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A Review of SEM Characterization for Essential Oils

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Abstract: *Not only in hospitals, but also in our homes, plant essentials have been used as therapy. We can see diffusers being utilised in the home and business, and they just require a few drops of essential oil. The aromatherapy might help the person relax. Many essential oils, such as lemongrass, orange, lemon, and rose, can be observed because their aromatic compounds can help individuals relax and quiet down. Plant essential oils can also be utilised to treat inflammation, infections, and cancer. Traditional hydrodistillation is the most common method for extracting essential oils, but it takes time and energy. As a result, different techniques have been adopted, such as microwave assisted extraction. Scanning electron microscopy was used to characterise essential oils in this work (SEM).*

Keywords: SEM, essential oil

1. Introduction

Plant essential oil is well-known nowadays, and it is primarily used in indwell as aromatic plants. It is a volatile oily complex component with a strong aromatic odour. Plant essential oil has a long history of use as a benign natural chemical in a variety of industries, including food, pharmaceuticals, and natural remedies (Liu et al., 2021). Plant essential oil obtained through classical hydrodistillation is the most common method (HD). However, this method is time and energy intensive, and it frequently results in low yield and thermosensitive component deterioration.

There are different techniques to replace HD so that the plant essential oil diffuses from the raw materials rapidly and easily. Microwave aided hydrodistillation, which combines hydrodistillation with microwave dielectric heating as a green and effective alternative to employing an organic system to separate plant essential oils (Liu et al., 2021). As a result of the process, the yield and quality of essential oil is improved while time and energy are saved. Plant essential oil is a form of aromatic and medicinal plant whose therapeutic capabilities are increasingly being explored. Antimicrobial or antioxidant agents are included into the packaging materials in active food packaging, which is a rapidly growing and promising technology. It can give packaged foods superior quality, safety, and an extended shelf life by limiting or delaying the growth of bacteria.

2. Application Of Essential Oil

According to other researches, essential oil has a wide range of applications and benefits. Apart from being used as a therapy in the home or office nowadays, essential oils also offer anti-inflammatory, anti-bacterial, and other properties.

Essential oils were initially analysed in a laboratory to guarantee that they were safe for us to use. Mice or rabbits were typically used to test the oil.

a) Anti-inflammatory

Because the skin is the largest organ in the body, it plays a critical function in the immune system of individuals. Inappropriate or deficient immunological activity has been linked to the pathophysiology of many inflammatory illnesses. According to the study, the essential oil has anti-inflammatory properties, lowering levels of pro-inflammatory cytokines and reducing ear edoema (de Veras et al., 2021). (Elshamy et al., 2020).

Verbesina macrophylla is a South American medicinal plant that has been used for centuries by indigenous peoples to cure bacterial and fungal illnesses of the urinary and respiratory systems, including kidney issues, inflammation, and fever. According to the study, essential oil from V. macrophylla was equivalent to or better than commercial medications in terms of inhibiting the synthesis of pro-inflammatory mediators TNF- and IL-1 as a result of the anti-inflammatory effect.

b) Anti-bacteria

The bacteria Staphylococci aures (S. aureus) and Escherichia coli were evaluated with ginger essential oil (GEO) containing palygorskite (PGS) (E.coli). As a result of the findings, GEO-PGS composite has a significant antibacterial activity (Lei et al., 2017). S. aureus or E.coli growth patterns have three phases: lag phase, exponential phase, and stabilisation phase. S. aureus entered the exponential phase of growth at 8 hours and continued for 12 hours before entering the stabilisation phase, whereas E.coli entered the exponential phase at 2 hours and lasted for roughly 14 hours before entering the stabilisation phase. When GEO-PGS was added to the media of both bacteria during the lagging phase, the optical densities (O.D) fell and the growth curve shifted dramatically. These findings suggested that the bacterial proliferation phenomena had not occurred again. When GEO-PGS was given to the media during the exponential phase, the O.D values did not increase, and the growth and reproduction of both bacteria were entirely stopped (Lei et al., 2017).

c) Anti-cancer

Cancer is a significant public health issue, accounting for the world's second highest cause of death from 2009 to 2012. The study employed Zataria essential oil (ZEO), which is a valuable essential oil with a wide range of biological activity. Monoterpenoids and monoterpenes with high antioxidant potential are the main components of ZEO (Azadi et al., 2020). Because of their great ability for metastasis to neighbouring tissues, TC1 and 4T1 were chosen. The purpose of the study was to look into the anticancer effects of ZEO on breast and cervical cancer using the 4T1 and TC1 cell lines, respectively. 4T1 cells were subcutaneously implanted at the back of BALB/c mice and TC1 cells were subcutaneously inoculated at the right side of C57BL/6 mice as experimental animals.mZEO treatment was started after tumour surveillance and lasted for eight days in the manner of every other day.

According to the findings, ZEO showed dose-dependent suppression against murine cancer cell lines and spheroids (4T1 and TC1). Induction of apoptosis, in which anti-cancer medications destroy cancer cells, is one of the main mechanisms. The results demonstrated that 4T1 and TC1 cells treated with ZEO exhibited apoptotic cell features, indicating that the anti-proliferative action of ZEO was connected with apoptosis induction.

As a result, ZEO is expected to limit cancer cell viability by increasing apoptosis (Azadi et al., 2020).

d) Calmness effect

In this investigation, lavender essential oil and chamomile essential oil were employed. Participants in this study had to be at least 65 years old, able to converse verbally, and have no history of neurological or psychological sickness, respiratory issue, olfactory disorder, or lavender or chamomile allergies. Aside from that, no anti-anxiety, anti-stress, or anti-depressant medications were given to the individuals. Participants were assigned to one of three groups: lavender (A), chamomile (B), or control (C) (Ebrahimi et al., 2021).

According to the findings, 30 days of inhalation aromatherapy with lavender and chamomile essential oils improved depression immediately after intervention. After intervention, the impact can persist up to one month.

In addition, employing lavender essential oil inhalation aromatherapy for seven days decreases depression in hospitalised elderly patients. In addition, it was discovered that a three-week intervention could help elderly women with osteoarthritis minimise their depression symptoms. Apart from postpartum and hemodialysis patients, lavender essential oil aromatherapy relieves depressive symptoms in menopausal and elderly women.

In institutionalised patients with recently diagnosed acute leukaemia, inhalation aromatherapy with chamomile essential oil improved depressed symptoms.

According to the findings, the use of chamomile essential oil inhalation aromatherapy to treat depressive symptoms is restricted.

3. Essential oil Characterization using SEM

Lemongrass

Lemongrass, also known as Cymbopogon flexuosus, is an aromatic perennial grass that grows to a height of 90 cm to 2 metres. It is essential oil is derived from the leaves (Mohamed Hanaa et al., 2012). Lemongrass essential oil is used in flavour and aroma, cosmetics and toiletries, as well as pharmaceuticals and therapy. It's essential oil can be used to treat mental and gastrointestinal problems. Lemongrass has significant cytotoxic and anti-cancer properties, making it a traditional and possible treatment for a variety of diseases (Balti et al., 2018). In other words, lemongrass essential oil contains a component that can be used as a chemotherapeutic preventive in cancer instances. In addition, lemongrass contains citral. Citral is an important component with anti-inflammatory, antibacterial, antifungal, and mosquito-repellent activities.

Three microparticles, M1 (5 percent essential oil), M2 (10 percent essential oil), and M3 (15 percent essential oil), were prepared in this investigation, all in w/w. In all systems, maltodextrin DE20 and gelatin were utilised in a 4:1 (w/w) ratio as encapsulating agents (Martins et al., 2021). Using a Q150R ES system, a thin layer of gold was sputter-coated on M1, M2, M3, and the encapsulating agent. SEM at 20 kV was used to determine the microparticles (MI-M3) and agents.

Thymus Vulgaris L.

Thymus essential oil (TEO) is derived from Thymus Vulgaris L. leaves. It is appropriate for use in the food and pharmaceutical industries due to its antioxidant characteristics, antibacterial, antifungal, antiviral, and anti-inflammatory activity. Thymol and carvacrol are the two major components of TEO. It is utilised in the food business as a flavouring and preservative, and it can also be used to cure and prevent cancer and chronic diseases (Rezaei et al., 2021).

A scanning electron microscope was used to examine TEO –NSs. A drop of dispersion was dried onto the glass slide after a little amount of powder (5 mg) was dispersed in distilled water (5 ml). To increase their conductivity, the samples were then coated with a thin layer of gold using a gold sputter coater. The mean particle size was calculated using a zeta-sizer and dynamic light diffusing at 25 °C with a scattering point of 90 °. Before measurement, the samples (5 mg) were disseminated in ethyl acetate (10 ml) (Rezaei et al., 2021).

Cinnamon

Cinnamon has been utilised in traditional herbal therapy for centuries. Terpenes and aromatic compounds, which can be produced using fragrance extraction techniques such as distillation, are the most important components of cinnamon essential oil (CEO). CEO is commonly used in the medicinal, seasoning, cosmetic, food, beverage, commodity essences, and chemical sectors (Yang et al., 2021). CEO-NPs were examined at high vacuum and 3.0kV using a scanning electron microscope at various magnifications.

Ginger

Zingiber officinale Roscoe, often known as Ginger, is an aromatic plant that is commonly used in the kitchen. Many commercial natural products in the developing nutraceutical and functional foods sector contain ginger. Due to its biological features, ginger has antibacterial, antioxidant, anti-inflammatory, anticancer, and antidiabetic benefits (Amalraj et al., 2020). Ginger essential oil (GEO) is derived from the plant's roots.

The major chemical components of GEO are zingiberene, -sesquiphellandrene, camphene, and ar-curcumene. Solvent casting was used to make polyvinyl alcohol (PVA), gum arabic (GA), and chitosan (CS) integrated with GEO. The prepared film was sputter coated with gold and mounted in aluminium stubs using double-sided carbon tape. The created composite film was scanned with a 20kV accelerating voltage (Amalraj et al., 2020).

4. Summary of Result

Table 1: Result of SEM images

Essential oil	Micrograph of SEM image	References
Lemongrass essential oil	A micrograph of maltodextrin DE 20 reveals a smooth, pore-free surface that is sealed. A micrograph of gelatin exposes an uneven surface with fractures and pores. With increasing essential oil content, microparticles displayed a distinct microstructure with uneven shape and an increasing number of pores, as well as flaws. Due to the high vacuum circumstances in which freeze drying is	(Martins et al., 2021)

	performed, there were morphological differences between M1, M2, and M3.	
Thymus essential oil	The created NS displayed a porous structure in the SEM pictures, which is visible in the red square box. Using zeta-sizer, the mean particle size was calculated using dynamic light scattering. Those that were treated with ultrasonic method had smaller particle sizes (205nm) than samples that were not treated with ultrasonic method (326nm).	(Rezaei et al., 2021)
Cinnamon essential oil	SEM images revealed the production of agglomerated spherical CEO-NPs with a smooth surface and a size of 100-200 nm. The particle size of CEO-NPs, on the other hand, varied due to the different embedding materials used and the different methods used to embed them. When the wall material, pH value, emulsifier agent, and mass ratio of oil to wall material were 0.5 percent (w/w), 4 gelatin, and 1:1:8, respectively, SEM images were produced. The microcapsule packed with gum Arabic had a particle size of 8.20 mm and typical monoclinic crystalline structures.	(Yang et al., 2021)
Ginger essential oil	Due to the high compatibility of the three polymers of PVA, GA, and CS, SEM images of the PVA/GA/CS composite film revealed a compact and smooth microstructure with cavities. The surface of the GEO-PVA/GA/CS film was rougher than the PVA/GA/CS film, according to SEM micrographs. Furthermore, due to the migration of oil droplets towards the film surface and additional volatilization of GEO, the coarseness of the film surface is rising. The evaporation of water caused the GEO to volatilize, resulting in an uneven surface. These results suggested that in the presence of GEO, the structural rearrangement of PVA, GA, and CS in the film matrix.	(Amalraj et al., 2020)

Conclusion

According to the research experiment, SEM examination revealed the formation of inclusion complex between essential oils LEO, TEO, CEO, and GEO and their microparticles components.

Based on the findings, it can be concluded that each essential oil successfully combines with its microparticle component. GEO combined with PVA/GA/CS composite film, for example, could be a good alternative to standard food packaging and wound healing materials (Amalraj et al., 2020). Furthermore, the study found that CEO-NPs might be employed as a natural

preservative and that its antibacterial properties could be used during food preservation (Yang et al., 2021).

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