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OPEN ACCESS JOURNAL ISSN: 2148-6832

MSD Medical Science and Discovery
2018; 5(11):374-9

Review Article Doi: 10.17546/msd.482929

Antibacterial Activity of Laurus nobilis: A review of literature

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Abstract

The presence of phenolic compounds in spices and herbs, along with the essential oils, has been gaining attention due to their various functions like antioxidant capacity, antimicrobial properties, and flavoring properties. The Bay leaf belongs to Lauraceae family and is endemic in the Mediterranean region. *Lauraceae*, is an aromatic plant frequently used as a spice in Mediterranean cookery and as a traditional medicine for the treatment of several infectious disease. *L. nobilis* also belongs to *Lauraceae*. *L. nobilis* is aromatic tree, and is 2 m to 10 m high. *L. nobilis* contains about 1.3% essential oils and polar flavonoids mono, sesquiterpenes, alkoloids, glycosylated flavor-noids, megastigmane and phenolic components. It is known to have various pharmacological effects, including antimicrobial, cytotoxic and immune modulating. Its' essential oil containg eucalyptol, α-terpinyl acetate, linalool, methyl eugenol, sabinene and carvacrol. The property of every essential oil varies according to the harvest country, altitude, period of sunshine, conditions of harvest. These essential oil contents of *L. nobilis* are strong antibacterial activity against Gram negative and Gram positive foodorne pathogens (*Salmonella, Staphylococcus aureus, Esherichia coli, Listeria* monocytogenes like that), spoilage bacteria (*Pseudomonas aeroginosa*) as well as antifungal effects. The synergy between terpenes (linalool), lactones, oxides (1,8 cineole) and monoterpenes (camphene, alpa-pinene) gives to the essential oil of Laurel a good antibacterial activity. Its essential oils' various or single chemical compositions at different concentrations have different inhibition mechanisms that can affect a variety of pathogens by changing membrane permeability, denaturing proteins and inhibiting enzymes. The oils are not affecting on existing beneficial intestinal bacteria.

Key words: Essential oils, *Laurus nobilis*, Antibacterial Activity, Review

Introduction

Antibiotic or multiple antibiotic resistance (MDR) microorganism particularly pathogen bacteria has dramatically increased in human and animal. Therefore, resistance microorganism caused diseases have posed a risk in human and treated public health. Due to these resistance properties of microorganism, researchers started looking for alternative way for treatment or for preventing diseases. Nowadays, ingredients obtained from plants, like essential oil, can be used as alternatives to antibiotics. Bay laurel, cinnamon, oregano and clove like plants have antimicrobial activity against both some Gram negative and positive microorganisms (1). In this review, L. nobilis (bay leaf) and its effects as antimicrobial properties against some microorganism are highlighted.

Laurel (L.) nobilis (bay leaf) is an aromatic plant and evergreen tree which belongs to the family of Lauraceae, it is one of the most widely used culinary spices in all Western countries and Asian countries.

It is cultivated and endemic in the Mediterranean countries of Turkey, Spain, Morocco, Greece, Portugal, as well as in Mexico and other temperate and warm parts of the world. This aromatic tree is 2 m to 10 m high (2). The plants inherently cultivated in coastal areas to an altitude of 600-800 meters. The plant's leaves and berries are commonly used as a spice aroma and enhancer for foods especially for meats, sauces and soups (3). Besides its special aroma, it is also used to cure diseases all over the world. Some compounds of this plant such as essential oils and organic acids have shown strong antibacterial activity against some foodborne pathogen microorganism besides spoilage bacteria (4, 3,5,6).

Essential oil is a hydrophobic liquid compartment obtained from various parts of plant such as flowers, seeds and stems. Because of its aromatic characteristic, essential oil is used in as a flavoring agent in cosmetic and food industries

Received 15-11-2018 **Accepted** 20-11-2018 **Available Online** 21-11-2018 **Published** 30-11-2018
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http://dx.doi.org/10.17546/msd.482929

It has also biologic effects such as antimicrobial, antidiabetic and anticancer activities (4). The plant's essential oils have antimicrobial activity (1). Therefore, essential oils have been shown to have advantages as natural antimicrobials. These oils' various chemical compositions or single components at different concentrations have different inhibition mechanisms that can affect a variety of pathogens by changing membrane permeability, denaturing proteins and inhibiting enzymes. It has also shown effective antimicrobial activity against drug-resistant strains (7).

Essential oil of bay leaves

The property of every essential oil varies according to the country of harvest, period of sunshine, conditions of harvest, quality of the distillation, storage and usage (8). However, it is generally reported that the basic components of the essential oil of bay leaves are 1.8-cineole, linalool and a-terpinyl acetate (9).

In addition, it has also some phenolic components such as epicate-chin, procyanidin dimer, procyanidin trimer, flavonol and flavonederivatives and many volatile active components such as a-pinene, ß-pinene, myrcene, limonene, linalool, methyl chavicol, a-terpineol, geranyl acetate, eugenol and chavicol. All these compounds are known as antimicrobial (3,6), anti-oxidant (6), digestive and anti-cancer and immune modulating (10).

There have been detailed analyses on of essential oil of obtained from bay leaf. For instance, the GC/MS analysis reports that, the main components of oil are: an ether-oxide of terpenic nature: 1.8 cineole or eucalyptol (35.31%), which is the main component of the essential oil of Bay leaf, and considered as drug and phenologic stadium of the Bay leaf. Linalool and camphene are present as monoterpenes. Sesquiterpenes represented by sesquiterpenic lactones (cadinene and caryophyllene) constitute 22% of the oil. Terpinol (3.18%) is predominant alcohol.

From Turkey, (5) it was reported that the major components detected in bay laurel essential oil were eucalyptol (27.2%), α-terpinyl acetate (10.2%), linalool (8.4%), methyl eugenol (5.4%), sabinene (4.0%) and carvacrol (3.2%). In Table 1, chemical composition of L. nobilis essential oil is shown.

Table 1. Chemical compositions of *L. nobilis* essential oil (3)

	Compounds	RT	Composition (%)
1.	α-Thujene	9.4	0.2
2.	α-Pinene	9.7	3.7
3.	Sabinene	12	10.1
4.	β-Pinene	12.1	2.8
5.	Myrcene	13.1	0.9
6.	α-Phellandrene	13.8	0.5
7.	1,8-Cineole	15.7	51.8
8.	γ-Terpinene	17.3	0.5
9.	trans-Sabinene hydrate	17.8	0.6
10.	cis-Sabinene hydrate	19.9	0.4
11.	Linalool	20.2	1.9
12.	Pinacarvone	24.1	0.1
13.	Terpinen-4-ol	25.3	3.1
14.	α-Terpinenol	26.2	5.2
15.	Bornyl acetate	30.7	0.1
16.	Pseudolimonene	31.9	0.4
17.	α-Terpinyl acetate	33.1	11.2
18.	Eugenol	33.3	0.4
19.	Neryl acetate	33.6	0.3
20.	β-Elemene	34.4	0.4
21.	Methyl eugenol	34.8	0.8
22.	Germacrene	37	0.1
23.	Bicyclogermacrene	37.4	0.2
24.	β-Eudesmol	41.3	0.3
25.	Elemol	41.3	0.1
26.	Eremanthin	48.7	0.1
27.	1,2 Benzenedicarboxylic acid	70.0	0.4
	Total		96.6

RT: Retention time

Antibacterial effects of essential oil of bay leaves

One of the important properties of essential oils and their components is their hydrophobicity, which allows them to partition the lipids of the bacterial cell membrane and mitochondria, disturbing the cell structures and making them more permeable (11). The antimicrobial activity depends on not only the chemical composition of the essential oil, but also on lipophilic properties and power of functional groups or aqueous solubility. The mixture of compounds with different biochemical properties can improve the effectiveness of essential oils (1).

Commonly, essential oil of bay leaves is more effective against Gram negative bacteria than Gram positive bacteria (12). This resistance is due to bacterial cellular membranes' nature group. Hence, their external structures make them to highly hydrophobic surface 13).

There are some studies according to essential oils of L. nobilis' antimicrobial activities. One of them, (13)'s studies. They report that the essential oil of L. nobilis L. had demonstrated a strong activity on the majority of tested 22 strains; the highest sensitivity was in Enterobacter species having an inhibition diameter of 22.4 mm, 16.8 mm pure oil and 1/8 dilution. The most resistant strain was P. aeruginosa. They also reported that 1.8 cineole had a part in this activity having antimicrobial activity against E. coli, P. aeruginosa and Staphylococcus aureus. Laurel's essential oil contains terpenes (linalool), lactones, oxides (1,8 cineole) and monoterpenes (camphene, alpha-pinene). There is a good synergy among the substances for antimicrobial activity.

In another study, (14) reported that ampicillin resistant E. coli was sensitive to the pure oil and diluted at ½, on the other hand, it was of a weak sensitiveness to the essential oil diluted at ¼, 1/8, and 1/16. Proteus spp. was resistant to ampicillin, ticarcillin, cotrimoxazol and chloramphenicol. This strain showed a very big sensitiveness towards the pure essential oil but it was resistant to the different used dilutions. Serratia was resistant to ampicillin, ticarcillin, ofloxacine and cotrimoxazol. This strain was rather sensitive to both pure essential oil and different used dilutions. Klebsiella pneumoniae, Staphylococcus aureus, Streptococcus D, Pseudomonas aeruginosa and Acinetobacter, which are resistant to at least one of antibiotics such as kanamycin, penicillin, nalidixic acid, lincomicin, cefazolin, imipenem, gentamicin, pefloxacin, phosphomycin and piperacillin. But They are susceptible to essential fatty acids diluted 1/2 and at 1/4 (6)'s study aimed to evaluate the antimicrobial and antioxidant activities of essential oils obtained from bay laurel, white wormwood and rose-scented geranium against Salmonella typhimurium and Escherichia coli O157:H7 on fresh produce and to examine consumer acceptability of fresh produce treated with these essential oils. Bay laurel's essential oil consisted of 30-50% 1.8-cineol, 10-20% linalool, 2.13% methyl eugenol and 0.01% eugenol. They found that while essential oil derived from rose-scented granium exhibited the most effective antimicrobial activity, the highest activity was occurred in bay laurel essential oil.

From Turkey, (3) has obtained essential oil from leaves of Laurus nobilis using extraction technique. After extraction, they found that the main components of oil were 51.8% 1,8-cineole, 11.2% α-terpinyl acetate, and 10.1% sabinene. They also found that the L. nobilis essential oil was of the high antibacterial, antifungal and antioxidant potential.

(5) reported that natural extracts from myrtle and laurel can be used by the food industry to extent the shelf life of seafood because they exhibited promising antioxidant and antimicrobial effects. (15)'s study results also showed that 1% thyme essential oil treatment was effective in inhibiting spoilage bacteria growth in the iced storage fish. They also obtained same results in treatment of laurel essential oil. In addition, two plant's essention oil had positive effects on shelf life of iced stored fish samples.

Nano- particules of Laurus nobilis (Ln-ZnO NPs) and antimicrobial effects

Nanoparticles have widely emerged as an anti-bacterial agent in the last decade. It has particularly showed specific targeting and minimum toxicity. They have proven useful for inhibiting antibiotic-resistant bacteria particularly Nanoparticles are in the size ranges from 10-100 nm. The appearance and usefulness of nanoparticles brings many advantages and opportunities. These nanoparticles can be synthesized by physical, chemical and biological methods. In the course of time several groups have achieved success in the synthesis of silver, titanium oxide, copper oxide, iron oxide, zinc oxide (ZnO) and gold etc. Because of the fact that nano particles significatly inhibit growth of many type microorganisms, many researchers have been interested to develop many applications. There are very kinds of nanoparticles. Among them, silver nanoparticules are more common than others. Silver and their compounds have highly antmicrobial effects on microorgaisms such as Escherichia coli and Staphylococcus aureus (16). It has long-lasting biocide and low volatility. In contrast, it has low toxicity to human cells (17). Beside silver, zinc oxide nanoparticules have more inhibitory effects on micriorganisms than silver nanoparticules. Hence, its small size and high surface-to-volume ratio of zinc oxide nanoparticles allow for better interaction with bacteria (18)., So zinc oxide nanoparticle is highly biocompatible and its electron transport kinetics rate is fast and, it's it is suitable to be used as a biological membrane or for other biological applications (19). The nanoparticles have selective toxicity to both Gram-positive and Gram-negative bacteria such as E. coli O157:H7, Salmonella, Listeria monocytogenes, and Staphylococcus aureus and Streptococcus pyogenes, Escherichia coli, Klebsiella aerogenes, Pseudomonas aeruginosa, Proteus mirabilis, Mycobacterium tuberculosis and Bacillus subtilis (figure 1). For reduction and stabilization of nanoparticle, phytochemicals are used. These phytochemicals may contribute to the anti-bacterial activity of nanoparticles by starting a cascade of events like ROS generation, disrupting the bio film formation, cell membrane integrity disruption, enzyme inhibition, protein denaturation, or by accelerating the process (Figure 2) (20, 19).

http://dx.doi.org/10.17546/msd.482929

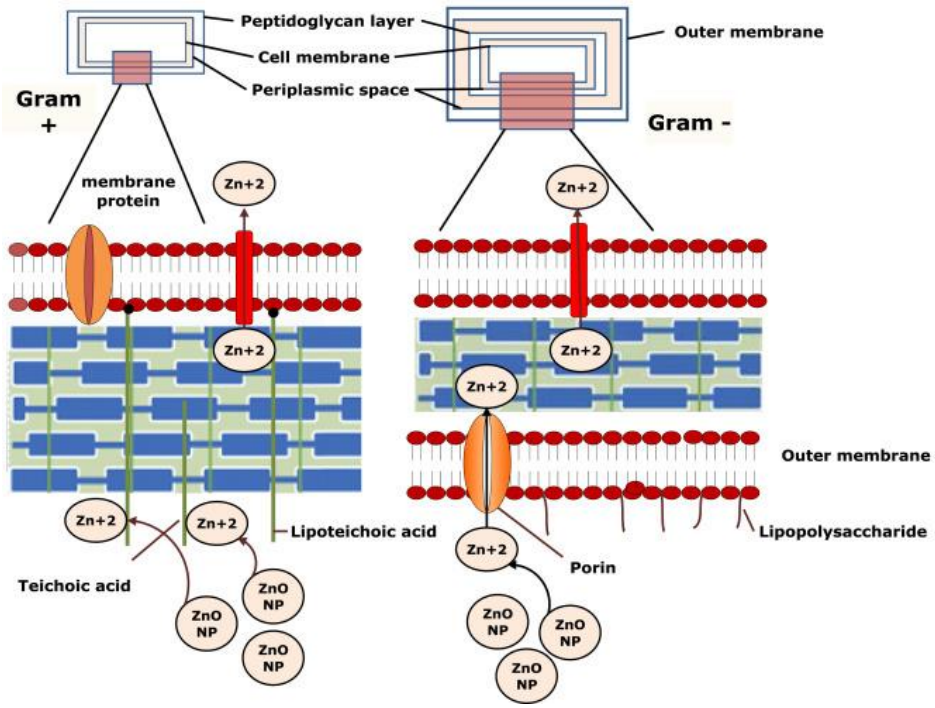

Figure 1. ZnO- NPs interaction with Gram positive and negative cell (19).

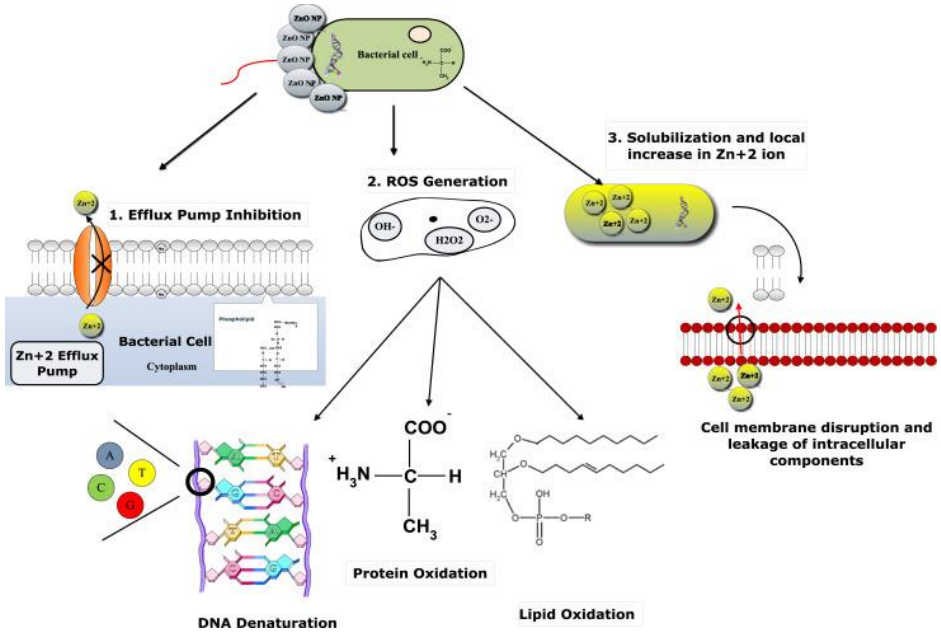

Figure 2. Anti-bacterial mechanisms of ZnO- NPs (19)

Silver, zinc oxide, gold and palladium nanoparticles using extracts obtained from unicellular organisms like bacteria (21,25) and fungi, as well as extracts from plant parts, e.g., geranium leaves, Bay leaf (Laurus nobilis), neem leaves, lemon grass, aloe Vera and several others (22). Green synthesized nanoparticles surround themselves with a large group of organic phytochemicals which helps in ligand-based complexation with various receptors like proteins, lipid, phospholipid, lipoteichoic acid at the microbial surface.

This complexation of nanoparticle with bacteria prevents biofilm formation and their growth (23).

Nanoparticles synthesized by green route tend to exhibit better anti-bacterial activity than physical or chemical method derived nanoparticles due to the coating of various pharmacologically active biomolecules on their surface which allows multiple ligands based conjugation of nanoparticle with receptors on bacterial membranes.

These biomolecules are mainly organic acids, flavones, aldehyde, ketone, amides, polysaccharides, and quinones and known to have significant therapeutic effect against a wide range of human pathogen (24).

Nanoparticuls obtained from L. nobilis have antibacterial activity against microorganisms. (22) conducted a study. In this study, they obtained the green synthesis of zinc oxide (nanoparticles using the aqueous leaf extract of Laurus nobilis (Ln-ZnO NPs) by co-precipitation method. They found that the antibacterial activity of Ln-ZnO NPs was greater against Gram positive (Staphylococcus aureus) bacteria than Gram negative (Pseudomonas aeruginosa) bacteria. In addition to this, the light and confocal laser scanning microscopic images gave evidence that Ln-ZnO NPs effectively inhibited the biofilm growth of S. aureus and P. aeruginosa at 75mg mL1.

Conclusion

Mainly essential oil of Laurus nobilis has strong antibacterial activity against Gram negative and Gram positive foodorne pathogens, spoilage bacteria as well as antifungal effects. Use of nanoparticles as an antibacterial agent in current studies with metal nanoparticles like silver, gold, copper, iron and metal oxide nanoparticles like zinc oxide etc, it has not been common. Laurus nobilis origin zinc oxide nanoparticules (Ln-ZnO NPs) have antibacterial activity especially against Gram positive bacteria. Drug made from plants and nanoparticles are alternative approaches to spoilage due to potoogens and microorganisms.

Acknowledgement: None.

Conflict of Interest: The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Author's Contributions: BS, CY, AG; Review literature, planning and design of research **AG;** preparing article and revisions.

Ethical issues: All Authors declare, Originality and ethical approval of research. Responsibilities of research, responsibilities against local ethics commission are under the Authors responsibilities.

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