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Chamomile Oil - Role of Nanoemulsion and Liposomal Formulation in Enhancing Bioavailability

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Abstract: *Matricaria chamomilla L., commonly known as chamomile, is a well-known medicinal plant found all over the world. It has been used in traditional medicine for many years to treat different kinds of health problems such as infections, mental and nerve disorders, breathing problems, stomach and liver diseases. It is also used as a sedative (to calm the nerves), antispasmodic (to relieve muscle spasms), antiseptic (to kill germs), and antiemetic (to stop vomiting).*

Keywords: Nanotechnology formulations, liposomal formulations, chamomile oil, nanoemulsion.

I. INTRODUCTION

Matricaria chamomilla L., commonly known as chamomile, is one of the oldest and most widely used medicinal plants in the world[1].Its essential oil possesses numerous pharmacological activities, including anti-inflammatory, antioxidant, antimicrobial, antispasmodic, and sedative effects.These therapeutic benefits are mainly due to its rich content of bioactive compounds such as α-bisabolol, chamazulene, and bisabolol oxide[2].However, the practical use of chamomile oil in medicine and cosmetics is often limited because of its poor water solubility, low stability, high volatility, and limited bioavailability when administered by conventional methods.

To overcome these drawbacks, nanotechnology-based delivery systems have emerged as promising tools. Among them, nanoemulsions and liposomal formulations have attracted significant attention for improving the performance of essential oils. Nanoemulsions are thermodynamically stable systems with very small droplet sizes (typically 20–200 nm), which enhance the solubility, absorption, and controlled release of hydrophobic compounds like chamomile oil. Similarly, liposomes, composed of phospholipid bilayers, provide biocompatible and biodegradable carriers that can encapsulate both hydrophilic and lipophilic molecules, protecting them from degradation and enhancing targeted delivery. By incorporating chamomile oil into nanoemulsion or liposomal systems, researchers have observed enhanced penetration through biological membranes, improved therapeutic efficacy, and prolonged release of active constituents. Therefore, the combination of nanotechnology and natural products offers a novel approach to maximize the medicinal potential of chamomile oil, leading to more effectiveformulations for pharmaceutical, cosmetic, and therapeutic applications.

Chamomile contains more than 120 natural chemical compounds.Its essential oils mainly include terpenoids such as α-bisabolol, chamazulene, and β-farnesene. Its extracts are rich in phenolic compounds like flavonoids, coumarins, and phenolic acids[3, 4].

Studies show that chamomile has many biological and medicinal properties, such as:

1. Antioxidant (protects cells from damage)
2. Antibacterial and antifungal (fights germs and fungi).
3. Antiparasitic and insecticidal (kills parasites and insects)[5].
4. Antidiabetic (helps control blood sugar)[6].
5. Anticancer (may slow cancer cell growth)[7].

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6. Anti-inflammatory and pain-relieving[8].
7. Antidepressant and fever-reducing

Because of these effects, chamomile is used in medicine, food preservation, agriculture, and even industry (for example, as a surfactant and anti-corrosive agent) [9].

Encapsulating chamomile oil or extracts (putting them in protective capsules) can make them work better and last longer.

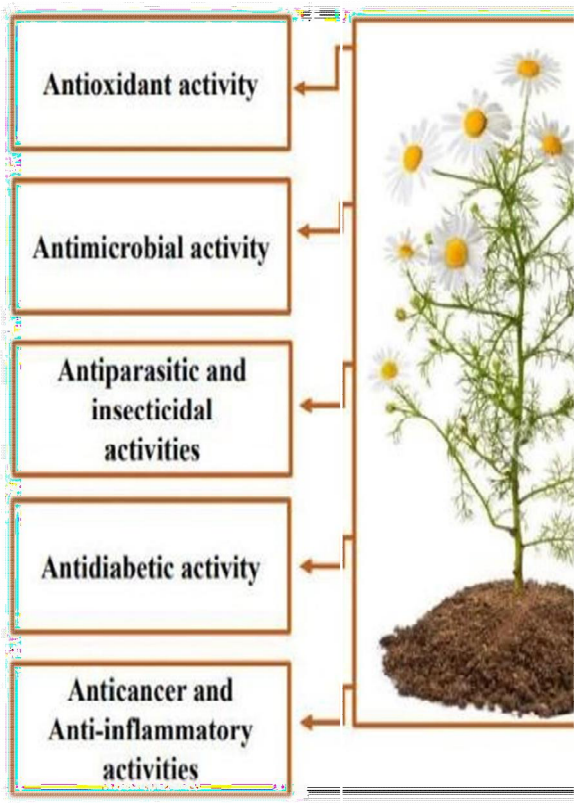

Fig 1:- properties of matricaria chamomilla

Traditional Chinese Medicine (TCM) has been practiced in China for over 5,000 years and encompasses the use of numerous medicinal herbs [10] . Today, TCM has become an essential component of both traditional and modern healthcare systems worldwide. In contemporary medicine, it is mainly employed

for disease prevention and overall health promotion. Consequently, TCM continues to gain global recognition for its significant contributions to human wellbeing [11].

Chamomile, a member of the Asteraceae family, is an annual or perennial herb known for its diverse therapeutic properties. It helps stimulate appetite, reduce painful inflammation, and promote sweating [12].Native to the temperate regions of Asia and Europe, chamomile is now cultivated globally due to its high medicinal, cosmetic, and nutritional value.Chamomile demonstrates a wide range of pharmacological activities, including anticancer, antiinfective, anti-inflammatory, antioxidant, hypoglycemic, hypotensive, hypolipidemic, antiallergic, antidepressant, and neuroprotective effects, among others[10,11,12].

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Table 1 :- Taxonomical Classification of Matricaria chamomilla L(Chamomile)[13]

Taxonomic rank	Classification
Kingdom	Plantae
Subkingdom	Tracheobionta (Vascular plants)
Superdivision	Spermatophyta (Seed plants)
Division	Magnoliophyta (Flowering plants)
Class	Magnoliopsida (Dicotyledons)
Subclass	Asteridae
Order	Asterales
Family	Asteraceae (Compositae)
Genus	Matricaria
Species	Matricaria chamomilla L.
Common names	German Chamomile, Wild Chamomile, Blue Chamomile

Herbal medicines exhibit a broad spectrum of synergistic effects on various physiological systems. Nevertheless, it is important to acknowledge that medicinal plants can also pose potential toxicity risks[14]. Misidentification, improper preparation, or incorrect administration by insufficiently trained individuals may lead to adverse effects. The global market for medicinal plant products now exceeds 100 billion dollars annually, reflecting a rapid worldwide rise in their use[15]. Chamomile, a member of the Asteraceae (Compositae) family, is among the most ancient and extensively used medicinal herbs. It is primarily represented by two major species: German chamomile (Matricaria chamomilla or Chamomilla recutita) and Roman chamomile (Chamaemelum nobile)[16].Of these, German chamomile has gained notable popularity due to its wide use in promoting health and wellness. The plant is cultivated across many regions of the world and holds substantial international market demand. It has been recommended for a variety of therapeutic purposes. The dried flowers are rich in bioactive compounds such as terpenoids and flavonoids, which are responsible for its pharmacological effects. Both chamomile extracts and essential oil are highly valued for their broad range of healing and medicinal benefits[17].

BOTANY:[18,19,20,21]

• True chamomile is an annual herb.
• It has thin, spindle-shaped roots that spread shallowly in the soil.
• The stem is erect, highly branched (ramified), and grows up to 10–80 cm in height.
• The leaves are long, narrow, and bi- to tripinnate (deeply divided).
• The flower heads are solitary, pedunculate, and heterogamous. o Each flower head measures about 10–30 mm in diameter.
• The central tubular florets are golden yellow, 1.5– 2.5 mm long, with five teeth, and end in a glandular tube.
• Surrounding the center are 11–27 white ray florets, each 6–11 mm long and 3.5 mm wide.
• The ray florets are arranged concentrically around the disc florets, giving the flower its characteristic daisy-like appearance.
• The receptacle of true chamomile is 6–8 mm wide, flat at first, and later becomes conical or cone shaped.
• It is hollow inside, which is an important identifying feature of Matricaria species.
• The flower head lacks paleae (small scales).
• The fruit is a yellowish-brown achene (a small, dry, single-seeded fruit).
• True chamomile is often mistaken for plants of the genus Anthemis.
• Special care is needed to distinguish it from Anthemis cotula L., which is poisonous and has a strong, unpleasant smell.

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• Unlike true chamomile, A. cotula, A. arvensis L., and A. austriaca Jacq. have bristly, pointed paleae and a solid (filled) receptacle.
• These Anthemis species are generally almost odourless.
• Although the classification of chamomile is clear today, naming errors and confusion have occurred in the past.
• The names Anthemis, Chamomilla, and Matricaria have often been used interchangeably, leading to uncertainty in identification
• The confusion increased because Linnaeus made some naming mistakes in the first edition of Species Plantarum , which he later corrected.
• The correct and widely accepted botanical name.
• for true chamomile is Matricaria recutita (also known as Matricaria chamomilla or Chamomilla recutita (L.) Rauschert).
• It belongs to the genus Chamomilla and the family Asteraceae.
• M. chamomilla is a diploid species (2n = 18), cross-pollinated, and shows genetic variation as a commercial crop.
• Chamomile is an ancient medicinal plant known by many common names, including
• Baboonig
• Babuna
• Babuna
• Babunj
• German chamomile
• Hungarian chamomile
• Roman chamomile
• English chamomile
• Single chamomile

Bioactive compound:-

Chamomile flowers contain a rich spectrum of phenolic compounds, mainly flavonoids such as apigenin, quercetin, luteolin, patuletin, and their glycosidic derivatives. Alongside these, the flowers also possess coumarins and specific dicycloethers. The essential oil extracted from chamomile is predominantly composed of terpenoids—including α-bisabolol, its oxides, and azulenes such as chamazulene [22–23].

The bioactive phenolic profile of chamomile includes coumarins (herniarin, umbelliferone), phenylpropanoids (caffeic and chlorogenic acids), flavones (apigenin, apigenin-7-O-glucoside, luteolin, luteolin-7-Oglucoside), flavonols (quercetin, rutin), and the flavanone naringenin[24] . Moreover, chamomile oil contains chamazulene (1–15%), chamazulene carboxylic acid, and proazulenes [25].Studies have shown that its essential oil can inhibit aflatoxin G1 (AFG1) formation, with both (E)- and (Z)-spiroethers identified as the active constituents responsible for this bioactivity [26]. The primary therapeutic components of the essential oil are bisabolol oxides, bisabolonoxide A, trans-β-farnesene, α- farnesene, spathulenol, and the cis/trans-en-in-dicycloethers[27] .

In addition to these terpenoids, chamomile comprises flavonoids, coumarins, mucilages, and carbohydrate fractions (mono- and oligosaccharides) that contribute to its pharmacological properties[28] . Chamazulene carboxylic acid, derived from the degradation of proazulenic sesquiterpene lactones and matricin,

exhibits significant anti-inflammatory activity . Notably, chamomile is recognized as one of the richest natural sources of apigenin, containing approximately 840 mg per 100 g of plant material[22].

Pharmacological profile:-

Chamomile has a longstanding history of traditional use across various medical and wellness contexts. It is commonly utilized for managing hay fever, inflammatory responses, muscle spasms, menstrual irregularities[29], peptic ulcers, rheumatic discomfort, and hemorrhoidal conditions[30]. Chamomile extracts are frequently administered as mild

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sedatives, valued for their capacity to soothe the nervous system, alleviate anxiety, and address sleep disturbances such as insomnia, nightmares, and episodes of hysteria. The leaves, flowers, and stems of the plant contribute a multifaceted range of pharmacological actions, including antioxidant, analgesic, antiviral, antiinflammatory, antiseptic, antidiabetic, antiproliferative, antibacterial, and anthelmintic (anti-leech) effects[31]. Additional research highlights its benefits in relieving menstrual symptoms, providing hepatoprotective effects[32], and demonstrating acaricidal activity. Chamomile-based preparations are also recognized for preventing oral mucositis and promoting anti-ulcer activity[33]. In addition to these applications, dried chamomile flowers are widely included in herbal teas, baby massage oils, gastrointestinal stimulation remedies, and traditional therapies for cough and cold[34].

1. Immunomodulatory activity:-

Chamomile heteropolysaccharides, when delivered intragastrically or parenterally, have demonstrated the capability to normalize the developing immune response under air cooling conditions and to further enhance it when subjected to immersion cooling. This immunomodulatory activity is attributed to the stimulation of heavy erythrocytes, activation of peripheral blood immune regulatory cells, and an increase in effector cell sensitivity to helper signals[34] .

2. Anticancer Activity :-

Aqueous and methanolic chamomile extracts have been your shown to induce apoptosis selectively in cancer cells, sparing normal cells at identical dosages. Numerous investigations suggest chamomile may benefit patients undergoing chemotherapy, primarily by alleviating treatmentrelated side effects and enhancing quality of life, though it does not directly increase chemotherapy efficacy or alter survival rates [35].

3. Antihyperglycemic Action :-

In streptozotocin-induced diabetic rats, chamomile ethanol extract provided significant protection to pancreatic islet cells, subsequently reducing hyperglycemia through a dosedependent mechanism. Chamomile extract also helped counter oxidative stress related to elevated blood sugar levels, thereby preserving beta-cell function[36,37] .

4. Antiallergic Activity :-

German chamomile extracts administered in the diet significantly inhibited compound 48/80-induced itch-scratch responses in experimental models. The effect was comparable to that of oxatomide, an established anti-allergic drug, suggesting chamomile's promising role as a natural antiallergic agent[38] .

5. Antisolar Properties :-

Extracts from Hamamelis virginiana, Matricaria recutita, Aesculus hippocastanum, Rhamnus purshiana, and Cinnamomum zeylanicum, prepared using methods such as repercolation, maceration, and microwave extraction, have shown an ability to boost SPF values when added to octyl methoxycinnamate.
This highlights their potential in enhancing sunscreen efficacy and broadening photoprotective formulations .

6. Antimicrobial activity :-

Chamomile essential oil demonstrated significant inhibitory effects against three strains of Staphylococcus aureus and various Candida species, indicating its potential use in managing acute otitis externa infections[39].

7. Anti-Chikungunya Potential :-

Compounds with a 5,7-dihydroxyflavone structure, such as apigenin—found abundantly in chamomile—have been demonstrated to suppress the expression of viral marker genes (EGFP and Renilla Luciferase) in chikungunya virus replicon systems. These findings highlight the prospective antiviral action of chamomile phytoconstituents against chikungunya virus replication[40,41] .

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Traditional uses:-

• It is utilized as a natural remedy to support digestion and relieve various gastrointestinal issues such as gas, motion sickness, upset stomach, nausea, and vomiting.

• It is used to treat wounds, rheumatic pain, hemorrhoids, migraine, headache & other ailments[42, 43].

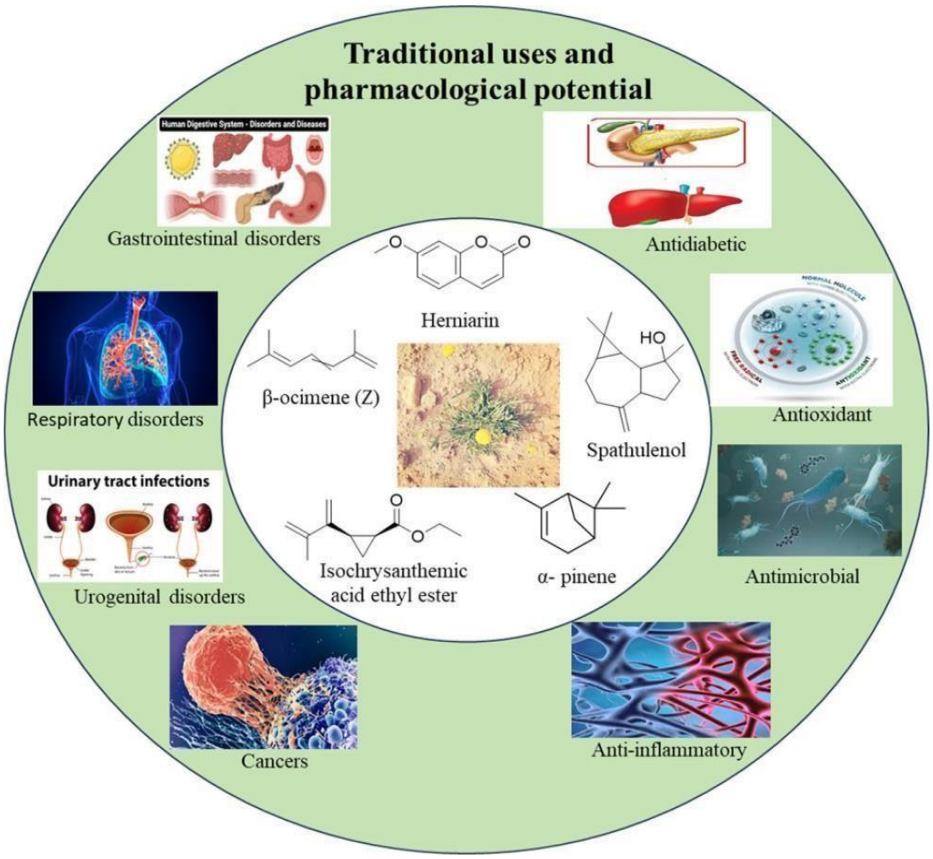

Fig.2:-Traditional uses and pharmacological potential

Contraindications and safe doses :-

Chamomile is generally safe for most people, but a few may be sensitive and experience allergic reactions. Sometimes these allergies could actually be due to contamination with "dog chamomile," a similar but highly allergenic plant with a bitter taste. There is limited evidence about chamomile's crossreaction with other drugs, so more studies are needed before confirming this concern[49].

Its safety has not yet been clearly established for young children, pregnant or breastfeeding women, or people with liver or kidney problems. So, these groups should use it carefully. No cases of serious toxicity from drinking chamomile tea have been proven so far[50].

The commonly recommended safe doses are about 3 to 4 grams of chamomile tea, taken three times a day, or around 270 mg twice daily if used as a medicinal extract[51]. People allergic to ragweed or other plants from the daisy family should be cautious. Overall, allergic reactions to chamomile are rare, and no harmful substances have been identified in it[52].

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II. CONCLUSION

Chamomile has been used as a natural remedy since ancient times. However, there is still a strong need for more research, especially studies that connect animal experiments with human trials for different diseases. Such studies can later be confirmed through clinical trials to prove the true healing potential of chamomile. Without this scientific evidence, it will be difficult to confirm whether its traditional uses are genuinely effective. Overall, chamomile products appear to be safe and may offer significant health benefits when properly studied and used.

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