

Chapter 24

Uses of Various Essential Oils along their Anti-Biofilm Potential in Poultry

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ABSTRACT

Plant-based essential oils have been recognized and fascinated people for ages for their aromatic and volatile compounds. This abstract study looks at certain essential oils in detail, covering their uses, geographical origins, historical and cultural significance, extraction techniques, and antibiofilm applications. These oils have played important roles in traditional medicine, religious rituals, and cultural practices throughout history. The volatile compounds in plant materials are carefully preserved by selecting the right extraction methods like solvent extraction, steam distillation, and cold pressing that guarantee the potency and integrity of the finished product. These oils are widely used in aromatherapy, skincare, and have both medicinal and non-medicinal uses. This book chapter provided insight antimicrobial, anti-inflammatory, and antioxidant properties while supporting health and well-being through the formation of pathogenic biofilms in poultry.

KEYWORDS

Biofilm, Essential Oils, Extraction, Medicinal, Non-medicinal, Poultry

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INTRODUCTION

Plant-based essential oils have been recognized and fascinated people for ages for their aromatic and volatile compounds. Essential oils from more than 500 plants are extracted and used for different purposes (Moazzam et al., 2018). These oils have played important roles in aromatherapy, skincare, and have both medicinal and non-medicinal uses. Nowadays, their applications are also seen in poultry, fish and livestock. This book chapter is covering different essential oils such as almond, basil, black paper, chamomile, clove, coffee, eucalyptus, garlic, and fenugreek with reference to uses, geographical origins, historical and cultural significance, extraction techniques, and their antibiofilm potential particularly in poultry.

Almond Oil

Almond trees are scientifically known as *Prunus dulcis* and are a rich source of almond oil (Sana et al. 2021). The plant has two species. *Prunus dulcis* is one which can be cultivated and sweet in taste while, its other species is wild and bitter in taste (Delplancke et al., 2012). The trees are native to the Middle East and South Asia (Chalak 2013). Its origin is from central Asia and from where it was shifted to all old civilizations such as Asia, Europe and Africa. However, nowadays, these are also cropped in Mediterranean, California, and parts of Asia. Additionally, these are also cropped in the Southern Hemisphere, including Chile, Argentina, South Africa, and Australia (reached in 1800) (Wirthensohn and Iannamico, 2017).

Historical Importance

Almonds have a long history of cultivation and usage, dating back thousands of years (Delplancke et al. 2013). They were highly prized by ancient civilizations such as the Egyptians (Kiple and Ornelas, 2000), Greeks (Diekman and Chelf, 2017), and Romans for their nutritional value and versatility (Gradziel, 2011). The first proof of the occurrence of wild almonds during the Pleistocene era (7.8×10^5 BCE) came from Israel. Almonds hold significant cultural importance in many societies, often symbolizing fertility, prosperity, and good fortune. In some cultures, almonds are used in wedding ceremonies and other celebrations as a symbol of blessings and abundance (Gradziel, 2017).

Extraction Methods

Several advanced and mechanical methods are in practice to extract almond oils (Table 1).

Table 1: List of essential oils with the most common extraction methods

Sr. No.	Plant	The most common Extraction Methods	References
1.	Almond oil	1. Cold-pressing or soxhlet extracted methods 2. Hydraulic press or screw press 3. Ultrasonic-assisted extraction, supercritical fluid extraction, subcritical fluid extraction, and salt-assisted aqueous extraction	Al Juhaimi et al., 2018; Barreira et al., 2019; Ouzir et al., 2021; Shrestha, 2022
2.	Basil Oil	1. Solvent-free microwave extraction (SFME). 2. Solvent extraction, hydrodistillation, and steam distillation.	Charles and Simon, 1990; Chenni et al., 2016; da Silva, et al., 2022
3.	Black paper	1. Steam distillation 2. GC-MS	Aziz et al., 2012; Balasubramanian et al., 2016
4.	Chamomile	1. Steam distillation	Singh et al., 2017
5.	Clove	1. Steam distillation 2. Hydro distillation, ultrasound-assisted extraction, microwave-assisted extraction, cold pressing, and supercritical fluid extraction	Haro-González et al., 2021
6.	Coffee	1. Cold-pressing or solvent extraction methods 2. solid-liquid and liquid-liquid extraction, ultrasound, microwave, supercritical fluid, subcritical water, pulsed electric field, and fermentation	Bondam et al., 2022
7.	Eucalyptus	1. Steam distillation	Galadima et al., 2012; Kidane, 2016
8.	Garlic	1. Steam distillation or cold pressing.	Abe et al., 2020
9.	Fenugreek	1. Cold pressing or steam distillation	Sarwar et al., 2020; Raza et al., 2022

Chemical Composition

The chemical composition of various oils is given in Table 2.

Table 2: List of essential oils their composition and applications

Sr. No.	Plant	Composition	Applications	References
1	Almond oil	Diverse types of Fatty acids (mainly oleic acid), tocopherol and phytosterol content.	1. Oxidative stress reduction 2. Cardiovascular risk management 3. Glucose homeostasis, 4. Neuroprotection, and many 5. Cosmetic and dermatologic applications	Ahmad, 2010; Chalak, 2013; Lin et al., 2017; Mohiuddin, 2019; Ouzir et al., 2021; Flores-Balderas et al., 2023; Selwyn and Govindaraj, 2023
2	Basil Oil	Diverse types of Fatty acids, antioxidant compounds and carbohydrates	1. Treatment of kidney problems 2. Treatment of colds and malaria 3. Oxidative stress reduction 4. Cardiovascular risk management 5. Anti-cancer and antimicrobial activity 6. Therapeutic applications 7. Aromatic qualities 8. Insecticide	Gebrehiwot et al., 2015; Poonkodi, 2016; Shahrajabian et al., 2020
3	Black paper	Various types of Terpenoids and caryophyllene, sabinene and terpinen-4	1. Used as preservative and biocontrol agent 2. Excellent antioxidant potential 3. Anti-fungal and anti-amoebic activity 4. Treatment of diabetic and asthmatic problems	Lee et al., 2014
4	Chamomile	Terpenoids, flavonoids, coumarins, phenolic acids, tannins, and phytosterols	1. Oxidative stress reduction 2. Antimicrobial agent 3. Anti-hypertensive, anti-allergic and anticancer activity	Sah et al., 2022
5	Clove	Eugenol, eugenyl acetate, β -caryophyllene, and α -humulene.	1. Anti-inflammatory and analgesic activity 2. Anticancer activity	Haro-González et al., 2021

6	Coffee	Fatty acid (mainly linoleic acid and palmitic acid), aldehydes, pyrroles, furans, pyrazines, pyridine, flavonoids and phenolic compounds	1. Antioxidant agent 2. Wound healing 3. Cosmetic and pharmaceutical industries	Calligaris et al., 2009; Dias et al., 2023
7	Eucalyptus	Terpenes, aromatic phenols, alcohols, oxides, ethers, esters, aldehydes and ketones such as Eucalyptol, <i>p</i> -cymene, α -pinene, β -myrcene, γ -terpinene and citronellal,	1. Used as Biopesticides in agricultural field 2. As drugs in pharmaceutical industries 3. As flavorants in food industries 4. Antioxidant agent 5. Treatment of bronchial infection	Almas et al., 2021; Āmikova et al., 2023
8	Garlic	Allyl polysulfides	1. Oxidative stress reduction 2. Antimicrobial activity 3. Antihypertensive and antihyperlipidemic activity 4. Anticarcinogenic and immunomodulatory properties	Satyal et al., 2017; Verma et al., 2023
9	Fenugreek	Saponins, alkaloids, flavonoids, and essential fatty acids	1. Managing diabetes 2. Cardiovascular diseases 3. Hypercholesteremia 4. Improve lactation in breastfeeding mothers, and boosting libido 5. Culinary applications	Khorshidian et al., 2016; Murad et al., 2019; Shukla et al., 2019; Shahrajabian et al., 2021; Joshi et al., 2022; Singh et al., 2022

Applications

The emollient and moisturizing qualities of almond oil makes them fit for skincare products to help hydrate and nourish the skin (Chalak, 2013; Mohiuddin, 2019; Selwyn and Govindaraj, 2023) (Table 2).

Antibiofilm Activity

The antibacterial effect of almond oil is also reported against many biofilms forming Gram positive and Gram-negative species and its use is particularly recommended in poultry feed for good health of the birds and control of various bacteria such as *L. monocytogenes* and *S. Enteritidis* (Somrani, 2020; Mezher et al., 2022; Movahedi et al., 2024).

Basil Oil

The leaves of the basil plant are used to make basil oil. This plant is known by its scientific name, *Ocimum basilicum* (Bilal et al., 2012; Ch et al., 2015; Pettman, 2010; Pushpangadan and George, 2012). It is a member of the *Lamiaceae* family, and well-known by the name "king of herbs" (Dudai et al. 2020). There are more than 150 species of the genus *Ocimum* of basil that are grown all over the world (Poonkodi, 2016). Basil is native to tropical regions of Asia and Africa (Ch et al., 2015) but is now cultivated worldwide, particularly in Mediterranean countries, Turkey and Southeast Asia (Tilebeni, 2011; Yıkımıř et al., 2017).

Historical Importance

Basil has a long history, and it was frequently used by ancient Egyptian, Indian, and Greek civilizations. For centuries, people have prized it for its culinary and therapeutic properties (Renfrew and Sanderson, 2012). It has cultural significance in many societies and is frequently connected to spirituality, love (Italy), and protection. It is used in religious burials and ceremonies and is regarded as a blessed herb in some cultures (India) (Dudai et al. 2020; Pettman, 2010).

Extraction Methods

Several advanced and mechanical methods are in practice to extract basil oils (Table 1).

Chemical Composition

The chemical composition of various oils is given in Table 2.

Applications

Basil oil is effective in fighting infections and promoting immunological health due to its antibacterial, antiviral, antifungal, and antioxidant properties (Poonkodi, 2016; Parham et al., 2020; Sharafati-Chaleshtori et al., 2021; Zagoto et al., 2021) (Table 2).

Antibiofilm Activity

Basil oils have also potent bactericidal effects against *Pseudomonas aeruginosa* with 99.9% growth reduction and inhibiting virulence besides eradicating all stages of biofilm development and applicable in poultry as well (Pejčić et al., 2020; Oliveira et al., 2024). In chickens, basil oil has demonstrated promise as an anti-biofilm agent, especially against harmful bacteria like *Salmonella* and *E. coli*. Its bioactive ingredients help in lessening the bacterial colonization in the poultry intestine by preventing biofilm formation, which enhances general health and lowers the risk of illnesses. Relying less on artificial antibiotics and preserving poultry hygiene are two benefits of this natural intervention (Marzlan et al., 2023).

Black Pepper

Black pepper (*Piper nigrum*) is an important member of the piperaceae family. Its dried fruit is used to obtain black pepper oil (Milenković and Stanojević, 2021). It is also referred to as the "king of spices" and is well-known for many health advantages, spicy taste and scent (Umarkar et al., 2011; Hammouti et al., 2019; Takooree et al., 2019; Spence, 2024). It is one of the oldest spices in the world (Krishnamoorthy and Parthasarathy, 2010; Bosland et al., 2012). It is indigenous to the Indian subcontinent (Divakaran et al., 2018; Hammouti et al., 2019; Kumar et al., 2021). Along with Southeast Asia, Africa, and Latin America, it is also cultivated in tropical regions (26 nations) (Yang et al., 2017; Nair, 2020; Tripodi et al., 2021). Reed and Leleković, (2019) reported its status as an alien species in Pannonia.

Historical Importance

For millennia, black pepper is considered as culinary and therapeutic assets (Bosland et al., 2012; Shaffer, 2013). Ancient societies like the Greeks, Romans, and Egyptians valued it high and utilized it as a spice and a kind of money (Hammouti et al. 2019). This is typically connected to warmth, vibrancy, and prosperity and has cultural importance to ward off evil spirits and provide good fortune in many countries.

Extraction Methods

Several advanced and mechanical methods are in practice to extract black pepper oils (Table 1).

Chemical Composition

The chemical composition of various oils is given in Table 2.

Applications

Black pepper oil is useful for reducing pain and inflammation (Adiani and Variyar, 2020). It is also utilized to enhance circulation, increase metabolism, and support digestive and cardiovascular health (Yang et al. 2019; Wang et al., 2021) (Table 2).

Antibiofilm Activity

Beneficial effects of black pepper as essential oils have been reported to show its potential use as an efficient anti-virulence strategy against prolonged *S. typhi*, and *L. monocytogenes* infections in poultry (dos Santos et al., 2020). Black pepper, and their common constituent cis-nerolidol at 0.01 % markedly inhibited *S. aureus* biofilm formation (Lee et al., 2014).

Chamomile Oil

The chamomile belongs to the Asteraceae family of plants. Chamomile oil is harvested from their blooms (Srivastava et al., 2010; Menge et al., 2016). It's a little shrub with fluffy leaves and flowers that resemble daisies. *Matricaria chamomilla* and *Chamaemelum nobile* are the names of two of its variations (Sharafzadeh and Alizadeh, 2011; Sah et al., 2022). It was originated in Europe and Western Asia and currently grown all over the world, especially in temperate climates with lots of sunshine and well-drained soil (Menge et al., 2016).

Historical Importance

It has a long history of use in traditional medicine and folk remedies. It was highly valued by ancient civilizations such as the Egyptians, Greeks, and Romans for its medicinal properties (Heinrich et al., 2012; Saheedha, 2019; Mekhlfi, 2023). It holds cultural significance in many societies and is often associated with relaxation, tranquility, and healing. In some cultures, chamomile tea is used as a soothing beverage to promote restful sleep and calm the nerves (Antol, 1995; Hosen and Madhu, 2023).

Extraction Methods

Several advanced and mechanical methods are in practice to extract chamomile oils (Table 1).

Chemical Composition

The chemical composition of various oils is given in Table 2.

Applications

Patients who take chamomile oil report feeling less stressed, more relaxed, and less depressed and anxious. To reduce skin irritations, itching, and speed up the healing of wounds, resolve menstrual issues, it is also used topically (Martins et al., 2009; Sharafzadeh and Alizadeh, 2011; Gad et al., 2019) (Table 2).

Antibiofilm Activity

In poultry, chamomile oil has an anti-biofilm function, and it help in improving chicken health and lowering bacterial infections, this may lessen the demand for antibiotics in chicken production. Antibiofilm and anti- QS activity of chamomile is also reported in poultry and livestock (Ibrahim, 2017).

Clove Oil

The clove tree, (*Syzygium aromaticum*) is a member of the Myrtaceae family (Cortés-Rojas et al., 2014; Kaur and Kaushal, 2019). Its clove oil is derived from flower buds (Kaur and Kaushal, 2019). It is well known for its spicy scent and many health advantages (Kumar et al., 2012; Poornima et al., 2022). The clove trees are native to Indonesia's Maluku Islands (Sundari et al., 2019), presently they are also grown in tropical climates across the globe, such as Tanzania, Madagascar, India, and Sri Lanka (Charoonratana, 2022; Poornima et al., 2022).

Historical Importance

Clove has been utilized in both traditional medicine and cooking from prehistoric times (Otinola, 2022). It is highly prized in ancient cultures such as Greeks, Romans, and Chinese, for its fragrant and therapeutic characteristics (Giannenas et al., 2020). It is commonly connected to healing, purification, and protection and has cultural significance in many countries to draw in good energy and ward off bad energy (Izzah et al., 2018).

Extraction Methods

A few advanced and mechanical methods are in practice to extract clove oils (Table 1).

Chemical Composition

The chemical composition of various oils is given in Table 2.

Applications

For its antiseptic qualities, clove oil is applied topically to treat toothaches, sore gums, and oral infections (Hosseini et al., 2011; Bhowmik et al., 2012). It is also used in treating headaches, rheumatoid arthritis, and muscular aches (Milind and Deepa, 2011; Esmaeili et al., 2022; Ugboogu et al., 2022; Yadav et al., 2022) (Table 2).

Antibiofilm Activity

Clove oil has been shown to have promising antibiofilm properties against bacterial species. The oil has been reported to induce alteration in individual bacterial cells length and visible increase of their roughness and it was speculated that Clove essential oil seems to discharge exopolysaccharides from bacterial biofilm and inducing bacterial detachment from the surface. Due to anti-*A. acidoterrestris* biofilm activity, the clove oil showed potential to hinder a development of *A. acidoterrestris* biofilms on production surfaces in food industries (Kunicka-Styczyńska et al., 2020). The vivid antibiofilm effect of clove oil was also observed against *E. coli* O157:H7, *P. aeruginosa*, and *A. hydrophila* (Kim et al., 2016; Hussain et al., 2017). Clove oil have significant potential to inhibit the bacterial biofilm formation and reduce the virulence factors of the pathogens in poultry (Liu et al., 2022).

Coffee Oil

The Coffe plant is a member of the *Rubiaceae* family, and its roasted seeds, or coffee beans, are used to make coffee oil (ALAsmari et al., 2020). It has two varieties such as *Coffea arabica* and *Coffea canephora* (Anzueto et al., 2005; Lim and Lim, 2013; Dulmini, 2023). It is highly valued for its multifaceted health and skincare benefits, as well as its deep flavor and rich aroma (Esquivel and Jimenez, 2012; dos Santos et al., 2021; Sharmeen et al., 2021). Although coffee trees are native to tropical parts of Asia and Africa. However, it is also grown in many equatorial countries, such as Brazil, Colombia, and Vietnam (Wintgens, 2012; DaMatta, 2018). *Coffea arabica* is particularly famous in Ethiopia (Sisay, 2018).

Historical Importance

Coffee has a long history as in Yemen and Ethiopia it was famous for its use even from sixth century (Fregulia, 2019; Yilmaz et al., 2019). It is culturally significant and is linked to vitality, productivity, and socializing. In various cultures it is an essential component of everyday life, signifying friendliness and unity (Topik, 2009; Yoseph, 2013; Duressa, 2018; Bacha et al., 2019; Purnomo et al., 2021).

Extraction Methods

A few advanced and mechanical methods are in practice to extract black pepper oils (Table 1).

Chemical Composition

The chemical composition of various oils is given in Table 2.

Applications

According to Del Castillo et al. (2019), coffee oil is thought to possess antioxidant qualities that help shield cells from oxidative damage and lower the risk of chronic illnesses (Table 2).

Antibiofilm Activity

Extraction of green coffee beans and robusta coffee beans showed Inhibitory activity and biofilm degradation (Wicahyo et al., 2024). Coffee beans have also been found to show anti-bacterial and antibiofilm agents against multi drug resistant bacteria (extended-spectrum beta-lactamase (ESBL) and methicillin-resistant *Staphylococcus aureus* (MRSA)-positive biofilm-forming strains of *Pseudomonas aeruginosa* (*P. aeruginosa*), *Escherichia coli* (*E. coli*), and *Staphylococcus aureus* (*S. aureus*) obtained from foot ulcers) in Diabetes-related complications such as diabetic foot infections (Zubair, 2024). It was proven a good ingredient for the broiler chickens' live body weight, feed conversion ratio, and pathogenic bacterial counts were all increased when given 2.5 g/kg of green coffee powder (GCP). GCP changed the color characteristics and raised pH to improve the quality of meat. Moreover, coffee oil may help to improve the health and performance of chickens by reducing pathogen biofilms (Ashour et al., 2020).

Eucalyptus Oil

Eucalyptus trees are one of evergreens plant (Sunder, 1993). Different types of eucalyptus trees are used to produce eucalyptus essential oil. There are around 900 species in the genus *Eucalyptus* (Dhakad et al., 2018). *Eucalyptus globulus*, *Eucalyptus radiata*, and *Eucalyptus citriodora* are the three most common species that are well known. It is cropped at various places although, it is native to Australia. Origins Geographically Native to Australia, eucalyptus trees flourish there in a variety of habitats (Trivedi and Hotchandani, 2004). They are grown for a variety of uses after being brought to other regions of the world, including North and South America, Europe, and Asia (Paine et al., 2011).

Historical Importance

The leaves of eucalyptus have traditionally been used as medicine by Indigenous Australian cultures. They used them as insect repellents, wound treatments, and remedies for respiratory problems (Khan et al., 2020; Oke et al., 2021). The significance of the tree is both social and economic (Turnbull, 2000).

Extraction Methods

Several advanced and mechanical methods are in practice to extract eucalyptus oils (Table 1).

Chemical Composition

The chemical composition of various oils is given in Table 2.

Applications

It facilitates easier breathing, it can be incorporated into steam or utilized in chest rubs (Shao et al., 2020; Sudradjat, 2020). It can be used as antiviral, antifungal, antibacterial, and insecticidal (Trivedi and Hotchandani, 2004; Zhang et al. 2010; Sebei et al. 2015; Mieres-Castro et al., 2021) (Table 2).

Antibiofilm Activity

The antibiofilm effects of *Eucalyptus globulus* oil have been reported to be due to its main component 1,8-cineole, against MRSA, as well as their anti-Quorum sensing potential also noticed high (Balhaddad and AlSheikh, 2023). The activity of *Eucalyptus globulus* leaves is also reported against multi drug resistance bacteria in poultry (Ullah et al., 2021). In chicken, eucalyptus oil may prevent and interfere with the production of biofilms which reduces the load of harmful microorganisms and possibly improves the poultry's health. Because of its antibacterial qualities, poultry environment may operate better overall and be cleaner.

Garlic Oil

The *Allium sativum* plant belongs to the family *Alliaceae*. Its bulbs are used to extract garlic oil. It has a long history and is used both for culinary and medicinal contexts (Satyal et al., 2017; Miri and Roughani, 2018; Saif et al., 2020). Garlic is indigenous to northern Iran and Central Asia (Shaaf et al., 2014; Sarpaki, 2021). However, China, India, Egypt, Russia, and the Mediterranean region are among the many places in the world where it is commonly farmed (Cavagnaro and Galmarini, 2007; Dhall et al., 2023). Garlic and its derivative products, such as garlic oil, are mostly produced in these regions.

Historical Importance

Garlic cultivation dates to than 5,000 years (Parreño et al., 2023). Many different cultures have placed a high value on garlic. Garlic was prized for its therapeutic qualities by ancient societies like the Egyptians, Greeks, Romans, and Chinese, who used it to cure anything from infections to stomach problems. Additionally, it was thought to protect workers from evil spirits and provide them stamina and vigor (Omar et al., 2007; Sarpaki, 2021). According to Ezeorba et al. (2022) it has been linked to energy, healing, and protection. Garlic is sometimes put under pillows to induce pleasant dreams or hung outside dwellings to fight off evil spirits (Rivlin, 2001).

Extraction Methods

Several advanced and mechanical methods are in practice to extract garlic oils (Table 1).

Chemical Composition

The chemical composition of various oils is given in Table 2.

Applications

Several studies (Fialová et al., 2016; Miri and Roughani, 2018; Espinoza et al., 2020) report on its antimicrobial, antifungal, antiviral, and anti-inflammatory qualities (Table 2)

Antibiofilm Activity

Garlic oil has been reported to inhibit *S. typhimurium* biofilm and could be applied in the food and poultry industry (Morshdy et al., 2022; Robinson et al., 2022). Garlic oil improves sensory qualities and successfully lowers coliform counts in chicken meat; a 1.5% concentration yields the best outcomes. Its antibacterial qualities help to improve the safety and quality of meat while it is being stored (Wafy et al., 2019). Similarly, nanoemulsion of garlic oil in water dramatically inhibited *L. monocytogenes* biofilm development (Liu et al., 2024).

Fenugreek Oil

Trigonella foenum-graecum, is scientific name of Fenugreek and a member of the *Fabaceae* family. It is an annual crop with small yellowish white flowers and a source of fenugreek oil Çamlıca and Yaldız, 2019; Sarwar et al., 2020). It has a unique flavor and scent, and for ages, people have used it in food and medicine (Singh et al., 2022). Its origin is from the Mediterranean region, specifically Egypt and Greece. However, now it is widely grown in many nations with suitable climates, such as India, China, and Morocco (Hilles and Mahmood, 2021).

Historical Importance

Fenugreek was found in the writings of the ancient Greek, Roman, and Egyptian civilizations, demonstrating its great historical relevance (Kumar, 2019). In many cultures, it represents fertility, prosperity, and purity (Godara et al., 2017). Its seeds are frequently used to bring good fortune and blessings into rites and ceremonies, especially those pertaining to marriage and childbirth.

Extraction Methods

A few advanced and mechanical methods are in practice to extract Fenugreek oils (Table 1).

Chemical Composition

The chemical composition of various oils is given in Table 2.

Applications

Fenugreek oil has been used historically to treat a wide range of illnesses, including skin diseases, inflammation, and digestive disorders (Yusharyahya, 2020). It also helped in hypercholesterolemia, diabetes, cardiovascular disease, lactation improvement in nursing moms, and increased libido, according to research (Shahrajabian et al., 2021; Singh et al., 2022).

Antibiofilm Potential of Fenugreek

Fenugreek seeds have been reported to show antibacterial activities against pathogenic bacterial strains as well as anti-cancerous activity (Shapiro et al., 2001; Sharief and Gani, 2004). The seed extract has also a high potential in preservation of meat (Daneshniya et al., 2023). Fenugreek has strong antibiofilm qualities and is useful in treating biofilm-related diseases in chicken. It is a viable substitute for industrial chicken raising due to its easier availability and cheaper cost.

Conclusion

This book chapter offers valuable insights into the importance of various essential oils, their extraction methods, and applications, particularly focusing on glimpses of their anti-biofilm potential in poultry. The study highlights that essential oils such as clove, garlic, and basil have demonstrated strong anti-biofilm capabilities in poultry feed. By inhibiting biofilm formation, these oils can reduce illnesses caused by pathogens, contributing to better poultry health.

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