

Lavender Plant: Farming and Health Benefits

Sameer Ullah Khan^{1,2,*}, Baseerat Hamza¹, Kaneez Fatima and Fayaz Malik¹

¹Department of Cancer Pharmacology, CSIR-Indian Institute of Integrative Medicine, Jammu and Kashmir, India

²Department of Cancer Biology, Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India

Abstract

Lavender is a Mediterranean shrub from the Lamiaceae family. Lavender flowers (*Lavandula flores*) include active ingredients (3%), Anthocyanins, Sugars, Phytosterols, Minerals, and Tannins, and are majorly used for herbal applications. Lavender essential oil's descriptive and analytical composition varies depending on genotype, growing region, climatic circumstances, propagation, and morphological characteristics. There are around 300 chemical components in essential oil. The Linalool, Terpinen-4-ol, Linalyl Acetate, Ocimene, Acetate Lavandulol, and cineole are the most prominent constituents. Lavender oil has antibacterial and antioxidant properties and a noticeable improvement in the digestive and neurological systems. Lavender extract helps to prevent dementia and may slow cancer cell growth, while Lavender oil hydrolate is used to treat skin problems. This review will cover the recent medical, economic and regional advancements in Lavender propagation and how CSIR IIM aroma mission is actively acting as a bridge between farmers and their economic improvement by attracting them to the field of medicinal plant cultivation.

Keywords: Lavender • Essential oil • Hydrolate • Alzheimer's disease • Anticancer • Antidepressant • Autophagy

Introduction

Herbal active substances have multifaceted phytotherapeutic potential and are used to treat intestinal, cardiovascular, pulmonary, and bladder infections, and also chronic disorders in children and the elderly [1-3]. They also have antibacterial, antifungal, antispasmodic, and antioxidant properties, as well as the ability to control digestive activity [4-6]. Herbs have antibacterial, antioxidant, and therapeutic characteristics due to the bioactive chemicals found in them, and they can be employed as effectively as synthetic medications [7,8]. Lavender is a plant that has a range of health benefits for humans. Lavender is widely utilized in the cosmetic, fragrance, food, and aromatherapeutic sectors, in addition to herbal medicine (Figure 1) [9-11].

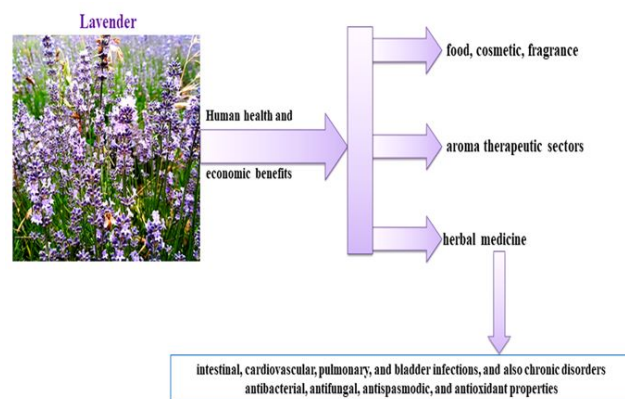


Figure 1. Lavender benefits: Lavender extracts and oils are used in cosmetic industries and have various medical benefits.

Origin of lavender

Lavender (*Lavandula angustifolia*) is an evergreen perennial plant that is also called medicinal lavender, genuine lavender, or ordinary lavender [12,13]. Lavender is a mediterranean plant native to Spain, France, and Italy, although it is also planted in many other locations, including Poland [14,15]. Lavender gets its name from the Latin (v. Lavo), lavare, which means to wash or clean [16]. The medicinal benefits of lavender have been known since ancient times, as indicated by Dioscorides' treatise "de Materia Medica."

*Address for Correspondence: Sameer Ullah Khan, Department of Cancer Pharmacology, CSIR-Indian Institute of Integrative Medicine, Jammu and Kashmir, India, Tel: 9797011287; E-mail: muminsameer@gmail.com

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Received: 12 October, 2022, Manuscript No. JPNP-22-77015; Editor assigned: 14 October, 2022, PreQC No. JPNP-22-77015 (PQ); Reviewed: 13 December, 2022, QC No. JPNP-22-77015; Revised: 14 March, 2023, Manuscript No. JPNP-22-77015 (R); Published: 21 March, 2023, DOI: 10.37421/2472-0992.2023.9.246

Lavender was utilized as a bath addition by the Romans, and it was one of the most advanced oil fields used in fragrance and soap production during the middle ages. It was employed as a laxative as well as a food additive [17].

Lavender creates compact, uniform clumps and blooms to a length of 40 cm-70 cm. The stem's bottom half is wooden, while the upper half is green. Lavender has straight or lanceolate leaves with curled margins and a fibrous root structure that is extremely branching [18, 19]. Tomentum protects silver green lavender leaves from direct sunlight, wind, and increased water loss. Lavender grows in spikes in the top half of the stalk, grouped in circles (3-5 blooms per circle). Although variations with white leaves (Alba) and pink blooms (Rosea) have been created, they are pale violet in hue. Lavender (*Lavandula angustifolia*) thrives on well drained, fertile, lime rich soils [20]. It thrives in direct sunlight with some protection from the wind. Lavender may be treated with compost or chemical fertilizers in subsequent years of culture, although care should be given not to oxidize the ground or add quite so much nitrogen, as this produces excessive growth in the green portions and a reduction in inflorescence. Lavender is susceptible to frost in Poland, thus it needs robust winter protection.

Literature Review

Plants can be grown from seeds, soft and hardwood cuttings, or tissue culture. Lavender shrubs are clipped on a regular basis to encourage plant development and lowering. Between July and August, the shrubs bloom. Harvesting should be done in sunny, dry weather. Flowers should be picked before being opened and dried in bunches in a cool, well-ventilated location. Flowers or blooming aerial portions (Herba Lavandulae) are utilized for herbal uses, and the material used for volatile oils manufacturing is fresh or dried heads of flowering plants.

Essential oil

Essential Oil (EO), originates in oil glands of the calyx, in the whorls among the hairs, is the most important ingredient obtained from lavender (*L. angustifolia*). EO is contained in levels ranging between 2% to 3%. It's made by Steam/Hydrodistillation, and it's yellow with a strong lavender aroma with a subtle note of fruit and wood. The composition of lavender (*L. Angustifolia*) essential oil is determined by genotype, growth region, climatic circumstances, propagation, and morphological traits. Linalool (from 9.3% to 68%)

and Linalyl Acetate are the most common chemical components in essential oils (from 1.2% to 59.4%). The NIR characteristics of the EO extracted from fresh and frozen lavender buds (from Poland) are the most similar to those of the EO obtained from France.

The great quantity of linalyl acetate and linalool, as well as their shared proportions, determine the quality of lavender essential oil (higher than 1). Borneol, terpineol, lavandulol acetate, terpinene-4-ol, as well as Linalool oxides, caryophyllene and are the most common chemicals. The majority of the compounds are oxygenated monoterpenes (74%), with monoterpene alcohols accounting for 36% of the total. The high proportion of lavandulol and its acetate produces a characteristic herbal-rosy perfume, whereas ocimene, camphor, cineol, and terpinen-4-ol have negative effects on the fragrance.

Hydrolates are produced during the hydrodistillation of essential oils. Hydrolates also referred to as herbal or hydrosols water, are made up of plant derived water and processing water. Hydrolates have a powerful herbal fragrance, a pleasant floral lavender smell, or a scarcely noticeable lavender aroma, depending on their final volume (variety). Volatile organic compound concentration in hydrolates varies from 24.80 to 97.33 mg/100 ml hydrolate. Linalool (39 percent), terpineol (15 percent), and coumarin are the primary chemical components (7%). The hydrolates are deficient of linalyl acetate, a biochemical molecule found in significant quantities (1.2%-59.4%) in lavender EO.

Lavender (*L. Angustifolia*) loses more than 50% of its natural ingredients while drying, according to research by Migielski et al. When fresh lavender is dehydrated in fluidization in a sealed circuit system with a dehydrating agent and a heat transfer fluid, the powder generates more flammable and are biologically very active compounds at a specified humidity and concentrated water from the plant, which is referred to as Fluidolat. Using traditional processing methods, this bioactive and novel product is completely lost. Lavender fluidolates have an scent that is comparable to that of hydrolates, but more strong and fragrant. VOC concentration in fluidolates varies depending on the degree of substance drying and varies from 120.60 to 180.20 mg/100 ml fluidolate.

Terpinen-4-ol (6.3%-16.4%), lavandulol (0.8 percent-4.4 percent) and Linalool (65.2%-79.2%) are the most common chemicals. The majority of the chemicals are oxygenation compounds of monoterpene compounds (80-91%), including monoterpene alcohols (47-61%). Linalyl acetate is also lacking in fluidolates.

No	Compound	Italy (%)	Poland (%)	France (%)	Bulgaria (%)
1	Ocimene	-	1.9-2.9	0.2-18.2	6.8-7.7
2	Camphor	0.3-0.6	0.2-0.3	0-3.4	<0.5
3	Linalool	33.3-42.2	27.3-34.7	9.3-68.8	30.1-33.7
4	Linalyl Acetate	37.8-41.2	19.7-22.4	1.2-59.4	35.2-37.6
5	Lavandulol	-	0.6-0.8	0-4.3	-
6	Lavandulol Acetate	-	4.5-5.7	0.3-21.6	-
7	Cineol	0.02-0.2	0.2-0.5	0-3.4	2.1-3.0

8	Terpinen-4-ol	2.8-3.6	1.1-2.0	0.1-13.5	4.5-5.8
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Table 1. The composition of lavender (*L. Angustifolia*) essential oil is determined by genotype, growth region, climatic circumstances, propagation, and morphological traits.

Chemical composition

Essential oil, phytosterols, anthocyanins, sugars, coumaric acid, minerals, glycolic acid, ursolic acid, valeric acid, herniarin, coumarin, and tannins are all found in lavender (*L. Angustifolia*) [15]. The macronutrient composition of lavender varies based on the cultivar. The Munstead cultivar has 17.7 g/kg dry matter (d.m.) of potassium, while lavender lady has 23.9 g/kg d.m. The levels of calcium in lavender vary greatly according to the climate; in Romania, the mean result is 2.13 g calcium per 1 kg d.m, whereas, in Pakistan, it is 10.50 g calcium per kg d.m.

The calcium content of the Blue River type is 8.10 gkg⁻¹ d.m., while the Munstead variety is 13.8 gkg⁻¹ d.m. Low magnesium (from 1.40 gkg⁻¹ d.m. for Lavender to 3.60 gkg⁻¹ d.m. for Munstead) and Na (from 0.11 gkg⁻¹ d.m. for Munstead to 0.15 gkg⁻¹ d.m. for Lavender Lady) levels distinguish lavender. Colceru-Mihul and Adnan et al. [9] both found modest levels of these elements, ranging from 2.19 to 4.25 g Mg per kg d.m. and 0.37 g Na/kg d.m., respectively.

The number of trace elements discovered varies depending on the cultivar. Zinc concentrations range between 24.0 to 106.28 mg kg⁻¹ d.m. The high amount of this micronutrient was also confirmed by Adaszyska's study: from 25.7 mgkg⁻¹ d.m. for Lavender Lady to 39.3 mgkg⁻¹ d.m. for Elegance Purple. The Lavender Lady and Munstead cultivars have copper levels of 7.2–11.1 mgkg⁻¹ d.m. and manganese levels of 9.6–18.0 mgkg⁻¹ d.m., respectively. Ellagance Purple has the highest iron concentration (489 mgkg⁻¹ d.m.), while Munstead has the lowest (137 mgkg⁻¹ d.m.).

Appliance of Lavender

Flowers, petals, and branches of lavender (*L. angustifolia*) are delicious and used to flavor bone broth and jams. The aroma of lavender is great at repelling moths and flies, thus the plant is kept in wardrobes and closets. Perrucci and O'Brien's tests have validated this insecticidal activity. Lavender lower extracts and tinctures contain calming and analgesic qualities. The effects of lavender tincture on sadness, headaches, and anxiety have been proven in research by Akhondzadeh. The lavender extract decreased Alzheimer's disease related dementia in rats, while a cytotoxic examination of the extract's effects on lung cancer found that carcinogenic cell growth was inhibited.

Perfume, cosmetics, and household chemicals all include lavender essential oil. It adds a strong top note to commode liquid, eau de cologne, moisturizers, and aftershaves, as well as a perfume of cleanliness and purity to home cleaning products. Many well-known cosmetic firms, including Avon, Procter and Gamble, and Aloe Vera, sell lavender-scented products. At dosages of 4.0–9.0 mg/ml, the essential oil of *L. Angustifolia* possesses bactericidal action. Mayaud's research verified its antibacterial properties against 65 strains of bacteria at concentrations ranging from 0.94 percent to 10% (the efficiency against gram-positive germs was higher than gram-negative bacteria).

S. Enteritidis, *E. coli*, *K. Pneumoniae*, *S. Aureus*, *C. albicans*, *P. Aeruginosa*, and *A. niger* are all inhibited by the lavender essential

oil. Essential oils from flowers in the *Lavandula* genus have a wide range of biological effects. *Lavandula dentata* essential oil kills the bacteria such as *Salmonella*, *Klebsiella*, *Enterobacter*, *E. coli*, *Staph aureus*, and *Listeria monocytogenes*. At doses of 0.5–2.0 gml⁻¹ for bacteria and 2.0–4.0 gml⁻¹ for fungi, the crude extract of *L. Bipinnata* has antibacterial and antifungal (against *A. niger*, *P. notatum*, and *C. albicans*) activities.

Lavender essential oil inhibits the growth of gram+germs (*B. subtilis*, *S. aureus*) as well as gram-pathogens (*E. coli*, *P. aeruginosa*) at levels of 0.6 or 1.0 lml⁻¹, depending on the variety (Prusinowska, unpublished). The antibacterial activity of lavender essential oil has been researched in Poland. The essential oil has been reported to be antifungal (yeasts and molds) such as *Candida A* with MICs 2.5-3 x lower than bacteria. Antimicrobial activity of lavender hydrolates against *S. Aureus*, *P. aeruginosa*, *E. coli*.

Essential oils have protective capabilities, which protect cells from free radical damage. Dapkevicus demonstrated the antioxidant properties of lavender essential oil. In a linoleic acid physical model, Economou demonstrated that this oil inhibits fat oxidation processes and lipid peroxidation. Chia-Wen Lin investigated the antioxidant capabilities of lavender essential oil (*L. angustifolia*), particularly its ability to immobilize free radicals, using DPPH. At a level of 6 g⁻¹, the result of 15.18 0.009% suggests qualities similar to those of lemon and marjoram essential oils. At the same concentration, Viuda-Martos et al. found that the essential oil had a considerably decreased ability to immobilize free radicals (4.11%).

The potential of this lavender oil to eliminate 50% DPPH radicals has been tested in various studies, with results ranging from 289 gml⁻¹ to 48.7 mgml⁻¹. This value was found to be IC 50=339.0 mlml⁻¹ in research on essential oil extracted from lavender produced in Poland. Some essential oil components, such as terpineol and linalool, according to Buchbauer, have an influence on the central nervous, diminishing physical activity in people and pets, reducing anxiety, and encouraging sleep. Systemic injection of lavender oil causes sleepiness in mice and rats. Following inhalation of lavender essential oil, 40 healthy participants showed enhanced activity of waves and performed better on math tests in research of brain waves. As a result, patients have reported feeling calm and having a pleasant outlook on life, along with drowsiness. Experiments in humans to investigate the sedative characteristics of lavender oil have revealed that using essential oils aromatherapy leads to extended sleep periods and, in the case of individuals requiring hypnosis, a reduction in medication use. A clinical trial of 245 people found that 72 percent of those who inhaled lavender oil slept soundly, contrasted with only 11 percent of those in the comparison group. In the therapy group, 4 out of 5 patients reported a general sense of well-being, compared to only 25% in the control group.

Anxiolytic action has also been found in lavender (*L. angustifolia*), according to a pig investigation. Essential oil aromatherapy was proven to reduce anxiety in 122 critically ill patients in a randomized clinical trial, compared to those who received a message without aroma and those who rested. Between the two patients, there was no change in blood pressure or respiratory tract health.

Results and Discussion

Aromatherapy using lavender essential oil reduced the anxiety associated with the anticipated unpleasant feelings, according to a study conducted in a dental surgery waiting room. Yamada found that inhaling or intraperitoneally administering lavender essential oil prevents seizures induced by nicotine or pentylentetrazol. The antispasmodic activity of lavender essential oil is due to an increase in messenger cAMP levels, but the actual mechanism is unknown. *In vitro* research has shown that this essential oil has analgesic qualities, and rabbit investigations have demonstrated its anesthetic properties. Massage with lavender oil decreased the need for painkillers in young HIV patients, and in some cases totally eliminated pain moreover lavender is known to reduce the labor pain during the birth.

Rabbits inhaled lavender essential oil, which lowered cholesterol content and atherosclerosis in the aorta but had no effect on serum cholesterol levels. Inhaling the lavender oil of lavender decreases diastolic and systolic blood pressure and slows the heart rate, according to studies. Lavender essential oil aids in the treatment of gastrointestinal problems by regulating bowel motions and the bile duct, as well as preventing flatulence. Inhalation of lavender oil has been proven in rats to stimulate bile production and reestablish the normal activity of oxidative enzymes responsible for catabolism. The lavender essential oil was discovered to be a calm muscle relaxant in the guinea pig, suppressing the contractile reaction of histamine and acetylcholine.

Lavender is used as an aphrodisiac as well as a hair growth supplement. Gruss and Hirsch performed experimental testing on a group of 31 males who inhaled 30 various fragrances and discovered that the pumpkin dough and lavender aromas generated the greatest increased blood flow to the urethra by 40% over the control. These points to the possibility of using odoriferous compounds to treat sexual dysfunction. Lavender essential oil is also beneficial for enhancing hair growth a group of 86 individuals with alopecia areata was given massages with lavender oils, including lavender, for 7 weeks, and nearly half of the patients had an improvement in hair growth.

Lavender hydrolates are beneficial for treating insomnia and headaches as well as being refreshing and soothing. They are advised for burns and skin disorders. Lavender hydrolates and fluidolates can be utilized successfully in organic and natural cosmetics. Fluidolates are thought to exhibit similar qualities based on their chemical makeup; however, research in this field is currently underway. According to the research, lavender (*L. angustifolia*) and its secondary byproducts or metabolites show multidimensional biological activity. Lavender cultivated in Poland is a rich plant supply with biological and chemical features equivalent to French lavender, according to our research, and so should pique the interest of local herb growers. Phytochemicals and synthetic medications appear to have a synergistic effect in modern medicine, which could help solve a variety of problems, including bacteria susceptibility to synthetic antibiotics.

Lavender plays a disease protective role by affecting various molecular pathways

In one study lavender oil is shown to modulate autophagy and show cardio-protective function. Autophagy is a cellular catabolic pathway, activated in various cellular stressful conditions. It degrades all the unwanted biomolecules or organelle in the cell thus maintaining the integrity of the cell. A study on wistar rats demonstrated that Lavender oils are found to have an important role in reducing myocardial infarctions by up regulating autophagy. While in gastric cancer lavender extract was shown to down regulate various cancer markers Annexin 1, Anolase 1 and HSP 70 thus reducing the tumor formation potential of these cells. In another study on glioma cells and lung cancer cells lavender (*Lavandula angustifolia* Mill.) essential oil is shown to have significant lysosomal mediated anticancer activity. The lavender extract is shown to have anticholinesterase activity and thus can prove to be very effective in Alzheimer's patients where the cholinesterase enzyme is found to be dysregulated. Another group has shown that lavender extract (*Lavandula angustifolia*) improved the septal performance in Alzheimer's mouse models it may be the outcome of a decrease in the reduction of the metabolites (alanine, glutamine, serine, isoleucine, valine, carnitine, isobutyrate, pantothenate, etc) involved in the pathogenesis-related to the disease. Moreover, the lavender extract is also shown to have pancreatic lipase inhibitory activity and could play a crucial role in reducing the chance of diabetes. Pancreatic lipase is a very active enzyme and has a definite role in diabetes. Components of Lavender are shown to increase the Trkb/ Bdnf levels in the hippocampus thus reducing the depression symptoms. Having such a diverse activity of lavender species more investigation is needed to be done to signify it on large scale to check its other potential activities for other diseases (Figure 2).

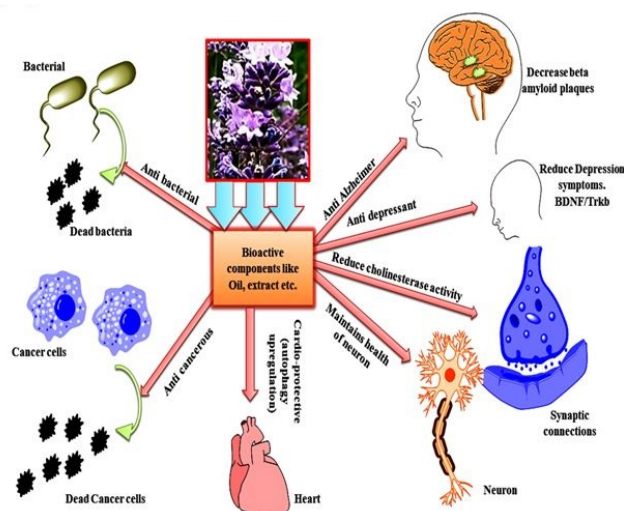


Figure 2. Diverse health benefits of Lavender. Lavender extracts are very active in reducing anxiety, depression, heart disease, and neurodegenerative diseases and have anticancerous properties.

CSIR IIIM aroma mission on the propagation of lavender

Kashmir is one of the most beautiful states of India and is enriched with medicinal plants including lavender which is now contributing much to the farmer economy and has gained medicinal importance as well and the CSIR IIIM aroma mission is actively

working on it. The lavender farming trend is now gaining importance among farmers of Baderwah, Doda who prioritize lavender farming over traditional farming of maize crops (purple revolution). Union government aroma mission is assisting low-scale farmers growing lavender to improve their income and trained them to extract raw materials for drug discovery from them and other natural products. CSIR IIIM actively carries out the aroma mission to provide cutting-edge technology and aromatic crop raw material to farmers in order to benefit them to their maximum. Lavender was introduced to Jammu and Kashmir by CSIR IIIM Jammu under the CSIR-Aroma mission established in 2018 and was transformed in the fields of Doda, Kishtwar and Rajouri large scale. Further its cultivation was encouraged by CSIR IIIM in other districts of Kashmir (like Budgam) due to favorable growth environment conditions available. From the commercial point of view, *Lavendula angustifolia* syn. *L. officinalis* commonly identified as English Lavender have attained economic importance due to its better-rooting qualities and high oil content. Kashmiri and Bulgarian lavender variety is reflected to be the best one and shows Physico-chemical similarity thus have increased the international marketplace for their high quality components. CSIR-IIIM (Srinagar and Jammu branch) has developed a high oil yielding variety called Kashmiri Lavender and is very famous at the international level. The CSIR IIIM Aroma Mission acts as a bridge between rural empowerment through cultivation, processing, value addition and marketing of aromatic plants. Additionally, CSIR aroma mission provides other additional benefits to farmers and other ambitious entrepreneurs lavender cultivation and processing and provides technical support for material processing.

Scientists and scholars of CSIR-IIIM are helping, managing and assisting the lavender grower hand in hand. The main purpose of the aroma mission is to motivate and enhance the homegrown varieties than imported aromatic oils. Aditi International, Ajmal Biotech private limited, and Navnetri Gamika are well-known Biotech companies that manufacture aromatic products and are their primary buyers of the lavender raw materials produced from four distillation units set up by CSIR-IIIM in Doda.

Conclusion

Lavender plants represent and play a considerably important role in benefiting human health. The multiple explored and unexplored benefits in this review designate that more scientific investigations on large scale are needed to be done to validate the traditional medicinal claim to the reality of more specific therapeutic agents.

Author Contributions

FM and S.K conceived the idea. S.K, S.B, K.F wrote the manuscript. SUK prepared the Figures.

Funding's

For FM laboratory was provided by Council of Scientific and Industrial Research (CSIR) India, a grant from the Department of Biotechnology Ministry of Science and Technology (DBT) (BT/IN/Swiss/48/FM/2018-19). SK is the recipient of the CSIR-SRF

Fellowship Government of India; KF is the recipient of the UGC-JRF Fellowship Government of India

Competing Interests

The authors declare no competing interests.

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Acknowledgments

We would also like to thank Dr. Abdul Sami Shawl (Emeritus Scientist, Indian Institute of Integrative Medicine (CSIR-Sanatnagar, Srinagar) for critically reading the manuscript, our colleagues particularly Dr. Reyaz Hassan, Kaneez Fatima and Yasir Dar (University of Kashmir) for their fruitful discussions and for keeping our science moving forward during pandemic times.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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How to cite this article: Alkhubata, Malek, Sanaa Alkhalwaldeh, Asma Alkhalwaldeh and Linda Alkhateeb, et al.. "Lavender Plant: Farming and Health Benefits." *J Pharmacogn Nat Prod* 09 (2023):246.