The chemical profile and the importance of lavender essential oils in medicine

ALINA, DEMIAN
UNIVERSITATEA TEHNICĂ DIN CLUJ-NAPOCA
Centrul Universitar Baia Mare
Facultatea de Științe
Specializarea: Chimie Medicală

Coordinator: Prof. Ing. Conf. Thomas Dippong

Abstract
The discussion encompasses the chemical profile of lavender essential oils, medical usage of lavender essential oils, and authentication methods.

Keywords: lavender, lavender essential oils, chemical profile, linalool synthesis, eucalyptol synthesis, camphor synthesis, beta-myrcene synthesis, extraction methods, authentication.

Introducere

Lavender (Latin - Lavandula) is a woody shrub or annual herb which belongs to the Lamiaceae family, also known as the Mint family [1]. It is a member of the Nepetoideae subfamily. It can be found in Mediterranean areas, England, North America, North Africa, and several other European countries [2]. Throughout history lavender was used for its pleasant perfume and medicinal properties. It is believed that the name "Lavender" comes from the Latin "lavando", derived from the verb "Lavare" which means "to bathe", due to the possibility of Lavandula being used as a perfuming herb by the Romans in their baths [1]. Its medical usages were of a tonic, laxative and antidote for several types of poison in Ancient Times; however, during the Medieval Times and the early Modern Era it was used to treat lice infections, to escape evil spirits, curing of pulmonary congestion, in the treatment of epilepsy and convulsions, to ameliorate insomnia and headaches, to help [1].

Medical properties

Lavender is well known for its relaxing and anxiety relieving effects on the body. Several studies were conducted which broadened the domains in which lavender can be used. It has been established that applied aromatherapy of lavender essential oil can improve the accuracy and speed of both pupils and adults when asked to solve mathematical computations [1]. It has been proven that diffused lavender essential oil can improve the sleep quality of even the most restless people, thus marking it as an efficient sleep promoter [1]. Because of its antioxidant properties, LEOs (lavender essential oils) were shown to have positive effects on patients suffering from Alzheimer's disease [3]. Studies have shown that LEOs have an anticonvulsive effect when it comes to seizures induced in animals and it can ameliorate headaches in both humans and animals [3]. Applied aromatherapy of LEO can also decrease the labor pain in women who give birth for the first time [4]. Lavender was also shown to increase the progesterone levels and regulate menstrual cycles in women suffering from polycystic ovary syndrome [5].

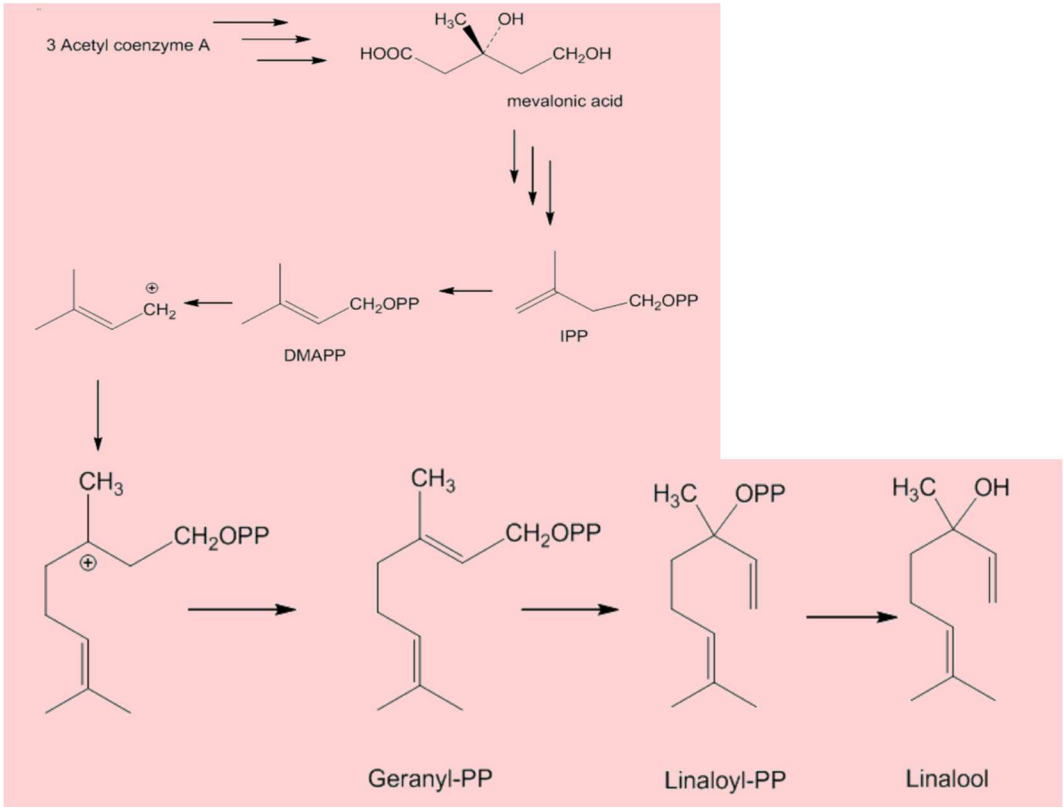
However, despite its manifold advantages and positive effects on the body, lavender consumption can also lead to undesirable results if done in excess: a study done on a male patient showed that the consumption

of lavender herbal tea for 5 days in a row to treat a respiratory tract infection led to the development of acute nephritis [6].

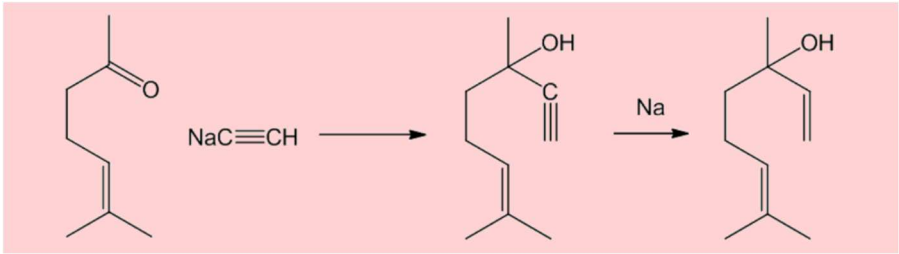
Volatile compounds

Lavender has a complex chemical profile which mainly consists of aldehydes, hydrocarbons, ketones and alcohols. Furthermore, the medical usage of some of the main compounds found in lavender will be discussed (linalool, eucalyptol, camphor and beta-myrcene).

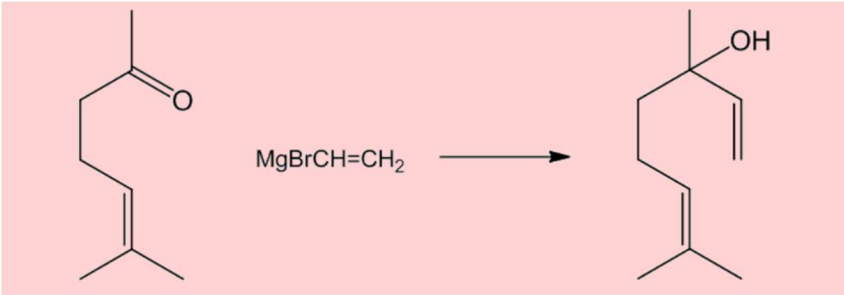
Linalool can be used as a strong anti-inflammatory agent in lung diseases [7] and carboxymethyl hydrogels loaded with linalool were shown to be useful in inhibiting the growth of tumor cells which cause cervical cancer [8]



Synthesis of Linalool done by plants
Source: https://www.chm.bris.ac.uk/motm/linalool/linalooljm.htm [9]

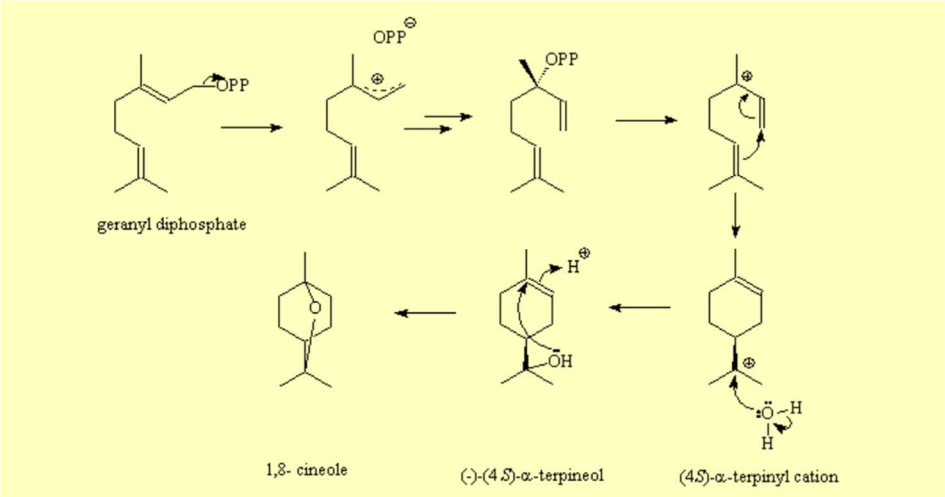


Synthesis of Linalool done in the lab (I)
Source: https://www.chm.bris.ac.uk/motm/linalool/linalooljm.htm [9]



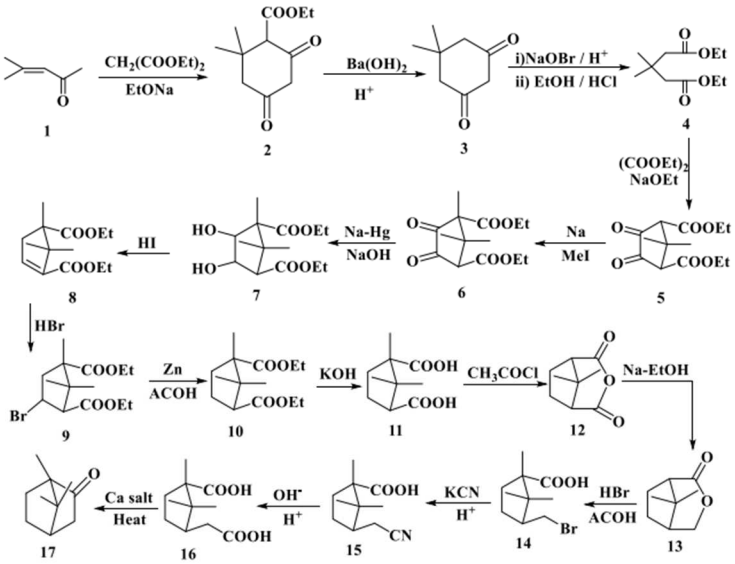
Synthesis of Linalool done in the lab (II)
Source: https://www.chm.bris.ac.uk/motm/linalool/linalooljm.htm [9]

Eucalyptol has strong anti-bacterial properties. When it was tested against other antibiotics, it was not as strong as the other antibiotics; however, when it was combined with other drugs it was shown to decrease the minimum inhibitory concentration [10]. Studies have shown that it can also ameliorate seizure induced in rats, decreasing their death rate [11].



Synthesis of eucalyptol done by plants
Source: https://www.chm.bris.ac.uk/motm/cineole/cineoleh.htm [12].

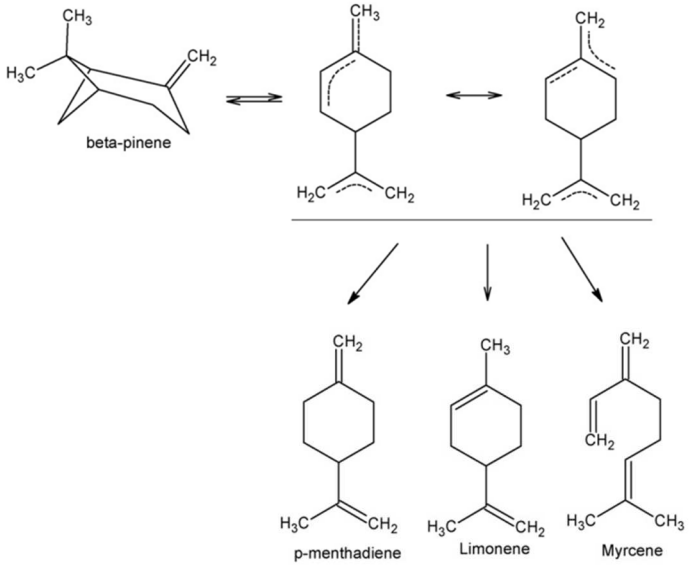
It has been shown that besides its analgesic effects on inflammatory and nociceptive pain models, camphor can also have a potential effect on neuropathic pain [12].



Scheme 1. Synthesis of camphor from mesityl oxide.

Source: [14]

Beta-Myrcene was reported to have strong anxiolytic effects on the nervous system; it can also be used as a powerful antioxidant and anti-inflammatory agent. 1,8-Cineole has shown anticarcinogenic properties on a broad range of cancer cells [15]



Scheme 1. The molecular rearrangements during the isomerization of β-pinene, according to Burwell [11].

Source:[16]

Extraction

Lavender essential oil is usually obtained by steam distillation, hydro distillation, supercritical solvent distillation and solvent distillation [17].

New methods of extraction for essential oils were proposed, such as: microwave extraction, ultrasonic-assisted extraction and negative pressure cavitation extraction [17, 18, 19].

Authentication

The harvest conditions and materials used in reducing the cost of producing lavender essential oil can result in harmful products for the consumers [20].

Some of the most common adulterants of lavender oil are acetylated lavandin, synthetic linalool and linalyl acetate, fractions of ho leaf oil and rosewood oil, terpinyl propionate, isobornyl acetate, terpineol, fractions of rosemary, aspic oil, lavandin. Lavandin oil is the most common adulterant due to its high yield [1].

The authenticity of lavender oil can be established with the aid of chromatography, which can be combined with other methods of identification, such as IR, MIR, NIR or mass spectrometry [1].

Conclusions

Lavandula is a plant which presents several health benefits due to its complex chemical profile which encompasses dozens of chemical compounds, each having unique usages in medicine; some of them are linalool (a strong anti-inflammatory agent which can be used in inhibiting the growth of cervical cancer cells), eucalyptol (a strong antibacterial agent which can boost other antibiotics'' therapeutic action and can ameliorate seizures induced in animals), camphor (an analgesic agent) and beta-myrcene (an anxiolytic, anti-inflammatory and anti-oxidant agent with anticarcinogenic effects on a broad range of cancer cells).

Bibliografie

[1] Lis-Balchin, Maria, ed. *Lavender: the genus Lavandula*. CRC press, 2002

[2] Burdock, George A. *Fenaroli's handbook of flavor ingredients*. CRC press, 2016

[3] Bavarsad, N.H., Bagheri, S., Kourosh-Arami, M. and Komaki, A., 2023. Aromatherapy for the brain: Lavender's healing effect on epilepsy, depression, anxiety, migraine, and Alzheimer's disease: A review article. *Heliyon*.Karatopuk

[4] Karatopuk, S. and Yarıcı, F., 2023. Determining the effect of inhalation and lavender essential oil massage therapy on the severity of perceived labor pain in primiparous women: a randomized controlled trial. *Explore*, *19* (1), pp.107-114

[5] Simaei, S.R., Askari, V.R., Rostami, M., Kamalinejad, M., Farzaei, M.H., Morovati, M., Heydarpour, F., Jafari, Z. and Rahimi, V.B., 2024. Lavender and metformin effectively propagate progesterone levels in patients with polycystic ovary syndrome: A randomized, double-blind clinical trial. *Fitoterapia*, *172*, p.105720.

[6] Ozer, H., Sayan, Z.A., Baloglu, I., Ozturk, Y., Yonet, F. and Turkmen, K., 2023. Unknown criminals for kidney: Acute interstitial nephritis due to lavender tea. *EXPLORE*, *19*(6), pp.859-860.

[7] Huo, M., Cui, X., Xue, J., Chi, G., Gao, R., Deng, X., Guan, S., Wei, J., Soromou, L.W., Feng, H. and Wang, D., 2013. Anti-inflammatory effects of linalool in RAW 264.7 macrophages and lipopolysaccharide-induced lung injury model. *Journal of Surgical Research*, *180* (1), pp. e47-e54.

[8] An, Y., Zhai, R., Chen, J. and Xie, P., 2023. Preparation and application of a novel pH-responsive linalool carboxymethyl chitosan hydrogel. *Journal of Macromolecular Science, Part A*, *60* (5), pp.336-345.

[9] https://www.chm.bris.ac.uk/motm/linalool/linalooljm.htm

[10] Hoch, C.C., Petry, J., Griesbaum, L., Weiser, T., Werner, K., Ploch, M., Verschoor, A., Multhoff, G., Dezfouli, A.B. and Wollenberg, B., 2023. 1, 8-cineole (eucalyptol): A versatile phytochemical with therapeutic applications across multiple diseases. *Biomedicine & Pharmacotherapy*, *167*, p.115467

[11] Bezerra, D.S., de Araujo Delmondes, G., Lopes, M.J.P., Araujo, I.M., de Lacerda Leite, G.M., de Oliveira Barbosa, M., Barbosa, R., Alves, A.F., Medeiros, C.R., Florencio, S.G.L. and de Menezes, I.R.A., 2023. Eucalyptol prevents pilocarpine-induced seizure and neuronal damage in mice, through the cholinergic, monoaminergic and antioxidant pathways. *Food Bioscience*, *53*, p.102824.

[12] https://www.chm.bris.ac.uk/motm/cineole/cineoleh.htm

[13] Li, Z., Gan, Y., Kang, T., Zhao, Y., Huang, T., Chen, Y., Liu, J. and Ke, B., 2023. Camphor attenuates hyperalgesia in neuropathic pain models in mice. *Journal of Pain Research*, pp.785-795.

[14] Mahdy, A.H.S., Zayed, S.E., Abo-Bakr, A.M. and Hassan, E.A., 2022. Camphor: Synthesis, reactions and uses as a potential moiety in the development of complexes and organ catalysts. *Tetrahedron*, *121*, p.132913.

[15] Surendran, S., Qassadi, F., Surendran, G., Lilley, D. and Heinrich, M., 2021. Myrcene—what are the potential health benefits of these flavorings and aroma agent? *Frontiers in nutrition*, *8*, p.699666.

[16] Kolicheski, M.B., Cocco, L.C., Mitchell, D.A. and Kaminski, M., 2007. Synthesis of myrcene by pyrolysis of β-pinene: Analysis of decomposition reactions. *Journal of analytical and applied pyrolysis*, *80* (1), pp.92-100.

[17] Nayik, G.A. and Ansari, M.J. eds., 2023. *Essential Oils: Extraction, Characterization and Applications*. Academic Press.

[18] Sarkar, Tanmay, and Siddhartha Pati, eds. *Bioactive Extraction and Application in Food and Nutraceutical Industries*. Springer Nature, 2024.

[19] Gul, O., Dar, A.H., Dash, K.K., BhagyaRaj, G.V.S., Khan, S.A., Sultan, U., Ayoub, W.S., Zahoor, I., Rasool, S. and Dwivedi, M., 2023. Essential oil extraction from lavender using negative pressure cavitation extraction and coating to extend grape shelf life. *Applied Food Research*, *3* (2), p.100335.

[20] Philippe, F., Dubrulle, N., Marteaux, B., Bonnet, B., Choisy, P., Berthon, J.Y., Garnier, L., Leconte, N., Milesi, S., Morvan, P.Y. and Saunois, A., 2022. Combining DNA Barcoding and Chemical fingerprints to authenticate Lavender raw material. *International Journal of Cosmetic Science*, *44* (1), pp.91-102.