

Research Article

Nutritive Values of Organic and Conventionally Cultivated Spices

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Abstract

India is the world's leading producer of spices. Not only spices enhance taste of food but nutritional elements in spices are good for health. In this study, we examined the qualities of ten spices; Coriander, Clove, Cardamom (green), cinnamon, Black pepper, Fenugreek, Mustard, Cumin Seeds, Chilli- Red and Turmeric which are available commercially and organically grown in Vidarbha region. The comparison takes into account proximate content- % moisture, % ash, % fat, and crude protein content as well as antioxidant activity and antinutritional components – oxalates and tannins. The findings indicate that organically grown spices contain significantly higher levels of essential nutrients, including ash content, fat, and protein, compared to conventionally grown counterparts. This suggests that organic cultivation methods may enhance the overall nutritional profile of spices, potentially due to improved soil quality and the absence of synthetic chemicals. Additionally, the increased antioxidant activity in organic spices highlights their potential health benefits, as antioxidants play a crucial role in reducing oxidative stress and preventing chronic diseases. The study reveals that organically grown spices contain higher concentrations of tannins and oxalates compared to conventionally grown varieties, suggesting differences in plant metabolism influenced by organic farming practices. Tannins, known for their antioxidant and antimicrobial properties, may contribute to enhanced flavor and potential health benefits in organic spices. However, the increased presence of oxalates, which can interfere with mineral absorption and contribute to kidney stone formation in excess, highlights the need for balanced consumption. Further research is required on antinutritional factors and bioactive compounds to accurately determine the specific qualities of organically grown crops.

Keywords

Organic Spices, Turmeric, Fat Content in Organic Spices, Tannin in Clove, Chemical Fertilizers, Organic Fertilizers

1. Introduction

India exports more spices than any other country in the world. In 2021-22, production of spices in India was 10.88 million tonnes. [14] The export of spices hit a record high in 2020–21 in terms of both value and volume, growing by 17% in US\$ value terms and 30% in volume terms [15]. The market offers a wide variety of spices. Spices cultivated

commercially and organically are both sold in the market.

Organic food, contrary to popular assumption, is neither a new trend nor a temporary fad. Prior to the green revolution, all agriculture in India was organic by default. In the 19th century, chemical fertilizers and insecticides were increasingly used to boost agricultural production. Currently, the

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majority of farming is done with the use of synthetic chemical fertilisers, GM crops, artificial germination promoters, pesticides, insecticides, fungicides, and weedicides, etc. Organic farming, on the other hand, relies primarily on agricultural wastes such as cow dung, cow urine, and green mulching to offer required nutritional boosts and pest control. Although the usage of synthetic chemicals resulted in a significant boost in agricultural yield, extensive studies conducted over the last 20 years have demonstrated that these chemicals are also hazardous to the general health of the ecosystem in addition to being harmful to human health [9].

The global market for organic spices is increasing. India has made a concerted effort to export organic spices. In 2020-21, around 5200 tonnes of organic spices worth 194.10 crores were shipped from India to various countries (<http://www.indianspices.com/>). Customers are more inclined to purchase organic spices when they are available. It claimed that organic spices are superior to commercial or inorganic spices in terms of taste and flavour [7]. Food Safety and Standards Authority of India (FSSAI) does not certify all organic spices. Due to the scarcity of recognized sources, people often purchase spices from uncertified but well-known organic brands.

Spices- clove, cinnamon black pepper contains to have high levels of antioxidants that shows anti-inflammatory, anti-tumorigenic, anticarcinogenic, and glucose- and cholesterol-lowering activities. Besides antioxidants, many spices also contain compounds such as sulphur-containing compounds, tannins, polyphenols, phenolic diterpenes, flavonoids, various minerals and vitamins [8, 12].

Research regarding vitamin content, metal, heavy metal content in organic and conventionally grown fruits and vegetables suggests vitamin C content is relatively higher in organically produce fruits and vegetables. Metal content in terms of iron, magnesium, and phosphorus are increased in organically produce with decrease trend of heavy metal content; however not much studies available about organic and conventional spices [5, 10].

Few studies have been conducted to evaluate the nutritional value of organically cultivated spices to commercial/inorganic spices. In a 2020 study, researchers evaluated four spices produced organically versus inorganically: basil (*Ocimum basilicum* L.), bear's garlic (*Allium ursinum* L.), marjoram (*Origanum majorana* L.), and oregano (*Origanum vulgare* L.). They discovered that organic spices have a greater concentration of total polyphenols, flavonoids, and phenolic acids than conventional spices [3].

Although it is widely assumed that organic spices are superior to inorganic spices, very little research has been conducted to compare the nutritional value of organic and inorganic spices. In the current study, we compared the nutritional value of organically grown spices to those grown commercially. We selected ten spices for comparison Coriander (*Coriandrum sativum*), Clove (*Syzygium aromaticum*), Cardamom-green (*Elettaria cardamomum*), cinnamon (*Cin-*

namomum verum), Black pepper (*Piper nigrum*), Fenugreek (*Trigonella foenum graecum*), Mustard (*Brassica juncea*), Cumin Seeds (*Cuminum cyminum*), Chilli- Red (*Capsicum annum*) and Turmeric (*Curcuma domestica*).

Objectives of this study were to analyse differences in organic and conventionally produced spices in terms of proximate content- moisture, ash, fat, protein, antioxidant activity and antinutritional factors- tannins, oxalates. This is an attempt to study if organically grown spices are healthy or not.

2. Materials and Methodology

Analytical grade Chemicals (AR grade) were procured from Global marketing. Ten spices were selected for comparative analysis between organic and conventionally available. Coriander, Clove, Cardamom (green), cinnamon, Black pepper, Fenugreek, Mustard, Cumin Seeds, Chilli- Red and Turmeric. All samples were analyzed in duplicates.

2.1. Sample Collection

The collection of plant material, complied with national, and international guidelines of Organic farming and legislation. For comparative analysis of organic and conventional samples of spices, organic samples were procured from authentic organic certified farmers from Vidarbha region namely *Gauri* farms, *Neem foundation*, *Rujva organics*. Samples were mixed and blended for further use. Inorganic or conventional samples of spices were collected from retail market *Gajanan Supermarket*, *Khamla Road*.

2.2. Proximate Analysis

Proximate analysis of moisture, ash, fat, and protein content was performed using AOAC techniques [1]. Moisture analysis was carried out using the oven dry method at 80 degrees celsius for 4 hours, followed by cooling in a desiccator until a constant weight was achieved. Samples were incubated in a muffle furnace for 6 hours before cooling in a desiccator for ash analysis. Fat analysis was carried out using the Soxhlet device for 4 hours. The crude protein content was determined using the Kjeldhal method of protein estimation.

2.3. Antioxidant Activity

Antioxidant activity was analysed by DPPH method by using distilled water and ethanol in 50% - 50%. Sample extracted in dark by using solvent water mixture followed by centrifuge. Sample was treated with DPPH and kept in dark for reaction. Discolouration measured at 517 nm on double beam UV-VIS spectrophotometer [13].

2.4. Analysis of Antinutritional Factors

AOAC procedures were used to test antinutritional factors such as oxalate, tannins, and trypsin inhibitors [1].

2.4.1. Oxalate Content

0.1 g blended sample was extracted by using 30 ml 1 M HCL for 30 min in water bath at 100 °C. 0.5 ml of 5% calcium chloride was added, resultant suspension was centrifuged for 15 min, pellet was washed with 2 ml 0.35 M NH₄OH. Supernatant was further used for analysis and titrated with standard solution of 0.1 M KMnO₄ with maintained temperature of 60 °C to faint violet color [1].

2.4.2. Tannin Content

1 g sample was extracted in distilled water at 90 degree for 30 minutes. 25 ml Indigo carmine solution was added which is titrated against 0.1 N KMnO₄ aqueous solution. Blank test was performed without sample and used for calculation.

3. Results and Discussion

Proximate content- moisture, ash, proteins, fat and antioxidant activity, antinutritional factors- tannin, oxalate in organic and conventionally available spices are as follows. Values presented in Table 1 are mean values of duplicate analysis.

Table 1. Proximate Analysis of Organic and Conventionally Available Spices.

Proximate Analysis of Organic and Conventionally Available Spices												
	CO % Moisture	O % Moisture	p - value	CO % Ash	O % Ash	p - value	CO Fat %	O Fat %	p - value	CO Protein gms/100gms	O Protein gms/100gms	p - value
Coriander	9.65	5.052	0.0012	5.22	6.395	0.0012	1.15	1.7	0.0007	2.05	3.51	0.0012
Clove	6.45	5.611	0.0786	5.17	6.335	0.0002	3.58	6.055	0.0000	2.05	7.98	0.0001
Green Cardamom	5.5	6.51	0.0371	7.6	11.4	0.0001	0.37	0.855	0.0056	7.195	7.505	0.0005
Cinnamon	7.1	7.3	0.4231	2.81	3.2	0.0065	0.88	2.11	0.0001	0.735	1.205	0.0002
Black pepper	6.05	5.54	0.1835	4.9	6.9	0.0001	1.93	2.17	0.0035	1.455	7.75	0.0016
Fenugreek	5.05	4.805	0.2441	3.065	4.54	0.0023	1.4	0.75	0.0061	7.995	9.05	0.0023
Mustard	6.21	6.61	0.0031	4.3	4.75	0.0010	3.2	8.15	0.0009	2.915	3.59	0.0003
Cumin Seeds	7.35	6.8	0.0673	7.06	7.93	0.0052	0.505	2.03	0.0001	12.465	11.25	0.0441
Chilli- Red	9.2	11.2	0.0025	7.32	8.7	0.0007	1.54	1.73	0.0055	1.485	9.355	0.0000
Turmeric	2.2	5.2	0.0011	5.345	8.19	0.0001	1.7	3.335	0.0000	8.28	4.345	0.0000

Table 1. Proximate Analysis of Organic and Conventionally Available Spices: Table depicts Proximate content- Moisture %, Ash %, Protein in gms/100 gms and Fat % in Organically grown and conventionally available spices. Results of statistical analysis by using student's t test are shown as p- value. [CO- Conventionally available O- Organically grown].

This data was tested statistically by two tailed Student's 't' test and p values are presented in table. Many spices show statistically significant differences except clove, cinnamon black pepper, fenugreek and cumin seeds. Organically grown spices may have less moisture due to careful handling as compared to conventionally available. Ash content is found to be more in organically grown spices as compared to conventionally available spices. And these differences are statistically

significant as p values are less than 0.05. Ash content serves as an indicator of the total mineral composition in spices, reflecting essential nutrients such as calcium, magnesium, and potassium. The higher ash content in organically grown spices suggests a greater mineral presence, likely due to the improved soil fertility and natural farming practices used in organic cultivation.

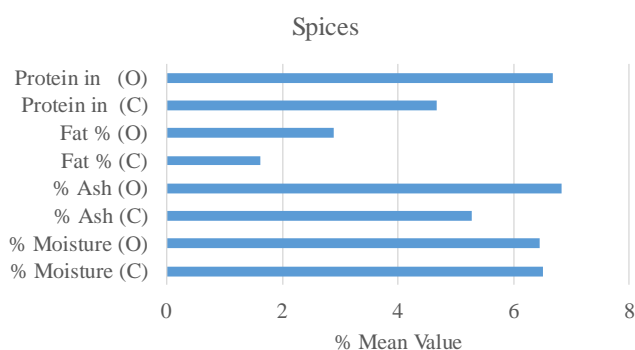


Figure 1. Differences of Organic and Conventionally available Spices in Proximate Content.

Figure 1 Differences of Organic and Conventionally available Spices in Proximate Content: Figure is a pictorial representation of differences in Organic and Conventional Spices with respect to Protein, Fat, Ash and Moisture. Figure 1 shows gap between organic and conventionally available spices with respect to proximate content in graphical manner.

[CO- Conventionally available O- Organically grown].

Crude fat content measured by Soxhlet apparatus was more in organically cultivated spices than conventionally available samples of spices except fenugreek. Organically grown samples of spices smells differently than conventionally available spices.

Organically grown spices contain more proteins than conventionally available except cumin seeds and turmeric. Conventionally available turmeric is often mixed with *maida* (refined wheat flour) which act as anticaking agent on contrast to pure turmeric in organically grown samples. This can justify why conventionally available turmeric contains more protein than organically grown. Differences between organically grown and conventionally available spices with regards to protein content is significant at 95 % level of significance.

Besides proximate content, Antinutritional factors and Antioxidant activity of Organic and Conventionally Available Spices were analysed and data was tested statistically by two tailed Student's 't' test and *p* values are presented in below mentioned table.

Table 2. Antinutritional factors and Antioxidant activity in Organic and Conventionally available Spices.

Antinutritional factors and Antioxidant activity of Organic and Conventionally Available Spices								
	CO Tannins mg/100 gms	O Tannins mg/100 gms	<i>p</i> - value	CO Oxalate mg/100 gms	O Oxalate mg/100 gms	<i>p</i> - value	CO AOA % inhibition	O-AOA % inhibition
Coriander	1.99	3.3	0.010	133.5	175.5	0.001	74.5	71
Clove	12.435	63.15	0.001	246.5	225	0.007	73.665	76
Green Cardamom	14.115	3.15	0.000	611	665	0.002	28.35	81.3
Cinnamon	10.42	8.8	0.033	113	350	0.000	46	68.75
Black pepper	4.125	24.2	0.001	351	630	0.000	60.5	85.5
Fenugreek	4.35	8.8	0.005	153	455	0.000	52.4	22.46
Mustard	5.35	7.9	0.024	178.5	280	0.000	68.85	59.245
Cumin Seeds	14.425	27.25	0.000	690	735	0.004	70.425	68.28
Chilli- Red	16.7	24.45	0.004	469.5	700	0.000	66	62.25
Turmeric	13.75	18.35	0.006	987	1291	0.001	43.9	55

Table 2. Antinutritional factors and Antioxidant activity in Organic and Conventionally available Spices: Table 2 depicts analytical values of antinutritional factors- tannins, oxalates and antioxidant activity in organic and conventional spices. [CO- Conventionally available O- Organically grown, AOA- Antioxidant Activity].

Wide variations were found in CO and O samples with regards to tannins and oxalate content that were found statistically significant.

Figure 2. Antioxidant activity of Organic and Conventionally available Spices: Figure 2 is a graphical representation of antioxidant activity in organic and conventional spices. [CO- Conventionally available O- Organically grown].

Figure 2 graph shows overall high antioxidant activity in organically grown spices. In Clove, Green Cardamom, cinnamon, black pepper and turmeric, organically grown shows higher AOA than conventionally available. Whereas conventionally available coriander, mustard, red chilli, and cumin seeds contain higher AOA than organic samples. These results are in line with previous research of organic and convention-

ally available fruits and vegetables. Results reveal more antioxidant activity in organically cultivated fruits and vegetables [6].

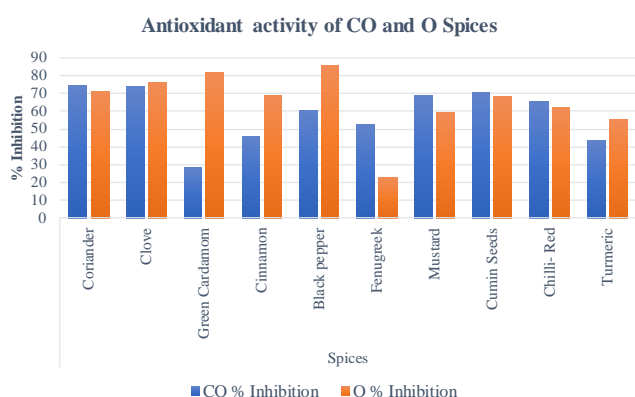


Figure 2. Antioxidant activity of Organic and Conventionally available Spices.

Consumption of antioxidants helps in prevention of long term diseases and there are various compounds that showcase antioxidant activity such as phenols, alkaloids, vitamin E, vitamin C etc. Antioxidant activity was studied by DPPH as measurement of each antioxidant will be tedious.

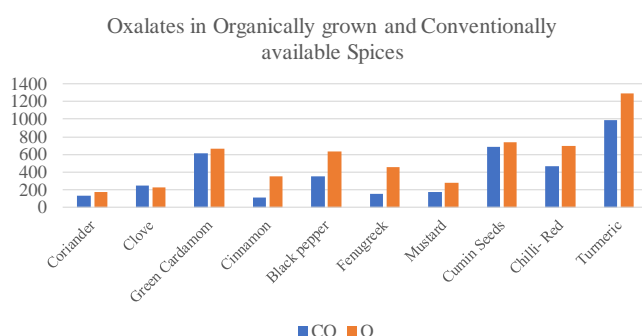


Figure 3. Oxalates in Organically Grown and Conventionally Available Spices.

Figure 3. Oxalates in Organically Grown and Conventionally Available Spices: **Figure 3** shows graphical representation oxalates in organic and conventional spices. [CO- Conventionally available O- Organically grown].

Figure 3 graph shows higher oxalate content in organically grown spices than conventionally available. Oxalates are salts of oxalic acid and minerals present in food sources such as cereals, legumes, spices. Higher oxalate content depletes absorption of minerals and increase chances of kidney stones. However higher oxalate content means higher mineral content [2]. High ash content was also found with high oxalate content in spices. New research shows no correlation between high calcium content in diet and antinutritional effect of oxalates. It reveals high calcium content in combination with oxalate

content have no effect of calcium bioavailability and decrease outbreak of cardiovascular effect [11].

Only a few studies have suggested that the carcinogenic potential of tannins may be due to their associated components rather than tannins themselves. Certain studies have showed a correlation between tea intake and an increased risk of cancer. Numerous tannin components, including tea polyphenols, have been linked to anti-carcinogenic properties. Several tannin compounds have also been shown to reduce the carcinogenic activity of mutagens [4]. So higher tannin content can be correlated with high antioxidant activity.

This study highlights significant differences between organically grown and conventionally available spices in terms of proximate composition, antinutritional factors, and antioxidant activity. These variations may be attributed to differences in agricultural practices, particularly the use of organic fertilizers versus synthetic ones, as well as the absence of chemical pesticides in organic farming. The findings suggest that organic cultivation methods could positively influence the nutritional and bioactive properties of spices, potentially enhancing their health benefits.

Present study comparatively analyses antioxidant activity, oxalates and tannins in organic and conventionally available spices which is first of its kind. This shows possibility of differences between organic and conventionally available with regards to antinutritional factors.

4. Conclusion

Organic and conventional spices are different not only by overall appearance but also by proximate content and antinutritional factors. Differences in antioxidant activity of organically grown and conventionally available spices shows presence of more antioxidants in naturally grown spices. Data shows significant difference in terms of ash, fat, protein and tannins content. More amount of antinutritional factors- oxalates and tannins found in organically grown spices. This throws light for future research on organic spices for health benefits. More studies need to be conducted on presence of antinutritional factors in spices. As per this research data, use of organic spices in kitchen may prove beneficial for health as well as welfare of society.

Abbreviations

FSSAI	Food Safety and Standards Authority of India
AR	Analytical Grade Chemicals
AOAC	Association of Official Analytical Chemists
DPPH	1,1-diphenyl-2-picrylhydrazyl for Antioxidant Activity
AOA	Antioxidant Activity
CO	Conventionally Available
O	Organically Grown

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Ethical Approval

Not applicable here as experiments conducted on farm produce and no living being used for this study.

Author Contributions

Mrunmayee Paranjape Joglekar: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Kalpana Jadhav: Funding acquisition, Resources, Supervision, Writing – review & editing

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Data Availability Statement

Experimental data that supports findings and conclusion is included in research paper Experimental data that supports findings and conclusion is included in research paper.

Conflicts of Interest

The authors declare no conflicts of interest.

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