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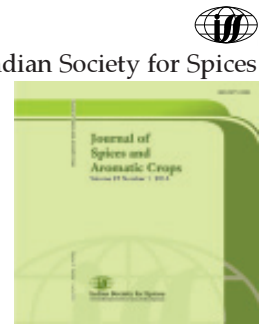

Analysis of medicinally important compounds and anti-oxidant activity in solvent extracts of coriander (*Coriandrum sativum* L.) plant parts

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Abstract

Total phenolic, flavonoid content and antioxidant activity of crude extract of seeds, roots, stem and leaves of coriander plant were determined. Maximum phenolic content (62.6 and 50.141 mg gallic acid equivalents (GAE) g^{-1} extract) was observed in distilled water extract of fresh and dried roots followed by methanol extract (49.53 and 47.32 mg in green and dried stem respectively). Ethyl acetate extract showed more phenolics in dried stem (12.734 mg GAE g^{-1} extract) and leaves (8.62 mg GAE g^{-1} extract) as compared to green stem and leaves (1.808 and 5.433 mg, respectively). Distribution of flavonoids content in different green as well as dried plant parts and different solvents showed less variation in phenolic and flavonoid contents which ranged from a maximum of 9.843 mg quercetin equivalents (QE) g^{-1} extract in green seeds to a minimum of 4.40 mg in green stem. 1, 1-Diphenyl-2-picrylhydrazin scavenging as a measure of antioxidant capacity was more in distilled water extract of green stem (94.49%) followed by methanol crude extract (76.256%) and ethyl acetate extract (59.706%).

Keywords: antioxidant activity, Coriander, *Coriandrum sativum*, flavonoids, phenolics

Coriander (*Coriandrum sativum* L.) is a culinary and medicinal plant from the *Apiaceae* family and cultivated throughout the sub continent for both seed as well as tender leaves. Rajasthan, Gujarat, Andhra Pradesh, Uttar Pradesh, Madhya Pradesh and Himachal Pradesh are the major coriander growing states in India. The purpose of the present study was to analyze crude extracts of different plant parts of coriander for their antioxidant potential. Crude extracts prepared in different solvents were analyzed for total phenolic and flavonoid contents as well as antioxidant capacity.

Seeds of coriander variety ACr 1 were obtained from seed store of ICAR-National Research Centre on Seed Spices, Ajmer. Sowing was done in field during *rabi* season of 2011–12. Standard agronomic practices were used during the course of plant growth and development. Pre-mature plants before harvesting were pulled and green leaves, stem and roots were separated. Approximately 10 g green and dried plant parts were ground to fine paste and powdered separately, by grinding or milling. The resulting materials were extracted sequentially with distilled water, methanol and

ethyl acetate. All the extracts were centrifuged thrice and supernatants were pooled for further analysis. Final concentration of crude extracts was adjusted to 100 ppm. These diluted extracts were used for determination of the total phenol and flavonoid concentration as well as antioxidant activities. Similarly, a set of plant parts were kept in oven at 60°C for drying and extraction was made in distilled water, methanol and ethyl acetate from dried plant parts.

Total phenol concentrations were determined using a Folin-Ciocalteu assay, as described by Amin *et al.* (2006). An aliquot of 0.1 mL from 1000 ppm crude methanol extract was taken in a test tube and made up to 1.0 mL by adding solvent. 3.0 mL of 10% sodium carbonate. Previously 10-fold diluted Folin-Ciocalteu reagent was added to the mixture. The mixture was allowed to stand at room temperature for 90 minutes and then absorbance was measured at 710 nm. Gallic acid was used as the standard phenol. The phenolic content was calculated by using the standard curve of Gallic acid having R^2 value ranged from 0.96-0.99 and was expressed as mg Gallic Acid Equivalents (GAE) g^{-1} crude extract.

Total flavonoid concentration was determined as per Chang *et al.* (2002). About 1 mL of crude seed extract was taken in a test tube and 100 μL aluminum chloride (1 M) solution was carefully added from the side wall of the test tube followed by addition of 100 μL potassium acetate (1 M). The total volume was made up to 4 mL by adding 2.8 mL of solvent in the test tube. After 30 minute incubation of reaction mixture at room temperature stable yellow colour was developed. Absorbance was measured at 517 nm. Quercetin was used as the standard flavonoid. The amount of flavonoid was calculated by using the standard curve of quercetin having R^2 value ranged from 0.96-0.99 and was expressed as mg Quercetin Equivalents (QE) g^{-1} crude extract.

The antioxidant activity of crude extract was evaluated on the basis of its activity in scavenging the stable DPPH radical using the method described by Shimada (1992). Crude extract was diluted in methanol to give at least 5 different concentrations. An aliquot (1.0, 1.5, 2.0, 2.5 mL) of the extract of each concentration was mixed with 1.0 mL of 1M DPPH solution. The mixture was then vortexed and left to stand for 30 min in the dark. The absorbance was measured at 517 nm against a blank of methanol using a spectrophotometer. DPPH solution plus methanol was used as control and Butyl Hydroxyl Toluene (BHT) was used as a standard reference synthetic antioxidant with R^2 value ranged from 0.95- 0.99. Results were expressed as mg Butyl hydroxyl toluene (BHT) Equivalent g^{-1} crude extract.

Results were expressed as a mean standard deviation from three replicate measurements. The percent scavenging effect was calculated as follows:

Scavenging effect (%) = $[(A_{517}$ of Control – $A_{517}$of Extract) / ($A_{517}$of Control)] × 100

Total phenolic content in different green and dried part of coriander genotype ACr 1 was expressed as mg GAE g^{-1} plant part. In green or fresh plant parts, maximum phenolic content was observed in distilled water extract than methanol and ethyl acetate extract, except green stem which showed maximum (49.53 mg) phenolic content in methanol crude extract. In distilled water extract, maximum phenolic content was observed in root (62.6 mg) followed by leaf (54.296 mg), green seeds (43.103 mg) and green stem (38.86 mg). Contrarity in methanol and ethyl acetate extracts maximum phenolic content was observed in stem (49.530 and 1.808 mg respectively) and minimum was observed in seeds (25.019 and 0.635 mg) (Table 1).

The same plant parts when dried showed lesser amounts of phenolics as compared to green plant parts. In distilled water extract, maximum (50.141 mg) phenolics were observed in roots followed by stem (28.688 mg) seeds (25.518 mg) and leaf (14.697 mg). In methanol extract maximum phenolic content was observed in dried stem (47.328 mg) followed by leaves (44.836 mg), seeds (24.729 mg) and roots (21.310 mg). Ethyle acetate extract of green plant parts yielded very less phenolics in either plant parts, the maximum being (5.433 mg) in leaves. But

Table 1. Total phenolic and flavonoid content in crude seed extract of different plant parts of coriander var. ACr 1

Plant parts	Distilled water extract				Methanol extract				Ethyl acetate extract			
	Total phenolic content (mg GAE g^{-1} crude extract)		Total flavonoid content (QE g^{-1} crude seed extract)		Total phenolic content (mg GAE g^{-1} crude extract)		Total flavonoid content (QE g^{-1} crude seed extract)		Total phenolic content (mg GAE g^{-1} crude extract)		Total flavonoid content (QE g^{-1} crude seed extract)	
	Green	Dried	Green	Dried	Green	Dried	Green	Dried	Green	Dried	Green	Dried
Root	62.600	50.141	6.199	5.093	35.970	21.310	7.579	5.151	0.742	9.141	5.392	5.826
Seed	43.103	28.518	9.843	5.691	25.019	24.729	7.184	5.566	0.635	9.431	6.057	6.259
Stem	38.863	28.688	4.400	4.698	49.530	47.328	6.808	5.209	1.808	12.734	6.173	6.375
Leaf	54.296	14.697	5.035	5.778	34.985	44.836	5.758	5.720	5.433	8.620	6.567	6.781
Mean	49.715	30.511	6.369	5.315	36.376	34.551	6.833	5.412	2.155	9.982	6.047	6.310
SEm (±)	0.246	0.098	0.094	0.011	0.142	0.135	0.010	0.021	0.248	0.110	0.014	0.008
CD ($P<0.05$)	0.853	0.339	0.326	0.039	0.491	0.467	0.035	0.072	0.859	0.380	0.050	0.029
CV (%)	0.858	0.556	2.565	0.372	0.676	0.677	0.253	0.668	1.995	1.905	0.414	0.226

contrary to distilled water and methanol crude extracts dried plant parts showed significantly high amount of phenolics and maximum was registered (12.734 mg) in stem and minimum (8.62 mg) in dried leaves (Table 1).

In the present study, maximum phenolic contents were observed in green or fresh plant parts extracted in distilled water and methanol while ethyl acetate showed very less amount of phenolic content.

Table 1 showed total flavanoids content in different plant parts expressed as mg QE g^{-1} crude extract. Distribution of flavonoids in different plant parts either green or dried showed less variation. Immature green seeds showed maximum flavonoid (9.843 mg) when extracted in distilled water followed by roots, leaves and stem (Table 2). In case of methanol extraction maximum flavonoid was observed in root (7.579 mg) followed by seed and stem (7.184 and 6.808 mg, respectively). Ethyl acetate extract showed no variation in flavonoid content extracted from either green or dried plant parts.

Total antioxidant content and scavenging percentage of different plant part extracts is presented in Table 2. The maximum DPPH scavenging was observed in distilled water extracts of green plant parts followed by methanol and ethyl acetate extracts. In distilled water extract, total antioxidant content was maximum (11.760 mg BHT E g^{-1} crude extract) in green stem which was at par with roots (11.756 mg) followed by leaf and seeds. In case of distilled water extracts stem had maximum DPPH scavenging effect (94.490%) followed by roots (94.490%), leaf (91.889%) with minimum in seeds (89.416%). Contrary to this methanol crude extract of seeds showed highest antioxidant content (12.039 mg) followed by roots (11.348 mg) while green stem and leaves showed less amount of antioxidant content (10.883 and 10.246 mg, respectively, Table 3). Methanol extract showed maximum scavenging (76.256%) in seed extracts while minimum in leaf extracts (65.380%). However, ethyl acetate extract had less amount of anti oxidants as compared to distilled water and methanol

Table 2. Total antioxidant content (mg BHT E g^{-1} crude extract) in different plant parts of coriander var. ACr 1

Plant parts	Distilled water extract		Methanol extract		Ethyl acetate extract	
	Antioxidant content	Scavenging %	Antioxidant content	Scavenging %	Antioxidant content	Scavenging %
Root	11.756	94.454	11.348	72.105	7.299	58.933
Seed	11.190	89.416	12.039	76.256	7.004	56.613
Stem	11.760	94.490	10.883	69.240	7.476	60.325
Leaf	11.468	91.889	10.246	65.380	7.811	62.954
Mean	11.544	92.562	11.129	70.745	7.398	59.706
SEm (±)	0.002	0.019	0.012	0.069	0.019	0.150
CD (P<0.05)	0.007	0.065	0.040	0.238	0.066	0.518
CV (%)	0.031	0.035	0.181	0.169	0.445	0.434

extract. Maximum antioxidant content (7.811 mg) was observed in leaves extracted in ethyl acetate while minimum (7.004 mg) in seed extract. Ethyl acetate extract showed comparatively less scavenging of DPPH free radical, the maximum being observed (62.954 mg) in leaf extract and minimum (56.613 mg) in seed extract.

The presence of different anti-oxidant components in plant tissues especially fruits and vegetables make it relatively difficult to measure anti-oxidant component separately. In the present study, we followed sequential extraction in distilled water, methanol and ethyle acetate. This indicated that most phenolic compounds in coriander are water soluble. However, distribution of flavonoids in different plant parts and solubility in different solvents including distilled water indicated the presence of flavonoid compounds in every part of plant.

Distilled water extract showed a positive correlation in phenolic content and antioxidant activity (r = 0.27), but showed inverse relationship in flavonoid content and antioxidant activity (r = -0.8). In methanol extract both phenolic and flavonoid content showed positive correlation (r = 0.83 and 0.172) which was non significant for phenolic content but significant for flavonoid content. Ethyl acetate extract showed negative and non significant correlation (r = -0.04) between phenolic content and antioxidant activity. Except in roots all other plant parts showed positive and significant correlation (r = 0.91) between flavonoid content and antioxidant activity.

The phenolic and flavonoid content may contribute directly to the anti oxidant activity (Awika *et al.* (2003). While measuring anti-oxidant activity and total phenolic content of some Asian vegetables, Kaur & Kapoor (2002) categorized coriander in moderate or low phenolic containing vegetable group, but found very high anti-oxidant activity. In the present study, however we observed reasonably good amount of total phenolic content and high antioxidant activity in coriander depending upon solvent used for extraction and the plant parts. This can be explained on the basis of high anti-oxidant activity of some individual phenolic units, which may act as efficient antioxidants rather than contributing to high total phenolics. The scavenging action of various phenolic compounds is closely connected with their spatial conformation. Similar results have been reported by Chu *et al*. (2000) in vegetables like white cabbage and crown daisy, which despite having low phenolic contents had moderate antioxidant activity. They attributed this to the presence of some other phytochemicals such as phenolics, ascorbic acid, tocopherol and pigments, which also contribute to total antioxidant activity.

From the present work, it could be concluded that different plant parts have different amount of total phenols, flavonoids and anti oxidant

activities. Presence of more phenolics and flavonoids in distilled water extract indicated that coriander plant contains water soluble phenolic and flavonoid compounds which may or may not contribute to the antioxidant activity. Further, studies are needed for the isolation and identification of the active component from the extract.

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