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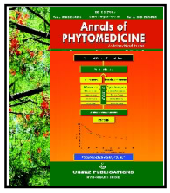

Original article

# Antimicrobial and antioxidant activity of *Coriandrum sativum* L.

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**Abstract**

Coriander is an annual herb which belongs to the Apiaceae family, its leaves and roots have been widely used as spice. It is a good source of dietary fibre which helps in preventing constipation and ensures proper bowl movement. Roots are used to make curries and soups. Whole plants are eatable, but the fresh and green leaves are used traditionally in cooking and as medicine. This traditional plant has been also used as anti-inflammatory, analgesic and antimicrobial agent. In present study, the antimicrobial and antioxidant potential of this well known spice have been assessed using standard protocols. The obtained results showed that the leaves, roots and their juice have remarkable efficacies against selected pathogenic strains of bacteria and fungi. Further, the leaves have significant antioxidative properties. On the basis of results, it is evident that the daily use of this precious plant is beneficial for the human health in many ways.

**Keywords:** *Coriandrum sativum* L., polyphenolic compound, antioxidant, antimicrobial agent

## 1. Introduction

Plants have always found a special mention in Indian culture and rituals. In India, about 45,000 species of plants are reported among them, around 20,000 have some medicinal properties; however, traditional practitioners use only 7,000-7,500 plants for treatment. Plants are the main sources of natural products and these products differ in their biological properties, structures, and mechanism of action (Rajeshwari and Andallu, 2015; Ansari, 2016).

*Coriandrum sativum* L. is a commonly used spice in the sub-continent. All parts of this plant have medicinal uses. Leaves of coriander contain a high amount of protein, calcium, phosphorus, zinc, iron and vitamins. The leaves of coriander contain fatty acids, low amount of essential oils and are the source of major phenolic acids like vanillic, p-coumaric, cis-ferulic and trans-ferulic acids. Phenolic compounds play a significant role as antioxidants (Rajeshwari and Andallu, 2014). The fruits are used to cure diseases related to digestive system, respiratory and urinary track problems, constipation, intestinal worms, rheumatism and joint pain (Wangensteen *et al.*, 2004; Pathak *et al.*, 2011). It is also used to cure insomnia, anxiety, and convulsion very effectively (Emamghoreishi and Heidari-Hamedani, 2008). Silva *et al.* (2011) reported that essential oil of coriander inhibits a broad spectrum of micro-organisms. Use of coriander seed and leaves in daily diet helps in controlling cholesterol and blood pressure.

The present work is conducted to optimise the extraction of the phenolic acids present in *C. sativum* and study their antimicrobial and antioxidant properties.

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## 2. Materials and Methods

### 2.1 Collection and identification of plant sample

In the present study, the whole plants of coriander plants were collected from the medicinal garden of Banasthali Vidyapith. The voucher specimen was submitted to the Banasthali Vidyapith Herbarium (BURI). Fresh leaf sample was used to perform the experiments.

### 2.2 Test organism

For studying the antimicrobial activity, bacteria strains *Escherichia coli* and *Bacillus subtilis* and fungal strains *Aspergillus niger*, *Fusarium oxysporum* and *Macrophomina phaseolina* obtained from MTCC, Chandigarh were used.

### 2.3 Extraction

Extraction of phenolic acids was done for alcoholic (80%) methanol (M), acidic (0.1 N HCL) methanol soluble (HM), alkaline (1N NaOH) methanol soluble (NM) extraction by following the method of Harborne (1998), in which the stock solution was prepared from each of the crude extracts such as hexane, chloroform, ethyl acetate, butanol and methanol extracts (100 mg); and was dissolved in 10 ml of its own mother solvents. The obtained stock solutions were subjected to preliminary phytochemical screening according to the method of Chakraborty and Mandal (2008) with slight modification.

### 2.4 Total phenolic content

Fresh leaves were used to determine total phenolic content. Total phenolic content was observed by using Folin-ciocalteau reagent and expressed as gallic acid (GA) equivalents (Singleton *et al.*, 1999).

### 2.5 Total antioxidant activity

Total antioxidant activity of sample extract was determined by following the method of Prieto *et al.* (1999), which is based on the reduction of phosphomolybic acid to phosphomolybdenum.

### 2.6 Free radical scavenging activity

Free radical scavenging of sample extracts was observed following the protocol of Singh *et al.* (2002) using DPPH (1, 1 dihydroxy 2-picryl hydrazyl), a stable free radical.

### 2.7 Reducing power

The reducing power of sample was observed following the method of Oyaizu (1986). Ascorbic acid was used as standard.

### 2.8 Antimicrobial activity

#### 2.8.1 Antibacterial assay

Broth dilution method (Bais *et al.*, 2002) was used to test antimicrobial activity in phenolic extracts. Minimum Inhibitory Concentration (MIC; 1 mg/l) and minimum bactericidal concentration (MBC; 1 mg/l) of extract were used, inoculum (100, 200, 300 µl) was added to culture medium supplemented with various concentrations of extract. Individual bacterial culture without extract was used as control. After 24 h, bacterial growth was measured at 540nm.

#### 2.8.2 Antifungal assay

The protocol of Chakraborty *et al.* (2007) was followed to test the antifungal activity of phenolic extracts. Phenolic acid extracts were added potato dextrose broth medium (15 ml). The fungal mycelia were transferred to the PDB medium in conical flasks and various concentrations (150 µl and 300 µl) of extract were added and incubated at 37°C. The dry weight of fungal mycelium was measured by filtering and drying it in oven at 50°C. Antifungal index was calculated as follows:

Antifungal index (AI %) = 1 – (Wa/ Wb) × 100; where, Wa is the weight of fungal mycelia in the experimental set and Wb is the weight of mycelium in control set.

### 2.9 Statistical analysis

All experiments were repeated at least thrice. The data represented are as Mean ± standard deviations (SD) of all the three replicates. Difference between values significantly ($p$<0.05) are compared using LSD, at the same (5%) probability level. Values of $LC_{50}$ were calculated by using R version 2.9.0 (2009-04-17), Copyright (C) 2009.

## 3. Results

The amount of total phenolic acids and total antioxidant activity in coriander leaves is represented in Table 1. It is observed that maximum amount of phenolic acids is present in the alcoholic extract, followed by aqueous acidic extract and alkaline extract. In *C. sativum*, a high level of total antioxidant activity, DPPH scavenging activity and reducing power was detected in alcoholic extract while it was low in the alkaline extract.

The antibacterial activity of *C. sativum* plant extracts is represented in Table 2. The alcoholic extracts show low $LC_{50}$ values for both *E. coli* and *B. subtilis* strains which indicate their efficacy in controlling the bacterial strains.

The antifungal activity of *C. sativum* plant extracts expressed as AI% is represented in Table 3. In the present investigation, it was found that the alcoholic fractions were more effective against *A. niger* and *F. oxysporun*, but it is less effective against *M. phaseolina*. Among the fungi tested, *Aspergillus* and *Fusarium* spp. produce a large number of chemically diverse mycotoxins. While *Aspergillus* is associated with rancidity of food items, *Fusarium* and *Macrophomina* spp. infect crop plants inflicting widespread damage.

**Table 1:** Total phenolic content and antioxidant activity of *C. sativum* leaf extract

| Plants | Extract | Total phenolic content GA equivalent (mM $g^{-1}$ fwt)* | Total antioxidant activity AA equivalent (µM $g^{-1}$ fwt)* |
|---|---|---|---|
| *C. sativum* | Alcoholic | 3.169 ± 0.012 | 3.75 ± 0.03 |
| | Aq. Acidic | 2.909 ± 0.024 | 1.37 ± 0.04 |
| | Alkaline | 1.959 ± 0.037 | 0.78 ± 0.02 |
| | Sig., LSD | 0.00 ± 0.008 | 0.00 ± 0.04 |

Values followed by the same alphabet in a column are statistically not significantly different at $p$=0.05 following ANOVA and LSD

**Table 2:** Antibacterial activity represented as $LC_{50}$ values of *C. sativum* leaf extract

| Bacteria | Extract | $LC_{50}$ (mg/ml) |
|---|---|---|
| *E.coli* | Alcoholic | 25.88 |
| | Aq.acidic | 44.62 |
| | Alkaline | 97.91 |
| *B.subtilis* | Alcoholic | 20.57 |
| | Aq.acidic | 23.26 |
| | Alkaline | 28.67 |

**Table 3:** Antifungal activity represented as antifungal index (AI%) of *Coriandrum sativum* leaf extracts

| Fungus | Extract | AI% |
|---|---|---|
| *A. niger* | Alcoholic | 69.48 |
| | Aq. Acidic | 36.48 |
| | Alkaline | 10.63 |
| *F. oxysporun* | Alcoholic | 81.87 |
| | Aq. Acidic | 40.71 |
| | Alkaline | 05.28 |
| *M. phaseolina* | Alcoholic | 49.13 |
| | Aq. Acidic | 46.76 |
| | Alkaline | 16.61 |

## 4. Discussion

Plants are the natural source of phenolic compounds, which play significant role in plant defence mechanism (Nehetea *et al.*, 2010; Mandal *et al.*, 2010; Fahim *et al.*, 2017). Organic solvents like methanol and ethanol have traditionally being used in extraction of phenolic acids from plant material, but extraction at acidic pH sometimes gives better yield (Mattila and Kumpulainen, 2002; Wang *et al.*, 2004; Nix *et al.*, 2017).

Oxidation of molecules is a natural process which produces free radicals in body. When in excess, the group of free radicals start chain reaction that damage cells and cause diseases in the body. Antioxidants are capable in inhibiting chain reaction of free radicals because of redox properties (Kaur and Kapoor, 2002; Nooreen *et al.*, 2018).

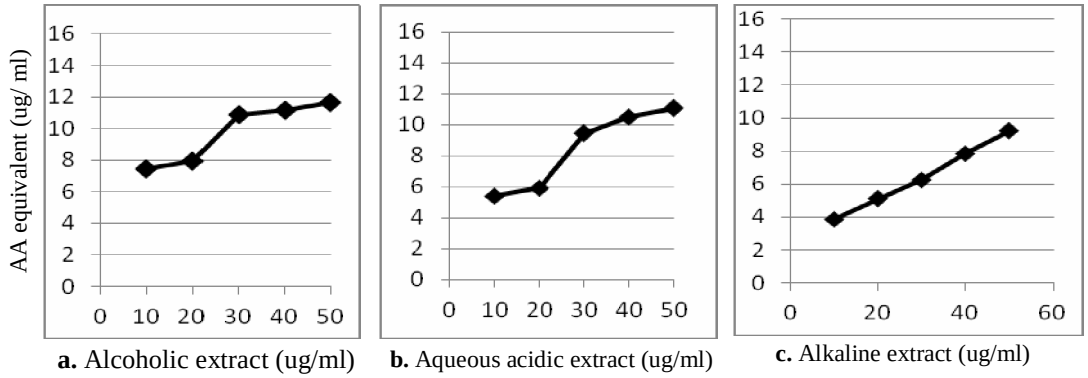


**Figure 1:** DPPH - Free radical scavenging activity of (a) Alcoholic extract, (b) Aqueous acidic extract, (c) Alkaline extract of *C. sativum.*

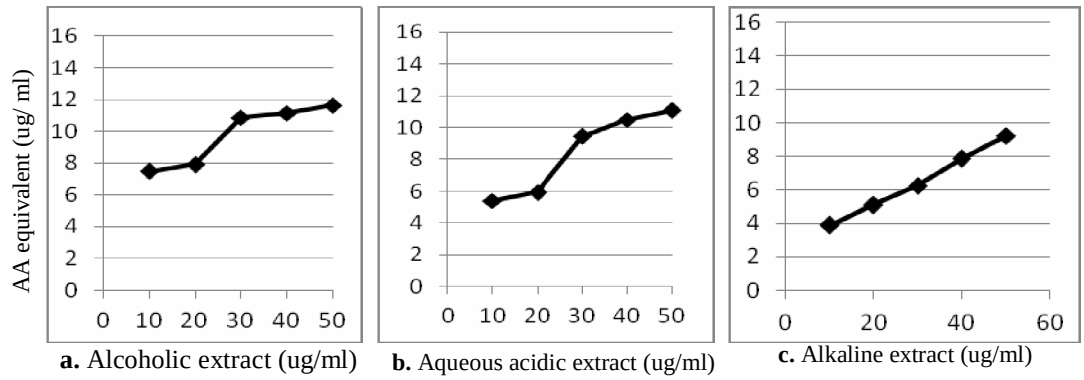


**Figure 2:** Reducing power of (a) Alcoholic extract, (b) Aqueous acidic extract, (c) Alkaline extract of *C. sativum.*

Phenolic compounds of plants are secondary metabolites which play a significant role in tide over oxidative stress working as antioxidants (Grassmann *et al*., 2002; Urquiaga and Leighton, 2000). Exponential addition of antioxidant impact is the function of development of the reducing power, which demonstrates the antioxidant properties are concomitant with the development of reducing power (Oyaizu, 1986). Uses of artificial antioxidant affect our health and, therefore, it is necessary to substitute them with naturally occurring antioxidants (Amie *et al.,* 2003; Aqil *et al.,* 2006; Pourmorad *et al.,* 2006). Home grown therapeutic plants like coriander are rich in natural antioxidants (Cesquini *et al.,* 2003).

Alkaline fraction was less effective against all the three fungal strains. Delaquiset *et al*. (2002) studied that essential oil of coriander efficiently inhibited some gram-positive bacteria, but less effective against gram-negative bacteria. It is believed that polyphenols show antifungal activity due to the formation of multinucleate stage by the breakage of intersepta in the mycelium and cell surface damage by pilferage (Bais *et al.,* 2002).

Some pathogenic, *E. coli* are responsible for bloody-diarrhoea, abdominal cramps, vomiting, kidney failure, nausea and fever. In rare cases, this pathogenic strain produces toxins which are associated with haemolytic uremic syndrome, mastitis, septicaemia and pneumonia (Hacker and Kaper, 2000). Ayurvedic medicines can manage and effectively treat *E. coli* infections. Natural drugs boost our immune system and fight against bacterial diseases. *Bacillus subtilis* is ubiquitous, aerobic, spore forming, gram positive bacteria (Ryan and Ray, 2004). Presence of hydroxyl group on the antioxidant molecules is responsible for antibacterial activity. So, intakes of natural antioxidant inhibit the oxidative stress and cell damage.

Antimicrobial compounds with plant sources are very useful in infectious diseases and it also limits the side effects of antimicrobial compounds (Chakraborty *et al*., 2007; Jin *et al.,* 2009). Polyphenolic compounds and phenolic acids are known to show antibacterial activity and plant extracts rich in these compounds are reported to show considerable activity against a host of pathogenic bacteria (Sakanaka *et al.,* 1989; Vijaya *et al.,* 1995). These substances when incorporated in food are effective in giving protection against several diseases caused by microbes (Scalbert *et al.,* 2005).

## 5. Conclusion

Plants provide us natural antioxidants that fight with the free radicals. The present study shows that methanolic extract of *C. sativum* contains a huge quantity of phenolics. The detection of antioxidant activity indicates that intake of this plant parts could be helpful in decreasing the some health hazards related to digestion and heart. Coriander shows effective antibacterial activity as well as antifungal activity. Apart from a rareness of activities, advance studies are required for the production of specific transgenic plants of *C. sativum* to find out new bioactive compounds and to standardize the doses of the phytochemicals in medicinal uses.

Scaling up of the whole technique will be of great interest economically and can contribute towards making *C. sativus* as money generating plant with various industrial applications.

## Conflict of interest

The authors declare that no conflict of interest exists in the course of conducting this research. Both the authors had final decision regarding the manuscript and the decision to submit the findings for publication.

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