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Review Article

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Review Study on the Physiological Properties and Chemical Composition of the *Laurus nobilis*

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Abstract The *Laurus nobilis* is one of the plants of the *lauraceae* species which has many physiological properties. It is an antimicrobial, antifungal, anti-oxidant and other properties that make laurel oil and its compounds a good and a valuable substance for use in pharmaceuticals and cosmetics, chemically contains many compounds such as: turbines, anthocyanins coumarins and others.

Keywords *Laurus nobilis*, essential oil, pharmacology, chemical composition

Introduction

Laurus nobilis is traded as sweet bay leaf and true Romanor Turkish laurel. It is small evergreen tree of *lauraceae* family. It is hardy multibranched tree with smooth bark that grows to about 10 m high [1-2]. It has alternate, narrowly oblong-lanceolate leaves. The flowers are small and four lobed; the male has 8-12 stamens and female 2-4 staminodes. The fruit is 10-15 mm, ovoid and black when ripe [3].

These are aromatic and fragrant plants yielding fixed and volatile oil as well as camphor, it is native of south Europe [4].

Laurus nobilis is a plant of industrial importance, used in foods, drugs, and cosmetics. The dried leaves and essential oils are used extensively in the food industry for seasoning of meat products, soups and fishes. Its antimicrobial and insecticidal activities are other factor for which bay is used in the food industry as a food preservative. The fruits contain both fixed and volatile oils, which are mainly used in soap making [5]. Traditionally it is used in rheumatism, dermatitis [6], gastrointestinal problems such as epigastric bloating, impaired digestion, eructation, and flatulence. The aqueous extract is used in Turkish folk medicine as an anti-hemorrhoidal, anti-rheumatic, diuretic, as an antidote in snakebites, for the treatment of stomachache [7-8] and diuretic [9]. Recently it is used in treating diabetes and preventing migraine [10].

Pharmacology

Antioxidant Activity

The *in vitro* and *in vivo* antioxidant activities of different extracts of laurel leaves were studied. Free radical scavenging capacity (RSC) was evaluated measuring the scavenging activity on the DPPH, NO, O_2• and OH radicals. The effects on lipid peroxidation (LP) were also evaluated. Experimental results indicate that ethyl acetate extract of leaves has exhibited the largest RSC capacity in neutralization of DPPH, NO,O_2• and OH radicals. The same result was obtained in investigation of extracts impact on LP. The *in vivo* effects were evaluated on some

antioxidant systems (activities of GSHPx, LPx, Px, CAT and XOD, and GSH content) in the mice liver and blood-hemolysate after treatment with the examined laurel extracts or in combination with carbon tetrachloride (CCl_4).
On the basis of the results obtained it can be concluded that the examined extracts exhibited a certain protective effect, which is more pronounced on the liver than on blood hemolysate parameters. The results obtained indicate toxicity of CCl_4, probably due to the radicals involved in its metabolism. Combined treatments with CCl_4 and the examined extracts showed both positive and negative synergism. Based on the experimental results, the strongest protective effect was shown by the EtOAc extract [11].

Antibacterial Activity

Staphylococcus aureus infection is of great importance on clinical view and prevalence in medical care centers, so its prevention is also important. The main aim of this study was to determine the *in vitro* antibacterial activity of hydroalcoholic solution of *Laurus nobilis* extract against *Staphylococcus aureus*. *Laurus nobilis* extract was assayed for antibacterial activity by agar well diffusion and agar dilution methods in order to determine the zone diameter of inhibition compared with tetracycline zone diameter of inhibition as control. The extract showed antibacterial activity against *Staphylococcus aureus*. The results indicate the antibacterial use of the *Laurus nobilis*e extract for the treatment of *Staphylococcus aureus* infection [12].
Laboratory studies were carried out to evaluate the effects of some essential oils from *Laurus nobilis* and *Mentha pulegium* against *Sitophilus zeamais* on stored maize. The concentrated essential oils at different volumes of 0.5 µL, 1.5 µL, 2.5 µL, 5.0 µL and 10 µL, were poured on filter papers with 2 cm each. For diluted oils, the fixed volume of 15 µL of different concentrations of 1:150v/v, 1:100 v/v, 1:75 v/v, 1:50 v/v and 1:10 v/v either in methanol or n-hexane were used to impregnate the filter papers. Treatments with the concentrated oils were more effective. All the concentrations used from *M. pulegium* provided 100% adult mortality and no progeny production were achieved. *L. nobilis* has revealed 100% adult mortality at 3.185 $\mu L/cm^2$. Regarding the treatments with diluted oils once again the oil from *M. pulegium* provided 100% adult mortality at concentrations of 1:50 v/v and 1:10 v/v. *L. nobilis* was not effective at any of the concentrations used. There were no significant differences between the solvents used [13].
The effects of various methods of drying on the chemical quality and antimicrobial activity of the essential oil of *Laurus nobilis* were studied. The most prominent component in the air-dried, fresh leaf and microwave-dried leaf oils is 1,8 Cineole (58.8, 35.62 and 42.9% respectively). The essential oil has undergone significant chemical transformation in its monoterpenoids when the leaves of plant in the question were dried by the three different methods.
The oils have screened for antimicrobial activity against both Gram positive (*Staphylococcus aureus, Enterococcus hirae*) and Gram negative (*Escherichia coli*, *Pseudomonas aeruginosa*) bacteria and two fungal species (*Penicilium digitatum* and *Alternaria sp*). The microbial strains tested have been found sensitive to all essential oils studied [14].

Neuroprotective activity

The effects of *n*-hexane fraction from *Laurus nobilis* leaves on dopamine induced intracellular reactive oxygenspecies (ROS) production and apoptosis in human neuroblastoma SH-SY5Y cells was investigated. Compared with apomorphine (APO, IC50=18.1 µM) as a positive control, IC_{50} value of hexane fraction for DA-induced apoptosis was 3.0µg/ml, and two major compounds from, costunolide and ehydrocostus lactone, were 7.3 µM and 3.6 µM, respectively.
Hexane fraction and these major compounds significantly inhibited ROS generation in DA-induced SH-SY5Y cells.
A rodent 6-hydroxydopamine (6-OHDA) model of PD was employed to investigate the potential neuroprotective effects of hexane fraction in *vivo.* 6-OHDA was injected into the substantianigra of young adult rats and an immune histochemical analysis was conducted to quantitate the tyrosine hydroxylase (TH)-positive neurons.
Hexane fraction significantly inhibited 6-OHDA-induced TH-positive cell loss in the substantianigra and also reduced DA induced α-synuclein (SYN) formation in SH-SY5Y cells and shown to be neuroprotective [15].

Anticholinergic activity

Essential oil, ethanolic extract and decoction of *Laurus nobilis* were analyzed for their activity towards acetylcholinesterase (AChE) enzyme. It showed AChE inhibitory capacity higher than 50% in the essential oil fraction. It also showed a high inhibition value of AChE in the ethanolic fraction 64% [16].

Insect repellent activity

Essential oils extracted from the seeds of fresh foliage of laurel *Laurus nobilis* Linn. were tested for their repellent activity against the adult females of *Culexpipiens*, usually the most common pest mosquito in urban and suburban settings in the Antalya province. The essential oils showed repellent activity [17].

Other Activities

An *α*-glucosidase inhibition assay was applied to evaluate the *in-vitro* antidiabetic activity of the essential oil. IC_{50} values were obtained for laurel essential oil, 1, 8-cineole, 1-(S)-*α*-pinene and R-(+)-limonene: 1.748 µL/mL, 1.118 µL/mL, 1.420 µL/mL and 1.300 µL/mL, respectively. We also found that laurel essential oil and 1,8-cineole inhibited the *α*-glucosidase competitively while 1-(S)-α-pinene and R-(+)-limonene were uncompetitive inhibitors [18]. In other study effect of laurel leaf extract (*Laurus nobilis*) on biochemical parameters and histo-morphology of rat liver induced by toxic damage of CCl_4 was studied. Result of the later study revealed that *L. nobilis* extract have capacity to manage metabolic and histological abnormalities of hepatocytes toxic damage induced by CCl_4 [19]. Mathematical Modelling and the Determination of Some Quality Parameters of Air-dried Bay Leaves (*Laurus nobilis* L.) were dried at 40, 50 and 60 ºC air temperatures and 5, 10, 15% relative humidity and also under sun and shade in outdoor areas to see whether any significant difference of quality occurs in drying with hot air. During the drying tests with hot air, air flow velocity was held stable and the samples were hung in the drying channels as the surface of the leaves were held parallel to the direction of air flow. To find out the moisture content changes of the samples, weight loss from the leaves were recorded at fixed intervals. Then, the data obtained from the drying tests were applied to various well-known semi empirical mathematical models of drying. As part of this effort five well-known models with drying rate constant as a function of air temperature and both temperature and relative humidity were tested for goodness of fit. Furthermore, to determine the effects of the drying conditions on the colour and the amount of essential oil of the bay leaves, fresh leaves and the leaves dried under different conditions were compared. Among all the drying models the Page model was found to satisfactorily describe the kinetics of convection drying of bay leaves. It was concluded that no significant loss of quality occurs when drying bay leaves at 608C air temperature [20]. Commercial *Laurus nobilis L.* essential oils against post-harvest phytopathogenic fungi on rice. Rice is exposed in the field and in stored conditions to a great variety of fungi that can cause a lot of diseases with potential risk to consumers. In the present study, the chemical composition of commercial *Laurus nobilis L.* essential oils and antifungal activity against five pathogenic fungi isolated from Mediterranean rice grains has been investigated. Thirty-seven compounds accounting for more than 99.5% of the total essential oil were identified by GC and GC/ MS. 1,8-Cineole (51.95%), a-terpinyl acetate (12.93%) and the monoterpene hydrocarbon sabinene (9.56%) were the main compounds in bay leaf essential oil [21]. Identification of cytotoxic sesquiterpenes from *Laurus nobilis* L. a new sesquiterpene, lauroxepine and six known sesquiterpene lactones were obtained through bioactivity-directed isolation from a methanol extract of the fruits of *Laurus nobilis*. The hexane-soluble part of the methanol extract yielded lauroxepine, costunolide and gazaniolide, while the dichloromethane-soluble part of the methanol extract afforded costunolide and four other sesquiterpene lactones including santamarine, reynosin, 11,13-dehydrosantonin and spirafolide. The new sesquiterpene lauroxepine and spirafolide have a rare molecular structure carrying an oxepine ring. Structures of the compounds were determined through 1D and 2D NMR and mass (EIMS) techniques. The extracts were investigated for both ovarian cytotoxic activity and DNA damaging properties against three yeasts. Among the three tested extracts prepared from flowers, leaves and fruits of *L. nobilis* the most cytotoxic active extract against ovarian cancer cell line was found to be the fruit extract with 98% inhibition. Among all tested extracts only the fruit extract showed marginal inhibition (63.2%) against one DNA repair-deficient yeast strain (pRAD52 Gal). Six known sesquiterpene lactones were found to be highly cytotoxic against the A2780 ovarian cancer cell line, however, lauroxepine was not found to be active in A2780 [22].

We have a study was aimed at evaluating the ability of polyphenolic and antioxidant-rich bay leaf extract (BLE) to protect testicular malfunction in experimental cryptorchidism based on histopathological and biochemical clarifications. Forty male Wistar rats were divided into four groups of ten animals each. The first group served as the control, the second and the fourth group received 60 mg/kg body weight of BLE daily for fifty six days. The third and fourth group was rendered cryptorchid with the fourth group subsequently treated orally with 60 mg/kg body weight of BLE daily for fifty six days. The animals were sacrificed and testis eight/volume and sperm parameters were determined. Animals with untreated cryptorchidism showed significantly reduction in testis weight/volume (p<0.05), testis weight/body weight ratio, sperm parameters (p<0.005) compared to the control and group treated with BLE-alone. Treatment of the cryptorchid rats with BLE significantly improved the sperm parameters (p<0.05) and testicular SOD and CAT activity levels when compared to cryptorchid rats that were not treated. This showed that deleterious and degenerative changes associated with cryptorchidism were mildly averted by simultaneous treatment with BLE [23]. Toxicity of naturally occurring compounds of *Lamiaceae* and *Lauraceae* to three stored-product insects The compounds 1,8-cineole, camphor, eugenol, linalool, carvacrol, thymol, borneol, bornyl acetate and linalyl acetate occur naturally in the essential oils of the aromatic plants *Lavandula angustifolia*, *Rosmarinus officinalis,Thymus vulgaris* and *Laurus nobilis*. These compounds were evaluated for fumigant activity against adults of *Sitophilus oryzae*, *Rhyzopertha dominica* and *Tribolium castaneum*. The insecticidal activities varied with insect species, compound and the exposure time. The most sensitive species was *S. oryzae*, followed by *Rhyzopertha dominica*. *Tribolium castaneum* was highly tolerant of the tested compounds. 1,8-Cineole, borneol and thymol were highly effective against *S. oryzae* when applied for 24 h at the lowest dose (0.1 ml/720 ml volume). For *Rhyzopertha dominica* camphor and linalool were highly effective and produced 100% mortality in the same conditions. Against *Tribolium castaneum* no oil compounds achieved more than 20% mortality after exposure for 24 h, even with the highest dose (100 ml/720 ml volume). However, after 7 days exposure 1,8-cineole produced 92.5% mortality, followed by camphor (77.5%) and linalool (70.0%). These compounds may be suitable as fumigants because of their high volatility, effectiveness, and their safety [24].

Chemical Composition

The volatiles of fresh leaves, buds, flowers, and fruits from bay (*Laurus nolilis L.*) were isolated by solvent extraction and analyzed by capillary gas chromatography-mass spectrometry. Their odor quality was characterized by gas chomatography-olfactometry-mass spectrometry (HRGC-O-MS) and aroma extract dilution analysis (AEDA). In fresh bay leaves 1,8-cineole was the major component, together with R-terpinyl acetate, sabinene, R-pinene, *α*-pinene, *α*-elemene, R-terpineol, linalool and eugenol. Besides 1,8-cineole and the pinenes, the main components in flowers were R-eudesmol, *α*-elemene and *α*-caryophyllene, in fruits (E)-*α*-ocimene and biclyclogermacrene, in buds (E)-*α*-ocimene and germacrene D. The aliphatic ocimenes and farnesene were absent in leaves. By using HRGC-O-MS 21 odor compounds were identified in fresh leaves. Application of AEDA revealed (Z)-3-hexenal (fresh green), 1,8-cineole (eucalyptus), linalool (flowery), eugenol (clove), (E)- soeugenol (flowery), and an unidentified compound (black pepper) with the highest flavor dilution factors.

Differences between buds, flowers, fruits, and leaves with regard to the identified odor compounds are presented [25].

Terpenoids

Various sesquiterpene lactones were found to present in *Laurus nobilis* such as 10-epigazaniolide, Gazaniolide, spirafolide, costunolide, eynosin and santamarine [26], 5α,9-dimethyl-3-methylene-3,3α,4,5,5α,6,7,8-ctahydro-1-oxacyclopenta[*c*]azulen-2-one and 3β –chlorodehydrocostus lactone along with other sesquiterpene lactones such as dehydrocostuslactone, artremorine [27] and, Lauroxepine, 11,13-ehydrosantonin [28], 5α,9-dimethyl-3-methylene-3,3α,4,5,5α,6,7,8-octahydro-1-oxacyclopenta[c]azulen-2-one and 3β-chlorodehydrocostuslactone [29], deacetyllaurenobiolide [30], 5αH,7αH-eudesman-4α,6α,11,12-tetraol and 1β,15-dihydroxy-5αH,7αH-eudesma-3,11(13)-dien-12,6α-olide [31], Trypanocidal terpenoidzaluzanin D [32]. Two steroisomeric monoterpine alcohol such as Cis and trans-thuj-2-en-4-ol were obtained in the essential oil of *Laurus nobilis* [33].

Glycosides

Laurus nobilis leaves yielded four nonpolar flavonoids kaempferol-3-O-α-L-(3",4"-di-E-p-coumaroyl)- rhamnoside, kaempferol-3-O-α-L-(2",4"-di-E-pcoumaroyl)-rhamnoside, kaempferol-3-O-α-L-(2"-4"-coumaroyl)- rhamnoside and a new product kaempferol-3-O-α-L-(2",4"-di-Z-p-coumaroyl)-rhamnoside [34]. Five new mega stigmane glucosides name dlaurosides A−E and a new phenolic glucoside were isolated from the methanolic extract of *L. nobili*s L. leaves [35]. Kaempferol- 3-hamnopyranoside, and kaempferol-3, 7- di-rhamnopyranoside were isolated from *Laurus nobilis* aqueous ethanolic extract [36].

Anthocyanin

The major anthocyanins were characterized as cyanidin 3-*O*-glucosideand cyanidin 3-*O*-rutinoside. Furthermore, two minor anthocyanins were detected and identified as 3-*O*-glucoside and 3-*O*rutinoside [37].

Essential oil

The major constituents of this oil were 1,8-cineole (35.7%), *trans*-abinene hydrate (9.7%), *α*-terpinyl acetate (9.3%), methyl eugenol (6.8%), sabinene (6.5%) and eugenol (4.8%). In the volatile of the bud stage, thirty-six compounds amounting 98.8% of the total components were identified which included 1,8-cineole (34.9%), *α*-terpinyl acetate (12.1%), *trans*-sabinene hydrate (11.9%), methyl eugenol (8.1%), sabinene (6.0%) and eugenol (3.8%) as main components. In the oil obtained from the flowering stage, thirty-six components were identified, which represented about 95.5% of the total composition.

1,8-Cineole (31.4%), *α*-terpinyl acetate (11.4%), *trans*-sabinene hydrate (9.8%), methyl eugenol (9.4%), sabinene (5.8%) and eugenol (5.5%) were the principal components of this oil [38]. The main components of the oil were identified. 1,8-Cineole along with α-terpinylacetate, terpinene-4- ol, α-pinene, β-pinene, *p*-cymene, linalool acetate. It also found to contain (*E*)-β-cymene, β-longipinene, cadinene, α-terpinyl acetate, α-bulnesene [39], terpinene-4-ol (4.25%), sabinene. The acyclic monoterpenes linalool and myrcenol were present in smaller amounts, while cumin aldehyde, dimethylstyrene, eugenol, methyl eugenol and carvacrol were found [40].

Conclusion

Many research on the Chemical composition and pharmacological potential of *Laurus nobilis* published so far. It was revealed from these articles that *Laurus nobilis* possesses significant *in vitro* and *in vivo* pharmacological potential for the treatment of different ailments and diseases and found to be safe.

Laurel extracts have also been found to antioxidant, antibacterial, neuroprotective and Anticholinergic activities. Many chemical compounds have been found such as Terpenoids, Glycosides, Essential oil and Anthocyanin which responsible *laurus* effects. Further research studies are needed to obtain more scientific data on this miraculous plant.

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