Lavender essential oil research and application process in China

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Abstract. Lavender, a perennial subshrub classified under the genus Lavandula and the family Labiatae, is native to the southern areas of Europe and the Mediterranean. It has also been brought to China, albeit with less research conducted on the subject. China is home to two primary cultivated species of lavender, which are primarily found in regions such as Xinjiang, Shaanxi, and Jiangsu. Among these regions, Xinjiang is the predominant cultivator, with a focus on the narrow-leaved lavender variety. The full understanding of the sensible and efficient utilisation of lavender essential oil is necessary due to its significant therapeutic and decorative significance. This paper provides a comprehensive overview of lavender essential oil, encompassing an analysis of its active components and recommended application guidelines based on a thorough assessment of relevant literature. Additionally, it compares and evaluates various extraction processes currently employed in the industry. Furthermore, the research delves into the safety considerations associated with lavender essential oil and explores appropriate practises for its consumption to ensure user well-being.

Keywords: lavender, essential oil, narrow-leaf lavender.

1. Introduction

Lavender, a perennial subshrub, is classified under the genus Lavandula under the family Labiatae. It is indigenous to the southern regions of Europe and the Mediterranean area. The genus Lavandula encompasses approximately 39 species, with notable species being Lavandula angustifolia, Lavandula intermedia (a hybrid of broad- and narrow-leaved lavender), and Lavandula spica [1]. The introduction of lavender in China occurred during the mid-twentieth century. Currently, there are two primary cultivated species of lavender, predominantly found in regions such as Xinjiang, Shaanxi, and Jiangsu. Among the regions under consideration, Xinjiang stands out as a highly developed area in terms of cultivation. The predominant crop farmed in this region is narrow-leaved lavender, with vast expanses of land dedicated to its cultivation in the Ili region of Xinjiang. Notably, the production of essential oil derived from narrow-leaved lavender in Xinjiang accounts for a substantial 95% of the entire output in China as a whole [2]. In contrast to other nations where lavender essential oil enjoys widespread use, China exhibits a relative deficiency in the adoption and implementation of lavender essential oil. This phenomenon is seen in the scarcity of pertinent literature, the limited level of public comprehension, or the insufficient depth of understanding to be effectively applied. This paper provides a comprehensive overview of the active constituents and recommended application guidelines for lavender essential oil, based on a thorough examination and analysis of relevant literature. Additionally, it conducts a

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comparative analysis of various extraction processes currently employed for lavender essential oil production. Furthermore, the research examines the safety considerations associated with lavender essential oil and explores appropriate usage practises to ensure its safe application. The objective of this study is to offer a thorough guide to the use of lavender essential oil in China. This will be achieved by integrating existing research and analysis, while incorporating other perspectives.

2. Components of essential oils and their extraction methods

2.1. Common components of essential oils

The research conducted in Xinjiang in 1960 aimed to investigate the aromatic plant resources, specifically focusing on lavender. The analysis of lavender flowers revealed the presence of aromatic oil, with a concentration of approximately 0.8% in fresh flowers and around 1.5% in dried flowers. The primary constituents of this oil were identified as linalyl acetate, linalyl butyrate, and coumarin. In the 1970s, the Shanghai Research Institute of the Spice Industry conducted a qualitative and quantitative determination of lavender oil components, designated as C-197. This analysis confirmed the presence of 31 chemical compounds, with linalyl acetate accounting for 38.04% of the oil's composition. The study also investigated the extraction method for lavender essential oil, along with its chemical composition. The Shanghai Spice Industry Research Institute conducted a qualitative and quantitative analysis of the components of lavender oil. The study revealed the presence of 31 chemical compounds in lavender oil, with linalyl acetate comprising 38.04%, linalool comprising 29.91%, lavandin acetate comprising 6.56%, and lavandin alcohol comprising 0.3% of the total composition. Based on chromatographic analysis conducted on lavender oil samples of varying quality, it has been observed that the concentration of linalyl acetate is greater than that of linalool. Additionally, lavender acetate and lavandin exhibit high concentrations in the oil. Furthermore, it is suggested that lavender oil of superior quality is characterised by lower levels of eucalyptus oleoresin, lobster, and camphor [2].

In 1990, the pertinent departments formulated the national standard for Chinese lavender oil (GB12653-90). This standard is based on the international standard ISO 3515-1987, specifically the "French lavender oil" standard. The samples utilised in this standard were obtained through steam distillation of essential oil extracted from the blossoming flowers of Xinjiang Ili lavender. The gas chromatographic image of Chinese lavender oil was analysed using a standard, which enabled the confirmation of the significant attributes of 13 components. The sample consisted of thirteen components, namely ninene, 1,8-eucalyptol, trans-rosene, cis-rosene, octanone-3, camphor, linalool, linalyl acetate, p-Blue-en-1-ol-4, Lavandula angustifolia, Lavandula angustifolia, Lavandula angustifolia, Lavandula angustifolia, Turpentine, and Lobelia. The technical specifications necessitate an ester value exceeding 108, which is comparable to a linalyl acetate concentration of 38%. Additionally, the camphor level should be limited to 0.5%. The year 1991. In their study, Chen Xinglie et al. employed gas chromatography-mass spectrometry to successfully identify a total of 27 compounds present in the essential oil of Lavandula angustifolia sourced from Ili, Xinjiang. Additionally, they identified 36 compounds in the essential oil of Lavandula indica, which is utilised in Uighur medicine and originates from India. This research was conducted in 1999. In their study, Zhang Chunling et al. documented the identification of 36 chemical constituents found in the volatile oil of Lavandula angustifolia originating from Yunnan [2]. These elements served as the foundation for the subsequent examination of the essential oils. In a study conducted in 1999, Zhang Chunling and colleagues identified a total of 36 chemical compounds present in the volatile oil of Yunnan Lavandula angustifolia. Additionally, the Uyghur Pharmacopoeia, published by Liu Yungmin and others, listed 21 chemical compounds specifically categorised under the Lavandula angustifolia species.

In a study conducted by Xie Chengxi et al. in 2002, the volatile oil of Lavandula angustifolia in Xinjiang was analysed using gas chromatography-mass spectrometry (GC-MS). The researchers identified and validated the presence of 35 chemical compounds in the oil. Notably, the oil was found to contain linalyl acetate at a concentration of 35.79%, linalool at 37.6%, lavandin acetate at 4.11%, lavandula propionate at 2.11%, and lavandin acetate at 4.11%. The composition of the substance

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includes 2.05% lavandin propionate and 0.59% camphor, among other constituents. In a study conducted by Ristorcelli, the terpenoids present in the essential oil of Lavandula angustifolia were examined using C-NMR. The analysis revealed the presence of various compounds including linalyl acetate, linalool, trans-linalool, cis-linalool, eucalyptus, basilene, eucalyptus brain, terpin-4-ol, and camphor. Notably, the concentrations of these compounds differed significantly depending on the specific lavender species utilised in the study. In their study, Hohman et al. (1999) successfully extracted rosmarinic acid, caffeic acid, lignan, and lignanoside from the aqueous-methanol extract of narrow-leaved lavender flowers. The relative concentrations were measured by thin-layer chromatography (TLC) to be 1.16%, 0.111%, 0.011%, and 0.140%.

The composition of lavender essential oil is subject to variation due to factors such as the species of lavender, its origin, the site of extraction, and the extraction procedure employed. Consequently, the essential oil does not exhibit a wholly uniform composition [2].

2.2. Lavender essential oil extraction method

Plant essential oil is synthesised by plants and possesses a volatile aromatic scent due to the presence of secondary metabolites. It falls under the category of water vapour that can be extracted through steam distillation, yielding a volatile oil that is insoluble in water. This volatile oil, also referred to as volatile oil, is composed of various chemical molecules such as terpenes, aldehydes, esters, alcohols, and other complex components. The composition and structure of plant essential oil consist of a diverse range of mixtures [3]. There exist four primary techniques employed in the extraction of lavender essential oil.

2.2.1. Water vapor distillation method. Due to its inherent simplicity, cost-effectiveness, and high productivity, this particular process stands as the prevailing and time-honored approach for the extraction of lavender essential oil. Nevertheless, the combination of elevated temperature and high humidity poses a considerable challenge in mitigating the influence of the active constituents present in lavender, hence diminishing the efficacy of the extraction process. Strict management of the distillation time is necessary to attain optimal outcomes. The experimental results demonstrate that the most favourable preparation circumstances consisted of an ultrasonic intensification time of 17.6 minutes, ultrasonic power of 171.0 watts, liquid-solid ratio of 16.6:1, and extraction time of 1.51 hours. According to the cited source, it was determined that the anticipated value of the essential oil output of Lavandula angustifolia was 0.761% under the specified circumstances [4].

2.2.2. Organic solvent extraction method. The aforementioned process demonstrates a higher level of efficiency in the extraction of essential oils, as it yields a greater quantity of oil content when compared to the water vapour distillation method. Nevertheless, due to the exorbitant expenses associated with implementing this approach and the presence of a greater number of contaminants in the extracted lavender essential oil, its utilisation in industrial production is very limited. In order to enhance the utilisation of the organic solvent extraction technique, it is recommended to employ the following optimal operating parameters: a material ratio of n(PhI): n(CuI): n(CF3COONa) at 1:2:8, employing dimethylformamide (DMF) as the solvent, conducting the reaction at a temperature of 160°C for a duration of 4 hours. Under these conditions, the product yield can reach as high as 77.8%, with iodobenzene serving as the substrate. In this particular circumstance, bromobenzene exhibited a notable level of reactivity. In contrast to the current chlorofluorination method, the synthesis of trifluoromethyl compounds through the reaction between sodium trifluoroacetate and halogenated aromatic hydrocarbons offers several advantages. This process is characterised by its ease of operation, as it eliminates the need for strong acids and corrosive reagents, thereby mitigating environmental pollution. Additionally, it yields a high quantity of products, benefits from readily available raw materials, and boasts a low cost. Consequently, this method holds promising potential for industrial applications [5].

2.2.3. Ultrasonic extraction method. In light of the aforementioned limitations associated with the organic solvent extraction method and water vapour distillation method, researchers have sought to

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enhance these techniques. Specifically, they have explored the integration of ultrasound technology to augment the extraction efficiency in the aforementioned methods. Ultrasound is employed in the organic solvent extraction technique to enhance the dissolution of active constituents of lavender into organic solvents, hence improving the efficiency of the process. Simultaneously, ongoing experiments are being conducted to explore the efficacy of utilising ultrasound-enhanced water vapour steam storage technique for the extraction of essential oils from Xinjiang lavender flowers. The objective of these experiments is to optimise and determine the most effective process parameters. The identified optimal conditions include an ultrasonic power of 160 W, an ultrasound enhancement time of 15 minutes, a liquid-solid ratio of 15:1, and a magnesium sulphate concentration of 10 g/L. The essential oil extraction rate obtained by the classic water vapour distillation process is 0.83%, which is 2.07 times more than the initial amount. The aforementioned approach exhibits convenience and efficiency, thereby serving as a foundation for conducting in-depth investigations on lavender essential oil and maximising resource utilisation [6]. Nevertheless, the current state of this method does not possess the necessary level of development to be used on a large scale in industrial production. Its application is now limited to laboratory settings, namely for the manufacture of essential oils [7].

2.2.4. Supercritical carbon dioxide extraction method. Due to its cost-effectiveness, energy efficiency, and user-friendly operation, this innovative technology holds significant potential for widespread adoption and use in industrial production. One factor to take into account is that the utilisation of this technology necessitates the acquisition of additional specialised apparatus and equipment, potentially leading to an increase in costs. In their study, Che Guoyong et al. employed supercritical carbon dioxide (CO2) extraction technology to create an orange clear oil. The extraction process was conducted at a pressure of 10 megapascals (MPa), a temperature of 321 Kelvin (K), and a duration of 120 minutes. The resulting oil exhibited a yield ranging from approximately 2.0% to 2.5%. When comparing the water vapour distillation method, it is evident that the lavender acetate concentration in the product was lower compared to that obtained through water vapour distillation. Conversely, the linalyl acetate content was much higher in the product compared to the water vapour distillation method [8].

3. Lavender essential oil applications

3.1. Lavender essential oil treatment of skin inflammation beauty and skin care

Lavender essential oil possesses various properties such as antibacterial, anti-inflammatory, and antioxidant effects. It also exhibits the ability to inhibit sebum secretion and tyrosinase activity, promote collagen synthesis, and stimulate hair growth. Consequently, lavender extracts find application in the production of face masks, perfumes, fumigation products, soaps, and laundry detergents. These applications aim to showcase the aroma of lavender, as well as its calming, tranquillizing, and nerve-soothing properties. Additionally, lavender extracts are known for their whitening, lightening, and anti-aging effects, among other multiple benefits. Furthermore, this particular substance has a lengthy historical record of practical implementation, stemming from its natural origins, and exhibits a promising outlook for advancement within the realm of cosmetics [9]. In the case of the Kiehl's white bottle, a specific quantity of lavender essential oil has been used. This addition serves a dual purpose: firstly, it imparts the product with the ability to whiten and diminish spots; secondly, it imparts a soothing lavender aroma to the product. The monthly sales of the product on China's domestic platform exceed 100,000 units. Customer feedback indicates that the product's effects become noticeable within around one week of usage, resulting in a significant brightening effect.

3.2. The medicinal value of lavender essential oil

Based on the findings in international literature, it has been observed that lavender flowers have been employed as traditional medicines for conditions such as nervous palpitations, carbylamine, and hernia discomfort. Additionally, these flowers have been noted for their potential diuretic properties. The essential oil possesses antibacterial properties, making it suitable for topical application on wounds to effectively disinfect and facilitate the healing process of the skin, hence minimising the formation of scars. Lavender stems, leaves, and essential oil possess antibacterial properties and have been employed in the treatment of burns, scalds, ulcers, and other dermatological conditions including skin rashes, eczema, and psoriasis. Additionally, lavender has been utilised to stimulate hair regrowth in cases of alopecia. Numerous studies have demonstrated the usefulness of lavender oil in repelling roundworms, mosquitoes, and mites. According to available data, it has been documented that the Spanish country historically employed lavender for its antipyretic and analgesic properties, as well as for the treatment of wounds. In Jordan, Indian lavender is employed for the management of hemiplegia, while Uyghur medical practitioners utilise it specifically for the treatment of vitiligo. Lavender holds a significant place in Xinjiang Uyghur medicine, where it is referred to as "Ustihudus" in the Uyghur language. Within the standardised Uyghur medicines fascicle, numerous traditional lavender prescriptions can be found. It is worth noting that these prescriptions are compound in nature, and the traditional medicinal practises typically involve the utilisation of the entire lavender herb. According to Uyghur medical practitioners, lavender is believed to possess properties that address the second level of dampness and heat. It is purported to have the ability to alleviate cold symptoms, invigorate the stomach and brain, mitigate dampness, and provide relief from pain. These qualities make lavender a potential treatment option for conditions such as chest and abdominal distension, colds, coughs, dizziness, headaches, palpitations, shortness of breath, as well as joint and bone pain. Currently, the Chinese market offers an over-the-counter medication called Qingfeng oil, which includes lavender as one of its components. Additionally, Yunnan Baiyao aerosol, another product available in China, also incorporates lavender oil [10].

4. Safety evaluation and safe use of lavender essential oil

In general, lavender essential oil undergoes quick metabolism and excretion following its application on the skin, rather than accumulating within the body. As a result, it can be considered a relatively safe dermal pro-osmotic agent. Nevertheless, despite the comparative mildness and lower irritability of lavender essential oil in comparison to other plant essential oils, it is important to acknowledge that it still possesses irritant and poisonous properties. In their study, Fan et al. (12) conducted repeated dose percutaneous toxicity tests to investigate the hepatotoxicity and nephrotoxicity of lavender essential oil. The results indicated that the lowest dose of 1250mg/kg exhibited detectable toxicity. Additionally, the researchers employed the mouse ear swollen belly test and mouse local lymph node test to assess dermal absorption, skin irritation, and sensitization caused by lavender essential oil. They observed a proportional relationship between concentration and dermal absorption, with the maximum concentration showing no detectable irritation and sensitization in 25% of cases. Furthermore, the chicken moon chorionic villous test was utilised to examine the impact of lavender essential oil on skin irritation and sensitization. The findings revealed a positive correlation between concentration and irritation and sensitization, with the largest concentration resulting in no detectable irritation and sensitization reactions in 25% of cases. The results of the Chorioallantoic Membrane (CAM) test indicated that lavender essential oil exhibited significant eye irritation. It was seen that the degree of eye irritation decreased as the concentration of the oil decreased. Notably, no irritation was observed at the highest concentration tested, which was 25%. In their study, Prashar et al. employed three distinct cell types, namely HMEC-1 endothelial cells, HNDF fibroblasts, and 153BR fibroblasts. The researchers determined that the highest concentration at which neither irritation nor sensitization was observed was 25%. In this study, three cell models of 153BR fibroblasts were utilised to investigate the cytotoxic effects of lavender essential oil and its main components, namely linalool and linalyl acetate, on human skin cells in vitro. The results demonstrated that the cytotoxicity exhibited by lavender essential oil and its components was dependent on the dosage administered. Specifically, when a concentration of 0.125% (v/v) of lavender essential oil was applied, the survival rate of the three cell models ranged from 80% to 100% [11]. However, as the concentration of lavender essential oil increased, the cell survival rate progressively decreased. Furthermore, the cytotoxicity of linalool was found to be influenced by the concentration of lavender essential oil. The cytotoxicity exhibited by lavender essential oil was found to be similar to that of linalyl acetate, while linalyl acetate had a higher level of cytotoxicity compared to lavender essential oil. The likelihood of discomfort and sensitization is further heightened by the autoxidation of linalool and linalyl acetate [12]. It is imperative to use caution in order to prevent over dosage when utilising lavender essential oil. It is advisable to avoid direct exposure to lavender essential oil with higher purity or 100% concentration due to its potential to induce skin irritation, sensitization, and eye discomfort.

5. Conclusion

There are currently four distinct techniques employed in the extraction of lavender essential oil, each possessing its own set of advantages and limitations. The selection of the most suitable approach necessitates a thorough evaluation of these techniques in relation to the specific circumstances at hand. The utilisation of processed lavender essential oil predominantly revolves around its therapeutic applications, as well as its incorporation into cosmetic and skincare regimens. It is imperative to exercise caution and attentiveness when considering the utilisation of concentration and dosage. Regarding restrictions, the aforementioned article lacks comprehensive elaboration on the specific application. It is necessary to integrate various individual circumstances and take into account the appropriate procedures and dose of lavender essential oil. Simultaneously, it is evident that this paper exhibits a deficiency in investigative rigour, as the employed data lacks the requisite level of precision. Furthermore, many data points are subject to temporal constraints, necessitating the requirement for additional experimentation or surveys to get more efficacious data.

References

[1] Seidler Lozykowska K, Mordalski R, Kucharski W, et al.Yielding and quality of lavender flowers (Lavandula angusti-folia Mill.)from organic cultivation[J]. Acta Scientiarum Polonorum Hortorum Cultus, 2014(6):173-183.
[2] Zhang Qun,Za Lingli. Research and application of Lavandula angustifolia[J]. Shizhen Guojian,2008(06):1312-1314.
[3] LIAO Zhenni. Research on the introduction of Lavandula angustifolia in different regions and its tolerance to humidity and heat[D]. Hunan Agricultural University,2014.
[4] YANG Hui,ZHANG Ruya,CHEN Liwei,LIN Zhongming,WU Zhangqiang,WANG Tian. Study on the optimal conditions for lavender essential oil extraction[J]. Feed Research,2019,42(06):89-92.
[5] Lv Yangcheng,Song Jin,Luo Guangsheng. Research on the extraction and cutting methods of lavender oil[J]. Fine Chemical Industry,2005(04):280-282+313.
[6] LI Shuangming,GU Yaling,XIE Xiao,LI Wenxiu,YU Sansan. Extraction of lavender essential oil by ultrasound-enhanced water vapor distillation[J]. Food Industry,2013,34(02):41-44.
[7] GUO Wenjuan. Research on efficient extraction technology of lavender essential oil[J]. Rural Practical Technology,2021(03):108-109.
[8] CHA Guoyong, PANG Hao, LIAO Bing, ZHANG Jingcheng, LIU Junling. Supercritical CO_2 extraction of volatile components from Lavandula angustifolia[J]. Chromatography,2005(03):322.
[9] GUO Fengjiao,LIU Fei,YANG Suzhen,HAN Tingting,WANG Qian. Research progress on the skincare effect of lavender essential oil[J]. Science of Daily Chemicals,2023,46(01):35-40.
[10] Deng Yanping,Chen Xin. Efficacy of lavender essential oil and its application in aromatherapy[A]. International Food Safety and Nutritional Health Summit Organizing Committee. Proceedings of the Third International Food Safety and Nutritional Health Summit [C]. International Food Safety and Nutritional Health Summit Organizing Committee: International Food Safety and Nutritional Health Summit Organizing Committee, 2021:4. DOI:10.26914/c.cnkihy.2021.021864.
[11] Fan, Sweetie. Research on the safety and efficacy of true lavender essential oil and bitter water rose essential oil[D]. Shanghai Jiaotong University,2017.
[12] GUO Fengjiao,LIU Fei,YANG Suzhen,HAN Tingting,WANG Qian. Research progress on the skincare effect of lavender essential oil[J]. Science of Daily Chemicals,2023,46(01):35-40.