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Studies on Exploration of the Proximate Composition, Physical Attributes and Qualitative Phytochemical Analysis of Fresh Coriander Leafy Vegetables

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation was undertaken in the Department of Processing and Food Engineering, College of Agricultural Engineering, Raichur to study the different properties of fresh coriander leafy vegetable like proximate composition, physical properties and bio-chemical properties. It was found that the moisture content, carbohydrate, crude protein, crude fat, crude fiber and ash content of

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fresh coriander leafy vegetable were found to 85.65, 4.26, 3.08, 0.3, 2.09 and 4.62 %, respectively. The total flavonoids, total phenols, chlorophyll content, ascorbic acid and *ß*-carotene content of fresh coriander leafy vegetable were found to be 318.40, 76.69, 222.36, 160.36, 34.32 mg/100 g, respectively. Overall, the combination of proximate composition, physical characteristics, and bio-chemical properties underscores the nutritional value and potential health benefits of fresh coriander leafy vegetables. Incorporating coriander into diets can provide essential nutrients and bioactive compounds, enhancing both the flavor and the potential well-being of individuals.

Keywords: Coriander; proximate composition; bio-chemical properties and fibers.

1. INTRODUCTION

Coriander (*Coriandrum sativum* L.) is a popular annual herb widely used as a leafy vegetable for seasoning purposes. It offers a diverse range of edible parts, including the seeds, leaves, and roots, each possessing distinct flavors and culinary uses [1]. Known for its light and distinctive taste, coriander can be utilized in its entirety, either in its fresh form or processed. In culinary applications, the whole plant, primarily the fresh leaves and ripe fruits, is employed [2]. Apart from its culinary value, coriander is highly regarded as a rich source of micronutrients and essential elements [3]. It boasts low saturated fat content while providing a noteworthy amount of linoleic acid, which serves as an excellent source of α-tocopherol (vitamin E) and vitamin K. The leaves of the coriander plant are particularly abundant in vitamins, while the seeds contain significant quantities of polyphenols and essential oils. Coriander is renowned for its various health benefits, such as its antioxidant, anti-diabetic, anti-mutagenic, anti-anxiety, antimicrobial, analgesic, and hormone-balancing properties. These qualities make it a favorable addition to food preparations, as it not only enhances flavor but also contributes to the preservation of food over extended periods, thus promoting its use in the culinary world [4].

Considering the above facts, it could be said that these coriander leafy vegetables have a high nutritional dietary and culinary importance. Hence, the objective of the research article is to study the detailed quality characteristics of Coriander leafy vegetables.

2. MATERIALS AND METHODOLOGY

Fresh coriander bunches were obtained in the morning from Merched village near Raichur city, Karnataka. The harvested coriander was carefully sorted and graded by hand, removing any diseased or irregular leafy vegetables. Only uniformly sized, mature, and cleaned coriander of the Var. local Multicut-special variety was selected for the investigation.

2.1 Proximate Composition of Fresh Coriander Leafy Vegetable

The proximate compositions *viz*., moisture content, carbohydrates, crude protein, crude fat, crude fiber and total ash content of fresh coriander leafy vegetables was estimated by following the standard procedures.

2.1.1 Moisture content

The moisture content of fresh Coriander leaves and was determined by using standard procedure [5] and equation given below

$$\text{Moisture content } (\%) = \frac{W_1 - W_2}{W_2} \times 100$$

Where, W_1 and W_2 are the initial and final weight of sample (g) respectively

2.1.2 Carbohydrate

The estimation of carbohydrate for fresh Coriander along with stems was carried out as per AOAC [5].

2.1.3 Crude protein

The nitrogen content in fresh Coriander leaves along with stem was estimated by using Kjeltech instrument (D-40599; Behr Labor Technik GmbH, Bavaria, Germany) by Kjeldahl's [5] and equating in

$$\text{Nitrogen } (\%) = \frac{\text{Volume of 0.1N HCL(mL)} \times 0.1 \times 14.007}{\text{weight of sample (g)} \times 1000} \times 100$$

Percent protein on total nitrogen basis = N (%) × Conversion factor
Conversion factor for leafy vegetables= 6.00

2.1.4 Crude fat

The crude fat content of the fresh coriander along with stems were estimated by soxhlet apparatus method [5] using SOCS – PLUS apparatus (Pelican Equipments; SCS-08, Tamil Nadu, India).

2.1.5 Total ash

The total ash content of fresh coriander leaves along with stem was determined as per the standard procedure [5] by using muffle furnace (MAC; MSW-251, Tamil Nadu, India).

2.2 Physical Properties of Fresh Coriander Leafy Vegetable

The physical properties of fresh coriander leaves was assessed by determining different quality parameters *viz.,* weight, leaf area, leaf thickness, bulk density and colour.

2.2.1 Weight

50 g of fresh, uniformly sized and matured coriander leafy vegetables were taken for the study. The digital weighing balance (Sartorius, L-610, Wisconsin, UK) was used for determination of weight and expressed in g. The experiment was repeated thrice.

2.2.2 Leaf area

The leaf area of the coriander was determined by taking average area of ten leaves. The digital planimeter (PLACOM, KP-90N, New Delhi, India) was used for determination of leaf area. The leaf was taken and spread over the sheet, the leaf margin was outlined with the help of pencil. Marking an initial point anywhere on the leaf outline the digital planimeter was moved on the same outline till marked point reached. The experiment was repeated by taking ten leaves and the readings were tabulated to calculate the mean value [6].

2.2.3 Leaf thickness

A digital screw gauge having a least count of 0.01 mm was used to determine the thickness of fresh Coriander leaves. Ten samples of Coriander leaves were randomly selected for the measurement. The thickness was measured at the centre of the leaf and readings were tabulated to calculate mean value and expressed in cm [7].

2.2.4 Bulk density

A rectangular plastic box (15×10×10 cm) was taken and its volume was determined and then the box was completely filled with Coriander leaves. The weight of the leaves taken in fill the box was recorded and the bulk density was determined using the following relationship formula [7].

$$\text{Bulk density (g/cm}^3\text{)} = \frac{\text{Weight of leaves (g)}}{\text{Volume of wooden box (cm}^3\text{)}}$$

2.3 Qualitative Phytochemical Analysis of Coriander Leafy Vegetables

The bio- chemical properties of fresh coriander leaves were assessed by determining different quality parameters *viz* total flavonoid, total phenols, chlorophyll content, ascorbic acid, *ß*-carotene and GC-MS analysis of different compounds.

2.3.1 Total flavonoid content of coriander leafy vegetables

Total flavonoid content of fresh coriander along with the stem was determined by aluminum chloride colourimetric method by using quercetin as a standard. This method was based on formation of flavonoid aluminum complex. 1 g of coriander leaves were extracted with 10 mL of pure methanol. 0.5 mL of extract solution was mixed with 1.5 mL of methanol, 0.1 mL of 10% aluminium chloride, 0.1 mL of 1 M potassium acetate and 2.8 mL of distilled water. The solution was then incubated for 30 min. The optical density of the reaction mixture was measured against the blank at 415 nm with the help of UV-Vis spectrophotometer. The standard calibration curve was prepared by using quercetin solutions at concentrations of 12.5 to 100 µg/mL in methanol [8].

2.3.2 Total phenolic content of coriander leafy vegetables

The concentration of total phenols in fresh coriander along with stem was estimated with Folin Ciocalteau reagent. 1 g of coriander was extracted with 10 mL of methanol: water (50:50, v/v). 0.5 mL of the diluted (1:10) extract or the

standard phenolic compound (Gallic acid) was mixed with 5 mL of Folin Ciocalteu reagent (1:10 diluted with distilled water) and 4 mL of aqueous Na_2CO_3 (1 M). The mixture was allowed to stand for 15 min and the optical density of the mixture was determined against the blank at 765 nm with the help of UV-Vis spectrophotometer. Standard curve was prepared using 0, 50, 100, 150, 200, 250 µg solutions of gallic acid per mL of methanol:water (50:50, v/v). Total phenol values were expressed in terms of the standard reference compound as gallic acid equivalent (g/100 g fresh weight of leaves [9].

2.3.3 Chlorophyll

The pigments (total chlorophyll) of coriander leaves along with stem were determined and quantified using the procedure proposed by Nagata and Yamashita [10]. 1 g of shredded sample was homogenized with 10 mL of acetone and n-hexane (4:6), using a tissue homogenizer (Labco, India) for 30 s. The homogenized solution was allowed to settle down. Then, 1 mL of supernatant was taken and was diluted with 9 mL of acetone and n-hexane (4:6). The resulting solution was analyzed spectrophotometrically with the help of an UV-Vis spectrophotometer. The optical density was measured at 453, 505, 663 and 645 nm using acetone and n-hexane (4:6) as a blank.

Chlorophyll concentration (mg/100 g) was quantified using the following equations

$$\text{Chlorophyll A} = 0.999\text{A}_{663} - 0.0989\text{A}_{645}$$
$$\text{Chlorophyll B} = -0.328\text{A}_{663} + 1.77\text{A}_{645}$$
$$\text{Total chlorophylla} = \text{Chlorophyll A} + \text{Chlorophyll B}$$

Where, A_{663} and A_{645} are the absorbance's at 663 and 645 nm respectively

2.3.4 *ß*-carotene content

The *ß*-carotene content of coriander leaves along with stem were determined and quantified using the procedure proposed by Nagata and Yamashita (1992). 1g of shredded sample was homogenized with 10 mL of acetone and n-hexane (4:6), using a tissue homogenizer (Labco, India) for 30 s. The homogenized solution was allowed to settle down. Then, 1 mL of supernatant was taken and was diluted with 9 mL of acetone and n-hexane (4:6). The resulting solution was analyzed spectrophotometrically with the help of an UV-Vis spectrophotometer. The optical density was measured at 453, 505, 663 and 645 nm using acetone and n-hexane (4:6) as a blank.

ß-carotene concentration (mg/100 g) was quantified using the following equation

$$\text{ß} - \text{carotene} = 0.216\text{A}_{663} - 1.220\text{A}_{645} + 0.452\text{A}_{453} - 0.304\,\text{A}_{505}$$

Where, A_{453}, A_{505}, A_{663} , A_{645} are the absorbance's at 453, 505,663 and 645 nm respectively

2.3.5 Ascorbic acid

The coriander samples were analyzed for the ascorbic acid content, using 2, 6-dichlorophenol indophenol dye titrimetrically as per the method suggested by Sadasivam and Manickam [11]. Two grams of the Coriander along with stems were first crushed with 10 mL of 4% oxalic acid and filtered through muslin cloth and then with Whatman No. 4 filter paper. An aliquot of extract (2 mL) of the samples were titrated against 2, 6-dichlorophenol indophenol dye till the pink end point persist for at least 15. Similar procedure was followed for acid mixture to get blank titre value and against standard solution made in 4% oxalic acid to get standard titre value. The results were expressed in terms of mg/100 g.

2.3.6 GC analysis of various compounds found in coriander

GC analysis of the methanol extract of fresh coriander leafy vegetables samples were carried out using Shimadzu Make QP-2020 with non polar 60 M RTX 5MS Column. Helium was used as the carrier gas and the temperature programming was set with initial oven temperature at 300°C and held for three min and the final temperature of the oven was 250°C with rate at 150°C/ min. One micro litre samples were injected with split mode of 1:50. Mass spectra was recorded over 35-1050 amu range with electron impact ionization energy 70 eV. The total running time for a sample was 45 min. The bioactive volatile compounds from the methanolic extract of Coriander leaves were identified by comparing the retention times of chromatographic peaks using Quadra pole detector with NIST Library to relative retention indices. Quantitative determinations were made by relating respective peak areas to TIC areas from the GC [12].

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Fresh Coriander Leafy Vegetables

The mean values of proximate composition for coriander leafy vegetable *viz*., moisture content, carbohydrate, crude protein, crude fat, crude fiber and ash content Coriander were determined using different standard analytical methods and the data obtained are presented in Table 1. The moisture content, carbohydrate, crude protein, crude fat, crude fiber and ash content of fresh Coriander leafy vegetable were found to 85.65, 4.26, 3.08, 0.3, 2.09 and 4.62%, respectively. The proximate composition of the Coriander leafy vegetable is depicted in Table 1.

3.2 Physical Properties of FRESH Coriander Leafy Vegetables

Physical properties of coriander leafy vegetables *viz*., leaf area, leaf thickness and bulk density were determined using standard methods and the average values are presented in Table 2. The Coriander leafy vegetable had an average leaf area, leaf thickness and bulk density values of 2.93cm^2, 0.15 cm, 0.08 g/cm^3, respectively. The colour values of fresh coriander leafy vegetable *viz., L*, a** and *b** vales were found to be 52.12, -20.51, 12.4, respectively.

3.3 Biochemical Analysis of Fresh Coriander Leafy Vegetables

The mean values of biochemical composition for coriander leafy vegetable *viz*., total flavonoids, total phenolic content, chlorophyll content, ascorbic acid and *ß*-carotene were determined using different standard analytical methods and the data obtained are presented in Table 3.The total flavonoids, total phenols, chlorophyll content, ascorbic acid and *ß*-carotene content of fresh Coriander leafy vegetable were found to be 318.40, 76.69, 222.36, 160.36, 34.32 mg/100 g, respectively. The bio-chemical properties of fresh Coriander leafy vegetable are presented in Table 3. The biochemical composition analysis of coriander leafy vegetable reveals its significant nutritional value. The determined values of total flavonoids, total phenolic content, chlorophyll content, ascorbic acid, and ß-carotene demonstrate the presence of bioactive compounds with potential health benefits. Coriander is rich in flavonoids and phenols, known for their antioxidant properties that help combat oxidative stress and reduce the risk of chronic diseases. The high chlorophyll content indicates its potential role in promoting detoxification and supporting overall well-being. Additionally, the presence of ascorbic acid (vitamin C) and ß-carotene suggests that coriander may contribute to immune health and provide a source of provitamin A. Incorporating fresh coriander into the diet can be a flavorful way to enhance nutrient intake and potentially support various aspects of health [13].

3.4 GC Analysis of Various Compounds Found in Coriander Leafy Vegetable

The various functional compounds in coriander leafy vegetable were analyzed using GC technique are presented in Table 4. The results revealed that, Coriander leaves contain essential oils such as linalool, cineole, and terpinene. These oils contribute to its distinctive aroma and flavor. Linalool, in particular, is known for its antimicrobial and antioxidant properties. These compounds help neutralize harmful free radicals in the body, reducing oxidative stress and preventing cellular damage. Antioxidants also play a crucial role in maintaining overall health and reducing the risk of chronic diseases, such as heart disease and certain cancers. These properties make coriander potentially beneficial in managing inflammatory conditions, including arthritis and certain digestive disorders. The chromatograph for fresh coriander leaves were shown in in Fig. 1.

Table 1. Proximate composition of fresh Coriander vegetables

Sl. No.	Proximate composition	Coriander (%)
1	Moisture content (%)	85.65
2	Carbohydrate (%)	4.26
3	Crude protein (%)	3.08
4	Crude fat (%)	0.30
5	Crude fiber (%)	2.09
6	Ash(%)	4.62

Table 2. Physical properties of fresh coriander leafy vegetables

Sl. No.	Physical properties	Coriander
1	Leaf area, cm^2	2.93
2	Leaf thickness, cm	0.15
3	Bulk density, g/ cm^3	0.082
4	Colour value	
	*L**	52.12
	*a**	-20.51
	*b**	12.41

Table 3. Qualitative phytochemical analysis of fresh coriander leafy vegetables

Sl. No.	Qualitative phytochemicals	Coriander (mg/100 g)
1	Total flavonoids content	318.40
2	Total phenolic content	76.79
3	Chlorophyll	222.36
4	Ascorbic acid	160.36
5	*ß*-carotene	34.32

Table 4. GC chromatogram extract of fresh coriander leafy vegetable

Sl. No.	Retention time	Peak area	Name of the compound
1	8.03	1.00	Dodecane
2	16.88	0.50	Benzenpropanoic acid
3	16.66	0.49	Linalool
4	11.16	1.46	Sucrose
5	14.18	34.41	4- Methylmannose
6	15.53	0.44	Heneicosame
7	7.99	0.79	Naphthalene
8	5.06	0.47	Undecane
9	8.15	0.72	2-Disopropylaminoethyl methy
10	1.25	24.20	Ethane, 1-chloro 1-fluoro
11	1.60	0.58	Oxalic acid
12	11.30	0.34	Octahydropyano
13	1.94	1.30	Acetoin
14	7.00	1.92	2- Methylpyrrolidine
15	12.45	0.96	TRANS-DECAHYDRO- beta
16	13.44	0.56	Cineole
17	18.55	0.98	Terpinene

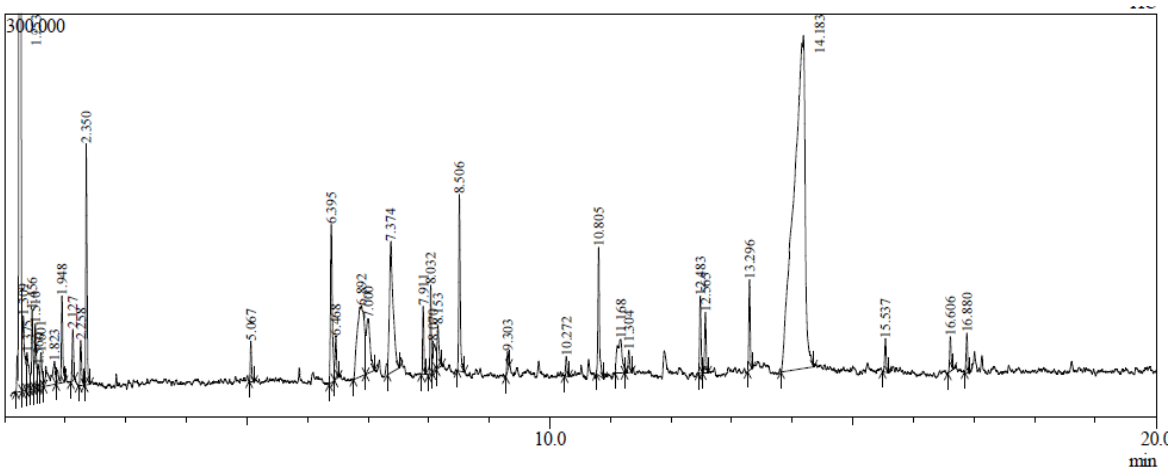

Fig. 1. GC chromatogram extract of fresh coriander

4. CONCLUSION

In conclusion, the qualitative phytochemical composition analysis of coriander leafy vegetable reveals its significant nutritional value. The determined values of total flavonoids (318.40 mg/100 g), total phenolic content (76.79 mg/ 100 9g), chlorophyll content (222.36 mg/100 g), ascorbic acid (160.36 mg/100 g) and ß-carotene (34.32 mg/100 g) demonstrate the presence of bioactive compounds with potential health benefits. Coriander is rich in flavonoids and phenols, known for their antioxidant properties that help combat oxidative stress and reduce the risk of chronic diseases. The high chlorophyll content indicates its potential role in promoting detoxification and supporting overall well-being. Incorporating fresh coriander into the diet can be a flavorful way to enhance nutrient intake and potentially support various aspects of health.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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