species to species, they are present in the majority of plant species. According to Morrissey and Osbourn, saponins function by building compounds with sterols or polysaccharides inside the microbial cell membrane, which destroys the integrity of the cytoplasmic membrane.

Pharmacological Properties of Prosopis Africana

Antimicrobial Properties

A study carried out by Badri, et al. showed essential oils from Prosopis africana have the capacity to inhibit the activities of some bacteria's, such as: Shigella flexneri, Salmonella typhi, Proteus mirabilis, Pseudomonas aeruginosa, Klebsiella pneumonia, Enterococcus faecalis, Listeria monocytogenes and Bacillus cereus due to the presence of phytochemicals like phenols, tannins and flavonoids which have been suggested to perform multiple biological activities against pathogenic organisms. Another studies have showed that methanolic and ethanolic extracts from the leaves, stem bark and roots of Prosopis are effective against Salmonella typhi, Proteus mirabilis, Enterococcus faecalis and Listeria monocytogenes.

The Properties of Antioxidants

Extracts that are aqueous, methanolic, and ethanolic have a number of medicinal uses and have the ability to scavenge free radicals that can lead to infections in an animal's body. Additionally, according to Saad, et al. prosopis oil demonstrated efficacy against Erwinia spp., C. albicans,

P. vulgaris, E. coli, and Shigella spp. Additionally, research has demonstrated that adding 400 mg/kg of prosopis oil to broiler diets can have a major impact on the activity of enzymes such as glutathione peroxidase, catalase, reduced glutathione, superoxide dismutase, and malondialdehyde [10].

Hypolipidemic Characteristics

According to earlier research by Rahman, et al. Prosopis extracts administered to rats at doses of up to 600 mg/kg significantly affected their levels of triglycerides, total cholesterol, low density lipoprotein, very low density lipoprotein, and atherogenic index (meat safety index), indicating a potential preventive effect against cardiovascular diseases. Additionally, according to Alagbe, et al. [11] adding 800 mg/kg of Prosopis africana essential oil to the diet can lower the amount of saturated fat and raise the amount of polyunsaturated fat in broiler meat [12].

Active compounds	Medicinal properties	References
Prosogerin A (6 Methoxy-7-hydroxyl dioxyflavone)	Antibacterial, antioxidant and immune-stimulaory	[13]
Prosogerin B (2,4 dihydroxyl -5 methyl dioxychacon)	Antimicrobial, hepato-protective and antioxidant	[14]
2,4-bis (1-phenylethyl) phenol	Antioxidants, antifungal	[15]
β-phenethylamine	Antifungal and immune-stimulatory	[16]
2,4,6-tris(1-phenylethyl) phenol	Antibacterial, antiviral	[17]
α-pinene	Antioxidant and digestive stimulants	[11,12]
α-terpinene	Antioxidant, antibacterial,	[18]
β-pinene	Antioxidant, antimicrobial	[19]
β-myrcene	Antioxidant, digestive stimulants	[20]
α-phellandrene	Antioxidant, Antifungal and antimicrobial	[21]
α-terpinolene	Antioxidant, antibacterial	[13]
γ-terpinene	Antioxidant, immune-stimulatory	[14]
1-terpineol	digestive stimulants	[22]
4-terpineol	digestive stimulants	[16]
Humulene	Antibacterial, anti-helminthic	[17]
Caryophyllene	digestive stimulants	[11,12]
Copaene	Antimicrobial	[23]
Cis-linaloxide	Antifungal	[24]
α-Selinene	Antioxidant, anti-inflammatory	[25]
γ-Elemene	digestive stimulants	[26]
α-Gurjunene	Immuno-stimulatory, antioxidant	[27]
β-Elemene	Antimicrobial, antioxidant, digestive stimulants	[28,29]
β-Cyclocitral	Anti-inflammatory, digestive stimulants	[1]
3-hexenyl-2-methylbutanoate	Anti-bacterial	[30]
Exo-methyl-camphenilol	Antimicrobial	[31]
Caryophyllene oxide	Antibacterial, antioxidant	[32]
Benzene -1-methoxy-2-methyl	Antifungal	[33]
Napthalene, 1,2 hydro-1,1, 6 –trimethyl	Antimicrobial	[30]
Cycloheptasiloxane, tetradecamethyl	Anti-inflammatory	[34,35]
Nerolidyl acetate	Anti-inflammatory	[36]
1-Cyclohexene-1- butanal, alpha, 2, 6, 6-tetramethyl	Anti-inflammatory	[37,38]

Table 1: Some bioactive compounds in Prosopis africana oil and their properties Adapted from [39-44].

Summary

Medicinal plants are infinitely capable of producing phytochemicals, which are chemical substances with a vast range of possible benefits, all aimed at improving bird performance. Prosopis africana extracts contain several substances, which have been demonstrated to be safe, efficacious, and environmentally benign. Additionally, studies have revealed that P. africana extract includes considerable amounts of phenols, tannins, alkaloids, terpenoids, and flavonoids, which provide them antibacterial, antioxidant, antifungal, antiviral, and other beneficial properties. Additionally, adding nutrition to broiler feed may improve the birds' performance. These will increase the output of chickens and lower the rising number of antibiotic-resistant illnesses.

Type of Extracts Used	Concentration Used	Effect on broilers
Prosopis africana essential oil	400 mg/kg	Increased body weight gain
		Increased pancreatic enzyme production
		Improved nutrient utilization
		Increased feed intake
		Reduced mortality rate
		Increased in carcass weight
Prosopis africana essential oil	800 mg/kg	Increased production of polyunsaturated fatty acid in meat sample
		Improved sensory attributes of meat
		Increased in pack cell volume, red blood cell, haemoglobin, white blood cell, total protein, amongst others
		Scavenging free radicals
		Increasing antibody titres in birds after vaccination
		Decrease in population of pathogenic microorganisms
Prosopis africana stem bark extracts (aqueous)	8ml/litre of water	Increased final body weight gain, feed intake and Lactobacillus sp count in the gut of broilers

Table 2: Effects of Prosopis africana extracts on the general performance of birds.

References

1. Kolapo A, Okunade M, Adejumobi J, Ogundiya M (2009) Phytochemical Composition and Antimicrobial Activity of Prosopis Africana against some Selected Oral Pathogens. World Journal of Agricultural Sciences 5(1): 90-93.

2. Ajiboye A, Agboola D, Fadimu O, Afolabi A (2013) Antibacterial, Phytochemical and Proximate Analysis of Prosopis africana (Linn) Seed and Pod Extract. FUTA Journal of Research in Sciences 9(1): 101-109.

3. Ayanwuyi LO, Yaro AH, Abodunde OM (2010) Analgesic and Anti-inflammatory Effects of the Methanol Stem Bark Extract of Prosopis Africana. Pharmaceutical Biology 48(3): 296-299.

4. Alagbe JO (2022) Use of medicinal plants as a panacea to poultry production and food security: A review. American Journal of Technology and Applied Sciences 1: 24-36.

5. Dai J, Mumper RJ (2010) Plant Phenolics: Extraction, Analysis and their Antioxidant and Anticancer Properties. Molecules 15(10): 7313-7352.

6. Cowan MM (1999) Plant Products as Antimicrobial Agents. Clinical Microbiology Reviews 12(4):564-582.

7. Cushnie TT, Lamb AJ (2005) Antimicrobial Activity of Flavonoids. International Journal of Antimicrobial Agents 26(5): 343-356.

8. Davies DG, Parsek MR, Pearson JP, Iglewski, BH, Costerton JW, et al. (1998) The Involvement of Cell-to-Cell Signals in the Development of a Bacterial Biofilm. Science 280(5361): 295-298.

9. Singh J (2008) Maceration, Percolation and Infusion

Techniques for the Extraction of Medicinal and Aromatic Plants. Extraction Technologies for Medicinal and Aromatic Plants 67: 32-35.

10. Alagbe JO (2023) Sensory evaluation and fatty acid composition of broiler chickens fed diets containing Prosopis africana oil. Journal of Healthcare and Biomedical Science 1(2): 36-45.

11. Alagbe JO (2022) Prosopis africana (African mesquite) oil as an alternative to antibiotic feed additives on broiler chicken's diets: haematology and serum biochemical indices. Central Asian Journal of Theoretical and Applied Sciences 3(2): 19-29.

12. Alagbe JO (2022) Prosopis africana (African mesquite) oil as an alternative to antibiotic feed additives on broiler chickens diets: performance and nutrient retention. Discovery 58(314): 134-142.

13. Guimaraes LGL (2010) Oleos Essenciais de Lippia sidoides Cham, Alomia fastigiata (Gardner) Benth, Ocotea odorifera (Vell.) Rohwer, Mikania glauca Mart. e Cordia verbenacea D.C.: Identificacao e Quantificacao Quimica, Caracterizacao das Estruturas Secretoras, Atividades Antioxidante Antibacteriana. Ph.D. Thesis, Universidade Federal de Lavras, Lavras, Brazil.

14. Jim enez-Arellanes AM, Meckes M, Ram IR, Torres J, Luna-Herrera J (2003) Activity against multidrug-resistant Myocbacteriun tuberculosis in Mexican plants used to treat respiratory diseases. Phytotherapy Research 17(8): 903-908.

15. Kokoska L, Polesny Z, Rada V, Nepovim A, Vanek T (2002) Screening of some Siberian medicinal plants for antimicrobial activity. Journal of Ethnopharmacology 82(1): 51-53.

16. Lin FYC, Ho VA, Bay PV, Thuy NTT, Bryla D, et al. (2000) The epidemiology of typhoid fever in the Dong Thap Province, Mekong Delta region of Vietnam. American Journal of Tropical Medical Hygiene 62(5): 644-648.

17. Loizou S, Lekakis I, Chrousos GP, Moutsatsou P (2010) Beta-sitosterol exhibits anti-inflammatory activity in human aortic endothelial cells. Molecular Nutrition and Food Research 54(4): 551-558.

18. John AO, Nnadozie AD, Daniel SM, Mohammad RS, Faniyi TO, et al. (2023) Growth performance and physiological response of weaned pigs fed diet supplemented with novel a phytogenics. Brazilian Journal of Science 3(1): 43-57.

19. Egunyomi AS, Oladunjoye S (2012) Studies on the chemical composition and Nutritive value of the fruit of African star apple. African Journal of Agricultural Research 7(31): 4256-4258.

20. Edeoga HO, Okwu DE, Mbaebie BO (2005) Phytochemical constituents of some Nigerian medicinal plants. African Journal of Biotechnology 4(7): 685-688.

21. Idowu TO, Iwalewa EO, Aderogba MA, Akinpelu BA, Ogundaini AO (2006) Antinociceptive, Anti-inflammatory and Antioxidant activities of Eleagnine: An alkaloid isolated from seed cotyledon of Chrysophyllum albidum. Journal of Biological Science 6(6): 1029-1034.

22. Lalitha V, Kiran B, Raveesha K (2011) Antifungal and antibacterial potentiality of six essential oils extracted from plant source. IJEST 3(4): 3029-3038.

23. Russell W (1994) The Complete Book of Natural and Medicinal Cures. Rodale Press, Inc., Emmaus, Pennsylvania.

24. Xu B, Chang S (2007) A Comparative Study on Phenolic Profiles and Antioxidant Activities of Legumes as Affected by Extraction Solvents. Journal of Food Science 72(2): S159-S166.

25. Shai L, McGaw L, Masoko P, Eloff J (2008) Antifungal and Antibacterial Activity of Seven Traditionally used South African Plant Species Active against Candida Albicans. South African Journal of Botany 74(4): 677-684.

26. Shaheen AY, Sheikh AA, Rabbani M, Aslam A, Bibi T, et al. (2015) Antibacterial Activity of Herbal Extracts Against Multi-Drug Resistant Escherichia Coli Recovered from Retail Chicken Meat. Pakistan Journal of Pharmaceutical Science 28(4): 1295-1300.

27. Özçelik B, Kartal M, Orhan I (2011) Cytotoxicity, Antiviral and Antimicrobial Activities of Alkaloids, Flavonoids, and Phenolic Acids. Pharmaceutical Biology 49(4): 396-402.

28. Sharma S, John AO,Xing L, Ram S, Amita K (2022) Comparative analysis of ethanolic Juniperus thurifera leaf, stem bark and root extract using gas chromatography and mass spectroemetry. International Journal of Agriculture and Animal Production 2(6): 18-27.

29. Omokore EA, Alagbe JO (2019) Effect of replacing soya bean meal with Indigofera zollingweriana leaf meal on the performance and carcass characteristic of growing rabbits. International Journal of Multidisciplinary Research and Development 6(5): 74-77.

30. Inngjerdingen K, Nergård CS, Diallo D, Mounkoro PP, Paulsen BS (2004) An Ethnopharmacological Survey of Plants used for Wound Healing in Dogonland, Mali, West

Africa. Journal of Ethnopharmacology 92(2-3): 233-244.

31. Ezike AC, Akah PA, Okoli CO, Udegbunam S, Okwume N, et al. (2010) Medicinal Plants used in Wound Care: A Study of Prosopis Africana (Fabaceae) Stem Bark. Indian Journal of Pharmaceutical Sciences 72(3): 334-339.

32. Enright MC, Robinson DA, Randle G, Feil EJ, Grundmann H, et al. (2002) The Evolutionary History of Methicillin-Resistant Staphylococcus Aureus (MRSA). Proceedings of the National Academy of Sciences of the United States of America 99(11): 7687-7692.

33. Fabricant DS, Farnsworth NR (2001) The Value of Plants used in Traditional Medicine for Drug Discovery. Environmental Health Perspectives 109(1): 69-75.

34. Chua LS (2013) A Review on Plant-Based Rutin Extraction Methods and its Pharmacological Activities. Journal of Ethnopharmacology 150(3): 805-817.

35. Anorue DN, Ubong F, John FO (2023) Investigating the effects of pawpaw (Carica papaya) essential oil dietary supplementation on the growth performance and carcass characteristics of broilers. Research in: Agricultural and Veterinary Sciences 7(3): 164-174.

36. Azmir J, Zaidul I, Rahman M, Sharif K, Mohamed A, et al. (2013) Techniques for Extraction of Bioactive Compounds from Plant Materials: A Review. Journal of Food Engineering 117(4): 426-436.

37. Atanasov AG, Waltenberger B, Pferschy-Wenzig EM, Linder T, Wawrosch C, et al. (2015) Discovery and resupply of pharmacologically active plant-derived natural products: A review. Biotechnology advances, 33(8): 1582-1614.

38. Alagbe JO (2024) Novel phytogenics impact on weaned pig's growth performance, haematology and serum biochemical indicators. Black Sea Journal of Agriculture 7(2): 1-9.

39. John AO, Anuore DN, Daniel SM, Adewale E, Taiwo A, et al. (2023) Impact of dietary supplementation of Carica papaya essential oil on the blood chemistry of broiler chickens. Science Letters 11(3): 105-110.

40. Alagbe JO (2023) Investigating the effects of dietary supplementation of Eucalyptus camaldulensis essential oil on the growth performance, nutrient digestibility and caecal fermentation of weaned rabbits. Research in: Agricultural and Veterinary Sciences 4(1): 139-148.

41. Alagbe JO (2023) Investigating the effects of dietary supplementation of Eucalyptus camaldulensis essential oil on haemato-biochemical indices, immune response and oxidative stress of weaned rabbits. International Journal of Agriculture and Animal Production 4(1): 34-46.

42. Atawodi SE, Ogunbusola F (2009) Evaluation of Anti-Trypanosomal Properties of Four Extracts of Leaves, Stem and Root Barks of Prosopis Africana in Laboratory Animals. Biokemistri 21(2).

43. Sandasi M, Leonard C, Viljoen A (2005) The in Vitro Antibiofilm Activity of Selected Culinary Herbs and Medicinal Plants Against Listeria Monocytogenes. Letters in Applied Microbiology 50(1): 30-35.

44. Alagbe JO (2021) Prosopis africana stem bark as an alternative to antibiotic feed additives in broiler chick's diets: Performance and Carcass characteristics. Journal of Multidimensional Research and Reviews 2(1): 64-77.