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Phytochemical, Pharmacological and Antimicrobial Effects of *Coriandrum sativum* extract

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Abstract

Coriandrum sativum belongs to the family Umbelliferae. *Coriandrum Sativum* is native to specific regions. *Coriandrum sativum* is a plant that can reach heights of up to 50 cm. The plant's leaves exhibit a variety of shapes, transitioning from broad and pointed at the base to slender and small as it approaches the flowering stage.The seeds of *Coriandrum sativum*are commonly used as a spice or ingredient in other foods, but can also be consumed alone.Phytochemicals were extracted by using the Soxhlet extraction method. After eight cycles of Soxhlet with ethanol as a solvent, the ethanolic extract of *Coriandrum sativum* was obtained. Plant extract contains organic compounds such as tannins, alkaloids, and carbohydrates, terpenes, steroids, and flavonoids.*Coriandrum sativum* shows excellent a*nti*-inflammatory, antioxidant, antidiabetic, antimicrobial, antifungal, and anthelminthic properties.*Coriandrum sativum*has various health benefits and has great potential to cure various infections such as fungal, and microbial. The research study aims to investigate various phytochemicals and various pharmacological activities of *Coriandrum sativum.*

Keywords: *Coriandrum sativum,* Phytochemical, Pharmacological, Antimicrobial effects.

1. Introduction:

*Coriandrum sativum*has been recognized for best medicinal uses. Secondary metabolites produced by plants such as phytochemicals, are increasingly utilized in food, health, and nutritional products (Rathod et al.,).Coriander (*Coriandrum sativum*.), also known as the "herb of happiness," is a widely used culinary spice and traditional medicine. The phytochemical content of the *C. sativum,* makes it a potentially beneficial meal for preventing lifestyle-related disorders. Coriander has numerous health benefits, including antioxidants, anticancer, neuroprotection, anticonvulsants, migraine relief, hypolipidemia, hypoglycemia, hypotension, antibacterial, anxiolytic, analgesic, and anti-inflammatory properties (Dhakshayani et al., 2022; Prachayasittikul et al., 2018).

Plants provide diverse natural products with unique structures, biological properties, and mechanisms of action. Plants' antioxidant activity is attributed to various phytochemical components such as polyphenols, flavonoids, and phenolic acids. Polyphenols have numerous biological effects, including antioxidant activity, inhibition of peroxidation, and chelation of transition metals (Rajeshwariet al.,2011).

Traditional procedures such as maceration, percolation, and Soxhlet have limitations, including time and solvent use, as well as the destruction of heat-sensitive bioactive chemicals (Palmieriet al., 2020,Azmir et al., 2013).However, the Soxhlet technique is still widely used in laboratories and enterprises for several approved processes (De Castroet al.,2010).

Medicinal plants have been precisely demonstrated to have therapeutic activities such as antihypertensive, anti-inflammatory, Antiatherosclerotic, anti-diabetic,antibacterial, and antifungal properties. They are used to treat a variety of syndromes globally (Anwaret al., 2007).The research shows antibacterial, antifungal, and anthelmintic properties. It has antioxidant, anti-inflammatory, and antidiabetic properties among other pharmacological benefits (Al-Snafi, 2016).Coriander has been documented to have many pharmacological assets, including antioxidant action (Wangensteenet al., 2004: Meloaet al., 2005), antifungal activity (Silva et al., 2011), anthelmintic activity (Silva et al., 2011), anti-diabetic activity (Matasyoh et al., 2009).

*Coriandersativum*is ayearly herb that can be grown in the summer or winter, liableon climatic conditions. *Coriandrum sativum*, also familiar as Dhania, is a green herb used as a spice and vegetable. It has a distinct flavor and is widely consumed in India, where raw leaves and the entire herb are used in various applications. It also shows some antifungal, antimicrobial, antioxidant, anthelmintic, and anti-inflammatory properties and is used in ayurvedic and folk medicine (Hazraet al., 2016). This research aims to inspect thephytochemical and pharmacological assetsofthe local plant known as "*Coriandrum sativum*." This study examined the phytochemicals found in *Coriandrum sativum*, an Indian medicinal herb. The phytochemical substances responsible for the plants' purported medicinal benefits were identified. The yield of extracts gained from these plants using solvent extraction (Njoku and Obi,2009). *Coriandrum sativum* L. contains flavonoids, essential oil, tannins, phenolics, alkaloids, terpenoids, fatty acids, sterols, and glycosides, according to phytochemical screening. The high nourishing value includes proteins, oils, carbs, fibers, minerals, trace elements, and vitamins (Sariet al., 2021; Laribiet al., 2015; Taherianet al., 2012).

We analyzed the extract for the presence of organic compounds like saponins, flavonoids, terpenoids, steroids, alkaloids, tannins, carbohydrates, and glycosides in *Coriandrum sativum*.

2. Materials and Methods

2.1. Collection of plant

Fresh leaves of *Coriandrum sativum*collected from Sangli, Maharashtra, India. The leaves underwent a rinsing process with distilled water.Before being dried in a hot air oven at 40°C. Following this, the dried leaves were fined and crushed into a powder using a grinder. The powder was used for further phytochemical analysis and pharmacological study.

2.2.The plant extract was prepared in the following manner

10 gm of powder was measured and placed into a thimble. The Soxhlet apparatus was set up, with the sample-filled thimble positioned in the extraction column. A volume of 100 ml of ethanol was poured into the flask. Heating was initiated on a heating mantle attached to the Soxhlet apparatus. The extraction procedure was conducted for eight cycles. The resulting extract was collected from the assembly, and any remaining ethanol was evaporated using the

heating mantle. The extract was then stored in a refrigerator. (Njoku and Obi,2009; Mahire and Patel, 2010).

2.3.Phytochemical analysis

2.3.1. Examination for Steroids / Terpenoids

a. Chloroform test

1 ml of the extractcombined with an equal volume of chloroform and concentrated sulfuric acid, followed by gentle heating for 2 minutes. The chloroform layer transitioned to a red hue, while the sulfuric acid layer exhibited a yellow coloration with green fluorescence (Njoku and Obi,2009; Kumar et al., 2014; Yadav and Agarwala, 2011; Fatemaet al., 2019).

b. Liebermann – Burchard Test

1 ml of plant extract treated with chloroform, 1 ml of acetic anhydride, and two to three drops of sulfuric acidwere added to test the sample. The formation of a dark green color signified the presence of steroids/terpenoids (Kumaret al., 2014; Yadav and Agarwala,2011; Fatemaet al., 2019; De Silvaet al., 2017).

2.3.2. Examination for Glycosides

a. Keller-Killiani Test

2 ml of plant extractcombined with an equal amount of glacial acetic acid and ferric chloride solution. This mixturewas then added to a test tube containing 1 ml of concentrated sulfuric acid. At the interface of the two layers, a brown ring appeared, indicating the separation of the layers (Njoku and Obi, 2009, Yadavand Agarwala, 2011).

b. LegalTest

When the plant extract was exposed to a combination of 1 ml of pyridine and 1 ml of sodium nitroprusside, a red hue developed in the test solution (Fatemaet al., 2019).

2.3.3. Test for Carbohydrates

a. Molisch Test

2 ml of Molisch reagent mixed with plant extract thoroughly combined. Then, 2 ml of concentrated sulfuric acid was carefully added down the side of the test tube. At the boundary, a violet ring appeared, suggesting the presence of carbohydrates (Njoku and Obi, 2009; Kumaret al., 2014; Yadavand Agarwala, 2011; De Silvaet al., 2017).

b. Benedict Test

The plant extract was mixed with 2 ml of Benedict's reagent and kept in a boiling water bath for 10 minutes. A brick-red color shown by the test sample indicates thatcarbohydrateswerepresent in the plant extract (Yadavand Agarwala,2011; Fatema et al., 2019; De Silva et al., 2017).

2.3.4. Examination for Alkaloids

a. Mayer's Test

The plant extract underwent treatment with Mayers reagent. Precipitation of the test sample was taken as evidence that alkaloids were present in the extract (Rathod et al.; Yadavand Agarwala, 2011; Fatema et al., 2019; De Silvaet al., 2017).

2.3.5. Examinationfor Phenol

a. Ferric Chloride Test

An ethanolic plant extract and ferric chloride solution were introduced in a test tube. The blue-green color formation showsthe presence of phenols (Njoku and Obi, 2009; Kumar et al., 2014; Yadavand Agarwala,2011; De Silva et al., 2017).

2.3.6. Examinationfor Proteins

a. Millon's Test

2 ml of Millon's reagent mixed with plant extract, resulting in the development of a white precipitate. Upon gentle heating, the precipitate transformed into a red color, validating the existence of protein in the extract (Yadav and Agarwala, 2011; Fatema et al., 2019; De Silva et al., 2017).

b. Ninhydrin Test

When theextract was heated with 2ml of 0.2% Ninhydrin solution,a violet hue developed in the solution, indicating the presence of proteins (Yadavand Agarwala,2011; De Silvaet al., 2017).

2.3.7. Test for Flavanols

a. Lead acetate solution test

When the plant extract came into contact with lead acetate solution, the development of precipitate, suggesting flavanols are present(Njoku and Obi, C 2009; Kumar et al., 2014; Fatema et al., 2019; De Silva et al., 2017).

b. Shinoda test

The plant extract was mixed withpieces of Magnesium ribbon, andconcentrated HCL was added to the test solution. Afterward, the test sampleexhibited a pink to red coloration (Njoku and Obi, 2009; Yadavand Agarwala, 2011; De Silvaet al., 2017).

c. Test using Alkaline Reagent

The plant extractwas blended with 2 ml of a 2% sodium hydroxide solution. The resulting test sample displayed a bright yellow color, which subsequently disappeared upon the addition of two to three drops of dilute acid, suggesting the flavonoids are present (Yadav and Agarwala,2011; Fatemaet al., 2019; De silva et al., 2017).

2.4.Pharmacological Analysis

2.4.1. Anti-inflammatory activity by Protein denaturation assay

Any physical injury or destruction of body cells or infection is known as inflammation which is categorized by swelling, redness, heat, and discomfort (Chandra et al., 2012; Madhurangaand Samarakoon, 2023). Inflammation is our body's protective response against tissue damage by trauma, microbial infections, or harmful chemicals in which the body responds to defuse the invasive organisms and ready for tissue curing(Chandraet al., 2012; Madhuranga and Samarakoon, 2023). The goal behind the protein denaturation assay is to check whether the extract can stop the egg albumin protein from denaturation. Denaturation means the structural changes and also changes in biological activity (Clark,1943). The protein denaturation assay is carried out to determine the capacity of the compound to prevent protein denaturation which evaluates the compound's capacity for reducing inflammation (Goryanin et al., 2022).

0.4 ml of fresh egg albumin and 5.6 ml of freshly prepared phosphate buffer saline was mixed in tubes. 200 microliters of plant extract at different concentrations were added to the reaction mixture in each tube. The tubes were first kept at surrounding temperature for 10 minutes,heating themixture at 70°C for 15 minutes. Subsequently, the optical density (OD)was measured at 530 nm. Diclofenac sodiumis utilized as a standard drug in the reaction. Finally, the percentage of inhibition was determined using a specific equation:(Foudahet al., 2021).

$$Percentage\ of\ inhibition\ (\%)\ =\ 100\left(1-\frac{A_{test}}{A_{control}}\right)$$

2.4.2. Evaluation of anti-inflammatory properties using the Human Red Blood Cell (HRBC) assay

Inflammation is a protective response by an organism's body against tissue damage and starts to recover damaged tissues (Madhurangaand Samarakoon; Ferrero-Miliani et al. 2007). Pain, Heat, Swelling, and Redness are general signs of inflammation (Ferrero-Milianiet al. 2007; Celsus, 1935). Anti-inflammatory medications mainly work by blocking the activity of cyclooxygenase enzymes, which are in charge of converting arachidonic acid into prostaglandins. Because the membranes of human red blood cells (HRBCs) bear resemblance to lysosomal membrane apparatuses, the suppression of hypotonicity-induced

HRBC membrane lysis served as a stand-in for assessing the anti-inflammatory effects of the Coriandrum sativum extract(Nagaharika andRasheed, 2013).

Isolated RBC and the test sample of various concentrations were added in test tubes.The reaction mixture was left to incubate at 37℃ for a duration of 30 minutes. after an incubation period, the absorbance of the reaction mixture was measured at 530 nm and then the percentage of inhibition was calculated by the given formula (Foudahet al., 2021).

$$Percentage\ of\ inhibition\ (\%)\ =\ 100\left(1-\frac{A_{test}}{A_{control}}\right)$$

2.4.3. Estimation of antioxidant activity using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay

Oxidants are free radicals thatshow oxidation, antioxidants are inhibitors of Oxidants. Syntheticanti-oxidantscause various health issues like cancer(Labo et al., 2010). Anti-oxidant activity of *Coriandrum sativum*was determined by DPPHassay(Alqarni et al., 2019).

Several concentrations of plant extracts were mixed with DPPH and incubated at 37℃ at dark conditions. DPPH scavenging a free radical. Following the incubation period, the absorbance of a specific tubewas recorded at 530 nanometers. The percentage of free radical scavenging potential (FRS) of DPPH was calculated using the provided formula (Foudahet al., 2021).

$$FRS\ (\%)=\ 100\left(1-\frac{A_{test}}{A_{control}}\right)$$

2.4.4. Anthelmintic assay

Both men and animals are susceptible to parasitic helminths, which results in severe suffering and stunted growth. The majority of helminth-related illnesses are chronic and debilitating; more morbidity and economic and social hardship among people and animals are likely caused by helminths than by any other category of parasites (Kapoor, 2017).

Two sets were prepared of an adult and equal sized earthworm. Six earthworms are kept in each set. In first set the standard drug was poured on earthworms. And in another set the plant extract was poured. After that time of paralysis and time of death was observed.

2.4.5. Antimicrobial assay

Many types of diseases attacking on human health. Some infections are due to themicroorganism. Due to uncontrol use of drugs these microorganisms are resistant to this drug (Davies and Davies,2010). Although artificial antibiotics are widely available, each has its unique set of side effects. Scientists are looking for natural antibiotics, notably from plants(Kumaret al., 2014; Ali and Malik, 2021; Laribiet al., 2015). Antimicrobial action of *Coriandrum sativum* was studied by well diffusion method (Bakhtet al., 2011).*Staphylococcus aureus* was used as test organism to check an antimicrobial activity.

A bacterial suspension of 100 microliters was evenly spread onto a growth medium. Wells of 6 mm diameter created on the medium using a sterile well borer. Different concentrations of the extract were diluted in Dimethyl sulfoxide (DMSO). These dilutions were then placed into the wells and incubated atof 37 ℃ for 24 hours. Zone of inhibition measured.

2.4.6. Antidiabetic assay

Diabetes stands as a significant contributor to premature mortality on a global scale, with a person succumbing to diabetes-related complications approximately every ten seconds, predominantly due to cardiovascular issues. Statistics from 2007 indicate that diabetes was responsible for 3.5 million deaths worldwide (Das and Rai, 2008; Narkhede et al., 2011). Despite advancements in modern medicine, traditional remedies involving medicinal plants continue to be prevalent in treating various human ailments. Ancient healing systems such as Chinese, Ayurvedic, and Unani medicine, which have flourished over the past 2500 years, particularly in the eastern regions, highlight the enduring influence of natural remedies

(Mamum-or-Rasidet al., 2014). The antidiabetic potential of *Coriandrum sativum* was evaluated using the α-amylase method.

In test tubes, 0.5 ml of different concentrations of plant extract and 0.5 ml of α-amylase enzyme were combined. Additionally, 0.5 ml of 1% starch solution were added. Subsequently, 0.5 ml of 3,5-Dinitrosalicylic acid (DNSA) were introduced into the reaction. The reaction mixture was then incubated, and the absorbance of reaction mixture measured. Finally, the percentage of inhibition was determined using the provided formula (Foudah et al., 2021).

$$Percentage\ of\ inhibition\ (\%)\ =\ 100\left(1-\frac{A_{test}}{A_{control}}\right)$$

2.4.7. Anti-fungal assay

Fungi are commonly found in the environment, leading to increased infection from fungal infections (Websteret al., 2008; Fleminget al., 2002; Walsh and Groll,1999).Mycotoxin contamination of grains, particularly from Aspergillus species, renders a major amount of agricultural produce unsafe for human consumption in the country and globally(Satish et al., 2007; Chandra and Sarbhoy,1997; Thirumala-Deviet al., 2001).

Antifungal activity of *Coriandrum sativum* against *aspergillus nigar* was evaluated using the adar well diffusion technique. 100 µl of *aspergillus nigar* suspension was spread on a sabouraud agar. 100 µl of extract of eachconcentration prepared in DMSO added in well, theplates were left to incubate at ambient temperature for 24 hours. The zone of inhibition was measured.

3. Results

3.1.Phytochemical examination

Phytochemical examination not only helps to reveal the constituents of plant extracts and which one predominates over the others, but it was also useful in screening of steroids/ Terpenoids, Glycosides, Carbohydrates, Alkaloids, Phenol, Proteins, Flavanols that can be used in the synthesis of useful drugs.Phytochemical examination of *Coriandrum sativum* showed the Steroids/ Terpenoids, Carbohydrates, Flavanols, Proteins,(Table 1) and Glycosides, Alkaloids, Phenol are absent (Table 2).

Table 1: Phytochemical analysis of *Coriandrum sativum*

Sr. No	Chemical constituents	Tests	Results
1	**Steroids/ Terpenoids**	1. Chloroform test 2. Salkowski test 3. Liebermann Burchard test	**+** **+** **+**
2	**Glycosides**	1. Keller Killiani test 2. Legal test	**-** **-**
3	**Carbohydrates**	1. Molisch's test 2. Benedict's test	**+** **+**
4	**Alkaloids**	1. Mayer's test	**-**
5	**Phenol**	1. $FeCl_3$	**-**
6	**Proteins**	4. Millon's test 5. Ninhydrin test	**+** **-**

7	**Flavonols**	1. Lead acetate solution test 2. Shinoda test 3. Alkaline reagent test	**+** **-** **-**

3.2. **Assessing anti-inflammatory activity through a protein denaturation assay**

The premise behind the protein denaturation assay is that substances possessing anti-inflammatory properties have the ability to stabilize protein structures, thus preventing denaturation, a process often linked with inflammation and tissue damage. To assess the anti-inflammatory potential of *Coriandrumsativum*, a protein denaturation assay conducted (Table 2 and Figure 1).

Table 2: Assessing anti-inflammatory activity through a protein denaturation assay

Concentrations	**O.D at 530 nm**		**Percentage of inhibition (%)**	
	Standard	Sample	Standard	Sample
200 µg/ml	0.90	0.89	25	25.83
400 µg/ml	1.01	0.50	15.83	58.33
600 µg/ml	1.15	0.52	4.16	56.66
800 µg/ml	0.75	1.11	37.5	7.5
1000 µg/ml	1.02	0.76	15	36.66

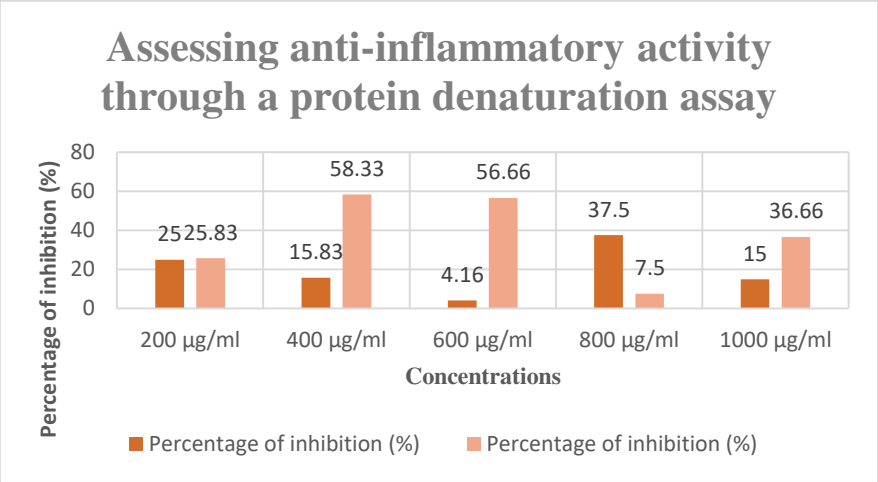

Figure 1: illustrates the anti-inflammatory activity assessed through a protein denaturation assay

3.3.**Anti-inflammatory activity by HRBC assay**

The HRBC assay was chosen to evaluate the in vitro anti-inflammatory effects because of similarity between the lysosomal membrane and erythrocyte membrane. The stability observed in erythrocytes implies that the extract may also have a stabilizing effect on lysosomal membranes. Anti-inflammatory capacity of Coriandrum sativum assessed by the HRBC method (Table 3 and Figure 2).

Table 3. Anti-inflammatory activity by HRBC assay

Concentrations	O.D at 530 nm		Percentage of inhibition (%)	
	Standard	Sample	Standard	Sample
200 µg/ml	1.24	0.09	24.39	94.5
400 µg/ml	1.36	0.15	17.07	90.85
600 µg/ml	1.40	0.24	14.63	85.36
800 µg/ml	1.44	0.31	12.19	81.09
1000 µg/ml	1.48	0.38	9.75	76.82

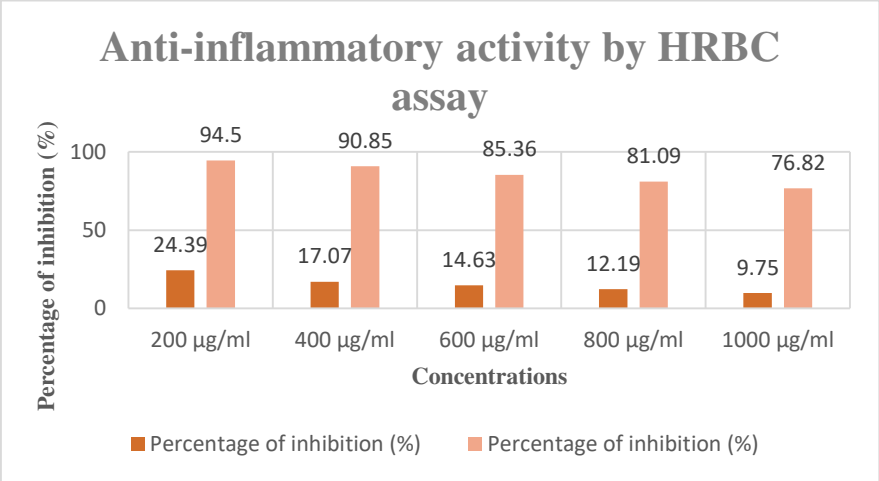

Figure 2: anti-inflammatory activity by HRBC method

3.4.**Assessment of antioxidant potential using the DPPH method**

The DPPH assay, known for its simplicity, speed, affordability, and widespread application, serves as a common technique for evaluating the potential of compounds to scavenge free radicals or donate hydrogen, as well as for assessing the antioxidant properties of various foods. In the case of *Coriandrum sativum*, the antioxidant activity was determined using the DPPH assay (Table 4 and Figure 3). This method can also be utilized to measure antioxidants in intricate biological systems, accommodating both solid and liquid samples.

Table 4. Antioxidant activity by the DPPH method

Concentrations	O.D at 510 nm		Percentage of FRS (%)	
	Standard	Sample	Standard	Sample
200 µg/ml	0.03	0.03	93.18	93.18
400 µg/ml	0.05	0.07	88.63	84.09
600 µg/ml	0.06	0.12	86.36	72.72
800 µg/ml	0.07	0.14	84.09	68.18
1000 µg/ml	0.08	0.20	81.81	54.54

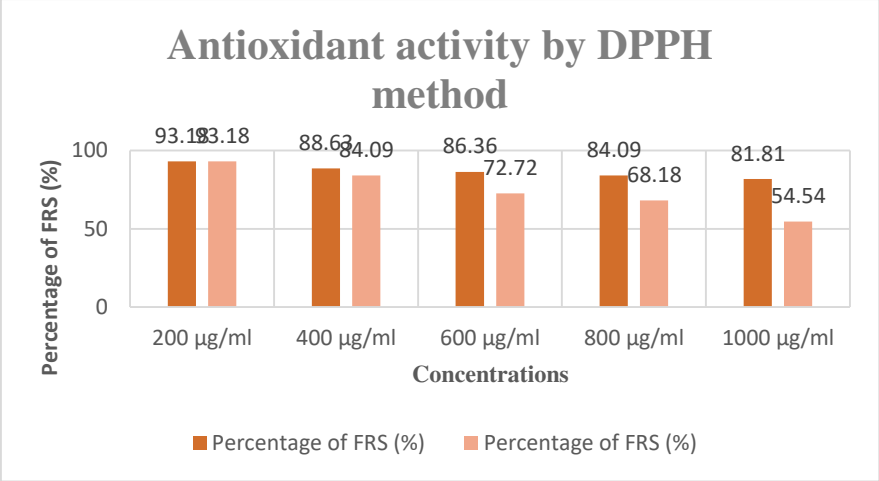

Figure 3: Antioxidant activity by DPPH method

3.5.**Anthelmintic activity**

Anthelmintic assay was performed the anthelmintic activity of *Coriandrum sativum* (Table 5).For this assay, an earthworm was used.

Table 5.Anthelmintic activity

Sr.no	Time of paralysis in minutes		Time of death in minutes	
	Control	Test sample	Control	Test sample
1	1.3	1.58	18.4	12.6
2	1.17	2.16	17.1	12.40
3	1.22	2.46	16.0	14.39

3.6.**Antimicrobial activity**

Antimicrobial activity is the capacity of extract to obstruct growth of microorganisms. These microorganisms cause infection to the animals, humans, and plants. *Coriandrum sativum* showed a good antimicrobial activity. We determine the antimicrobial activity of *Coriandrum sativum* by antimicrobial assay (Table 6).*E. coli* and *S. aureus* were used for antimicrobial activity.

Table 6. Antimicrobial activity

Sr.no	Standard in mm	Test Sample in mm
1	30	12
2	22	13
3	34	11

3.7.**Antidiabetic assay**

To check the ability of plant extract to restore the function of pancreatic tissue to secrete Insulin is the motive behind the antidiabetic assay. Antidiabetic assay by α-amylase was performed to determine the antidiabetic activity of *Coriandrum sativum*(Table 7, Figure 4).

Table 7. Antidiabetic activity by α-amylase method

Concentrations	O.D at 540 nm		Percentage of Inhibition (%)	
	Standard	Sample	Standard	Sample
200 µg/ml	0.70	0.68	27.83	29.89
400 µg/ml	0.71	0.67	26.80	30.92
600 µg/ml	0.70	0.68	27.83	29.89
800 µg/ml	0.71	0.70	26.80	27.83
1000 µg/ml	0.69	0.74	28.86	23.71

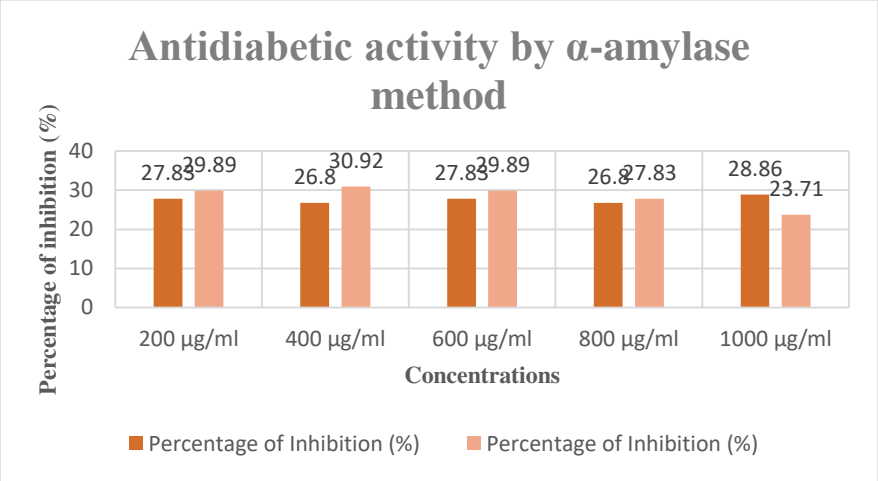

Figure 4: Antidiabetic activity by α-amylase method

3.8.**Antifungal activity**

The primary aim of the antifungal assay is to assess the effectiveness of the plant extract against fungal growth or to regulate its activity to inhibit fungal proliferation. The antifungal potential of *Coriandrumsativum* was evaluated (Table 8).

Table 8. Antifungal activity

Sr.No.	Standard in mm	Test Sample in mm
1	16	11
2	17	13
3	22	11
4	15	12

4. Conclusion

The result reveals the presence of plant compounds like steroids-terpenes/ terpenoids, glycosides, carbohydrates, alkaloids, phenol, proteins, and flavanols. Due to presence of these plant compounds, plant shows tremendous medicinal properties such as antimicrobial, antifungal, anthelminthic, anti-inflammatory, and antidiabetic activity. The plant *Coriandrum sativum* has good potential to act as the pharmacological components against the various infections.*Coriandrum sativum* has various health benefits such as helps in proper digestion, helps to prevent diseases, and control diabetes. It's uses in the daily routine diet is too much beneficial and acts as immunity enhancer for the human population. Present study shows the magnificent results of *Coriandrum sativum*extracts. From the current study, we concluded

that the plant *Coriandrum sativum*shows medicinal properties, it will help to treat and prevent many infections. Also, we recommended that the more study related the medicinal uses of *Coriandrum sativum*is required.

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Author contribution

NK and PM: conducted experiments and wrote the manuscript, MM and DK: analyzed the data, BP and GU: reviewed the manuscript, AJ: conceptualization, and finalized the manuscript.

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Ethical approval

This research article does not contain any studies with human participants or animals performed by any of the author.

Competing interest

The authors declare no competing interest.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

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