

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

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## 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.

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## 1. 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 [1-10].

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 [11]. 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 (Aremu et al., 2007). When dried, the seeds of *Prosopis africana* can open freely inside a yellow-intermeshed pod. According to Kolapo et al. (2009) [11], 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*. 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 [13-30].

Essential minerals like potassium, phosphorus, calcium, manganese, magnesium, zinc, and copper are present in *Prosopis africana* [1]. According to Yanwuyi et al. [4], 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 [36, 39].

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 [40-45].

## 2. Materials and Methods

### 2.1. Phytochemical Makeup of Extracts from *Prosopis Africana*

#### 2.1.1. Phenols

Due to their antioxidant and free-radical scavenging qualities, phenolic compounds help keep animals healthy (Dai and Mumper, [43]). Phenols work by depriving bacteria of their substrate, which causes fragmentation of the bacterial cytoplasm (Cowan 1999). In their investigations, Cushnie and Lamb (2005) [27] and Davies et al. (1998) [44] found that the inhibition of enzymes by oxidized substrate was the cause of phenols' potency against bacteria.

### 2.1.2. Alkaloids

According to Singh (2008) [42], alkaloids are naturally occurring organic molecules that have a nitrogen heteroatom in their framework. 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.

### 2.1.3. Flavonoids

According to Cowan (1999) [26], 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 [27].

### 2.1.4. 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. It also causes membrane rupture and substrate restriction as a result of complex formation.

### 2.1.5. 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. Saponins function by building compounds with sterols or polysaccharides inside the microbial cell membrane, which destroys the integrity of the cytoplasmic membrane.

## 2.2. Pharmacological Properties of *Prosopis africana*

### 2.2.1. Antimicrobial Properties

A study carried out 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. Other studies have shown 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*.

### 2.2.2. 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, 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 [33-39].

### 2.2.3. Hypolipidemic Characteristics

According to earlier research, 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. [36,39], 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 [36,39].

## 3. Results and Discussion

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 with 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.

**Table 1.** Some Bioactive Compounds in *Prosopis africana* oil and their properties [29-35].

Active compounds	Medicinal properties	References
Prosogerin A (6 Methoxy-7-hydroxyl dioxyflavone)	Antibacterial, antioxidant and immune-stimulatory	Guimarães (2010)
Prosogerin B (2,4 dihydroxyl -5 methyl dioxychacon)	Antimicrobial, hepato-protective and antioxidant	Jiménez-Arellanes et al. (2003)
2,4-bis (1-phenylethyl) phenol	Antioxidants, antifungal	Kokoska et al. (2002)
$\beta$ -phenethylamine	Antifungal and immune-stimulatory	Lin et al. (2000)
2,4,6-tris(1-phenylethyl) phenol	Antibacterial, antiviral	Loizou et al. (2010)
$\alpha$ -pinene	Antioxidant and digestive stimulants	Alagbe et al. (2022)
$\alpha$ -terpinene	Antioxidant, antibacterial,	Alagbe et al. (2023)
$\beta$ -pinene	Antioxidant, antimicrobial	Egunyomi and Oladunjoye (2012)
$\beta$ -myrcene	Antioxidant, digestive stimulants	Edeoga et al. (2005); Alagbe (2022)

$\alpha$ -phellandrene	Antioxidant, Antifungal and antimicrobial	Idowu et al. (2006)
$\alpha$ -terpinolene	Antioxidant, antibacterial	Guimarães (2010)
$\gamma$ -terpinene	Antioxidant, immune-stimulatory	Jiménez-Arellanes et al. (2003)
1-terpineol	digestive stimulants	Lalitha et al. (2011)
4-terpineol	digestive stimulants	Lin et al. (2000)
Humulene	Antibacterial, anti-helminthic	Loizou et al. (2010)
Caryophyllene	digestive stimulants	Alagbe et al. (2022)
Copaene	Antimicrobial	Wild (1994)
Cis-linaloxide	Antifungal	Xu and Chang (2007)
$\alpha$ -Selinene	Antioxidant, anti-inflammatory	Shai et al. (2008)
$\gamma$ -Elemene	digestive stimulants	Shaheen et al. (2005)
$\alpha$ -Gurjunene	Immuno-stimulatory, antioxidant	Özçelik et al. (2011)
$\beta$ -Elemene	Antimicrobial, antioxidant, digestive stimulants	Singh et al. (2023); Omokore and Alagbe (2019)
$\beta$ -Cyclocitral	Anti-inflammatory, digestive stimulants	Kolapo et al. (2009)
3-hexenyl-2-methylbutanoate	Anti-bacterial	Inngjerdigen et al. (2004)
Exo-methyl-camphenilol	Antimicrobial	Ezike et al. (2010)
Caryophyllene oxide	Antibacterial, antioxidant	Enright et al. (2002)
Benzene -1-methoxy-2-methyl	Antifungal	Fabricant and Farnsworth (2001)
Napthalene, 1,2 hydro-1,1, 6 –trimethyl	Antimicrobial	Inngjerdigen et al. (2004)
Cycloheptasiloxane, tetradecamethyl	Anti-inflammatory	Chua (2013); Daniel et al. (2023)
Nerolidyl acetate	Anti-inflammatory	Azmir et al. (2013)
1-Cyclohexene-1- butanal, alpha, 2, 6, 6-tetramethyl	Anti-inflammatory	Atanasov et al., 2015; Alagbe (2024)

**Table 2.** Effects of *Prosopis africana* extracts on the general performance of bird.

Type of Extracts Used	Concentration Used	Effect on Broilers
<i>Prosopis africana</i> essential oil	400 mg/kg	Increased body weight gain
		Increased pancreatic enzyme production

<i>Prosopis africana</i> essential oil	800 mg/kg	Improved nutrient utilization
		Increased feed intake
		Reduced mortality rate
		Increased in carcass weight
		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
<i>Prosopis africana</i> stem bark extracts (aqueous)	8ml/litre of water	Increased final body weight gain, feed intake and <i>Lactobacillus sp</i> count in the gut of broilers

#### 4. Conclusions and Future Scope

In conclusion, addressing the challenges posed by antimicrobial resistance, toxic residue buildup, and environmental contamination in the chicken sector requires a shift towards natural solutions. Medicinal plants, rich in phytochemicals such as phenols, flavonoids, terpenoids, tannins, alkaloids, and saponins, offer promising alternatives to antibiotics. Among these alternatives, extracts from *Prosopis africana* stand out due to their diverse pharmacological activities, including antioxidant, antibacterial, antifungal, anti-helminthic, antiviral, hepatoprotective, and immune-stimulatory properties. Additionally, these extracts provide essential minerals and amino acids that support enzyme function and help combat oxidative stress. Embracing the use of *Prosopis africana* extracts can pave the way for more effective chicken production, promote environmental sustainability, and enhance food hygiene standards in the poultry industry. By harnessing the potential of natural remedies, we can mitigate the risks associated with conventional antibiotic use and ensure a healthier future for both consumers and the environment.

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