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A comprehensive review on ecological description, ethnomedicinal uses along with pharmacological activity of matricaria chamomilla L. (german chamomile)

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Abstract:

Matricaria chamomilla is the plant used for medicinal plant and the species is well known in the Asteraceae family. Also known as the "miracle plant." The plant is now a highly valued and commonly used remedy plant in both indigenous medicine and unconventional medicine. After doing research in scientific and conventional field for many years researchers have demonstrated its multitherapeutic, cosmetic, and nutritional benefits. In folk medicine, this plant is often used as an ailment for various ailments, which includes infections, liver disorders, gastrointestinal, respiratory, and neuropsychiatric disorders. Furthermore, it contains antimicrobial, antiemetic, sedative, and antispasmodic effects. Chamomile tea, made from its flower heads, is another traditional herbal beverage used to soothe the body and soul. These historical applications have influenced modern study into its medical characteristics, which has included extensive in vitro and in vivo studies as well as clinical trials. M. chamomilla's pharmacological properties are attributed to its rich phytochemical composition, which includes flavonoids such as luteolin, apigenin, and quercetin, as well as sesquiterpenes like chamazulene and (−)-α-bisabolol. This review has bought together information regarding chamomile plant classification, description regarding botany and ecology, its use as an ethnomedicine, phytochemistry, biological and pharmacological properties, prospective industrial applications, and encapsulation. Scientific search engines such as springer-link, google scholar, PubMed etc., has been used to collect the data about Chamomilla.

1. Introduction:

Matricaria chamomilla, is a member belonging to Asteraceae family and is commonly recognized as chamomile, or English chamomile, and sometimes as Flos Chamomile. It has been widely acknowledged as herb often described as the "star, among healing plants." Its natural habitat includes regions, across Europe, Northwestern part of Asia, North America as well as North Africa and also various other parts of the globe. Chamomile (*Matricaria chamomilla* L.) is originated from Eastern Europe. Chamomile plant is often harvested in the regions of Hungary, Germany, Brazil, France, Yugoslavia, and Russia. In India this plant was introduced during Mughal era and is now cultivated mostly in Uttar Pradesh, Maharashtra, Jammu and Kashmir and Punjab. Hungary stands out as a producer of this plant biomass[1]. Chamomile flowers remain listed as an approved remedy, in the pharmacopoeia of 26 nations[2].

Chamomile has a history, in herbal medicine with its use documented in ancient civilizations, such as Egypt, Greece and Rome[3]. Among the Anglo Saxons this particular herb was considered one of the nine herbs bestowed upon humanity by a lord[4]. It is commonly used in traditional, Unani and homeopathic remedies[5]. It is utilized for treating air in the intestine, colic in infants, hysteria and intermittent fever[6]. The flowers of the Chamomile plant have an oil ranging from 0.2, to 1.9%, in blue color with a variety of uses[7]. Chamomile is primarily utilized for its inflammatory and antiseptic properties, as well, as its ability to ease spasms and induce mild sweating[8]. It is used internally mostly as a remedy for stomach ache and disturbances, slow digestion, diarrhoea, as well as qualm; sometimes, it is also used for urinary tract irritation and painful menstruation for which the plant has done exceptional job. This medication can be administered externally in powder form to treat gradually healing wounds, outbreak of spots in the skin, ulcerations and infections, haemorrhoids, and also disorders related to the mouth, throat, and eyes. Essential oil and various extract of M. Chamomilla has been studied regarding their composition revealing that there is a presence of, almost 120 identified constituents. In M. chamomilla essential oils, terpenoids were found to be the most significant compound category. Notable compounds among them were bisabolone oxide A, bisabolol and its oxide A & B, chamazulene, and beta-farnesene. In the makeup of chamomile plant various elements including the geographical locations, plant cultivators, genetic factors as well as environmental conditions together plays a role[9]. The chemical composition of an essential oil can also be prejudiced by other factors such as extraction and drying methods, salicylic acid concentrations[10], and the use of cyanobacterial suspensions as biofertilizers[11]. There are various phenolic substances in chamomile plant, among which, substances such as flavonoids,

coumarins, rutin and phenolic acids dominates the other compounds as seen in the plant extracts. Furthermore, there also has been research regarding the makeup of Amino Acids which concluded that their chemical makeup can be affected by the application of cadmium, copper and ethephon in terms of flavonoids, phenolic acid and coumarin.[12].

Many domains have looked into the application prospect of M. chamomile plant due to its extensive pharmacological activity. The medical industry was M. chamomilla's most significant application. In fact, numerous investigations using both patient and animal models demonstrated the plant's potential as a treatment for a variety of illnesses, such as those pertaining to the nervous system, the reproductive system, diabetes, obesity and associated metabolic disorders, the cardiovascular system, the gastrointestinal system, allergies, the skin, the eyes, and oral health issues. In addition, the herb promoted wound healing, pain relief, and kidney protection as well as the protection of reproductive system, gastrointestinal and liver. However, M. chamomilla can also be utilised as a fungal inhibitor in agriculture, a surface tension reducer or surface-active compound for enhanced oil recovery, also utilised as an anaesthetic in the field of aquaculture, supplemental feed for animals, and the food sector, and corrosion inhibitor for mild steel. Furthermore, silica, silver, chitosan, and alginate nanoparticles, as well as extracts and/or EOs of M. chamomilla, have been encapsulated. Their anti-cancer, anti-parasitic, catalytic, antibacterial, and antifungal capabilities were enhanced by this encapsulation, and it may also increase their utility as a food additive.

2. Botanical and ecology description:

The slender, spindle-shaped roots of the annual chamomile plant only reach a flat depth of earth. The height of the plant is 10–80cm, the plant is tall which is spread out and split up into many branches and divisions. The leaves of the plant are long and thin. They are bi- to tripinnate. The flower head is heterogamous are heterogamous, stalk, with a diameter of 10–30 mm. They are organised apart by oneself. The flowers of this plant is white and on the 11–27 plant are centrally aligned, they are approximately 6–11 mm long and 3.52 mm wide. The colour of the achene fruit is yellowish-brown[13].

The German chamomile plant is so adaptable that it can be harvested in all the different types of soil but the soils which are rich damp and heavy are not mostly preferred. Furthermore, when the temperature is between 2°C and 20°C[14] they are resistant. Seeds are used to reproduce the plant. A thousand of the crop's tiny seeds weigh between 0.088 and 0.153 grammes. The

appropriate temperature range for efficacious seed germination is 10°C to 20°C. According to Zalecki, varying sowing periods have an impact on when to harvest, but they have little effect on the amount of oil and chamazulene[15]. According to research on crop geometry, the best flower yields were obtained when crops were transplanted at close intervals of 15, 20, and 30 centimetres[16-19]. The plant requires regular irrigation to maintain an ideal moisture level since its shallow roots prevent it from absorbing moisture from the soil's lower moist horizon[20].

Figure. 1: German chamomile flower

3. Ethnomedicinal uses:

Table. 1: Ethnomedicinal use of M. chamomilla

Sl. no	Traditional use	References
1	Sundry disease	21
2	Stomach problem, cramps, dermatitis and minor infection	22
3	Improving appetite, painful swelling, and sweating, chronic headache, inflammation of join and disorders of urinary system.	1, 20
4	Muscle relaxation, anorexia, amenorrhea, urine retention, paralysis, headache, urolithiasis.	20

5	Functional digestive disorder, gastrointestinal disorder, skin disease, eye, nose and throat infection.	20, 23
6	Depression, nervousness, stress, insomnia, neuralgia	34
7	Diabetes mellitus	20

4. Phytochemistry:

Researchers have identified 301 chemicals have in chamomile, those are : 6 Polysaccharides, 16 Sterols, 10 Coumarins, 3 Guaiacolides, 50 Flavonoids, 27 Sesquiterpenes 39 Monoterpenes, 3 Triterpenes, 2 Diterpenes, 10 Miscellaneous components, and 7 Trace elements. Apigenin is a flavonoid that has strong anti-inflammatory properties. The anxiolytic and sedative properties of esters are seen in volatile oils. Sesquiterpenes containing α-bisabolol can guard against acute liver injury caused by APAP. Additionally, chamomile has antidepressant, hypoglycemic, hypotensive, hypolipidemic, antiallergic, antioxidant, genitoprotective, neuroprotective, anticancer, and anti-infective properties.

Table. 2:

Sl.no	**Compound/groups**	**Main compounds**	**References**
1	Organic acid	Carboxylic acid, sulfonic acid	25
2	flavonoid	Quercetin, apigenin, luteolin and rutin	26
3	coumarins	7-Methoxycoumarin, esculetin, skimming,	25, 26
4	Volatile oil	Isopentyl isobutyrate, isobutyl isobutyrate	20
5	monoterpenes	Ocimene, geraniol, citronellol menthol, bornanol	25
6	sesquiterpenes	α- bisabolol	26
7	Diterpenes and triterpenes	Alcohol, phytanetriol and oleanolic acid, teraxanol, teraxasterol	20
8	polysaccharides	D-Xylose, D-Galactose, L-Rhamnose, D-Galacturonic acid, D- Glucose	27
9	sterols	Stigmasterol, teraxasterol	28

5. Biological and pharmacological activity:

5.1. Antioxident activity:

Since ancient times, chamomile has been utilised as an herbal remedy. Its many bioactive phytochemicals that may have therapeutic benefits are the reason it is still in use today and most likely will be in the future[41]. Antioxidant activity is one such beneficial effect which was found in the research conducted by Patricia M. B. G. Maia Campos et.al.[29] in that study it was found that the extract of chamomile has IC50=0.14 µg/mL. The study was supported by Guimarães et al[43] who also found antioxidant properties. The antioxidant activity of Matricaria recutita was assessed. It was found out that methanolic extract of the plant and also its decoction, and distillation using DPPH scavenging activity, reduces the power of Fe^{3+}, beta-Carotene bleaching inhibition, and TBARS inhibition. Therefore, they concluded that all samples of the plant exhibited antioxidant properties.

5.2. Antidiabetic activity:

luteolin and apigenin are among the several terpenoids and flavonoids found in chamomilla and the extracts of dried flower. In order to ward off chronic illness such as type 2 Diabetes Mellitus the essential compounds are terpenoids and flavonoids which is present in the plant. According to various experimental studies the chamomile flower in the form of tea and also other extracts contains its bioactive constituents such as apigenin and luteolin which plays a major role against diabetes[44]. Numerous studies have shown that chamomile can reduce elevated blood glucose levels. Rats with diabetes had their blood sugar and HbA1c levels measured, and samples were collected both before and after meals. As a result, drinking chamomile tea reduced glucose levels. The use of chamomile also decreased the incidences of obesity in diabetic rats[30]. The use of chamomile extract and its active ingredients helped control rats' diabetes that was brought on by streptozotocin[31]. Lutein is the bioactive ingredient in chamomile[32]. Luteolin is in charge of transcriptionally activating peroxisome proliferator gamma-activated receptor and raising the sensitivity of insulin. Thus, PPARγ gene and the adenosine monophosphate-activated protein kinase enzyme are responsible for the storage of glucose in muscles and peripheral tissues. Lutein enhances the gene's expression as well. Furthermore, because of adiponectin, gluconeogenesis limitation prevents the synthesis of glucose[33].

5.3. Antibacterial activity

The study given by Ania Ahani Azari ET. al., [34]aimed to examine the extract of *Matricaria chamomilla*, Malva sylvestris and Capella bursa for its anti-bacterial activity against Methicillin -resistant Staphylococcus aureus (MRSA) which is obtained from the clinical samplings. According to their findings, neither the ethanolic extract of M. sylvestris nor C.

bursa-pastoris showed any inhibitory effect against the MRSA isolates. Bactericidal activity against 20 MRSA isolates was shown in the dose of 50 as well as 25 mg/ml by the chamomile extract. The seven MRSA isolates were shown to be inhibited by the chamomile leaf extract. The majority of MRSA isolates showed MIC and MBC values of 6.25 and 12.5 Mg/ml for chamomile flower extracts, furthermore a small number of MRSA isolates showed values of 12.5 and 25 mg/ml for chamomile leaf extracts. In the present research the ethanolic extract of chamomilla flower exhibited strong antibacterial activity against the isolates of MRSA. Therefore, it has been concluded that this plat extract might be a decent alternative as antibiotic therapy and also a useful tool to manage illnesses brought on by harmful bacteria and MRSA[35].

5.4. Antiosteoporotic activity:

For the first time, ethanolic extract from the flower of *Matricaria chamomilla* was assessed against glucocorticoid induced osteoporosis in an animal model. Biochemical parameters included creatinine, alkaline phosphatase, magnesium, calcium, and phosphate in serum were measured. The extract reduced serum calcium and phosphate ion levels by 54.01% and 27.73%, respectively, in the dosage of 400 mg/kg BW. While equated to the group receiving steroid treatment, there was a 20% increase in serum magnesium levels. Alkaline phosphatase and creatinine levels were also significantly lower, by 27.83% and 29.41%, respectively. Biomechanical investigations, which showed that at a higher dosage of the flower extract amplified bone strength and thickness, further corroborated the obtained results. In contrast to the sick group, it has no effect on bone length at the same time. The extract significantly increased trabecular thickness, and histopathological analysis showed that the extract had repaired the structure of cortical and trabecular and also assembled the bone matrix. Using molecular docking, the phenolic compounds were bonded with cathepsin K which is a receptor to examine the possible inhibitory effect. Using the free binding energy as a guide, it was seen that the best fitting score was made by rutin within the active site ($\Delta G = -54.19$ Kcal/mol). According to ADMET and toxicity prediction by computer assisted technology, the substances under investigation exhibited varying pharmacodynamic and pharmacokinetic features. These properties might be optimised to augment bioavailability when included into different dose forms. Consequently, it may be said that this plant extract shown possible osteoporosis treatment advantages[36].

5.5. Anti-ulcer activity:

Matricaria chamomilla Extract's antiulcerogenic effects on experimental gastric ulcers in mice were assessed by Saied Karbalay-Dous et al. Three sets of fifteen female bulb-c mice were

used to assess the antiulcer properties of the *Matricaria chamomilla* extract (five mice per group). Through the intragastric method, the 1st and 2nd groups were given 400Mg/Kg of Sucralfate and 400 mg/kg of *Matricaria chamomilla* extract, respectively. 1ml of drinking water was given to the normal control group. After 30 minutes, 1 millilitre of a 0.3 Molar HCl solution in 60 percentage of ethanol was given orally to each animal to cause stomach ulceration. An hour later by using a stereological approach the bleeding and the area the stomach lesions were quantified. Control and experimental group were divided by selecting 10 female and 10 male mice with 5 mice in each in order to examine the toxicity of the flower extract. Through the intragastric method, the experimental and control groups were administered a single dosage of five thousand mg/kg of the extract of *Matricaria chamomilla* and water, respectively. The animals were given 14 days to evaluate their hearts, livers, kidneys, and lungs macroscopically. At that point, the relative weights of each organ and body were calculated and statistical comparisons in between the two group were conducted by utilising the Mann-Whitney U test, up to 5000 mg/kg of *Matricaria chamomilla* extract does not have hazardous effects when given orally to mice, and it can be useful in avoiding stomach ulcers in these animals at 400 mg/kg. They concluded by mentioning that *Matricaria chamomilla* can shield mice from experimental stomach ulcers[37].

5.6. Anti-inflammatory activity:

Moroccan traditional medicine has utilised *Matricaria chamomilla* L. to treat inflammation, fever, and pain. It has antispasmodic and antibacterial properties and is also used as a mild laxative. Using common laboratory models, Ghizlane Hajjaj et al. investigated the properties of anti-inflammation of an aqueous extract of chamomilla flower. Wistar male rats (180–220g) and female Swiss mice (25–30g) were used in this investigation. A 24-hour maceration process at room temperature (25°) produced the aqueous extract. The OECD guidelines 423 served as the basis for the acute toxicity investigations. The lethal dose of the aqueous extract of the plant was determined to be greater than 2gram/kg, and they did not observe any signs of mortality as well as alterations in the experimental animals. The aqueous extract was examined for its anti-inflammatory effect by using carrageenan and experimental trauma induced hind paw edema in the experimental animal (mice) in the dose of 300mg/kg and 500mg/kg respectively. A normal dosage of 10 and 20 mg/kg of indomethacin was employed. According to the findings, *Matricaria chamomilla* L.'s aqueous extract exhibited noteworthy activity that was on par with that of the reference and control medications utilised in both animals. This study

provided evidence in support of Moroccan physicians' usage of *Matricaria chamomilla* L. to treat inflammatory illness conditions[38].

6. Conclusion:

In this review of M. chamomilla, we described its botanical and ecological characteristics, ethnomedicinal use, phytochemistry, and pharmacological activities. Traditionally, the chamomile plant has been used in various diseases which includes sundry disease, problems related to stomach, cramps, skin irritation, and minor infection, improving appetite, painful swelling, sweating, chronic headache, incompetent sweating, inflammation of the joint, disorders related to urinary system, muscle relaxation, anorexia, amenorrhea, urine retention, paralysis, headache, typhoid fever, urolithiasis , Functional digestive disorder, gastrointestinal disorder, skin disease, sores, haemorrhoids, eyes, nose and throat infections, Depression, anxiety, stress, sleeplessness, neuralgia, etc. Furthermore, during in vivo and in vitro research it was also found that the extract as well as essential oil of this plant has extraordinary antioxidant, antibacterial, antifungal, anticancer, antidiabetic, antiparasitic, antipyretic, anti-inflammatory, anti-osteoporosis, and analgesic properties.

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