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Unlocking the Therapeutic Power of Coriander: A Review of Coriandrum Sativum's Bioactive Compounds and Health Benefits

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Abstract: Coriander seed (Sativum) Lin (C. sativum), a plant of the umbelliferae/apiaceae family, is one of the most valuable medicinal herbs and spices that produces essential oils. The plant is used as a spice in food preparation and its leaves and seeds are also frequently utilised in medicine. The C. sativum is grown in India, Denmark, Ireland, Ukraine, Greece, Italy, Afghanistan, China, and Pakistan. Because it keeps food from spoiling, it is essential to preserving food's shelf life. Numerous beneficial and bioactive chemical components, including linalool, p-cymene, myrcene, tridecenal, terpinen-4-ol, camphor, linalyl acetate, limonene, 2-decenoic acid, 2-dodecenal and etc. Both volatile and essential oils with significant therapeutic importance can be found in excess in coriander seeds. In India, the herb that is most readily available is coriander. Moreover, essential oils contain phenolics, alkaloids, phenolics, flavonoids, fatty acids, steroids, glycosides, tannins, and reducing sugars. It also offers nutritional advantages, such as a range of vitamins, minerals, proteins, fats, carbohydrates, and fibres. Because of its several therapeutic uses, coriander is utilized as an antibiotic, antifungal, antioxidant, and digestive help during the process of digestion. This review article covers the morphology, phytochemical screening, extraction technique, and various pharmacological actions of the coriander plant.

Keywords: *Coriander Sativum Seeds, Chemical Constituents, Biological Distribution, Methods of Extraction, Photochemical Screening And Pharmacological Activities.*

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I. INTRODUCTION

Traditional herbal medicine continues to be used and is gaining popularity. In order to investigate the biological activities of their bioactive chemicals, this has drawn the attention of numerous researchers and motivated them to screen plants of therapeutic relevance. CORIANDER [1] is an example of a significant medicinal plant.

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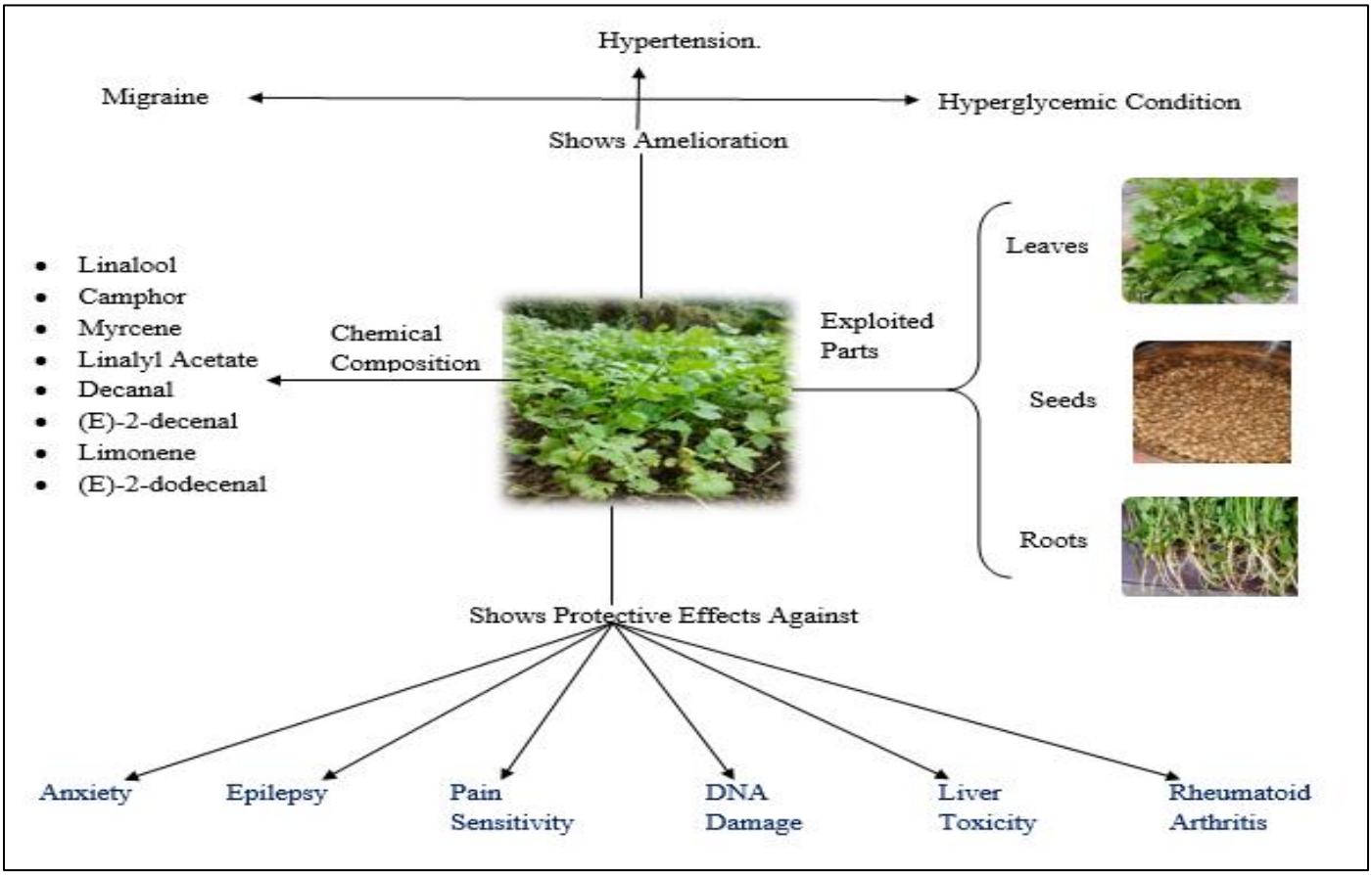

Fig 1: Overview of Coriander

Dhaniya is a synonym. The Umbelliferae family. Since ancient times, this annual herb has been used as a flavouring and medicinal ingredient [2]. Its natural habitat is the Mediterranean and Middle East. It is widely grown in Central and Eastern Europe and several Asian countries. There are medicinal and necessary applications for both the leaves and seeds [3]. Every plant part has been found to contain a variety of chemical substances. These substances include, among others, gallic acid, thymol, and bornyl acetate, which are anticipated to have anti-inflammatory and anti-cancer properties. Linalool, a terpene alcohol with neuroprotective, anticonvulsant, and analgesic properties, is said to be the main ingredient in coriander that contributes to its therapeutic advantages. Every portion of the plant is said to have unique nutritional and therapeutic qualities, and it has been traditionally eaten in a variety of places. Notably, coriander was used in India to treat respiratory, urinary, and gastrointestinal issues. In some parts of Pakistan, the entire plant is also used in traditional medicine to treat vomiting, diarrhoea, and dysentery. Over the past few decades, researchers have studied on biological activities and chemical components[4]. Its pharmacological actions included antibacterial, antifungal, anticonvulsant, antimutagenic, antidiabetic, and antioxidant properties [2]. Food borne illnesses and spoilage can be avoided by using coriander sativum in food preparation and preservation. In Sanskrit, coriander is called "KUSTUMBARI," while in Hindi, it is called "DHANIA." Finally, the plant can be used as a raw material for the food, beverage, and pharmaceutical sectors as well as a Spiece and medication [5].


Fig 2: Coriander Plant

II. TAXONOMY AND BOTANICAL PROFILE OF CORIANDER SATIVUM

The family is known for its aromatic plants, many of which have hollow stem and compounds Umbels flowers. C. sativum is herbaceous and grow annually with height of 20-70cm.

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The taxonomical classifications of C. sativum are as follows: Plantae is the **kingdom**; Tracheobionta is the **subkingdom**; Spermatophyta is the **superdivision**; Magnoliophyta is the **division**; Magnoliopsida is the **class**; Rosidae is the **subclass**; Apiales is the **order**; Apiaceae is the **family**; Coriandrum L. is the **genus**; Coriandrum sativum L. is the **species** [7,8].

Table 1: Coriander sativum (Common names)

Languages	Common names
English	Coriander, Cilantro.
Spanish	Cilantro (seeds), Coriandro (seeds).
French	Coriandre.
German	Koriander.
Italian	Coriandolo.
Portuguese	Coentro.
Arabic	Kuzbara.
Japanese	Korianda.
Bengali	Dhoneypata, Dhoney.
Chinese	Mandarin (Xiangcai).
Persian	Gashneez.
Hindi	Dhaniya.

A. Morphology:

This herbaceous plant is upright and short-lived, typically reaching a height of 1-2 meters.

➢ *Stems and Leaves:*

The branching stems have fine longitudinal (lengthwise) grooves, are mostly hollow, and are glabrous (hairless). Despite their pale green colour, they are dotted with pinkish or purplish areas (fig: 4). The alternate pattern of leaves is supported by long, hollow leaf stalks called petioles, which have a propensity to sheath the stem at their bases. They resemble ferns, are deeply divided (bi-pinnatisect), and have toothed (serrate) segments. Although they are usually 12 to 25 cm long, these glabrous (hairless) leaves can reach lengths of 50 cm and widths of 40 cm. The undersides of the greyish-green, or lighter green, leaves are found in contrast to the top, dark green surfaces(fig: 3). Crushed or broken stems and leaves release an overpowering odour [9,10].

Fig 3: Leaves of Coriander

Fig 4: Stem of Coriander.

➢ *Fruits and Flowers:*

A multitude of white flowers are carried in dense, flat-topped clusters at the tips of the branches (in terminal compound umbels). Individual blooms are small (2-4 mm in diameter), have five incurved petals, and five stamens. They are held on stalks (pedicels) that can grow up to 5 cm in length. An umbel is a little cluster of flowers made up of around fifteen of these stalks, also called pedicels, that radiate from a single point. Several tiny, leafy bracts, each approximately five millimetres in size, support a much larger cluster called a compound umbel, which is made up of six to twenty of these smaller clusters, also called rays. The spring and summer months see the most blossoming. The majority of blossoming occurs in summer and spring (fig: 5). The fruit turns from green to a greyish-brown colour as it ages, giving it a capsule-like appearance. Actually, it consists of two mericarps, which are single-seeded structures that disintegrate readily when the fruit reaches maturity (fig: 6). These seeds are glabrous (hairless), 2-4 mm long, and have five distinct, yellowish-colored ribs [11,12].

Fig 5: Flowers of Coriander

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Fig 6: Fruits of Coriander


Fig 7: Roots of Coriander

➢ *Roots:*

Taproot is a system used by coriander. The roots are lengthy, thin, and have a few tiny branches. It deeply penetrates the soil, facilitating the plant's uptake of water and nutrients from lower soil layers (fig: 7).

B. Distribution:

Coriandrum sativum has been grown since the dawn of humanity. As a spice plant, it is believed to have originated in the Eastern Mediterranean and moved to Morocco, China, India, Russia, and Central Europe [9]. Germany, Hungary, the Netherlands, Poland, Switzerland, Belarus, Estonia, Latvia, Lithuania, Denmark, Finland, Ireland, Norway, Sweden, the United Kingdom, Austria, Belgium, Czechoslovakia, Asia (Afghanistan, Morocco, Tunisia, and Ethiopia), Northern Africa (Algeria, Morocco, Tunisia, and Palestine), Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, China, India, and Pakistan), Moldova, Ukraine, Albania, Bulgaria, Greece, Italy, Romania, Yugoslavia, France, Portugal, and Spain)[10,13].

III. ETHNOBOTANICAL AND ETHNOMEDICINAL USES

A. Ethnobotany:

It is the study of how people in a specific culture and region use plants that are native to the area.

B. Ethnomedicine:

The study of herbal remedies and medicines derived from plants, animals or minerals and used to treat various disease is known as ethnomedicine.

With a long history extending back to approximately 1550 BC, C. sativum is one of the world's oldest varieties of seasoning plants [14]. Around the world, gastrointestinal illnesses, respiratory issues, rheumatism, stomach problems, and helminthic disorders appear to be the most common traditional uses of C. sativum. While the majority of coriander's parts are safe to eat, leaves and fruits are the most frequently used parts in cooking [15]. Coriander fruits are frequently used to spice a wide variety of dishes, including fish, cattle, bread, and other goods. Indigenous societies believe that coriander helps improve memory and consciousness, as well as increase male potency [16]. There are amazing accounts of coriander's ethnomedical uses in traditional European medicine. Fruits have long been used as a carminative, digestive, and appetizer in Turkey [17]. Abdominal pain may be effectively treated by an infusion of the aerial portions [18]. In Germany, digestive issues are treated using koriander leaves and fruits [19]. It is used as an appetiser, an aphrodisiac, a carminative, a stimulant, and a spasmolytic in Greece. It is also used to treat rheumatism, dyspepsia, stomach problems, and the common cold [20]. In the UK, the leaves and fruits are used to cure rheumatism and digestive issues like bloating and flatulence [21]. In Cyprus, the young stems and leaves are used as food flavouring, whereas in Portugal, the aerial portions, or coentro, are used as a condiment [22].The aerial portions are used as an appetiser, carminative, calmative, and antiseptic in Iran, where it is referred to as "Geshniz"[23]. It is thought to be effective in treating genitourinary system diseases in Korea [24]. It is referred to as "Dhanial" in Pakistan and is useful in treating low-grade persistent fever, hyperlipidaemia, headaches, asthma, cough, bronchitis, and respiratory issues [25]. The fruits are used in Indonesia to treat syphilis and relieve rheumatism.It is regarded as an anthelminthic, carminative, stomachic, stimulant, and antispasmodic in Indian traditional medicine [26]. The leaf paste is used orally to cure stomachaches and applied externally to treat allergic irritation in Nepal [27]. It is used as an anthelminthic, carminative, and male aphrodisiac in Iraq [28]. C. sativum, also known as Kasbour, is used by Moroccan traditional medicine practitioners to treat diarrhoea, rheumatic and muscular pains, bladder problems, stomach and intestinal difficulties, and sleeplessness [29]. Ethiopia uses coriander as

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a spice while Egypt uses it to heal foot pain and dizziness [30].

IV. PHYTOCHEMICAL CONSTITUENTS

A range of plant parts, including the leaves, flowers, stem, seeds, roots, and bark, can be used to extract essential oil. Nonetheless, the essential oil's composition may vary depending on the section of the plant. For instance, the essential oil taken from the cilantro seed and immature leaves differs from the essential oil extracted from the flower. Linalool is the primary component of C. sativum oil, which is made from dried and completely mature seeds. It has a moderate, sweet, warm, and aromatic smell and is a colourless or pale yellow liquid with a noticeable odour [31]. Aliphatic aldehydes, primarily C10–C16 aldehydes, which have a disagreeable odour, make up the majority of the volatile oil that is extracted from fresh plants [32]. However, linalool and other oxidised monoterpenes, as well as monoterpene hydrocarbons, are the main constituents of the fruit's oil. Coriander fruit contains 13% to 20% fat oil and 0.2% to 1.5% volatile oil [33]. C. sativum cultivars cultivated in different locales have different essential oil contents and seed yields. The essential oil of C. sativum varies in composition depending on the plant's section.

➢ *The Following are the Essential Oil Variations:*

- Seeds: geranyl acetate, camphor, p-cymene, g-terpinene, alpha-pinene, and linalool [34].
- Flowers: 2,4a-epioxy-3,4,5,6,7,8, methyl ester, benzofuran, and hexadecanoic acid,2-methyoxy-4-vinylphenol, 2,3,5,6-tetrafluroanisole, 2,6-dimethyl-3-aminobenzoquinone, dodecanoic acid, and -hexahydro-2,5,5,8a-tetramethyl-2h-1-benzofuran [35].
- Leaves: cyclodecane, cis-2-dodecena, dodecanal, trans-2-decenal, 2-decen-1-ol, and decanal [36].

Although the essential oil content of C. sativum leaves is lower than that of the fruit, the essential oil content of C. sativum fruits varies greatly, ranging from 0.5% to 2.5% [37] and rising as the fruit ripens [38]. The chemical makeup of raw coriander was primarily composed of linalool, with l-terpinene, alpha-pinene, camphor, limonene, geranyl acetate, and p-cymene following [39]. The maturity of the seed affects the oil's composition.

The qualitative and quantitative constituents of C. sativum oils varied across different plant sections. Linalool, geranyl acetate, and g-terpinene are the main constituents of the 53 compounds in the C. sativum leaf essential oil (CLEO), whereas the CLEO comprises 44 compounds, primarily aromatic acids.

Undecyl alcohol, capric acid, 2-decenoic acid, E-11-tetradecenoic acid, tridecanoic acid, and undecanoic acid are among the main components of CLEO [40]. Linalool, terpinene, a-pinene, camphor, decanal geranyl acetate, limonene, geraniol, camphene, and D-limonene were the primary volatile chemicals identified in CSEO, according to Shahwar et al. [41]. On the other hand, (E)-2-decenal, linalool, (E)-2-dodecenal, (E)-2-tetradecenal, 2-decenal, dodecanal, (E)-2-tridecenal, (E)-2-hexadecenal, pentadecenal, and a-pinene were the primary volatile chemicals identified in CLEO. The flavour and aroma of coriander are attributed to the essential oil (EO) that is present in mericarp oil glands. Linalool, the primary component of essential oil, has a pleasant, flowery scent; the concentration of this compound varies in C. sativum, which is grown in various parts of the world. The following are the chemical structures of the biological components found in coriander sativum:

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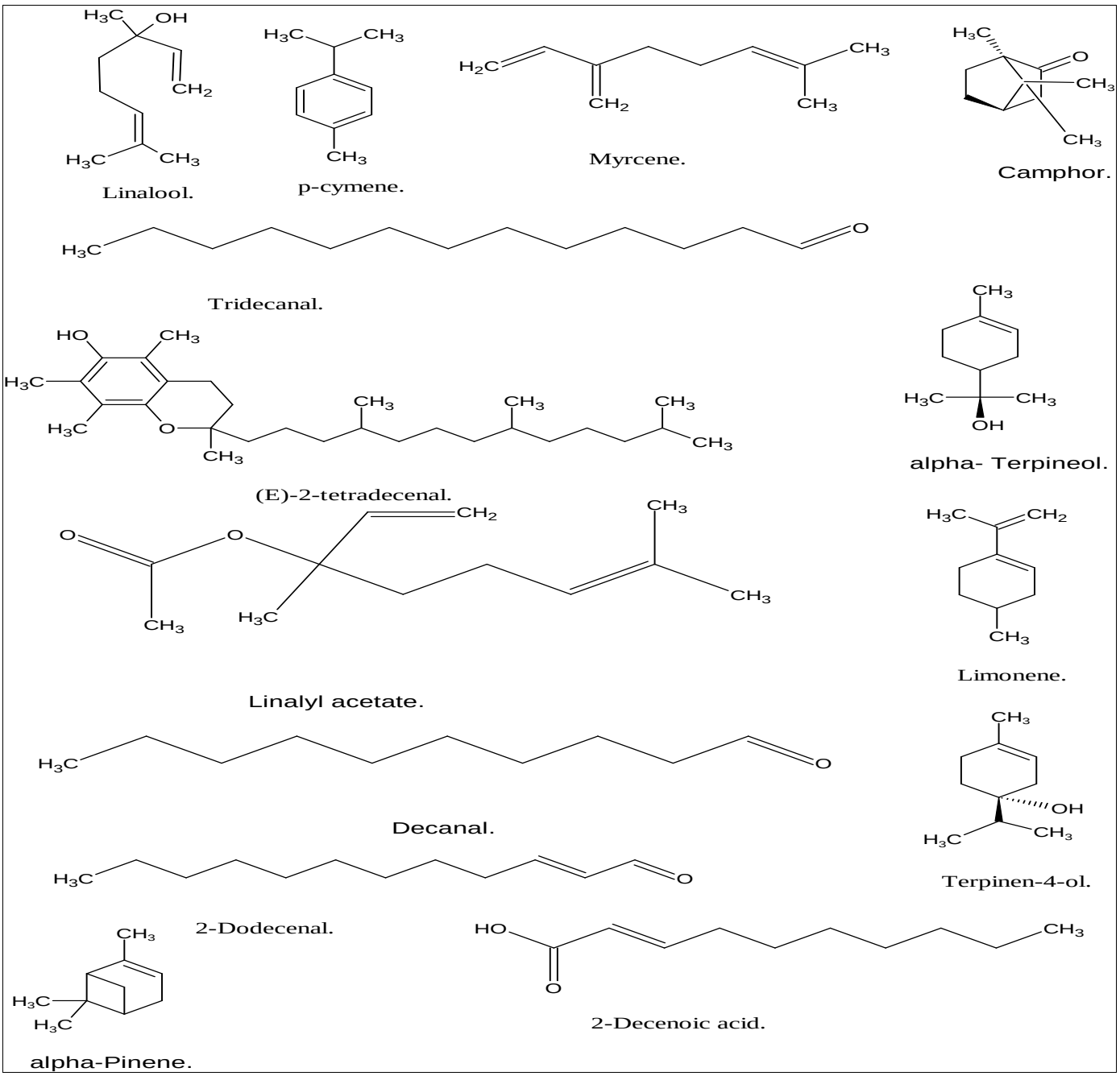

Fig 8: Chemical Structures of Biological Constituents

V. METHODS OF EXTRACTION

To extract bioactive components from Coriander sativum seeds, a variety of techniques can be used. A few extraction techniques are explained here:

A. Hydro Distillation (HD) using the Conventional Clevenger Apparatus:

This technique employed the Clevenger device. After grinding 200 grams of dried coriander seeds, they were put into a 2000 ml balloon and mixed with 1500 ml of distilled water for 240 minutes. According to Salehi Sourmaghi et al. (2014), dry essential oils were collected and kept at -18 degrees C [42].

B. Microwave-Assisted Hydro-Distillation (MAHD):

Using microwave equipment (MicRosynth, Milestone, USA) and temperatures below 100 °C and atmospheric pressure, MAHD was carried out. A 2000 ml flask was microwaved with 1500 ml of distilled water and 200 g of powdered coriander seeds. Using a condenser situated above (outside) the furnace, the extracted essential oil was collected. At 800 W of electricity, the temperature dropped to 100 degrees Celsius for 10 minutes, and then it was removed for 60 minutes at 500 W of power. According to Kosar et al. (2005), ventilation was considered for the final ten minutes [43].

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C. Soxhlet Extraction:

120 ml of methylene chloride were used to extract 15.0 grams of coriander seeds using a Soxhlet equipment. The solvent was extracted under vacuum after 15 extraction exchanges, or around five hours, and the resultant extract was subsequently dried for twenty-four hours at 40 °C. The resulting dry extract (SE) was used for further investigation [44].

D. Ultrasonic-Assisted Extraction:

Ethanolic extracts were first created using ultrasonic technology in order to assess the levels of polyphenols as well as the antibacterial and antioxidant properties of three coriander fractions. In short, the extractions were performed with a 1: 10 (w/v) sample to solvent ratio in 250 mL glass flasks. To do this, 20 g of powder from each half was separately dissolved in 200 mL of 80% ethanol. As previously described by Zekovic et al., ultrasonic-assisted extraction was performed for 40 minutes at a fixed frequency of 40 kHz, 30°C, and 140W of ultrasonic power in a sonication water bath (EUP540A, Euinstruments, France). The glass flasks remained stationary at their predetermined distance from the transducer. Following extraction, the extracts were immediately vacuum-filtered through filter paper and put in a glass container and for further analysis stored at 4 degree Celsius [46, 46].

VI. PHYTOCHEMICAL SCREENING

A. Total Phenolic Contents (TPC):

Following the guidelines provided by Mouhoubi et al. [47], the total phenolic contents (TPC) of extracts of coriander leaves, seeds, and flowers were ascertained using the Folin-Ciocalteu reagent-based approach. To put it briefly, 0.5 mL of the extract was combined with 2.5 mL of the diluted Folin-Ciocalteu reagent (1/10). Following two minutes at room temperature, the mixture was cooled in a water ice bath and then incubated at 50°C for fifteen minutes. The liquid was then supplemented with 2 millilitres of sodium carbonate (75 g/L). The specific absorbance at 760 nm was immediately measured using a Shimadzu UV-Vis spectrophotometer (Model UV-1800, Germany). Using milligrammes of gallic acid equivalents (GAE) per 100 grammes of dry weight (DW), the TPC was calculated.

B. Total Flavonoid Contents (TFC):

Zekovic et al. [46] used the aluminium chloride colorimetric method to determine the total flavonoid concentration (TFC). After measuring the absorbance at 510 nm, a standard diagram was made using quercetin. Milligrammes of quercetin equivalents (QE) per 100 grammes of coriander seeds, flowers, and leaves (mg QE/100 g DW) were used to express the results. To determine the mean values, each experiment was conducted three times.

C. Alkaloids:

The presence of alkaloids was tested using the Dragendorff reagent. Following a 5-minute incubation period in a water bath at 100°C, 0.5 grammes of extract were combined with 1 millilitre of 2N HCl and 9 millilitres of water. The extract was allowed to cool to room temperature before being filtered using Whatman no. 1 filter paper. The filtrate was then mixed with the reagent. A brownish or blackish precipitate will form in the presence of an alkaloid [48].

D. Flavonoids:

NaOH was used to test for the presence of flavonoids. After adding NaOH to two millilitres of the extract, the presence of flavonoids is shown by an appearance of yellow colour. It will be colourless if there are flavonoids and the solution was made with HCl or H2SO4.

E. Saponins:

To determine if saponin was present, 10 millilitres of hot water were added to the entire 0.5 gram extract in a falcon tube. Then, for ten seconds, the falcon tube was rapidly shaking. The appearance of foam that ranges in height from 1 to 10 cm may be a sign that saponin is present. If the foam continue after adding a drop of 2N HCL, saponin is present.

F. Quinones:

One millilitre of water was mixed with 0.1 gram of the extract to check the presence of quinones. A few drops of the extract and two millilitres of strong HCl then added to the test tube. Quinones are present in the extract as indicated by the development of a yellowish precipitate [48].

G. Tannins:

One millilitre of the extract was combined with two millilitres of a 5% ferric chloride solution to test for the presence of tannin. Tannin can be identified by a deep green, blue-black, or brownish-green colouration.

H. Steroid and Terpenoid:

To determine whether the extract contains any terpenoid or steroid components, the Salkowski and Liebermann-Burchard tests were employed. The extract was filtered after being dissolved in 10 millilitres of chloroform. H2SO4 was then added to the extract until a layer developed. If a reddish-brown colouring develops in the interface, a terpenoid is present. To create a layer, the remaining 5 millilitres of the extract were mixed with 1 millilitre of acetic acid anhydride and 1 millilitre of H2SO4. Pink or violet colouring indicates the presence of terpenoids, while green-blue colouring indicates the presence of steroids [48].

VII. PHARMACOLOGICAL ACTIVITIES OF CORIANDER SATIVUM

A. Antioxidant Activity:

One of the primary causes of metabolic syndrome, Parkinson's disease, Alzheimer's disease, stroke, chronic renal illness, chronic pulmonary obstructive disease, and cardiovascular problems is oxidative stress [49,50]. Oral ethanol extract from coriander leaves has been shown to dramatically reduce creatinine, serum urea, and blood urea nitrogen levels in rats with nephrotoxicity [51]. Flavonoids found in the aqueous extract of coriander seeds have also demonstrated a suppressive action against oxidative damage in mice with renal and hepatic lead poisoning. Glutathione (GSH), catalase (CAT), and superoxide dismutase (SOD) levels were increased and lipid peroxidation was reduced when these extracts were taken orally [52]. A significant 1,1-

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diphenyl-2-picrylhydrazyl (DPPH) radical scavenging effect has been shown by coriander fruit methanol extract, indicating the fruit's potential as an antioxidant compounds used in food industry [53].

B. Anticancer:

Phenolic compounds have an antiproliferative effect because they prevent oxidative stress, DNA damage, and abnormal cell formation. The third most frequent disease in the globe for both sexes is bowel cancer, also referred to as colorectal cancer [54, 55]. Applying coriander leaf ethanol extract to HT-29 colon cancer cells resulted in a dose-dependent decrease in cell viability; this discovery may be related to polyphenolic compounds [56]. Linalool is one of the primary components of coriander essential oil. Cell proliferation is somewhat inhibited by this monoterpenoid compound. The cytotoxicity and pro-apoptotic effects of doxorubicin (DOX) on MCF-7 and multidrug-resistant breast cancer cell lines may be amplified by subtoxic doses of linalool. The ability of linalool to encourage DOX accumulation may be the cause of this [57]. The application of 250 µM linalool to HCT-116 colon cancer cells has resulted in cell shrinkage and chromatin fragmentation, both of which may be signs of cell death and apoptosis. Furthermore, subcutaneous tumours in a mouse model of cancer xenograft decreased in size and weight when linalool was administered orally [58].

C. Antiseizure Effect:

Oxidative stress plays a significant role in the aetiology of epilepsy, a rather common neurological disorder [59]. Recurrent seizures, which may raise the brain's concentration of oxygen free radicals and affect a patient's mental and cognitive functioning, are a hallmark of epilepsy, according to Sudha et al. (2001) [60]. For this reason, antioxidants are essential for managing seizures [61]. Coriander extracts improve the brain's antioxidant capacity by reducing malondialdehyde (MDA) levels and increasing total thiol content. Many extracts from coriander aerial parts can significantly lengthen seizure latencies. This activity may be caused by the main component, linalool, which prevents glutamate attachment in the rat brain. The mechanisms via which linalool works on the central nervous system are comparable to anticonvulsant and antianxiety medications [62]. These processes include activation of GABAA/chloride channel receptors and inhibition of voltage-gated sodium and calcium channels [63]. According to in vivo studies employing an epileptic model, minimum-dose linalool lowered the rising phase of action potentials, extended the duration following a shock, and raised the threshold for action potentials. On the other hand, high dosages of linalool stimulated neurones and enhanced epileptogenic activity [64]. The main excitatory neurotransmitter in the brain, glutamate, is elevated in epilepsies and seizures. Linalool can reduce glutamatergic transmission by inhibiting the binding of L-[3H] glutamate, preventing quinine-induced convulsions, delaying the onset of seizures brought on by N-methyl-d-aspartic acid (NMDA), and reducing the levels of cyclic adenosine monophosphate (cAMP) [65].

D. Antimigraine Effect:

Migraine disease is indicated by frequent moderate-to-severe headaches. Headaches often last a few hours to three days, affect half of the head, and pulse naturally [66]. Migraine pain is thought to be associated with neurological pathways that cause neuronal hyperexcitability and cerebral vascular dilatation. One of the primary causes of migraines is thought to be the production of proinflammatory mediators [67]. Linalool cures migraines due to its analgesic and anti-inflammatory qualities. Linalool can lessen migraine symptoms by blocking glutamate transmission since it is an antagonist of the glutamatergic receptor [68]. The nonselective transient receptor potential M8 (TRPM8) channel is susceptible to cooling substances such as menthol and cold temperatures. Two essential parts of the pain neurological system, the trigeminal and dorsal root ganglia, will express more TRPM8 in migraine sufferers [69]. The pathophysiology of migraines is significantly influenced by the expression of this gene, and studies have shown that linalool inhibits this channel [70].

E. Antimicrobial and Anthelminthic Effects:

Among the most well-established biological activity of C. sativum are its antibacterial qualities, which are found in its leaves, seeds, and essential oils. The essential oil significantly inhibited both gram-positive (Staphylococcus aureus and Bacillus spp.) and gram-negative (Escherichia coli, Klebsiella pneumonia, Pseudomonas aeruginosa, Proteus mirabilis, and Salmonella typhi) bacteria [71]. The development of biofilms from S. aureus, E. coli, Stenotrophomonas maltophilia, Campylobacter jejuni, and C. coli may also be considerably inhibited. Therefore, in the food industry, natural preservatives or additives such as linalool and essential oil can increase the food's safety and shelf life. Hexane and chloroform extracts of coriander fruits have demonstrated a strong inhibitory effect against Salmonella enterica, E. coli, P. aeruginosa, and specifically S. aureus biofilm formation. B. subtilis and E. coli growth may be inhibited by methanol and aqueous extracts of the leaves and stems. It is noteworthy that the methanol extract of coriander leaves exhibits a greater inhibitory effect than the other extracts, which may be due to its higher total concentration [72]. Coriander essential oil has shown synergistic activity with six distinct antibacterial drugs, including ciprofloxacin, chloramphenicol, gentamicin, cefoperazone, tetracycline, and piperacillin. Furthermore, coriander essential oil was found to interact with ciprofloxacin, gentamicin, chloramphenicol, and tetracycline in an effort to combat Acinetobacter baumannii. This interaction may indicate the possible effectiveness of the essential oil [73]. The essential oil of coriander seeds has demonstrated antifungal efficacy against Candida albicans, while the essential oil of coriander leaves can inhibit Candida species [74]. While coriander seed essential oils are helpful against Fusarium oxysporum, Curvularia palliscens, F. moniliforme, Aspergillus terreus, and grain insects, Sitophilus granarius, fruit essential oils can reduce strains of Microsporum canis. Coriander seed ethanol extract has the potential to kill adult tapeworms, such as Hymenolepis nana. The effect grew with dosage because greater doses might eliminate the worm faster [75].

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F. Anti-Inflammatory Effect:

Non-steroidal anti-inflammatory drugs, or NSAIDs, are commonly used pharmaceuticals that should be on the WHO Model List of Essential Medicines. The 2016 Global Burden of Disease report found a direct correlation between the usage of NSAIDs and a rise in musculoskeletal disorders. Reports of NSAIDs' capacity to prevent heart attacks and cancer lend credence to its analgesic, anti-inflammatory, and antipyretic qualities. However, the negative effects of NSAIDs on respiratory, cardiovascular, hepatic, renal, cerebral, and pulmonary disorders are distressingly demonstrated by data from several placebo-controlled trials. The market for improved anti-inflammatory medications is expanding as a result [76]. Flavonoids and polyphenols are two examples of plant bioactive compounds that have demonstrated anti-inflammatory properties through specific molecular targets [77]. It has been shown that pre-treating animals with coriander fruit ethanol extract and essential oil will lessen the severity and zone of ulcers in acetic acid-induced colitis. (7α, 8α)−3α-hydroxyl-12,13α-dimethyl-5(6)-en-bicyclo[5,3,0]caprolactone, which was extracted from coriander seeds, demonstrated a potent anti-inflammatory activity by inhibiting NO, with an IC50 value of 6.25 µM [78]. It has led to a reduction in reactive oxygen species (ROS), IL-6, TNF-α, and the expression of inflammatory cytokines such COX-2 and inducible nitric oxide synthase (iNOS) [79].

G. Analgesic Effect:

Several formulations of coriander aerial components have demonstrated analgesic effects. Extracts of ethanol and chloroform performed better than the others [80]. A 50% decrease in discomfort was seen in mice administered 200 mg/kg of coriander seed ethanol extract through the belly [81]. Tail flicking, hot plate, and formalin procedures were used to assess the pain-relieving potential of an aqueous extract of coriander seeds. It was shown that the watery extract had potent, dose-dependent analgesic effects [82]. A number of compounds, such as polyphenols and linalool, may be responsible for coriander's analgesic properties. These medications most likely have an antinociceptive effect through GABAergic transmission, which interacts with the central benzodiazepine receptor [83].

H. Anti Thyroid Effect:

Among the many substances found in Coriander sativum seeds are lignans and phenolic acids, which are categorised as phytochemical components. The compounds in issue are being studied because they may have anti-thyroid peroxidase (anti-TPO) effects. An important enzyme that has a direct role in the synthesis of thyroid hormones is thyroid peroxidase. Coriander Sativum seeds also contain flavonoids, a family of polyphenolic chemicals with strong anti-inflammatory and antioxidant qualities. There might be a connection between thyroid function and these new studies because these flavonoids can reduce inflammation and oxidative stress within the borders of the thyroid gland. The quantity of components present in Coriander Sativum seeds allows for the identification of important essential oils, including geraniol and linalool. By modifying immunological responses, these essential oils have the ability to lessen inflammation, which is strongly associated with several thyroid disorders. An important ingredient in the production of thyroid hormones is iodine. It's noteworthy to note that iodine is present in modest amounts in Coriander Sativum seeds. Nonetheless, research indicates that the seeds' iodine concentration and other ingredients might interact to potentially improve thyroid function in a synergistic way. The fact that iodine supplements are still a commonly used treatment for thyroid disorders is intriguing. In this regard, the measurable iodine concentration of coriander sativum seeds indicates that their prospective health benefits might be amplified [3].

I. Antidiabetic Effect:

Subchronic oral treatment of C. sativum extract decreased increased levels of insulin, insulin resistance (IR), total cholesterol (TC), low density lipoprotein (LDL)-cholesterol, and triglycerides (TG) and restored normal glycemia in an obese-hyperglycemic and hyperlipidemic animal model. Because C. sativum extract decreased atherosclerotic and increased cardioprotective indices, along with several components of the metabolic syndrome, it may have a cardiovascular preventive effect [85].It has been demonstrated that C. sativum extract enhances insulin production, glucose absorption and metabolism, and lowers hyperglycemia [86].

J. Hypotensive Effect:

The main objective of treating hypertension is to manage related illnesses such as heart attack, stroke, and heart failure (HF) [87]. Jabeen et al. (2009) claim that coriander has diuretic effects through a mechanism akin to that of furosemide and nonspecific interaction with muscarinic receptors in endothelial cells [88]. Methanol and aqueous extracts of coriander leaves have demonstrated that sodium excretion in the urine is greater than potassium excretion, which could be a safe profile for diuretic activity [89]. This could be considered a potential hypotensive action.

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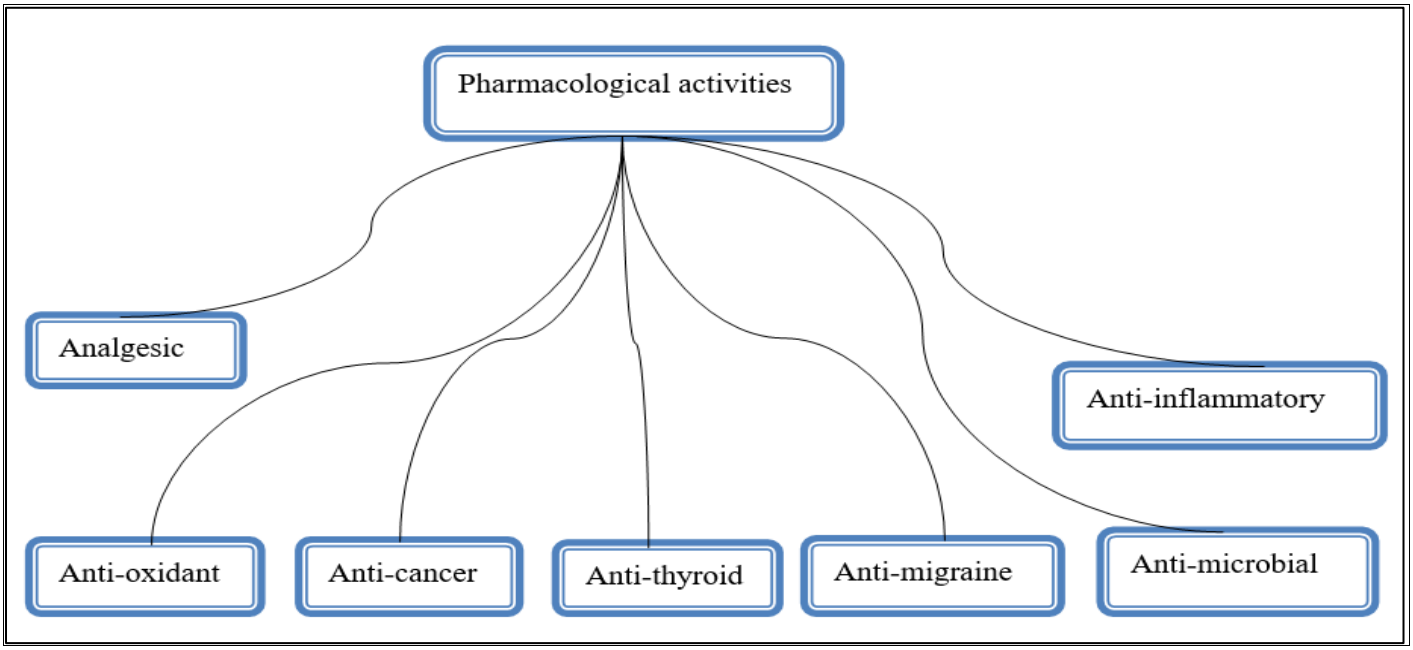

Fig 9: Pharmacological Activities of Coriander Sativum

Table 2: Chemical constituents and Pharm Acological Activity of Coriander sativum.

Sr no.	Pharmacological activity	Chemical Constituents	Reference
1.	Anti-oxidant.	Linalool, p-cymene, myrcene, decanal, tridecanal, (E)-2-tetradecenal, (E)-2-decenal.	[90,93,95,98,99,100,101]
2.	Anti-inflammatory.	Linalool, terpinen-4-ol, myrcene, linalyl acetate.	[90,91,95,97]
3.	Anti- cancer.	Linalool, alpha-terpineol, limonen.	[90,92,93]
4.	Anti- microbial.	Linalool, p-cymene, alpha-pinene ,camphor, linalyl acetate, decanal, tridecanal, (E)-2-tetradecenal, (E)-2-decenal, 2-decenoic acid.	[90,93,94,96,97,98,99,100,101,102]
5.	Anthelmintic	(E)-2-dodecenal.	[103]
6.	Analgesic effect.	Myrcene.	[95]
7.	Antimigraine	Linalool.	[90]
8.	Antiseizure	Linalool.	[90]
9.	Anti thyroid	Linalool, iodine content, flavonoids, lignans.	[90,03]
10.	Antihypertensive	Alpha-terpineol.	[92]

VIII. CONCLUSION

From the above study, it is concluded that coriander sativum seeds have many active constituents, which help to treat many types of the disease. The most active constituents are linalool, p-cymene, myrcene, alpha-terpineol, alpha-pinene, camphor and linalyl acetate and they also consist of different types of alkaloids, i.e., decanal, dodecenal and tetradecenal. Many of the studies in coriander sativum seeds introduced different methods of extraction, like, hydro-distillation using conventional Clevenger apparatus, microwave assisted hydro-distillation, soxhlet extraction, ultra-sonic assisted extraction and etc are most commonly used methods and help to produce high percentage of chemical constituents. The extract, seeds, and oil of coriander sativum have proved to manage hypertension, diabetes, cancer, thyroid disease as well as microbial effect, inflammatory effect, analgesic effect, carminative in humans, which can studied by different in silico or in vivo methods.

FUTURE ASPECTS

The study helps the researchers in finding the ideas about different medicinal activities mainly anti-thyroidal activity, phytochemical screening and methods of extraction of coriander sativum seeds.

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