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Laurus nobilis L – phytochemical profile, bioactivity and less known or unexplored aspects. A short review

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Abstract

Laurus nobilis L. is native to the Mediterranean region and is part of the Lauraceae family. It is known as an aromatic plant with culinary and medicinal properties. Bay extracts and oils have a phytochemical profile with antibacterial, antifungal, insecticidal, antioxidant effects. According to some studies, all the component parts of the plant could be exploited (seeds, roots, bark, leaves, flowers and fruits) in medicine, agriculture, cosmetic and food industry. The information collection methodology consisted of accessing scientific databases, reviewing studying articles and reviews of interest to researchers and people passionate about interested in this plant. In the current context, in which the demand for natural products is increasing and there are still insufficiently known or unexplored resources, this paper aims to address these aspects. Also, the manuscript offers an overview of the taxonomy, the geographical area, the influence of external factors, cultivation, botanical particularities, phytotherapy, biological activity, the connections between the modification of the chemical composition and the biological activity, therapeutic effects and the potential pathways for developing medicinal formulas ways open to the development of medicinal formulas.

Keywords: bay leaf, therapeutic potential, antimicrobial effect, antioxidant capacity, culinary properties

Introduction

A wide range of current drugs has become have become ineffective against microbial infections or have some negative side effects for the body. This is a serious reason for finding alternative therapeutic options. One of the alternatives is *Laurus nobilis* L., which is a source of multifunctional compounds with high bioactivity. Flavonoids are concentrated mainly in the leaves and flowers, giving them bright and attractive color for pollinators. They also play an important role in protecting plants from UV radiation [18,75] .

In Greek and Roman mythology *Laurus nobilis* L. Laurus nobilis L. is considered a sacred tree [55]. *Laurus nobilis* L. is known as bay, sweet bay, Apollo laurel, Roman or Turkish bay and is native to the Mediterranean area [6,66]. It is also found in southern Europe [65]. The laurel is part of the genus *Laurus, Lauraceae* family, which includes 2,500–3,500 species [24,80]. The genus Laurus includes two species: *Laurus nobilis* L. and *Laurus azorica* L.

It is currently cultivated in many areas of the world, with temperate and subtropical climates. *Laurus nobilis* L. Laurus nobilis L. is a versatile plant, with multiple uses. It is a shrub used in the food, pharmaceutical and medical fields. In Europe and the USA it is cultivated mainly as an ornamental and medicinal plant [15]. For some countries it is an emblematic plant, very valuable from an economic point of view (e.g. Greece, Turkey), [81].

Bay laurel is an evergreen shrub with glabrous, smooth, alternate, narrowly oblong-lanceolate leaves [41]. The flowers are small, colorful and four-lobed. Female flowers have 2-4 stamens, and male flowers have 8-12 stamens. The fruits of the bay laurel are called berry. They are 10-15 mm in size, oval in shape and dark purple in color, and when ripe the berries turn black. Bay leaves are used in many international cuisines [74], for aromatisation and preserving meat, fish and vegan dishes [19,22,70].

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Many studies have demonstrated that bay has a chemical composition rich in sesquiterpene alcohols, alkaloids, flavonoids, minerals, tannins and vitamins [1,37]. Phytochemical compounds have antioxidant potential [26,27,28,52,77], antibacterial and antifungal [15,21,26,32,35,77,79]. It has been shown that the effectiveness of bay oil against microorganisms may be greater than some antibiotics [47]. Due to its biological activity, essential bay extract could be considered a natural supplement or a good antioxidant in cosmetics [67,82] and medicine [31,88]. The bay leaves are the bay leaves are also effective in treating digestive problems [74], neurological [31], dermatological and rheumatic problems [37]. It is of interest for agriculture and industry [4]. Studies have shown that bay leaf extracts have antioxidant, antidiabetic, and anticholinergic properties.

All these properties are attributed to the high content of phenolic compounds. Bay oil is used to make bakery products. It is a flavouring, spicy and preservative plant. Some researchers claim that bay oil is little studied, in contrast to other oils extracted from aromatic plants [50]. Demirbas et al (2010) [20] mention that bay is a potential source of biodiesel.

Currently, there are still many beneficial aspects of bay leaves that are not fully known. The paper aims to provide information that will provide theoretical support regarding the use of bay leaves and new discoveries concerning in terms of bio compounds with antimicrobial and clinical applicability.

Chemical composition of leaves, flowers and fruits of *L. nobilis* L.

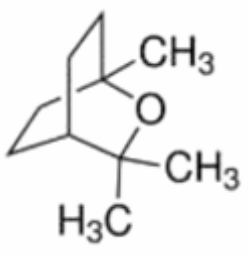
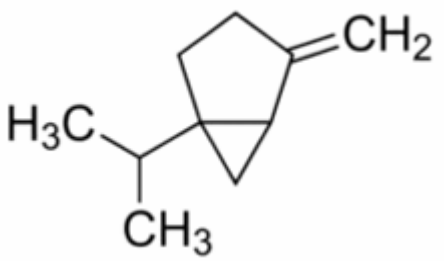
From the bay tree (*Laurus nobilis* L.) the leaves and fruits are used [70], because they have high essential oil a high oil content. The commercial value of this species derives from its essential oil, the application of which could be extended in different industrial sectors branches. The chemical composition of the oil from the leaves and fruits depends on the environmental conditions, region, season in which the plants are collected, drying and extraction methods, as well as on analytical as analytical conditions. Characterization and chemotyping of the essential oil of *L. nobilis* L. are extremely important, because changes in composition can affect biological activities.

Phytochemical analyses carried out by some authors have proven that volatile and non-volatile oils of the bay of bay tree contain flavonoids, tannins, sesquiterpene alcohols, alkaloids, minerals and vitamins [72, 2,3]. Bay contains phenolic compounds and flavonoids, which are very valuable natural antioxidants for human applications fields of activity [73,78]. Flavonoids are found in abundance in all parts of plants, from roots, stems, to leaves, flowers and fruits [54,62]. Castilho et al. (2004), [17] found that in the oil studied triacylglycerols represented 85% and hydrocarbons 15%.

The yield of bay oil varies between 0.6-1.5% when extracted from leaves [3,16,28,43,46] and 1-5% when extracted from fruits [70]. According to other studies, bay fruits can contain between 15-35.87% oil [34,36]. Some compounds have been identified in almost all bay oils, regardless of the geographical area or plant organ. Some studies have shown that the main compounds in the chemical composition of bay are vanillic acid (4,599.00 4,599 µg/L), followed by catechin hydrate (3,351.53 µg/L) [5] [..]. In contrast, Dobroslavić et al. (2021) [23], observed that the extracts are rich in kaempferol and quercetin glycosides. The authors isolated 29 phenolic compounds from bay leaves, using green extraction techniques.

Caputo et al. (2017),[15] studied the essential oil of *L. nobilis* L. The plants were collected from southern Italy. Fifty-five 55 compounds were identified in the oil, representing 91.6% of the total oil. The main compounds highlighted were 1,8-Cineole (31.9%), linalool (10.2%) and sabinene (12.2%). Other studies support the presence of a large amount of 1,8-cineole and eugenol in bay oil. Both compounds are considered good preservatives.

Table 1. The main compounds highlighted in leaves, fruits and flowers of the bay [7,28a,55,74]

Compounds	Chemical Structure
1,8-cineole (a), sabiene (b)	 a  b

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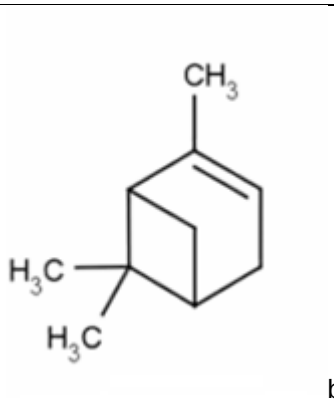
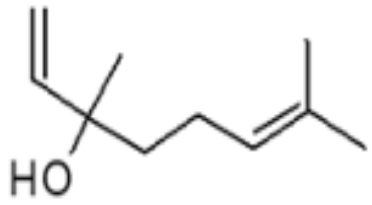
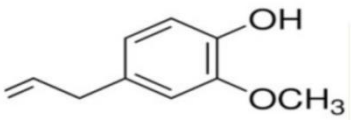
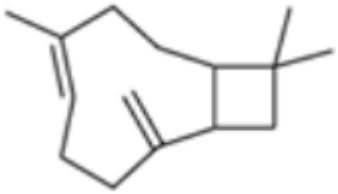
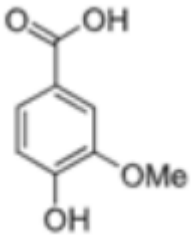
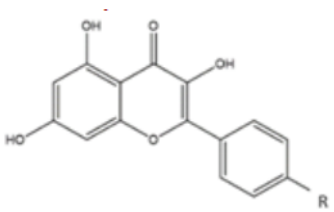
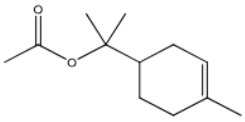
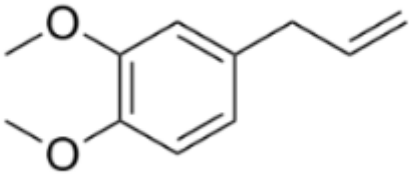
α-pinene (a), linalool (b)	 a  b
eugenol (a), β-caryophyllene (b)	 a  b
vanilic acid (a), kaempferol derivatives (b)	 a  b
α-terpinylacetate (a), methyleugenol (b)	 a  b

In many European countries it has been observed that the oils present both common and different chemical compounds. Most of the compounds identified in the bay leaf oil were: 1,8-cineole, α-terpinyl acetate, methyleugenol, linalool, sabinene, limonene, α-pinene, eugenol, β-pinene, terpinen-4-ol, eucalyptol, α-caryophyllene, bornyl acetate, spathulenol, linalool, etc. (table 1) (Table), [3,28a,16,51].

The oil from bay flowers had the following composition: β-caryophyllene, germacrene-D-4-ol, β-elemene, humuladienol, viridiflorene, 1,8-cineole, viridiflorol, ϒ-cadinene, (E)-ocimene, terpinyl acetate, α-cadinol, methyleugenol, humulene, humuladienol, β-eudesmol, etc. The quantity and quality of bay oil may differ depending on the country and the organs from which it was extracted.

Fidan et al. (2019), [28a] highlighted the following compounds in the essential oil from bay fruits: 1,8-cineole, α-terpinyl acetate, α-pinene, β-elemene, sabinene, β-phellandrene, bornyl acetate and camphene. The same authors extracted from the twig oil the compounds methyl eugenol, β-linalool (3.8%), β-pinene and terpinen-4-ol which were not present in the leaf oil. However, but also in this oil were found compounds highlighted in the leaves. Among them we mention 1,8-cineole and α-terpinyl acetate, which dominated quantitatively. The fruits contain anthocyanins such as: cyanidin 3-O-glucoside, cyanidin 3-O-rutinoside, 3-O-glucoside and 3-O-rutinoside [Marzouki, 2008].

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According to research carried out by Georgiev and Lazarov (1992) laurel trees from warmer areas of Bulgaria have a higher oil content. They also found that the leaves in the middle part of the shoots have a higher oil content, and the twigs had lower amounts had a lower amount [30].

Mkaddem Guedri et al. (2020), [45] analyzed bay leaf oils from three countries. In the Tunisian oil, camphor (over 30%), 1,8-cineole (over 20%) and α-terpineol dominated. In the oils from France and Austria, the following compounds were found in large quantities: 1,8-cineole (over 40%), bornyl acetate and methyl eugenol.

The antimicrobial, antioxidant potential and possible toxic effects

Bay laurel is known as a shrub with antioxidant, antibacterial, antifungal Fig.1 (fig. 1) and antiviral properties [12]. These promising properties are due to phenolic compounds that have a key role in reducing oxidative stress. Naringenin is a good antioxidant and antimicrobial and has potential against metabolic disorders [13]. Vanillic acid and catechin are the dominant compounds in bay and have antioxidant and antimicrobial properties [63].

Caputo et al. (2017) [15] studied the antibacterial and antifungal activities of bay essential oil compared to that of the compound 1,8-cineole. They observed that bay oil has high biological activity against the tested bacterial species (*Staphylococcus aureus, Bacillus cereus, Escherichia coli* and *Pseudomonas aeruginosa*), starting with the lowest concentration of 0.4 µl/mL, up to the highest concentrations of 1 and 2 µl/mL. At high concentrations, the results are comparable to those obtained by contact of bacteria with tetracycline. This effect is probably the result of the synergism between the compounds present in bay essential oil. According to Sırıken et al. (2018) [76] the synergism between terpenes, lactones, 1,8-cineole and monoterpenes determines the antimicrobial activity of bay essential oil. The target of the compounds in the essential oil are enzymes and structural proteins of the cytoplasmic membrane. As a result of this action, the selective permeability of the membrane is modified and the catalytic activity of the enzymes is inhibited.

Mssillou et al. (2020) [40a] observed that oils obtained from *Laurus nobilis* L. flowers have high antioxidant and antifungal activity, due to the high content of 1,8-cineole. Essential oils from laurel leaves from Tunisia, France and Austria also show antifungal activity. The essential oil from Tunisia showed higher antioxidant activity compared to other oils and is considered a source for obtaining new pharmaceutical formulas and a solution for treating infectious diseases. Also, tests have proven that the oil from Tunisia has a negative effect against Gram-positive bacteria (*Bacilus subtilis, Staphylococcus aureus* and *Listeria monocytogenes*) and Gram-negative bacteria (*Escherichia coli, Klebsiella pneumonia, Salmonella enterica*) Mkaddem Guedri et al. (2020), [45]. The minimum inhibitory concentrations for Gram-positive bacteria were 0.004 mg/ml, respectively 0.01 mg/ml for Gram-negative bacteria.

Fig. 1. Antimicrobial effect of the bay plant

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Fidan et al. (2019), [28a] tested the biological activity of bay leaf essential oil from bay leaves and branches. According to the results, the oil from the leaves had antibacterial and antifungal effects against the tested microorganisms [28a,49], while the oil from the branches had low inhibitory activity only against the bacterium *Staphylococcus aureus.*

Sırıken et al. (2018), [76] stated that the properties of bay leaf essential oil depend on the region, altitude, sunshine period and harvesting conditions of the organs from which the oil is extracted. The authors of this study mention that *Salmonella, Staphylococcus aureus, Esherichia coli, Listeria monocytogenes, Pseudomonas aeroginosa* and fungi are sensitive to bay leaf essential oil, but they do not have a negative effect on beneficial bacteria in the intestine. The sensitivity of *Staphylococcus aureus, Enterococcus faecalis, Bacillus subtilis* and *Candida albicans* to oils from bay leaves and fruits was also observed by Bojović et al. (2025), [10]. According to these results, the oils can be used as antimicrobial agents in health, cosmetics and the food industry. Detailed analysis of residues is recommended because they can be important sources of compounds with utility in practical human fields. This suggestion was made based on concrete evidence, which shows that the fatty oil has a high content of compounds of interest for the medical field. Although the bay fruits are not harvested, they may contain acids with special properties and novel biological activities [28a].

Mehani et al. (2019), [44] have shown that bay essential oils, at different concentrations (0,05, 0,25, 0,5%), have significant antifungal properties against the fungus *Fusarium sporotrichioides* (0.05-0.5%). It has been shown that including aqueous bay extracts, at concentrations of 50, 100, 200 mg/ml have antibacterial activity. *Staphylococcus aureus* and *Klebsiella pneumoniae* have high sensitivity to all tested concentrations, while *Escherichia coli* has moderate sensitivity. At high concentrations, *Pseudomonas aeruginosa* is inhibited [64].

Pharmacological potential

The pharmacological properties and the importance in the cosmetic and food industry

The discovery of plants with therapeutic potential [72,83] is very important at present. Among the plants with therapeutic implications is *Laurus nobilis* L. The bay has been used in folk and traditional medicine since ancient times. It has been observed that the plant has biocidal, antioxidant, antimicrobial, antiviral properties. All these properties transform it into a plant of clinical importance.

The bioactivity of bay is attributed mainly to phenols, terpenoids and fatty acids [7,78]. Among the isomers of phenolic compounds, isocoumarins have biological action. The bay leaf extracts have been shown to have anticholinergic, antidiabetic, [Abu-Dahab, 2014]antispasmodic, anti-inflammatory properties [7,12,59], antiallergic, antithrombotic [60,69] and an essential role in modulating neurodegenerative enzyme activities [5,7]. Myricetin is said to have good effects against degenerative diseases of the nervous system [60,85]. and cancer. Anticholinergic agents inhibit acetylcholine in the nervous system and control neurodegenerative diseases (Alzheimer's, Parkinson's disease), motion sickness and overactive bladder [9,85]. The degenerative diseases are believed to be the result of oxidative stress, and obtaining pharmaceutical formulations from plants with antioxidant and anti-amyloidogenic properties is a viable and promising solution [53]. It has been discovered that alcoholic extracts rich in phenolic compounds could prevent or treat neurodegenerative diseases, such as Alzheimer's disease.

Bay leaves have anticonvulsant, antiepileptic role [15,68]. In the anticancer process, kaempferol is involved [57]. A dominant compound in bay is vanillic acid, which is also synthesized chemically. This phenolic acid has anticancer, antiobesity, antidiabetic, hepatoprotective effect and anti-inflammatory activity [5,48]. Anti-inflammatory activity also has luteolin [25] from the flavones group.

Many researchers have proven the antihemorrhoidal and antirheumatic role [33] of bay leaf extracts. The effect of the extracts against dermatitis [36], the treatment of psoriasis [34] and the prevention of migraines [87] is also known. In folk medicine, bay is considered an antidote for snake bites [33].

Recently, the antiproliferative capacity of bay leaves has also been discovered [1]. A fatty oil has been extracted from bay fruits, effective in relieving earaches and treating sprains and bruises [39]. A fatty oil for external use has been discovered in the fruits, effective in relieving earaches and treating sprains and bruises Leyel, (1984), [39]. Catechin is one of the flavonoid isomers with an essential cardioprotective role and the improvement of diseases caused by oxidative stress [71]. Similarly, naringenin is useful in metabolic disorders [13]. Bay leaves are a good diuretic. They are effective against diarrhea, amenorrhea, respiratory and gastrointestinal diseases, by stimulating gastric secretions [8,33,61,58].

The role of bay leaves in cosmetics

Bay leaves have high antioxidant capacity [48] [Morita, 2003] and antibacterial and antifungal properties, which is why they can be used in the cosmetic industry, whether it is creams or hair lotions [34,87]. Fruit oils are mainly used in the cosmetic industry. These oils are also used to make soap [11].

The nutritional role of bay leaves

Dried bay leaves are known as a spice in many cuisines around the world. Bay leaves have antimicrobial and insecticidal capacity, which is why they can be used for food preservation [41]. Vanillic acid, which is also found in large quantities in bay leaves, is used to flavor some food products [5], especially pastries and confectionery. The compounds present in bay leaves are also found in other plants. Vanillic acid can be assimilated by the body through the consumption of spices, tea, fruits and vegetables [63]. Catechin is present in tea, berries, grapes, cocoa [84]. Luteolin is found in celery, broccoli, artichokes, parsley, thyme and mint [56].

Bay leaf contamination and toxicity

Some studies have shown that medicinal plants can be contaminated with various toxic chemical, bay chemicals. Bay leaf is one of them. Research has established that bay leaf can be contaminated with arsenic. Arsenic is carcinogen. It also inhibits enzymes with an energetic role and those involved in the synthesis or repair of genetic material [2].

The toxicity of bay oil has been reported in very rare cases. Repeated skin contact with the oil can cause allergic dermatitis [2,14]. This reaction is thought to be due to the sodium lauryl sulfate in the plant. In addition, Uter et al. (2010) reported that ingestion or inhalation of bay oil contributes to systemic reactions, such as generalized exanthema [86].

Conclusions

Laurus nobilis L. is an inexhaustible source of natural compounds with antioxidant, antibacterial and antifungal capacity. Laurel is considered a viable and promising solution for obtaining pharmaceutical formulas with role in the therapy of metabolic diseases and neurological disorders. *L. nobilis* L. has insecticidal and antimicrobial properties that demonstrate its capacity in food preservation, utility in agriculture and cosmetics.

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