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EXPLORING THE *ACHILLEA:* PHYTOCHEMISTRY, ANTIMICROBIAL, ANTIOXIDANT AND PHYTOTHERAPEUTIC POTENTIAL TO THE MANAGEMENT OF GASTROINTESTINAL DISORDERS

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ABSTRACT

Achillea L. is a largest genus of vascular plants belonging in the family (compositae) comprising 130 species spread throughout the world. Species of Achillea L. used for medicinal properties such as wound healing, asthma and especially for the management of gastrointestinal disorders. A total 15 species of genus Achillea L. were recorded for the treatment of gastro-intestinal disorders. This data was collected from various review papers using different websites like Google scholar, pubmed, Scopus, science direct, web of science, research gate and tropicos.com. Genus Achillea L. is rich in bioactive compounds including phenolic acid, alkaloids, flavonoids and sesquiterpene lactones (SQLS). Sesquiterpene lactones (SQLs) are present in large quantities in Achillea species L. have been used as herbal remedies for GI disorders in different cultures. Achillea species demonstrates antimicrobial activity against E. Coli, Aspergillus and Bacillus Subtilis. Achillea species L. possessive antioxidant activity prevents oxidative damage to cells. Some species such as Achillea millefolium L. and Achillea wilhelmsii C. Koch exhibit have some toxicity such as anti-fertile effects in adult rats.It is concluded that Achillea species have high medicinal values especially for the treatment of gastro-intestinal disorders, antimicrobial and antioxidant properties. It is recommended that further research is needed on depth study of phytochemicals isolation, mechanisms of action and potential therapeutic uses in modern medicine of Achillea species.

Keywords: *Achillea, Photochemistry, Antimicrobial, antioxidant, gastrointestinal*

INTRODUCTION

The genus *Achillea* L. is the largest family of vascular plants blongs to the Asteraceae (compositae). The plants of Asteracca are spread throughout the world semi and dry land region of temperate and subtropical areas. *Achillea* L. comprises 130 flowering and perennial species. These plants have aromatic leaves and smooth clusters of small flowers on the top of the stem so these flowers have many colors (Bremer 1994; Mozaffarian 1996; Mathew et al., 1991; Sheidai et al., 2009). The genus *Achillea* L. comprises basic chromosome number is x = 9 and many species of these genera are diploid with ecological ranges from water-logged to desert habitats (Dabrowska, 1992).

Achillea L. which means "hero" and was mostly used to cure diseases during battles (Aytac et al., 2016). *Achillea millefolium* L. is the species of genus *Achillea* L. which is an herbaceous perennial plant. These species with a long history of traditional applications in both conventional and folk

medicine. *Achillea millefolium* L .is used as an herbal tea for gastrointestinal disorder, headaches, against skin inflammation, wounds and burns (Verma et al., 2017).

Achillea ligustica All .is the species of genus *Achillea* L. with an aromatic and bitter taste. These plants height can reach 100 cm. the species grows in the Mediterranean areas (Venditti et al 2016; Quezel et al., 1962). *Achillea wilhelmsii* C. Koch. is the species of *Achillea* L. genus which is a chamaephyte and situated in Pakistan and Mediterranean Asia. It is characterized by stems with lobed yellow flowers, tubular flowers and compact white felt hairs (Zargari, 1996; Qomi et al., 2018). *Achillea fragrantissima* (Forssk) Sch. Bip. Is the species of *Achillea* L. genus is a desert plant has been studies for various pharmacological effects. A *fragrantissima* (Forssk) Sch.Bip is a plant native to countries in Middle East and northeastern Africa. This plant has small yellow flowers and 30-60 cm tall (Patocka and Navratilova, 2019). *Achillea santolina* L. species of the genus *Achillea Santolina* L. situated in warm regions such as Asia to Europe. This species is used for the treatment of many diseases such as fever, cramp, wounds and digestive diseases. *Achillea beibersteinii* Afan. is another species of *Achillea* L. genus. It has branched or simple stems with leaves that are 10 cm long. Its plants heigh is 30-60 cm (Baris et al., 2006). This plant uses for treatment of wounds and stomach pain (Bashi et al., 2012) *Achillea odorata* L. is a species of genus *Achillea* L. found in western and eastern Asia, New Zealand and North America (Benali at al., 2020). This plant has been used in anti-inflammatory, anti-diabetic and anti-microbial activity (Boutennoun et al., 2017). Achilla L. genus comprises another species which is *Achillea arabica* Kotschy. these species have been used in cure many diseases such as asthma, menstrual problems, wounds and abdominal pains (Sezik et al., 2001). *Achillea ageratum* L. is the species of *Achillea* L. genus has been used to treat gastrointestinal disease, stomach pain, antipyretic and analgesic effect (El Bouzidi et al., 2012). *Achillea* L. genus comprises another species *Achillea falcata* L. with its yellow sulfur flowers than height reaches to 30-50 cm and easily can be differentiate by its erect stem, narrow deflexed or *falcata* leaves *Achillea falcata* L. plants used in the traditional medicine in Jordan region for the treatment of many diseases such as depurative carminative and stomachic problems (Aburjai et al., 2007). *Achillea tenuifolia* Lam. is a species of *Achillea* L. genus situated Eastern Europe and Mediterranean areas. These plants are perennial herbs there height is 20-90 cm, with elongated, narrow leaves lacking petioles. The main compounds separated from this plant are a-humulene and1, 8-cineole (Sefidkon et al., 2021). *Achillea* L. genus comprises another species *Achillea Vermicularies* Trin. is a perennial herb with contain many branched stems developing from the base. It attains 20-50 cm in height and flowers grow in late spring through midsummer (Rabbi Angourani, 2021). Indigenous peoples have been used to *Achillea Vermicularis* Trin. remedies to cure flu, cold and stomach problems (Mukemre et al., 2015). *Achillea filipendulina* Lam. is a species of *Achillea* L. genus is an herbaceous plant, which could be situated in central Asia. This plant height is 40-120 cm and flowers are grown from June to August in summer (Mosayebi et al., 2008).

1.1. Phytochemical Characterization

The genus *Achillea* L. is rich in flavonoids are terpenoids which are bioactive compounds. Monoterpenes are the major constituents of essential oil of the genus *Achillea* L. although high levels of sesquiterpenes were quantified (Nemeth, 2016; Saeidnia et al., 2011; Si et al., 2006). Due to its high secondary metabolite concentration, which is responsible for its traditional and contemporary therapeutic applications, the genus *Achillea* (Asteraceae) is well-known (Boulos, 2002). *Achillea millefolium* L. often known as yarrow, is one of the most researched species and has a large variety of essential oils, flavonoids, phenolic acids, and sesquiterpenes. fatty acids, sterols, coumarins, alkaloids, tannins, and lactones. Due to its high concentration of camphor, 1,8-cineole, α-pinene, β-caryophyllene, and borneol, its essential oil has antimicrobial, anti-inflammatory, and spasmolytic effects (Chandler et al., 1982; Rustaiyan). et al., 1987). Its aerial components are high in flavonoids like apigenin, luteolin, quercetin, and rutin glycosides, which have potent antioxidant, anti-inflammatory, and cytoprotective properties (Orav et al., 2010). The plant also has phenolic acids such as chlorogenic acid, caffeic acid, ferulic acid, and

protocatechuic acid, which increase its antioxidant and hepatoprotective properties (Boulos, 2002). Sesquiterpene lactones such achillicin, matricarin, and millefin also have anti-inflammatory, antimicrobial, and cytotoxic effects (Chandler et al., 1982). In addition to coumarins (umbelliferone, scopoletin), sterols (β-sitosterol, stigmasterol), and fatty acids (linoleic, palmitic), trace amounts of pyrrolizidine alkaloids and condensed tannins also contribute to its biological effects. Oleic) sustains nutritional, membrane-stabilizing, and anticoagulant qualities (Al-Sodany, 2017).

Achillea filipendulina Lam. a species mostly grown for decorative reasons, also has a complicated phytochemistry. Due to its 1,8-cineole, sabinene, α-pinene, and β-caryophyllene content, its essential oil possesses antibacterial and anti-inflammatory qualities (Rustaiyan et al., 1987). Luteolin is the main flavonoid found in it. Derivatives of quercetin and apigenin have anti-inflammatory and antioxidant properties. Phenolic acids, notably chlorogenic and caffeic acids, which improve radical-scavenging and cytoprotective effects, are also present in the plant. Additionally, it contains sesquiterpene lactones similar to those found in *A. millefolium* L. such as achillicin-type chemicals (Rustaiyan et al., 1987).

Achillea falcata L. is a wild species with a restricted distribution that produces essential oils high in camphor, 1,8-cineole, and borneol, all of which have antimicrobial and anti-inflammatory effects (Boulos, 2002). Quercetin and isorhamnetin derivatives are examples of flavonoids, while phenolic acids such as caffeic acid and p-coumaric acid are also identified. The main bioactive components in this species are sesquiterpene lactones, such as parthenolide derivatives (Rustaiyan et al., 1987). Its medicinal value is increased by the presence of trace alkaloids, tannins, and coumarins.

The essential oil of *Achillea fragrantissima* (Forssk) Sch. Bip. which is well-known for its fragrance, contains a significant amount of thujone, camphor, and chrysanthenone, which are responsible for its aroma. to provide antimicrobial, anti-inflammatory, and insecticidal benefits (Al-Sodany, 2017). Flavonoids such as apigenin and rutin derivatives make up its profile, while phenolic acids such as caffeic and chlorogenic acids contribute to its antioxidant properties. In addition to small amounts of alkaloids, condensed tannins are also present, which aid in the defense of the gastrointestinal tract and have antimicrobial properties.

Achillea ligustica All. contains essential oils with α-pinene, β-caryophyllene, camphor, and germacrene-D; flavonoids with luteolin and apigenin glycosides predominating; and phenolic acids with caffeic and ferulic acids. as well as sesquiterpene lactones that resemble achillicin and have antioxidant, cytotoxic, and anti-inflammatory effects as a group (Chandler et al., 1982; Rustaiyan et al., 1987).

Achillea alpine L. is a species of *Achillea* L. genus contains many phytochemical constituents such as flavonoids, organic acids, mono and sesquiterpenoids and polyactylene compounds (Lee et al., 1975; Bohlmann and Jastrow, 1962; Valant 1978). *Achillea odorata* L. distributed throughout North America, chemical constituent present in these species are as follows such as borneol, oxygenated monoterpenes and 1, 8 – cineole camphor (Mohammad Hosseini et al., 2017*) Achillea* L. genus comprises another species *Achillea erba –rotta*. L. In these species, phytochemical constituents such as phenolics and volatile terpenoids are occur (Vitalini et al., 2006; Vitalini et al., 2016; Vitalini et al., 2022; Apel at al., 2021*)* *Achillea clavennae* L. is a species of *Achillea* L. genus the main phytochemical constituent of these species such as camphor, 1,8-cineole and borneol (Stojanovic et al., 2005; Bezic et al., 2003; chalchal et al., 2000*).*

Similar phytochemical classes, such as flavonoids, essential oils (monoterpenes and sesquiterpenes), are found in other *Achillea* L. species, like *Achillea tenuifolia* Lam. *Achillea santolina* L. *A. biebersteinii* Afan. And *A. vermicularis* Trin. Despite variations in the concentration and makeup across species, sesquiterpene lactones, tannins, minor alkaloids, phenolic acids (caffeic, chlorogenic, and ferulic acids), and flavonoids (apigenin, luteolin, quercetin, and isorhamnetin) are among the flavonoids found in them. (Al-Sodany, 2017; Rustaiyan et al., 1987) describes the variations between traditional applications and therapeutic actions.

The variety of phytochemicals in the *Achillea* L. genus, with essential oils, flavonoids, phenolic acids, and sesquiterpene lactones, emphasizes the multifaceted medicinal qualities of these plants overall. While tannins, alkaloids, coumarins, sterols, and fatty acids all have complementary pharmacological effects, flavonoids are the main bioactive ingredients (Boulos, 2002; Chandler et al., 1982).

1.2. Medicinal Properties of *Achillea* Species

The genus *Achillea* L. has been used in traditional medicine for the treatment of wounds, bleedings, pains, headaches, spasmodic diseases, inflammation, flatulence and dyspepsia. (Saeidnia et al., 2011). The many *Achillea* L. species are used the treatment and prevention of different diseases, mainly in the form of decoctions and infusions (herb, flowers and leaves) for wound healing, haemorrhages, pneumonia, spasmodic gastrointestinal disorder, rheumatic pain, as diuretic, anti-inflammatory and anti-pyretic agents, menstrual and gynecologic abnormalities. Due to these characteristic various thematic names have been given like blood wood, staunch weed, military herb. (Blumenttial et al., 2000). The aerial parts of *Achillea aleppica* DC. are used in Turkey under name "Civanpercemi" in decoction due to their carminative, diuretic, emmenagogue, stomachic, antiasthmatic and tonic effects, as well as for used in gynaecologic ailments, colds, nephralgia and wound healing (Sezik et al., 2001; Altundag and ozturk., 2011). *A. alpine* L. is used in for stomach disorder (Lee et al., 2019). In Mongolia, *A. asiatica* Serg. used for intestinal and stomach effects, ulcers, wounds and rheumatism (Dorjsembe et al., 2017). *A. atrata* L. to be effective in respiratory tract disorder (Ristic et al., 2004). *A. bibersteinii* Afan. found in Turkey used for wound healing and treatment of gastrointestinal disorders such as abdominal pains and haemorohoids (Sezik et al., 2001).

In Iran *A. biebersteinii* Afan. (Local name: ormadern) used for nephralgia, colds, gynaecologic condition such as women sterility and as jaundice and as astringent for skin conditions like oedema and erythema (Saric – kundalic et al., 2010: Skocibusic et al., 2004). In Turkey, *A. Cappadocica* Hausskn. Local name "Buykon" those leaves were used for the treatment of stomachic effects, astringent and emmenagogue (Altundag and ozturck., 2011). *A. coarctata* Poir. used for treatment for gastrointestinal and hypertension due to its diuretic properties. (Papakasta et al., 2020). *A. Collina* Becker Ex Rchb. found in Bosnia used for bedwetting by children and increased diuresis and removal of urinary stones. It has also been used for skin conditions such as injuries, rashes and liver ailments, blood purification, asthma, regulation of menstruation and throat ache (Ristic et al., 2004; Pirbalouti et al., 2013). *A. cretica* L. used for the treatment of gynecological and pathological disorder as well as used for wound healing urogenital and respiratory disorders (Bina et al., 2020). *A. clavennae* L. used for the treatment of relieve ailments such as abdominal pain, influenza, cold and respiratory disease and also used in stomachic and anthelmintic properties (Skocibusic et al., 2004). *A. falcata* L. used with beneficial effects on internal haemorrohages, stomach ailments gastritis and bladder stones (Nemeth and Bernath., 2008; Ghantous et al., 2009). *A. moschata* Wulfen. used in both human and veterinary health problems. It is administered as abdominal bloating, fever, gout, coughs, headache, insomnia, menopausal, neuralgia, skin inflammations, vaginitis and urinary tract inflammations (Vitalini et al., 2016). *A. millefolium* L. used inflammatory disorders and wound healing (Dorksembe et al., 2017; Tadicet et al., 2017). *Achillea. millefolium* L. used gastrointestinal disorder due to its bitter taste or for hepatobiliary complaints and also used for many gynaecological abnormalities like regulation of the menstrual cycle). *Achillea wilhelmsii* C. Koch. (bohemadran) used for the gastrointestinal treatment and pulmonary complaints in Italy and Turkey (Maffei et al., 1994). *A.wilhelmsii* C. Koch. also used for stomach ache, diabetes, blood coagulation, kidney stones, hypertension and constipation (Khazaneh et al., 2016; Altundag and Ozturk., 2011).

1.3. Traditional Application of *Achillea* Species in Skin Disorders

Achillea L. species have a long history of uses in traditional medicine as natural treatment for bleeding, wounds, inflammation, dyspepsia,and

spasmodic disorders.(Saeidnia et Al., 2011; Ali et al., 2017;Nemeth and Bernath,2008) *Achillea* L. species also have biological characteristics that are beneficial for cosmetic and dermatology uses .Extracts from others Achillea species may be successfully utilized and readily available components of therapeutic lotions and cosmetics due to its widespread distribution of these plants around the world. The word *Achillea* L. was used in conjunction with the following words such as wounad healing, tyrosinase, antioxidant, collagenase and skin keratinocyte. *Achillea* extracts can be contribute and identify the active components that contribute to the skin conditioning effect and dermatology. *Achillea millefolium* L. is the most well species in the genus, with the numerous conventional usages. *Achillea ageratum* L. and *Achillea millefolium* L. used for natural cures, including for skin ailments (Drobnik and Bacler, 2009).The raw materials for the production alcoholic extract and aqueous solutions topically in the form are the dried aerial parts of *Achillea millefolium* L. Of baths for treating inflammations of the skin and mucous membrane. Dried herb or fresh squeezed juice from *Achillea millefolium* L. Leaves has been used for wounds, sores and ulcers. For treatment of skin condition, to use an oil macerate of *Achillea millefolium* L. made by soaking the dried plant or fresh in the vegetable oil used for the treatment of inflammation or as defense against sunburn (saeidnia et al.,2011;Tadic et al., 2017)

In Iran and Pakistan traditional medicine prepared from *Achillea millefolium* L. For the treatment of wound healing. In Turkey and Italy numerous *Achillea* species extracts can be used for various diseases treatment (Ahmad et Al.,2017; Bina et Al.,2020). *Achillea millefolium* L. is very important role play in traditional medicine and its efficacy in treating inflammations. Traditional application and pain (Cuts , abrasions, and wounds) that might be alleviated by the use of ointments or lotions containing extracts of yarrow (Ali et al.,2017;Sharma et Al.,2017) *Achillea millefolium* L. can be used in Chinese medicine as anti-hemorrhagic, wounds healing, and as a cosmetic remedy for used in sores, snake bites, and skin healing properties (Applequist and Moerman ,2011).In Italy *Achillea ligustica* All. and *Achillea millefolium* L. have a long history of use in the management of skin illnesses treated with natural antibacterial and anti- inflammatory treatments (Venditti et Al.,2016)

1.4. *Achillea* Species Especially for the Management of Gastrointestinal Disorders

The most common symptoms of gastrointestinal disease are as follows like abdominal pain, nausea, bloating, heartburn, vomiting, diarrhea, gastrointestinal bleeding and constipation. Gastrointestinal disease involves different benign and malignant pathologies of liver, pancreas digestive tract as well as biliary tract. (Lee and kim, 2022). GID are divided into two main groups functional and structural. In case of functional gastrointestinal disorder the structure of the alimentary tract look like a normal. There are many problems and signs of functional GID including gas, bloating, constipation, irritable ball syndrome, poisoning and nausea. In the case of structural gastrointestinal disorder both abnormal outlook and motility are observed. The structural GIDs involve various forms of hepatitis, chronic pancreatitis, gastric and duodenal peptic ulcer disease as well as benign and malignant neoplasms, hemorrhoids, ulcerative colitis (UC) and crohn's disease (CD) (Lee and kim, 2022; Milivojevic et al., 2020). *Achillea* L. is widely used in traditional medicine for gastrointestinal disorders (Nemeth and Bernath, 2008). The decoction of *Achillea moschata* Wulfen. used to treat digestive tract disorders (Bottoni et al., 2020). Tea prepared from *Achillea biebersteinii* Afan. And *Achillea aleppica* DC. was used for abdominal pain. (Arasan and kaya, 2016). *Achillea millefolium* L. is used in crude forms for various therapeutic purposes such as teas for digestive problems (Applequist and Moerman, 2011). *Achillea wilhelmsii* C. Koch. is widely used in traditional medicine for gastrointestinal disorders. It has chemical components including alkaloid, cineol, rutin, flavonoids, camphor, thujene, monoterpenoids and sesquiterpenoids (Dokhani et al., 2005; Javidian et al., 2004). *Achillea millefolium* L. is a medicinal plant used in medicine to treat pain, gastrointestinal and inflammation, screening of gastro protective potential against acute and chronic ulcers has shown positive correlation with its uses in folk medicinal. The

aqueous extract of *Achillea millefolium* L. showed effectiveness in protecting the gastric mucosa against acute gastric lesions induced by ethanol and indomethacin and in healing chronic gastric lesions induced by acetic acid. (Cavalcanti et al., 2006). *Achillea coarctata* Poir. used for treatment of gastro-intestinal disease (Papakosta et al., 2020).

1.5. Antioxidant Activity of *Achillea*

The protective activity of natural antioxidants in biological systems has paid attention many medicinal plants have proved free radical scavenging or antioxidant activities (Mantle et al., 2000). The infusions of *Achillea* L. species were tested on antioxidant enzymes of erythrocytes and *Achillea falcata* L. is the most effective one against CAT (catalase), GPx (glutathione peroxidase) and super oxide dismutase (SOD) enzyme systems of erythrocytes. Therefore, *Achillea* species may be of potential sources of natural antioxidants for the prevention and treatment of many diseases (Konyalioglu and karamenderes 2005). The extracts of *Achillea alexandriregis* Bornm. & Rudsk. the hydroxyl and superoxide radicals' quantity in different in vitro systems have been demonstrated. The ethyl acetate extract exhibited hydroxyl radical scavenging activity in all tested biological systems (hemolyzed blood, liver homogenate, serum and post mitochondrial liver fraction), whereas butanol extract reduced hydroxyl raticals significantly only in the post mitochondrial live fraction (a homogenate of liver cells remaining after sedimentation of the mitochondrial fraction by centrifugation). Both extracts affected only hemolysed blood (Kundakovic et al., 2005). The hydro-alcoholic extract of *Achillea santolina* L. was studied on different vitro antioxiclative systems and it has been explained that the extract prevented formation of thiobarbituric acid reactive substances in Fez + ascorbate induced lipid peroxidation in rat liver tissue (Ardestani and yazdanparast 2007). The antioxidant capacity and cytoprotective activity of *Achillea collina* Becker ex Rchb. infusions against oxidative stress were reported by chemical (DPPH and Folin Ciocaltey assay) and biological assays that show the infusions of leaves had the highest antioxidant activity (Gi orgi et al., 2009).

1.6. Antimicrobial Activity of *Achillea*

Achillea L. species' essential oils have been the subject of the most research on their potential to kill germs. The majority of these oils contain monoterpenes such as 1,8-cineole, camphor, borneol, terpinen-4-ol, and sesquiterpene lactones, all of which are well known for their antibacterial properties. Compared to Gram-negative bacteria such as, numerous research have demonstrated that essential oils have a greater impact against Gram-positive bacteria, notably Staphylococcus aureus, Bacillus subtilis, and Enterococcus faecalis. such as Escherichia coli and Pseudomonas aeruginosa. The variations in activity are often ascribed to the structural variations in bacterial cell walls, since the outer membrane of Gram-negative bacteria prevents the entry of Essential oils contain hydrophobic substances (Kordali et al., 2002). In addition to essential oils, ethanolic and methanolic extracts high in flavonoids, tannins, and phenolic acids also show notable antibacterial properties, which frequently complement those of volatile oils. The most studied species for antimicrobial activity is *Achillea millefolium* L. (yarrow). In disc diffusion tests, hydroalcoholic and methanolic extracts of aerial parts demonstrated potent inhibition against Staphylococcus aureus, with inhibition zones of up to 21 mm. Furthermore, methanol extracts exhibited activity against Helicobacter pylori, with a minimum inhibitory concentration (MIC) of 50 µg/mL, indicating that it may be useful in treating gastrointestinal infections (Grigore et al., 2020). The essential oils of *A. millefolium* L. which include camphor and 1,8-cineole, showed significant antimicrobial activity against Gram-positive bacteria and moderate effects against Gram-negative species. (El-Kalamouni et al., 2017). These results support the ethnomedicinal use of *A. millefolium* L. in treating wounds and infections.

Achillea moschata Wulfen

The phytochemical make-up and antimicrobial properties of *Achillea moschata* Wulfen. another significant species exclusive to the Alps, have been researched. Gram-negative bacteria such as Pseudomonas and essential oils that were mostly made up of camphor and borneol displayed strong inhibitory activity against Bacillus cereus, Enterococcus faecalis, and Staphylococcus aureus.

The dichloromethane and methanolic extracts also demonstrated antibacterial action, but it was less potent than the essential oil, suggesting that volatile chemicals are responsible for its activity. However, aeruginosa was less susceptible (Salomon et al., 2016).

***Achillea setacea* waldst. Et Kit. and *Achillea teretifolia* L.**

The essential oils of *A. setacea* waldst Et Kit. And *A. teretifolia* L. exhibited broad-spectrum antimicrobial properties. The MIC values found in vitro against pathogens such as Clostridium perfringens, Acinetobacter lwoffii, and Candida albicans ranged from 0.28 to 2.25 mg/mL. The oils showed especially potent antifungal effects, with significant suppression of C. albicans development (Kordali et al., 2002). Their activity was linked to their high concentration of borneol, 303erpinene-4-ol, and 1,8-cineole.

***Achillea biebersteinii* Afan. And *Achillea ageratum* L.**

With MIC values for methanolic extracts as low as 0.1 mg/mL, polar extracts of *Achillea biebersteinii* Afan. showed potent antibacterial action against Staphylococcus aureus and Pseudomonas aeruginosa. extracts. The essential oils of *A. ageratum* L. demonstrated antifungal action against Candida albicans, with MICs ranging from 15.7 to 34.8 mg/mL (Wojdylo et al., 2021). These findings emphasize the significance of extraction techniques in assessing antimicrobial potency, with polar solvents producing phenolic-rich fractions with superior antibacterial activity, while essential oils are more effective against fungi.

***Achillea santolina* L.**

Recent research has concentrated on the species *A. santolina* L. which is indigenous to certain regions of the Middle East and Central Asia. Ethanolic extracts of the entire plant exhibited antibacterial and antifungal properties. The extract had potent antibacterial effects against Staphylococcus and also inhibited fungal pathogens like Aspergillus flavus (up to 89% inhibition) and Aspergillus niger (74%). These findings imply that A. santolinoides might be a potential source of natural antifungal compounds against Escherichia coli and aureus (Akbar et al., 2023).

Additional *Achillea* Species

The antimicrobial properties of a number of other species have been studied, including *Achillea filipendulina* Lam. *A. magnifica* L. and *A. tenuifolia* Lam. The essential oils of these plants exhibited only moderate antibacterial properties, but they were especially potent against fungal species like Cryptococcus neoformans, with IC50 values between 1.4 and 2.8. 15 to 45 µg/mL (Celik et al., 2018). This demonstrates that *Achillea*'s antibacterial profile differs between species, with some being more potent against fungi and others against bacteria.

1.7. Toxicity

The *Achillea millefolium* L. Showed a temporary antifertile effect in adult male rats (Takzare et al.,2010). *Achillea wilhelmsii* C. Koch LD50(lethal dose for 50%of test subject for flavonoids *Achillea wilhelmsii* C. Koch indicating moderate toxicity in mice (Ali et al.,2016) high concentration of sesquiterpene present in *Achillea odorata* L. can cause allergic reaction (Barda et al., 2021) *Achillea fragrantissima* (Forssk) Sch. Bip. damages acetic acid in rats (Rahman et al., 2015) *Achillea santolina* L. high hypoglycemia activity cause pancreatic damage in rats (Ardestani and yazdanparast,2007)*Achillea falcata* L. high concentration of essential oils inhibited the of epidermal human HaCAT cells(younos et al., 2020). *Achillea tenuifolia* Lam. High hydro alcoholic extract cause anxiety like behavior and reproductive parameters in a rat cause chronic stress (Bagheri et al., 2021). *Achillea filipendulina* Lam. toxic and dangerous to household and farm pets such as dogs, cats and horses (Asghari et al., 2020). *Achillea ligustica* All. and *Achillea vermicularis* trin can cause skin irritation. (Maggi et al., 2009)

1.8. Molecular Analysis and DNA Barcoding of *Achillea*

Many species of *Achillea* L. recognized the existence of the great chemotypic variations throughout the species (Benedek et al., 2007). Therefore, to utilize this genetic diversity in a breeding program a capable evaluation scheme needs to be utilized. In

latest year the use of molecular markers to evaluate genetic diversity has become essential tool in many plant species. Microsatellites also known as Simple Sequence Repeats (SSRs) is a small array of collaboratively arranged bases (one to six) distributes throughout the genomes. Microsatellites are polymorphic among and within species, co-dominantly inherited and multi-allelic molecular markers, which have become the marker of choice in breeding and plant genetics studies (Powell et al., 1996; Stajner et al., 2005). DNA barcoding is reliable tool utilizing an ultimate and exclusive source from genetic structure available in the organisms and provide reproducible and promising results with certainty. It is one of the most reliable concepts, aiming to afford rapid, accurate and automatable species identification technique using a standardized DNA region (Hebert et al., 2003). The ideal DNA barcoding system to meet those criteria a). It should be standardized with the same DNA region as possible used for various taxonomic groups. b). It should be sufficiently variable to discriminate among all species. c). It should be extremely robust, with highly reliable and highly priming sit for DNA sequencing and amplifications. Hence DNA barcoding proves to be mean when it is actually a tool to be used largely for identification and discrimination purposes (Chase et al., 2005). *Achillea millefolium* L. is an important medicinal plant belonging to the genus *Achillea* L. It is one of the most used herbal medicines to cure numerous diseases like high blood pressure, gastrointestinal disorder, gynecological disorders and burn wounds (Ali and Cibas, 2017). During trading *Achillea millefolium* L. is usually adulterated with the adhatodavasica Nees. The term adulteration means replacement or mixing of original herbal drugs with its resembled, inferior plant which has different therapeutic or chemical properties (Srirama et al., 2010; Kumar et al., 2015). Both plants although not have any morphological resemblance but they are adulterated either due to lack of elementary knowledge about the confusion in vernacular or authentic plant (Sunita, 1992; Uniyal and Joshi, 1993; Sarin, 1996). Adulteration in the case of *Achillea millefolium* L. cause harmful impact on health of human beings such as vomiting, diarrhea, reduced blood sugar level and miscarriages (Kumar et al., 2010). Since morphological structures of traded herbal plants are not intact in crude herbal drugs form hence it is needed to select techniques i.e. DNA barcoding for authentication of traded raw herbal drug. To determine the adulteration in traded medicinal plant species, DNA barcoding is an important molecular technique to determine the adulteration which is impose various health hazards and burning issue. DNA barcodes, short sequences of DNA are becoming most important protocol for the recognition and identification of plant species (Kress et al., 2005). It is based on the various conserved regions of divergent species to develop large scale reference genomic library and useful for phylogenetic analysis, genetic diversity and discrimination of different species (Wattoo et al., 2016). DNA barcoding techniques are free from subjective errors does not require any expertise as required in taxonomic parameters (Herbert and Gregory, 2005)

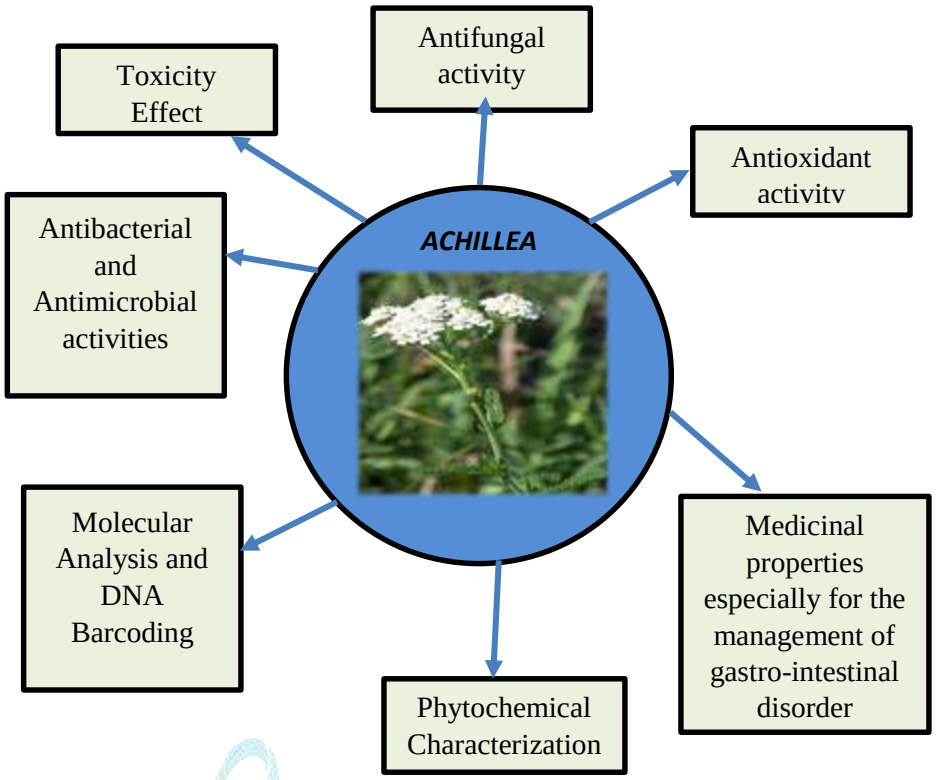


Figure 1.1 Illustrate the genus *Achillea* L. biological significance

3.MATERIALS AND METHODS

3.1. Study Design

This research aimed to conduct a review of the distribution, description, phytochemical, pharmacological, antimicrobial, antioxidant and medicinal properties especially for the management of gastrointestinal diseases of *Achillea* L. species. Information was methodically collected from preexisting pre-reviewed articles that provide experimental data and published reviews between (1996 – 2025). The focus was to assemble and critically evaluate existing information about phytochemical components and gastrointestinal disorders of this medicinal herb.

3.2 Sampling

Achillea species are distributed across Pakistan, Europe, Western and Eastern Asia. The purpose of sampling of the *Achillea* species for the identification of medicinal uses especially for gastrointestinal diseases management, phytochemical analysis, Antioxidant and antimicrobial activity, molecular studies and taxonomic identification.

Sampling Materials: Each plant, typically called;

i. Aerial Parts (Stems, Leaves and Flowers) for medicinal and phytochemical analysis.
ii. Leaves: for flavonoid and DNA studies
iii. Flowers: for essential oil composition studies

3.3. Data Collection Methods

The process of data aggregation included:

- The arranged review of scientific databases, including publication from PubMed, Google Scholar, Science Direct, Web of science, Scopus, Tropicos.Com and Research Gate applying the search terms: *Achillea* species, Medicinal especially for the management of gastrointestinal disorders, Phytochemical analysis, Antioxidant activity, antimicrobial activity and Toxicity applications.
- Incorporation of more than 200 articles and research studies relevant to the medicinal, phytochemical characterization of *Achillea* published from 1996 to 2025.

3.4. Phytochemical screening Methods (Reported in Review Literature)

Phytochemical	Test used	Analytical Technique	Reference
Alkaloids	Wagner's and Mayer's test using	GC – MS	(Anne et al., 2006)
Phenolics	Folin-Ciocalteu reagent used	HPLC / LC – MS	(Rostami, 2015)
Terpenoids	Salkowski test	Chromatography + Spectroscopy	(Sefidkon et al., 2021)

3.5. Antioxidant and Antimicrobial Assays

- Antioxidant Assay Assessed primarily by the DPPH (2,2 – diphenyl) – 1 picrylhydrazyl) radical scavenging assay, which quantifies the ability of *Achillea* L.to neutralize free radicals complementary assays such as oxidative processes inhibition were also reported.
- Antimicrobial Activity: Evaluated using disk diffusion methods to determine zones of inhibition against bacterial activity including Bacillus subtilis, E-Coli, Staphylococcus, and pseudomonas aeruginosa. Minimum inhibitory concentrations (MICs) were also reported in select studies to establish effective extract dosages.

Species	Pathogen	Method Type	Reference
Achillea Santolina L.	*C. albicans*	Broth dilution method	(Rezaei et al., 2021)
Achillea millefolium L.	*E. coli, S. aureus*	Disk diffusion method	(Orhan et al., 2012)

3.6. Research Tools and Techniques

In this research, I applied many tools used to find relevant scientific articles because my research based on review articles.

Tools	Purpose
Google Scholar	Broad search, high quality and discipline specific results
Springer and Wiley Link	Publisher – Specific searches
PubMed	Use for biomedical and life sciences literature review
Science Direct	Access to Elsevier use in biological sciences

2. RESULTS

Achillea species distributed throughout the world such as Iran, Turkey, Asia and Pakistan. *Achillea* L. exhibits numerous properties such as Phytochemistry anti-microbial, antioxidant activity and toxicity.

Achillea species exhibit medicinal properties making them valuable for the management of gastro-intestinal diseases.

2.1. Worldwide distribution, Medicinal, Chemical properties, Antioxidant, Antimicrobial and Toxicity of *Achillea* Species

Plant Name	Distribution	Medicinal Uses for Various Diseases	Chemicals	Antioxidant Activity	Anti-Microbial Activity	Toxicity	Reference
Achillea millefolium L.	North America, Native to Europe and Western Asia	Gastrointestinal disease, menstrual problems, wounds, skin inflammation, loss of appetite, fever, stomach disorder, external bleeding etc.	Alkaloids, Choline, borneol, sesquiterpenoids, volatile oil, glucoside, camphor, beta pinene and Linolenic acid	*Achillea millefolium* L. exhibits strong antioxidant activity due to its high content of Thymol, carvacrol and bornyl acetate.	*Achillea millefolium* L. has demonstrated antimicrobial activity against *E.coli, P.aeruginosa, B.cereus, and Aspergillus Fumigates*.	The extract of *Achillea millefolium* L. showed a temporary anti-fertile effect in adult male wi star rats.	(Anne et al., 2006), (wichtl, 2004) and (wiluhn, 2002), (Falconieri et al., 2001), (Benedek et al., 2007), (Kazemi, 2015), (Zengin et al., 2017) ; (Takzare et al., 2010)
Achillea wilhelmsii C. Koch	Pakistan and Mediterranean Asia	Blood coagulation kidney stone, diabetes, hypertension, stomachache, constipation, backache.	Flavonoids, Lactones, 1,8 – cinceole, camphor, thymol, borneol and sesquiterpenes.	*Achillea wilhelmsii* C. Koch exhibits strong antioxidant activity due to high content of flavonoids and phenolic contents.	*Achillea wilhelmsii* C. Koch has broad antimicrobial activity againt *E.cloacea, P.mirabilis, E.coli, K.pneumoniae*	The LD50 (Lehtal, dose for 50% of test subject for flavonoids of *Achillea wilhelmsii* C. Koch indicating moderate toxicity in mice.	(Zargari, 1996), (Qomi et al., 2018), (Naghibi et al., 2014), (Nasab et al., 2014), (Mosaddegha et al., 2012), (Afsharypuor et al., 1996), (Tosun et al., 2004), (Kazemi and Rostami, 2015), (Saeidi et al., 2018), (Ozgen et al., 2004), (Kazemi and Rostami, 2015), (Ali et al., 2016).

Achillea odorata L.	Western and Eastern Asia, New Zealand and North America	Respiratory tract disorder, hypoglycemic, expectorant	Borneol, camphor, monoterpenes and 1,8 cineole.	*Achillea odorata* L.exhibits strong antioxidant due to contains of methanol, Ascorbic acid	*Achillea odorata* L. has demonstrated antimicrobial activity against *Bacillus subtilis, staphylococcus aureus*	High concentration of sesquiterpene present in *Achillea odorata* L. can cause allergic reaction.	(Benali et al., 2020), (Ristic et al., 2004), (Bnouham et al., 2002), (Mohammad hosseini et al., 2017), (Huang et al., 2021), (Dinjaski et al., 2014), (Barda et al ., 2021)
Achillea Fragrantissima (Forssk) Sch. Bip	Middle East and North Eastern Africa, Saudi Arabia	Fever, digestive, carminative, aching joints, wound healing, kidney stones.	Camphor, cis-chrysanthenol, a-terpineol, borneol, thymol, cedrol, carvone and methyl chavicol	*Achillea Fragrantissima* (Forssk) Sch. Bip contains flavonoids, cardiac glycosides and sterols which contribute to its antioxidant activity.	*Achillea Fragrantissima* (Forssk) Sch. Bip has shows antimicrobial activity against gram-negative *E.coli* and gram positive (*Bacillus subtilis, staphylococcus aureus*.	Damages induced by acetic acid in rats.	(Patocka and Navratilova, 2019), (Youssef, 2013), (Bakr et al., 2014), (Hazem et al., 2012), (Mustafa et al., 1992), (Al-Gaby and Allam 2000), (Alsohaili, 2018), (Zeedan et al., 2014), (Abdel-Rahman et al., 2015).
Achillea Santolina L.	Turkey, Italy, France, Afghanistan, India, Iran, Jordan, Pakistan, Saudi Arabia	Antispasmodic, diabetes, depurative, stomachaches and carminative.	Lactones, flavonoids, sesquiterpene	*Achillea Santolina* L. exhibits strong antioxidant activity due to its high content of linoleic acid, flavonoid, and phenolic.	*Achillea Santolina* L. has demonstrated antimicrobial activity against *pseudomonas aeruginosa*, *Candida albicans*, and *staphylococcus aureus*.	High hypoglycemic activity of *Achillea Santolina* L. cause pancreatic damage in rats.	(Kumar and Kumari, 2021), (Hudaiba et al., 2008), (Hatam et al., 1988), (Ardestani and Yazdanparast et al., 2007)

Achillea falcata L.	Iran, Turkey, Lebanon and Jordan	Stomach ailments, bladder stones, gastritis, internal hemorrhages	Sesquiterpene, Lactones, Cineol and Borneol	*Achillea falcata* L. contains phenolic and flavonoids exhibits strong antioxidant activity	*Achillea falcata* L. shows strong antimicrobial activity against *Bacillus cereus* and gram-positive Bacteria	*Achillea falcata* L. essential oil might inhibit the growth of the epidermal human HaCaT cells	(Candan et al., 2003), (Saeidnia et al., 2005), (Senatore et al., 2005), (Oran and Al-Eisawi, 1998), (Ghantous, 2009), (Saikali, 2012), (Salla, 2013), (Tohme, 2013), (Konyalioglu and Karamenderes, 2005), (Karaalp et al., 2009), (Younos et al ., 2020)
Achillea tenuifolia Lam.	Eastern Europe and Mediterranean areas	Diabetes, cough, bronchitis, stomachic and hypercholesterolemia	Fatty acid, terpenoids, alkanes, lignanes and flavonoids	*Achillea tenuifolia* Lam. exhibits strong antioxidant activity due to high content of DPPH methanol, ethyl acetate and BHA.	*Achillea tenuifolia* Lam. has demonstrated antimicrobial activity against *Mycobacterium* intracellular.	Hydro-alcoholic extract of this plant on anxiety like behavior and reproductive parameters in a rat model cause chronic stress	(Sefidkon et al., 2021), (al tundag and ozturk, 2011), (Shafaghat, 2009), (Toncer et al., 2010), (Manayi et al., 2012), (Demirci et al., 2018), (Bagheri et al., 2021)
Achillea filipendulina Lam.	Central Asia (Tajikistan), Iran and Caucasus (Armenia, Azerbaijan)	Malaria, arthritis, gastrointestinal problems and cardiovascular diseases.	Borneol, 1,8 – cineole, Isoborneol and Santolina alcohol	*Achillea filipendulina* Lam. contain phenolic acid terpenes and flavonoids due to this strong antioxidant activity	*Achillea filipendulina* Lam. has demonstrated antimicrobial activity against *B. sibtilis, S. epidermidis, E. coli and S. thyhimurium*	*Achillea fillipendulina* Lam. toxic and dangerous to household and farm pets such as cats, dogs and horses	(Abdusalyamova et al., 1988), (Sharopov et al, 2018), (Sharopov et al., 2015), (Sharopov and Setzer, 2010), (sharopov et al., 2015), (Afshari et al., 2018), (Asghari et al., 2020).

Achillea Ligustica All.	Italy, Libya, Turkey, France, Egypt	Stomach pain, cold pains, rheumatic diseases and headache	Linalool, 1,8 cineole and piperitone	*Achillea Ligustica* All. contain phenols and n-hexame and flavonoid exhibits strong antioxidant activity.	*Achillea Ligustica* All. has demonstrated antimicrobial activity against *candida albicans, Enterococcus faecalis*, and *streptococcus mutans*	Low toxicity	(Quezel et al., 1962), (Bruni et at., 1997), (Tzakou et al., 1995), (Innocenti et al., 2007), (Maggi et al., 2009)
Achillea Vermicularis Trin.	*Achillea Vermicularis* is distributed in the mountainous regions in the North, Northwest, West and Central part of Iran	Stomach pain, fever, women sterility, dysentery and diuretic.	Camphor, germacrene D, piperitone and 1,8 – cineole	*Achillea Vermicularis* Trin. have been reported ethanolic and methanolic components exhibit strong antioxidant activity.	*Achillea Vermicularis* Trin. Demonstrated has antimicrobial activity against *staphylococcus* and *E.coli*.	High concentration of oil in *Achillea Vermicularis* Trin. can cause skin irritation	(Mozaffarian, 2009), (Tareen et al., 2010), (Altunodg and ozturk, 2011), (Cakilcioglu et al., 2010), (Gharibi et al., 2015), (Karami – osboo et al., 2015), (Gharibi et al., 2015), (Nickavar et al., 2006), (Barani et al., 2011), (Barda et al., 2021).

2.2. Distribution, Description and Medicinal Uses of *Achillea* Species in Pakistan

Plant Name	Distribution	Description	Medicinal uses	References
Achillea millefolium L.	Pakistan (Quetta, Ziarat, Kalat, Mastung)	The stem is angular and rough, the leaves alternate, 3 to 4 inches long and 1 inch broad. Leaves a feathery appearance. Flowers are white or pale being like minute daisies. The whole plant is more or less hairy, with white, silky appressed hairs.	Used in wounds healing, pneumonia diseases, fever and especially in the management of gastro-intestinal disorders.	(Radusience and Gudaityte, 2005), Jenabi and Fereidoony, 2015)
Achillea wilhelmsii C. Koch.	Pakistan	In *Achillea* wilhelmsii C. Koch. fern like leaves stem is rough and	Wound healing, stomachache, abdominal pain and diabetes	(Fathi et al., 2011), (Candan et al.,

	(Quetta, Ziarat, Mach region and Taftan)	angular with silky white hair. Flowers are small and clustered.		2003), (Baris et al., 2006)
Achillea biebersteinii. Afan.	Pakistan, Afghanistan	A flowering herbaceous plan Fern like feathery leaves. Flowers are yellow and white height is 1 meter.	Cough, Chest problems, menstrual pain, wound healing and gastro-intestinal	(Abbas et al., 2019), (Almadiy, 2020)
Achillea filipendulina Lam.	Pakistan, Iran	A perennial herb, leaves are lobed, pinnate and linear flowers are small in clusters form arranged in corymbs.	Clean wounds, mouth sores and gastro-intestinal disease treatment	(Sharopov and setzer, 2010), (Hasimi et al., 2015)
Achillea santolina L.	Pakistan (Ziarat and dry mountains of Kalat)	A perennial herb that grows in 30 cm tall green leaves and erect stems flowers are yellow and white colors.	Dysentery, insect repellent, provide cooling effect to the body	(Bader et al., 2003), (Al-Snafi and Esmail, 2013)
Achillea setacea Waldst. Et kit.	Kazakhstan	Is a herbaceous perennial plants leaves are fern-like and flowers are in clusters form	Use in diabetes and gastro-intestinal problems.	(Nemeth, 2010), (Smoylovska et al., 2017)

2.3. List Of *Achillea* Species Especially for the Treatment of Gastro-Intestinal Disorders

Species	Gastro-intestinal disorders treatment	References
Achillea biebersteinii Afan.	Used for the treatment of gastro-intestinal disorders such as abdominal pains	(Sezki et al., 2001)
Achillea millefolium L.	Widely used for gastro-intestinal problems including gastric pain, stomach problems and dyspepsia	(Benedek and kopp, 2007), (Baretta et al., 2012)
Achillea alpine L.	Used for the treatment of stomach disease	(Lee et al., 2019)
Achillea coarctata Poir.	Used for the treatment of gastro-intestinal issues	(Papakosta et al., 2020)

Achillea asiatica Serg.	For the treatment of stomach issues and gastro-intestinal disorders	(Dorjsembe et al., 2017)
Achillea ligustica All.	*Achillea ligustica* All. used for the treatment of gastro-intestinal and stomach problems	(Freires et al., 2015)
Achillea lanulosa Nutt.	*Achillea lanulosa* Nutt. used for the treatment of diarrhea and indigestion issue	(Nemeth and Bernath, 2018)
Achillea filipendulira Lam.	Especially used for the management of gastro-intestinal diseases	(Aminkhani et al., 2020)
Achillea wilhelmsii C. Koch.	*Achillea wilhelmsii* C. Koch used for gastro-intestinal, abdominal pain and constipation.	(Maffei et al., 1994)
Achillea vermicularis Trin.	Used for digestion and stomach problems	(Alundag and ozturk, 2011)
Achillea moschata Wulfen.	*Achillea moschata* Wulfen. used for constipation, dyspepsia and gastro problems	(Vitalini et al., 2016)
Achillea magnifica Heimerl.	Used for the treatment of gastro problems and stomach ailments	(Demirci et al., 2018)
Achillea fragrantissima (Forssk) Sch. Bip.	Used for gastrointestinal disturbances	(Elmann et al., 2011)
Achillea falcata L.	*Achillea falcata* L. is beneficial for the treatments of gastro issues, stomach ailments and bladder stones	(Ghantous et al., 2009)
Achillea clavennae L.	*Achillea clavennae* L. used for the management of gastro-intestinal disorders, abdominal pain and dyspepsia	(Skocibusic et al., 2004)

2.4. Phytochemicals of *Achillea* Species

Species	Compounds	References
Achillea filpendulina Lam.	1-8 Cineole, Isoborneol, Borneol, Santolina alchol	(Sharpov and setzer, 2010)

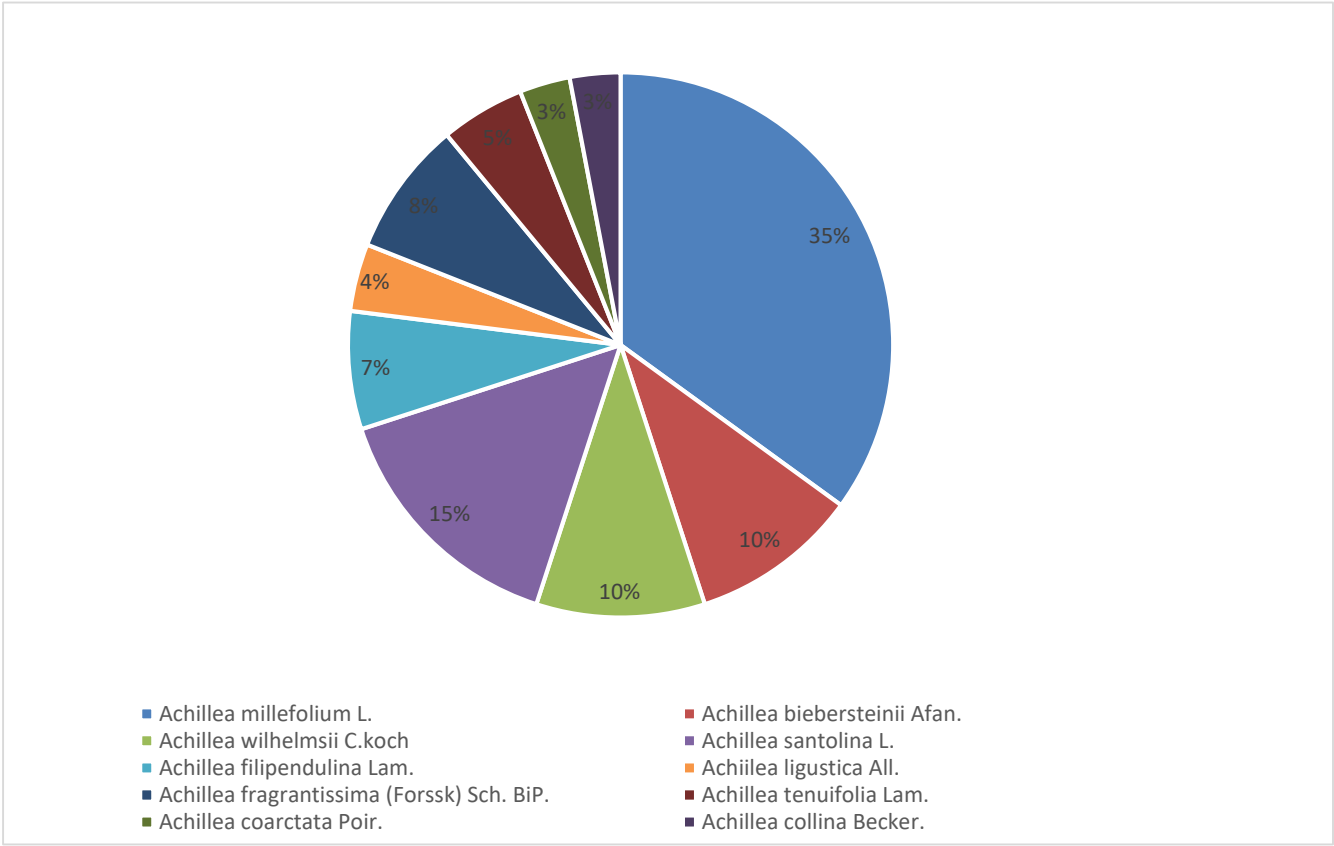
Achillea millefolium L.	Terpineol, morin, camphor, trimethyl, linoleic acid and kaempherol	(Georgieva et al., 2015)
Achillea beibrestinii Afan.	P-coumaric acid and Gallic acid	(Bashi et al., 2013)
Achillea fragrantissima (Forssk) Sch. Bip.	Thymol, carvacrol, camphor, borneol and iso bornyl acetate	(Bakr et al., 2014)
Achillea micrantha Wild.	P-cymene, 1.8 cineole and santolina	(Mazandarani et al., 2013)
Achillea nobilis L.	Caffeic acid, ferulic acid, vanillic acid and chlorogenic acid	(Tuncel et al., 2010)
Achillea wilhelmsii C. Koch	Alkaloids, borneol, carvacrol, camphor, monoterpenoids and sesquiterpenoids	(Serino et al., 2021)
Achillea ligustica All.	Luteolin, flavonoids, sesquiterpene lactones and monoterpene	(Tuberoso et al., 2009), (Tzakou et al., 1995)
Achillea odorata L.	Camphor, 1, 8 cineole, Borneol and monoterpenes	(Mohammad hosseini et al., 2017)
Achillea santolina L.	Phenolic compounds, terpenoids, tannins, alkaloids and resin	(Mota valizadehkakhky et al., 2013), (Afshari et al., 2018)
Achillea falcata L.	Lactones, Cineol, Sesquiterpene and Borneol	(Senatore et al., 2005)

4.5. Percentage of *Achillea* species use in Gastro-intestinal disorders management

Achillea Species	Use / Reported Activity	Percentage of use in GI Management	Reference
Achillea millefolium L.	Mostly used for stomach pain, ulcers, diarrhea and indigestion	35%	(Far et al., 2023)
Achillea biebersteinii Afan.	Exhibits antiulcer and antispasmodic activity – traditional remedy for dyspepsia	10%	(Abd- Alla et al., 2016)
Achillea wilhelmsii C.koch	Used for gastro protective antimicrobial and antioxidant effects	10%	(Niazmand et al., 2010)
Achillea santolina L.	Used for stomachic and reduce intestinal effects	15%	(Kumar and Kumari, 2021)
Achillea filipendulina Lam.	Shows digestive and antispasmodic activities	7%	(Barda et al., 2021)
Achiilea ligustica All.	Used for digestive complaints	4%	(Barda et al., 2021)

Achillea fragrantissima (Forssk) Sch. BiP.	Mostly used for the inflammation and gastric pain	8%	(Hala et al., 2018)
Achillea tenuifolia Lam.	Most beneficial for the management of gastrointestinal disorders	5%	(Barda et al., 2021)
Achillea coarctata Poir.	Used for intestinal and stomach disorders	3%	(Salehi et al., 2020)
Achillea collina Becker.	Used for stomachic effects.	3%	(Salehi et al., 2020)

Figure4.1; Percentage of Achillea species use in gastro-intestinal disorder management



3. DISCUSSION

This research presented and interprets the key findings from the study of *Achillea* L. The *Achillea* species highlights the distribution, description, medicinal, phytochemicals, antimicrobial, and antioxidant properties (Apel et Al.,2021). This study contains 15 species of *Achillea* L. were analyzed to the treatment of gastrointestinal disorders out of 130 species of *Achillea* L. (Benedek et al., 2007).

Distribution:

Achillea millefolium L. most widespread species occurring naturally across North America, Native to Europe, Western Asia and Pakistan due to its adaptability its habitats ranging from grasslands and meadows to distributed roadsides and soils (Anne et Al.,2006) While *Achillea wilhelmsii* C koch are mainly distributed in Pakistan (Quetta, Ziarat) , Afghanistan, and Iran. These species are often growing in dry soils and rocky regions (Qomi et Al., 2018) In contrast *Achillea odorata* L. expanded from its western and eastern New Zealand and north America (Benali et Al., 2020).

However, A. *fragrantissima* (Forssk) Sch.Bip is native to the Middle East and parts of North Africa. It has been reported in Egypt, Saudi Arabia, Jordan, Palestine, Iraq, Syria, Yemen, and Libya, where it often grows in desert margins, steppe habitats, and rocky terrains (Boulos, 2002; Al-Sodany, 2016). The species is well adapted to sandy and calcareous soils, thriving in areas with low rainfall and high temperatures.

While A. *santolina* L. has been observed in the Indian subcontinent, notably Pakistan, thriving in dry, semi-arid environments, demonstrating its capacity to adapt to a variety of arid ecosystems (Khan, 1998). In contrast, *Achillea falcata* L. is a species native to the Eastern Mediterranean and Western Asia (Kew, 2024). It is found in nature in nations like Lebanon, Syria, Palestine, Jordan, Iraq, and Turkey (Wikispecies, 2024). While *Achillea tenuifolia* Lam. species extends from Turkey to Pakistan and Central Asia, encompassing nations like Iran, Türkiye, and others.

It has been documented in several Iranian provinces, notably those in the north and northwest, where it may be found in its natural environment. (Manayi et al., 2012). On the other hands *Achillea filipendulina* Lam. in Iran, Afghanistan, Iraq, and Central Asia (including Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan), as well as western Pakistan.

Description

Achillea millefolium L. exhibit rough and angular stem, leaves are alternate 3 to 4 inches long and 1 inch broad and a feathery appearance, flowers are white or pale being like minute daisies .The whole plant is more or less hairy, with white, silky appressed hairs (Radusiene and Gudaityte, 2005) while *Achillea wilhelmsii* C. koch feathery and fern like leaves, stem is rough and angular with silky white hairs. Flowers are small, custured and aromatic (Fathi et Al.,2011). In contrast *Achillea biebersteinii* Afan. a flowering herbaceous plant fern like feathery leaves, flowers are yellow, and white height is 1meter (Abbas et Al.,2019) however *Achillea filipendulina* Lam. is perennial herb, leaves are lobed, pinnate and linear. Flowers are small in clusters form arranged in corymbs (Sharopov and setzer,2010). While, *Achillea santolina* L. a perennial herb that grows in 30cm in tall, green leaves and erect stems. Flowers are yellow and white colors (Bader et Al., 2003) in contrast *Achillea setacea* waldst .et kit. Is a herbaceous perennial plants leaves are fern like and flowers are clusters form (Nemeth, 2010)

Medicinal Uses

The perennial herb *Achillea wilhelmsii* C. Koch. which is well known for its wide range of therapeutic uses, is found throughout the Western Asia and Mediterranean. This plant is traditionally used to treat stomach pain, other gastrointestinal disorders and fever as well as to ease discomfort. jaundice in children (Ghavam et al., 2024). Due to its cineol concentration, alkaloid and flavonoid, the hydroalcoholic extract of A. *wilhelmsii C. Koch* has been shown to have antiproliferative properties, notably in prostate cancer cells (Rezai et al., 2019). Furthermore, studies have emphasized the plant's antioxidant and antimicrobial properties, indicating its potential use in treating oxidative stress and microbial infections (Chahrdoli et al., 2020). These The therapeutic potential of A. *wilhelmsii* C. Koch in contemporary

medicine is highlighted by its pharmacological characteristics, which complement its traditional applications.

While, *Achillea millefolium* L. has been used in traditional medicine in many cultures. The plant has been used in various parts of the world for its therapeutic, analgesic and anti-hemorrhagic properties, according to Saeidnia et al. (2011). Ali (2017) expounds further on its widespread usage in conventional medicine from Europe to Asia, notably for the treatment of gynecological conditions, hepatobiliary problems, spasmodic gastrointestinal disorders, wound healing and inflammation.

Achillea millefolium L. has a wide range of pharmacological effects. Its medicinal uses are supported by its anti-inflammatory and analgesic characteristics, which Far et al. (2023) emphasize. In addition, Dabbaghi et al. (2025) explore the plant's its application in the pharmaceutical, food and cosmetic industries is increased by its, astringent qualities, antifungal and antibacterial.

In contrast *Achillea odorata* L., which belongs to the Asteraceae family, has been used in traditional medicine due to its wide range of therapeutic effects, as reported by Saeidnia et al. Species of the *Achillea* genus, such as A. *odorata* L. have been utilized since 2011 to treat a variety of conditions, including inflammation, headaches, bleeding, wounds, discomfort, spasmodic disorders, and other ailments, bloating and indigestion. In a study by Dabbaghi et al. (2025), essential oils and extracts of *Achillea* species, including A. *odorata* L. showed a wide range of properties, variety of characteristics, including antioxidant, antibacterial, antifungal, and antimicrobial effects. Additionally, the chemical makeup and the aerial sections of A. *odorata* L. have antioxidant activity, with notable antioxidant capabilities.

However, the desert plant *Achillea fragrantissima*, (Forssk) Sch. Bip. often referred to as fragrant yarrow, has historically been used in the Arabian Peninsula for its wide range of medicinal benefits. This plant has been used in traditional medicine for a variety of illnesses, including skin inflammations, gastrointestinal issues, liver and biliary problems, and wound treatment, as per Patocka et al. (2019). Flavonoids, Polyphenols, Alkamides and Terpenes are among the pharmacologically active compounds discovered in A. *fragrantissima* (Forssk) Sch. Bip that are responsible for its anti- antioxidant properties and inflammatory.

While, *Achillea santolina* L. is frequently used to treat gastrointestinal illnesses such indigestion, dysentery and colic (Al-Snafi, 2013). Lactones, alkaloids, flavonoids, sesquiterpene and other bioactive compounds are abundant in the aerial portions of the plant, giving it its anti-inflammatory, antibacterial qualities and antioxidant (Khan, 1998).

In contrast, *Achillea falcata* L., has been historically used to treat gastrointestinal ailments like colic, indigestion, and dysentery (Barda, 2021). While, *Achillea tenuifolia* L., also known as narrow-leaved yarrow, has been historically used to treat gastrointestinal ailments including indigestion, colic and dysentery (Moradkhani et al., 2012).

On the other hands, *Achillea filipendulina* Lam. has been demonstrated to have potent antimalarial action, with consistent suppression of Plasmodium species. It also has xanthine oxidase inhibitory activity, implying the possibility of treating gout, and it has been historically used in malaria-prone regions (Al-Halawani et al., 2023). or hyperuricemia, and the methanolic extract exhibiting significant inhibition in in vitro tests (Al-Halawani et al., 2023). In contrast, A. *filipendulina* Lam. to treat cardiovascular ailments, gastrointestinal illnesses as a diuretic, and to alleviate pain (Shikov et al., 2014).

Phytochemistry

The yarrow plant (*Achillea millefolium* L.) has a diverse array of secondary metabolites that contribute to its pharmacological effects. The plant is notable for its high flavonoid content, including quercetin, rutin, apigenin and luteolin which give it its anti-inflammatory and antioxidant effects (Benedek & Kopp, 2007). Sesquiterpene lactones, such as, matricarin, achillin and, millefin have also been isolated from A. *millefolium* L. and linked to its antibacterial and anti-inflammatory properties (Candan et al., 2003). Volatile substances like borneol, camphor, chamazulene, and 1,8-cineole, which are well-known for their antibacterial and wound-healing properties, may be found in the essential oil of A. *millefolium* L. (Orav et al., 2006).

In addition, the plant's antioxidant potential has been increased by the discovery of phenolic acids, such as chlorogenic acid and caffeic acid (Benedek & Kopp, 2007). Recent research has also emphasized the existence of alkaloids and tannins, which adds to the phytochemical profile of A. *millefolium* L. and backs up its wide range of medicinal applications (Shikov et al., 2014).

While, *Achillea wilhelmsii* C. Koch contains a rich array of secondary metabolites, including phenolic compounds (such as C-glycosides and flavonoids of apigenin and luteolin) identified through HPLC-analysis in its water, ethyl acetate, hydroalcoholic, and chloroform extracts sesquiterpenoids, namely 1β,10β-epoxydesacetoxymatricarin and leucodin, along with methoxylated flavone aglycones including salvigenin in the chloroform fraction. (Akbar et al. 2023).

Akbar et al. (2023) describe that the ethanolic extract of *Achillea wilhelmsii* C. Koch (whole plant) shows total phenolic content ~14.81 ± 0.18 mg GAE/g and total flavonoid content ~12.27 ± 0.12 mg QE/g; phytochemical screening revealed presence of terpenoids, saponins, tannins, flavonoids, alkaloids, steroids, anthraquinones, coumarin, carbohydrates, and phlobatannins, but absence of quinones and cardiac glycosides (Akbar et al., 2023).

In contrast, the essential oil produced by *Achillea odorata* L. subsp. pectinata is high in oxygenated monoterpenes, with camphor (approximately 45.01%), bornyl acetate (approximately 15.07%), borneol (approximately 11.33%), and 1,8-cineole (approximately 2.96%) among them. key elements (Benali et al., 2020). The same study demonstrated the essential oil's potent antibacterial action against Bacillus subtilis, Proteus mirabilis, and Candida albicans, indicating that these important phytochemicals play a role to its bioactivity (Benali et al., 2020). The total phenolic content of the methanol extract of Algerian *Achillea odorata* L. was found to be high, and there were also significant amounts of flavonoids and flavonols, which were highly correlated having antioxidant effects in hydrogen peroxide, DPPH, and reduction power tests (Boutennoun et al., 2014).

However, a GC-MS analysis of leaves from Iraq revealed 57 chemical components in *Achillea fragrantissima* (Forssk.) Sch. Bip., which is high in essential oil components; the most prevalent ones. The components include artemisia-ketone (10.25%), 3-thujanone (7.82%), camphor (34.50%) and 1,8-cineole (14.60%), (Qader, Al-Saadi & Faraj, 2018).

While *Achillea santolina* L. has a wide variety of phytochemical elements, such as essential oils, phenolic compounds, triterpenes, tannins, flavonoids, glycosides and sterols. That the flowering stage has the highest total phenolic concentration in leaf methanolic extracts (84.1 0.17 mg/g dry weight), along with notable amounts of flavonoids, which are associated with significant antioxidant action. The Chemical Profiling by HPLC-DAD and GC-MS from Algerian samples (Benkaci-Ali et al., 2006).

In contrast, *Achillea falcata* L., a species found in Jordan and other Middle Eastern regions, has been studied for its phytochemical contents using both aqueous and hydro-alcoholic extracts (Hammad et al., 2013).

On the other hands the leaves of *Achillea filipendulina* Lam. have a variety of secondary metabolites. Qualitative screening shows the presence of alkaloids, flavonoids, glycosides, terpenoids, tannins, saponins and steroids (Khan, Kaur). In a GC-MS analysis of its essential oil from aerial parts, 31 bioactive compounds were discovered, including 13-docosenamide (Z) and 9-octadecenamide (Jhamta, 2019) were significant components (Khan, Kaur & Jhamta, 2019).

While *Achillea tenuifolia* Lam. a member of the Asteraceae family (Farajpour et al. 2024). Angourani et al. (2023) examined the essential oil composition of A. *tenuifolia* Lam. from the Zanjan area. Eighty-eight compounds were discovered by the analysis, with twenty-one making up 73.48% of the entire essential oil. The main components were 1,8-cineole (5.24%), camphor (16.48%), and α-pinene (5.35%), along with others. The aromatic profile of the plant is probably made up of a complicated combination of monoterpenes and sesquiterpenes.

The major phytochemical components in A. *ligustica*, All. according to a thorough analysis by Bouteche et al. (2024), are lactone sesquiterpenes and flavonoids. According to the study, these chemicals are responsible for the plant's wide range of pharmacological effects, such as antimicrobial,

anti-diabetic, antioxidant, and anti-psoriasis properties.

Antimicrobial Activity

The antimicrobial effects of *Achillea millefolium* L. (yarrow) have been thoroughly researched. Numerous studies have shown that the plant's essential oils, phenolic chemicals, and flavonoids play a key role in its antifungal and antimicrobial capabilities.

A. *millefolium* L. displayed significant inhibitory activity against both Gram-negative and Gram-positive bacteria, such as Escherichia coli and Staphylococcus aureus according to Candan et al. (2003). In a similar way, Benedek et al. (2007) found that the methanolic extract of the aboveground components demonstrated encouraging activity against Candida albicans, indicating its potential use as an antifungal drug.

While A. *wilhelmsii* C. Koch was discovered in Kashan, Iran, according to a study by Ghavam et al. (2024). The essential oil's unique profile was made up of a few oxygenated sesquiterpenes and acidic chemicals especially fragranyl acetate and fragranol. This chemotype exhibited antimicrobial action, especially against Gram-negative bacteria like Acinetobacter baumannii and Shigella dysenteriae. In contrast, Benali et al. (2020) used biological testing and GC–MS analysis to further expand upon these results by examining the essential oil of A. *odorata* L. subsp. pectinata in both conventional in vitro and in vivo contexts. tests and food model systems. Benali et al. found significant antibacterial activity against Gram-positive bacteria like Bacillus subtilis and foodborne Gram-negative strains like Proteus. mirabilis; significantly, they showed that MIC and 4xMIC doses of the oil were effective at lowering bacterial development in barley and cabbage food matrices, indicating practical preservative uses.

However, *Achillea fragrantissima* (Forssk.) Sch. Bip. formerly used in Middle Eastern folk medicine for respiratory problems and digestive, has received more attention recently for its antibacterial properties. Its bioactivity is linked to its essential oils flavonoids and phenolic acids, which have potent antifungal properties and antibacterial.

The essential oil from A. *fragrantissima* (Forssk) Sch. Bip. gathered in Egypt was tested by Hussein et al. (2010) for its antimicrobial activity, and it was discovered that it had potent inhibitory effects against gram-positive bacteria like Staphylococcus aureus and Bacillus subtilis, while moderate effects were seen against Gram-negative bacteria such Pseudomonas aeruginosa and Escherichia coli.

While A. *santolina* L. showed notable inhibitory activity against Staphylococcus aureus and Bacillus subtilis. The oil's antimicrobial activity was attributed to its high concentrations of camphor, borneol, and 1,8-cineole, although it exhibited limited activity against Gram-negative bacteria like Pseudomonas aeruginosa and Escherichia coli (Bader et al., 2014).

Likewise, El-Gendy et al. (2015) examined Egyptian populations of A. *santolina* L. and discovered that the essential oil had potent antifungal action against Candida albicans and Aspergillus niger.

In contrast, A. *falcata* L. which was collected in Egypt, was studied by Hussein et al. (2010), who discovered significant antibacterial activity, particularly against Bacillus subtilis and Staphylococcus aureus. Consistent with the overall resistance of Gram-negative species to essential oils, gram-negative bacteria like Escherichia coli were less susceptible.

On the other hands, at different developmental stages (vegetative, blooming, and fruiting), Aminkhani et al. (2019) examined the essential oil of A. *tenuifolia* Lam. gathered from Khoy, Iran. The focus of their research was on the essential oil. as shown by, Minimum Inhibitory Concentration (MIC), disk diffusion and Minimum Bactericidal Concentration (MBC) tests, it revealed significant antibacterial activity against both Gram-positive and Gram-negative bacteria. Notably, Bacillus anthracis was the most vulnerable species. The study highlighted how crucial the plant's developmental stage is to its biological characteristics, recommending the vegetative stage as the best for antimicrobial action.

While, Aminkhani et al. (2020) examined the antimicrobial activity of A. *filipendulina* Lam. derived from various plant components. The study discovered 16, 53, and 53 different essential oil components. and 35 compounds in the stem, leaf, and flower, respectively. In particular, just five compounds were found in all three sections. The

essential oil of the major components of the stem were neryl acetate, spathulenol, carvacrol, *santolina* alcohol, and trans-caryophyllene oxide. The leaf oil was made up of 1,8-cineole, camphor, ascaridole, trans-isoascaridole, and piperitone oxide. The floral oil was abundant in ascaridole, trans-isoascaridole, 1,8-cineole, p-cymene, and camphor. Using disk diffusion, minimum inhibitory concentration, and minimum bactericidal concentration, the antibacterial potency of these oils was determined. minimum bactericidal concentration (MBC) and minimum inhibitory concentration (MIC) tests were used against both Gram-positive and Gram-negative bacteria. The findings revealed that the various the flower oil had the strongest effect against Staphylococcus aureus and Escherichia coli in a variety of plant components.

In contrast, antimicrobial activity of A. *ligustica* All. collected from various plant components were analyzed by Bader et al. (2007). The stem, leaf, and flower had 16, 53, and 35 substances, respectively, according to the investigation. It should be mentioned that only five substances were found in all three sections. The stem's essential oil was mostly made up of neryl acetate, spathulenol, carvacrol, *santolina* alcohol, and trans-caryophyllene oxide. The flower oil was high in 1,8-cineole, camphor, ascaridole, trans-isoascaridole, and piperitone oxide, while the leaf oil contained 1,8-cineole, camphor, ascaridole, trans-isoascaridole, and piperitone oxide. Disk diffusion, minimum inhibitory concentration (MIC), and minimum bactericidal concentration (MBC) methodologies were employed to evaluate the antimicrobial activity of these oils against both Gram-positive and Gram-negative bacteria. The flower oil demonstrated the strongest action against Staphylococcus aureus and Escherichia coli, indicating that the different plant parts have differing levels of antibacterial capabilities.

The antibacterial action of silver nanoparticles produced using A. *vermicularis* Trin. extracts were studied by Rahmani et al. (2023). According to the research, the biosynthesized nanoparticles had notable antimicrobial effects against Staphylococcus aureus, Listeria monocytogenes, and Escherichia coli, as well as the yeast Saccharomyces cerevisiae. The disc diffusion approach was used to evaluate the antimicrobial effectiveness, emphasizing the capability of plant-mediated nanoparticles to fight microbial pathogens.

Antioxidant activity

Achillea millefolium L. Exhibit high antioxidant due to its high content of thymol, carvacrol, and bornyl acetate. These antioxidant activities protect cell damages (kazemi, 2015) while *Achillea wilhelmsii* C. Koch. exhibit antioxidant activity contains flavonoids and phenolic acid molecules that protect free radicals and reduce the cells from damages (Ozgen et al.,2004). In contrast, *Achillea odorata* L. Contains methanol and ascorbic acid which exhibit strong antioxidant activity which protect the tumor cell lines (Boutennoun et Al.,2017) However *Achillea fragrantissima* Forssk Sch. Bip. DPPH radical scavenging activity due to high content of ascorbic acid and Quercetin was used as positive control (Elsharkawy et al.,2021) while *Achillea santolina* L. contains linoleic acid, phenolic acid and flavonoids which exhibit more antioxidant activity free radicals scavenging and reduce potential activity of cell damages. (Ardestani and yazdanparast, 2007) In contrast *Achillea falcata* L. demonstrated antioxidant activity due to flavonoids and phenolic acid against H2O2 reduced oxidative damage in human leucocytes and erythrocytes. (Konyalioglu and karamenderes,2005) While *Achillea tenuifolia* Lam. contains high level of flavonoid and phenolic compounds these compounds highlights for the shielding biological and neutralize free radicals from oxidative damages. *Achillea tenuifolia* Lam. contains a number of antioxidant substances including beta - sitosterol, methyl gallate and salvigenin which aid radical scavenging and metal-chelation capabilities (Moradkhani et al., 2012). However, *Achillea filipendulina* Lam. contains high phenolic concentration responsible for the antioxidant activity these antioxidant activity helps for the neutralize free radicals using DPPH and ABTS method (Asnaashari,2023) on the other hands *Achillea ligustica* All. exhibit antioxidant activity due to rich contents of flavonoids and phenolic compounds. These antioxidant activity help in photo protective potential using different

methods like ABTS, DPPH, and beta carotene bleaching (conforti et al.,2005).

Toxicity

The *Achillea millefolium* L. Showed a temporary anti-fertile effect in adult male rats (Takzare et al.,2010) while *Achillea wilhelmsii* C. Koch LD50 (lethal dose for 50% of test subject for flavonoids *Achillea wilhelmsii* C. Koch indicating moderate toxicity in mice (Ali et al.,2016)In contrast high concentration of sesquiterpene present in *Achillea odorata* L. can cause allergic reaction (Barda et al., 2021) However *Achillea fragrantissima* (Forssk) Sch. Bip damages acetic acid in rats (Rahman et al., 2015) while in *Achillea santolina* L. high hypoglycemia activity cause pancreatic damage in rats (Ardestani and yazdanparast,2007)In contrast *Achillea falcata* L. high concentration of essential oils inhibited the of epidermal human HaCAT cells(younos et al., 2020) However *Achillea tenuifolia* Lam. High hydro alcoholic extract cause anxiety like behavior and reproductive parameters in a rat cause chronic stress. (Bagheri et Al., 2021) While *Achillea filipendulina* Lam. toxic and dangerous to household and farm pets such as dogs, cats and horses (Asghari et Al., 2020) on the other hands *Achillea ligustica* All. and *Achillea vermicularis* Trin. can cause skin irritation. (Maggi et al., 2009)

***Achillea* species especially for the management of gastrointestinal disorders**

There are 15 species of *Achillea* L. can be analyzed to the treatment of gastrointestinal disorders these species are as follows such as *Achillea millefolium* L. widely used for gastrointestinal problems including gastric pain, stomach problems and dyspepsia (Benedek and kopp,2007) while *Achillea wilhelmsii* C. Koch used for gastrointestinal, abdominal pain and constipation (Maffei et al., 1994). In contrast *Achillea biebersteinii* afan used for the treatment of abdominal pains (Sezik et al., 2001). However, *Achillea* Alpine L. used for the treatment of stomach diseases (Lee et Al., 2019) while *Achillea coarctata* Poir. Used for the treatment of gastrointestinal issues (papakosta et Al., 2020) In contrast *Achillea asiatica* serg. For the treatment of gastrointestinal and stomach issues (Dorjsembe et al, 2017) on the other hands *Achillea ligustica* All. Especially used for gastro problems (Freires et al., 2015). In contrast *Achillea lanulosa* nutt. used for the treatment of diarrhea and indigestion issues (Nemeth and Bernath,2018) while *Achillea filipendulina* Lam. especially for the management of gastrointestinal disease (Aminkhani et Al.,2020) however *Achillea vermicularis* Trin. Used for digestion and stomach issues (Altundag and ozturk 2011) While *Achillea moschata* wulfen used for the treatment of constipation, dyspepsia and gastrointestinal problems (Vitalini et Al.,2016) In contrast *Achillea magnifica* Heimerl. used for the treatment of gastro problems and stomach ailments (Demirci et Al.,2018) however *Achillea fragrantissima* (Forssk) Sch. Bip. used gastrointestinal disturbance (Elman et Al.,2011)while *Achillea falcata* L. is beneficial for the treatment of stomach ailments and bladder stones (Ghantous et Al.,2009) In contrast *Achillea clavennae* L. used for the management of gastrointestinal disorders, abdominal pain and dyspepsia (Skocibusic et al., 2004).

CONCLUSION

The *Achillea* L. comprising 130 species demonstrate significant ethno-medicinal especially for gastro-intestinal disease management. Tea prepared from *Achillea biebersteimii* afan. and *Achillea alpina* L. used for gastro-intestinal disease treatment. Phytochemicals present in *Achillea* species included phenolic acid, alkaloids terpenes, lactones etc. these bioactive compounds used for the treatment of many diseases such as asthma, bleeding and especially gastro-intestinal disorders. *Achillea* species demonstrates anti-oxidant activity using DPPH and ABTS, methods thereby preventing oxidative damage to cells. Many *Achillea* species have anti-microbial properties against various bacteria such as E. coli, Bacillus subtilis and staphylococcus etc. *Achillea* species also exhibit toxicity showed anti-fertile effects in rats. *Achillea* L. Genus offers a wealth of opportunities for medicinal, antimicrobial and anti-oxidant applications. Further research is needed on depth study of phytochemicals isolation, mechanisms of action and potential therapeutic uses in modern medicine.

FUTURE RECOMMENDATIONS

I suggested that further research is needed on depth study of phytochemicals isolation, mechanism of action and potential therapeutic uses in modern medicine, and investigate how the environment (climate, temperature, soil) influences the concentration of phenols, flavonoids, sesquiterpene lactones, essential oils and other substances in *Achillea* species.

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