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## Exploring the nutraceutical and therapeutic potential of commonly used Indian spices

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### Abstract

**Introduction:** Indian spices experience well-established reputations for their nutraceutical efficacy. These spices are a hidden treasure of numerous therapeutic components and are helpful for therapy against various health disorders. Moreover, these possess pharmacological and prebiotic activities. The healing qualities of spices have caught the attention of the nutraceuticals industry.

**Objectives:** The main objectives of the study were:

- To ascertain the efficient and effective usage of common Indian spices as a complete and promising functional food
- To assess the antioxidant capacity of various spices to combat ageing

**Methodology:** Extracts of seventeen commonly used Indian spices namely bay leaves, black pepper, green cardamom, cinnamon, coriander, clove, cumin, curry leaves, fennel, fenugreek, garlic, ginger, mint, mustard, nutmeg, onion and turmeric were prepared by steam distillation process and assessed for their antioxidant activity on copper induced in vitro protein oxidation. An extensive survey was conducted on the usage of the selected spices as medicine during various disorders by the local community of Kurukshetra.

**Results/Findings:** The tested spices were found to be rich in antioxidant sources. Maximum inhibition was observed with the extracts of mustard, cumin, turmeric, fennel, coriander and mint. Turmeric, fennel and mint inhibited the in vitro oxidation process completely even at 50 percent dilution. Inhibitory ratio observed with cinnamon, curry leaves, bay leaves, fenugreek seeds and black pepper was 30-35 percent. Diluted extracts of cinnamon and black pepper were ineffective to prevent oxidation of BSA in the assay. Ginger and onion had exhibited very low inhibitory ratio. Inclusion of green cardamom, nutmeg, clove and garlic had not shown any protection against oxidation.

**Conclusion/Recommendations:** Being a repository of medicinal benefits, the therapeutic potential of these spices may further be explored and exploited to develop new formulations.

**Keywords:** Nutraceutical, spices, therapeutic, lifestyle disorders

### Introduction

Nutraceutical products represent the fastest growing segment of the food industry, due to the combination of increased consumer demand for healthy foods with nutritional and nutraceutical advances in medical science (Childs, 1999) [3]. Nutraceuticals and functional foods have been reported to have significant biological actions and their use, across the globe continues to increase due to historical and more recent reports of clinical success through use of these products (Hardy, Hardy and Ball, 2003) [9]. Nutraceuticals comprise mainly of nutrients, herbals and dietary supplements which make them instrumental in maintaining health, act against various lifestyle disorders thereby promoting the quality of life (Dureja H. *et al.*, 2003) [5]. Indian spices experience well-established reputations for their nutraceutical efficacy. These spices are a hidden treasure of numerous therapeutic components like thymol, eugenol, curcuminoids, linalool, zingiberene, piperine, alpha crocin, coriandrol, cuminaldehyde, and capsaicin, and are helpful for therapy against various health disorders. Moreover, these possess pharmacological activities including antimicrobial, antioxidant, anticarcinogenic, antiemetic, antimutagenic, antihypertensive, antidiabetic, anticonvulsive, antifungal, antiviral, hypolipidemic, chemoprotective, and prebiotic activities. The healing qualities of spices have caught the attention of the nutraceuticals industry. Spices have also found their way into fortified foods and organic medicine, signifying immense opportunity for the Indian spice industry (Srinivasa, K 2014) [15].

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A nutraceutical is a food with a medical-health benefit, including the prevention and treatment of diseases. The term was coined in the late 1980s by Stephen DeFelice, M.D., founder and chairman of the Foundation for Innovation in Medicine (Satheesh, P.R., 2012) [14]. Nutraceuticals also referred to as natural functional/medical foods or bioactive phytochemicals that have health promoting, disease preventing or medicinal properties. These nutraceuticals normally contain the required amount of vitamins, lipids, proteins, carbohydrates, minerals, or other necessary nutrients, depending on their emphases. (Zeisel, S.H., 1999 and Whitman, M., 2001) [19, 18].

Oxidation may be defined as a process which involves the addition of oxygen (O<sub>2</sub>) or any other electronegative element or as a process which involves the removal of hydrogen (H<sub>2</sub>) or any other electropositive element. Oxidation is literally *decay*. It is a natural process that occurs around us all the time. Oxidation provided energy needed for life yet within our bodies the process is a two – edged sword. Unfortunately, a small number of oxygen molecules we breathe are converted within our bodies to unstable free radicals. This oxidative reaction plays a crucial role in the formation of human disorders like cancer, emphysema, cirrhosis, atherosclerosis and arthritis which are all correlated with oxidative damage (Halliwell B. *et al.*, 1996) [8].

Ageing appears to be in good part due to oxidants produced as byproducts of normal metabolism. Free radicals punch holes into our body's cellular membranes, damaging DNA, the genetic material within. Free radicals can even oxidise essential thiol groups of enzymes and proteins rendering them inactive. Hydrogen peroxide formed at in vivo high oxygen pressure can also cause damage.

Biomolecules inevitably get damaged by these processes. As we get older, lesions accumulate until we might have a few million lesions per cell. The body repairs much of the damage caused by oxidation. Our bodies have numerous ways of defending against damage caused by oxidation and repairing the lesions; glutathione protection, protection by enzymes such as catalase, glutathione peroxidase, glutathione reductase, superoxide dismutase, metal ions and antioxidants. However, the unrepaired damage can build up and over time may contribute to several diseases including cancer, cardiovascular or heart disease and cataracts. Antioxidants can prevent and reverse the harmful effects of oxidation. Thus the onset of disease caused by oxidation can be delayed or prevented. Antioxidants cannot delay ageing in healthy older people. But they do help to minimize the damage made by several diseases especially those associated with old age e.g. cancer, neurological diseases, cardiovascular diseases, complications of diabetes etc.

Vitamin B, C and flavonoids are water soluble and work within the cells, watery interiors by protecting the aqueous parts of our cells and tissues while vitamin E is fat soluble and protects the lipid portions, especially cellular membranes that surround cells; in addition it improves immune function in older people and reduces the risk of some age related conditions, including heart diseases, some forms of cancer etc. Use of antioxidant rich spices for their medicinal values is attracting great attraction. Various spices used in Indian foods such as turmeric, cumin, fenugreek, mint, clove, ginger etc. are also documented for their medicinal properties. Some of them are reported to have flavonoids, fat-soluble and water-soluble vitamins also. The present investigations were undertaken to explore the possibility of medicinal uses of the common spices for their antioxidant properties.

The main objectives of the study were:

- To ascertain the efficient and effective usage of common Indian spices as a complete and promising functional food
- To assess the antioxidant capacity of various spices to combat ageing

### Review of Literature

Reactive oxygen species (ROS) are highly reactive and potentially damaging chemical species (Frankel and Meyer, 2000, Carpenter *et al.*, 2007, Suk Kim *et al.*, 2011) [6, 2, 16]. Free radicals can also cause lipid peroxidation in foods, which leads to their deterioration. Oxidized polyunsaturated fatty acids may induce aging and carcinogenesis. When produced in excess, ROSs can cause tissue injury. However, tissue injury can itself cause ROS generation. The oxidative damages caused by ROS Oxidative stress is one of the major etiological factors for diseases like Cataract, Cancer, Heart ailments, Arthritis, Alzheimer's disease, nutritional deficiencies, bacterial, viral infections (Halliwell B., 1996) [7]. Antioxidants can prevent the oxidation of lipids or other molecules by inhibiting the initiation or propagation of oxidative chain reactions (Tachakittirungrod *et al.*, 2007) [17]. Spices are strong source of natural antioxidants which known to protect tissues / cells from oxidative stress, which is generally considered to be a cause of mutation and leads to cancer (Ringman *et al.*, 2005) [13].

Spices and herbs are recognized as sources of natural antioxidants and thus play an important role in the chemoprevention of diseases and ageing (Nooman A., 2008) [11]. A large number of medicinal plants and their purified constituents have shown beneficial therapeutic potentials. Various herbs and spices have been reported to exhibit antioxidant activity, including *Ocimum sanctum*, *Piper cubeba* Linn., *Allium sativum* Linn., *Terminalia bellerica*, *Camellia sinensis* Linn., *Zingiber officinale* Roscoe and several Indian and Chinese plants. The majority of the antioxidant activity is due to the flavones, isoflavones, flavonoids, anthocyanin, coumarin lignans, catechins and isocatechins (Aqil F *et al.*, 2006) [1]. Antioxidant-based drug formulations are used for the prevention and treatment of complex diseases like atherosclerosis, stroke, diabetes, Alzheimer's disease and cancer (Devasagayam T. P. A. *et al.*, 2004) [4]. Generally, Spices, like turmeric, fenugreek, mustard, ginger, etc. may offer many health benefits and have been proven to counteract oxidative stress *in vitro* and *in vivo* (Tachakittirungrod *et al.*, 2007) [17]. Most of these spices have been intensely studied only for their components like phenolic compounds, beta carotene, curcuminoids and flavonoids (Manda and Adams, 2010, Suk Kim *et al.*, 2011) [10, 16], but when these so called active components are subjected to thermal stability tests, it is observed that, their antioxidant ability is considerably reduced.

### Methodology

The selected spices were procured from the local market, identified and authenticated at Department of Botany, Kurukshetra University, Kurukshetra.

### Chemicals Used

1. Bovine Serum Albumin (BSA) fraction V
2. Copper Chloride
3. 5,5 – Dithiobis 2-nitrobenzoic acid (DTNB)
4. Ethylenediaminetetraacetic acid disodium salt (EDTA)
5. Phosphate buffer

- i. Monobasic sodium phosphate ( $\text{Na}_2\text{HPO}_4 \cdot 2\text{H}_2\text{O}$ )
- ii. Dibasic sodium phosphate ( $\text{NaH}_2\text{PO}_4 \cdot 2\text{H}_2\text{O}$ )

6. Tris (hydroxymethyl) aminomethane buffer
7. Urea

All the above mentioned chemicals were of analytical grade and obtained from Hi-Media Laboratories Limited, Mumbai (India) or Sisco Research Laboratories.

### Extraction

The seeds were dried at  $60^\circ\text{C}$  in hot air oven till constant weight was attained. Finely powdered spices seeds were extracted with 80 percent methanol (1g/10ml) in a shaker at room temperature for 4 hours. Residue was again extracted with 80 percent methanol for 2 hours. Collected extracts were filtered through double layered muslin followed by centrifugation at 5000rpm for 5 minutes in order to get clear supernatant. Extracts were concentrated in a vacuum evaporator and stored at  $-20^\circ\text{C}$  for further use. The extracts were diluted appropriately for various experiments.

### Calculations

Inhibitory ratio of each extract was calculated by comparing the total oxidation taking place in absence of any spice extract i.e. control to the sulphhydryl groups which could be saved due to the presence of extracts of some spices in the reaction mixture. Following equation was used to evaluate percent inhibitory ratio of each extract:

$$\text{Inhibitory Ratio (\%)} = \left( \frac{\text{Cystein SH residue in presence of test sample} - \text{Cystein SH residue in absence of test sample}}{\text{Cystein SH residue before incubation} - \text{Cystein SH residue in absence of test sample}} \right) \times 100$$

For every experiment, the following assays were done:

Incubated

1. Buffer +  $\text{CuCl}_2$  + BSA  $\xrightarrow{\text{Incubated}}$  EDTA + Urea + DTNB  $\rightarrow$  Read at 412nm say O.D. = c  
for 2 hrs. (in buffer) (in buffer)
2. Buffer +  $\text{CuCl}_2$   $\xrightarrow{\text{Incubated}}$  EDTA + Urea + BSA + DTNB  $\rightarrow$  Read at 412nm say O. D. = a  
for 2 hrs. (in buffer) (in buffer)
3. Buffer +  $\text{CuCl}_2$  + BSA + Extract  $\xrightarrow{\text{Incubated}}$  EDTA + Urea + DTNB  $\rightarrow$  Read at 412nm  
for 2 hrs. (in buffer) (in buffer) against blank

a-c = Total  $\text{CuCl}_2$  induced oxidation of BSA taking place in 2 hours at  $37^\circ\text{C}$

b = Sulphydryl groups present when spice extract is included in the assay mixture

b-c = Sulphydryl groups saved due to inhibitory effect of the spice on BSA oxidation

Therefore,

$$\text{Inhibitory Ratio (\%)} = \frac{b - c}{a - c} \times 100$$

### Survey

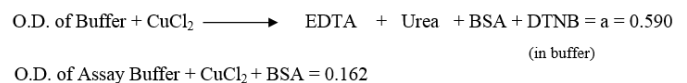
Continuous field surveys were conducted for 2 years to the selected 328 households of Kurukshetra for data collection on regular basis. Various formal as well as informal discussions were conducted with the knowledgeable persons of the families like housewives, old ladies etc. (n= 483) to extract the true information. A semi-structured questionnaire was administered to know the usage, culinary function and remedial function of various commonly used spices during illness or disorders. The data collected has been presented in the form of a table for better presentation and comparison.

### Results and Discussion

Spices, being agricultural commodities, are prone to spoilage by insect or microbial attack. Hence, the spice oils or oleoresins, which contain all the active principles of spices are extracted and marketed. Spice oils are obtained by the steam distillation of ground spices. Oleoresins are obtained by the solvent extraction of ground spices. The spice oils (extracts) prepared by steam distillation were used for the present studies.

### Effects of the extracts of various spices on in vitro Protein Oxidation

In the preliminary experiment, the extracts of the selected spices were used as such. 100 $\mu\text{l}$  of the extract was added to the reaction mixture and the results were observed in terms of inhibition of protein oxidation induced by copper. Data in Table 1 shows that total sulphhydryl groups in the BSA taken for assay recorded optical density of 0.590 after reaction with DTNB. But after incubating with  $\text{CuCl}_2$  for two hours, sulphhydryl groups left unoxidised recorded 0.162 at 412nm after reaction with DTNB.



$$\text{O.D. of Assay Buffer} + \text{CuCl}_2 + \text{BSA} = 0.162$$

Presence of extracts of mustard, cumin, turmeric, fennel, coriander and mint had offered an inhibitory effect on decrease in optical density i.e. oxidation of sulphhydryl groups to the extent of 80 percent to 100 percent. There was no oxidation of BSA when turmeric, fennel and mint extracts were included in assay mixture along with copper indicating strong antioxidant activity of these extracts. Presence of mustard, cumin and coriander extracts in assay mixture saved about 80 percent of sulphhydryl groups from oxidation as compared to control. However, extracts of cinnamon, black pepper, fenugreek, ginger, bay leaves and curry leaves could inhibit copper induced in vitro BSA oxidation by 27-40 percent when included in assay mixture, whereas inclusion of onion extract had marginal effect of 22.3 percent only. Oxidation of BSA was not affected by green cardamom, nutmeg, clove and garlic extracts.

**Table 1:** Effect of Inclusion of various Spice Extracts on Copper Induced *in vitro* Protein Oxidation

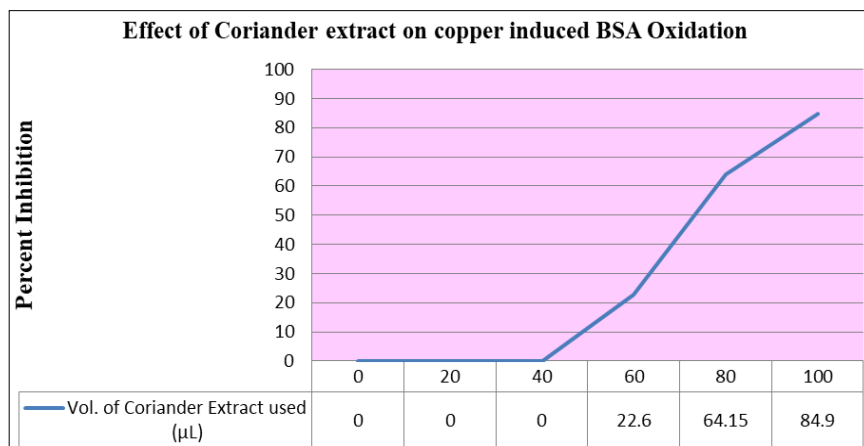
S. No.	Spice	O.D. at 412 nm (b)	Percent Inhibition (%)
1	Bay leaves	0.302	32.8
2	Black pepper	0.287	29.2
3	Green Cardamom	0.165	Nil
4	Cinnamon	0.317	36.2
5	Coriander	0.525	84.9
6	Clove	0.160	Nil
7	Cumin	0.506	80.2
8	Curry leaves	0.299	31.7
9	Fennel	0.598	100.0
10	Fenugreek	0.305	33.5
11	Garlic	0.163	Nil
12	Ginger	0.276	28.5
13	Mint	0.591	100.0
14	Mustard	0.509	81.3
15	Nutmeg	0.168	Nil
16	Onion	0.231	22.3
17	Turmeric	0.594	100.0

**Effect of varying Concentrations of Spice Extracts on Inhibitory Ratio**

In the subsequent experiments to observe the effect of varying concentrations of the extracts on inhibitory ratio, the extracts were diluted with 50mM Tris HCl buffer pH 7.4 Varying volumes of original extracts in 100µl of the diluted extract were included in assay mixture to observe the effect of varying volume of extracts in assay mixture on inhibitory

ratio.

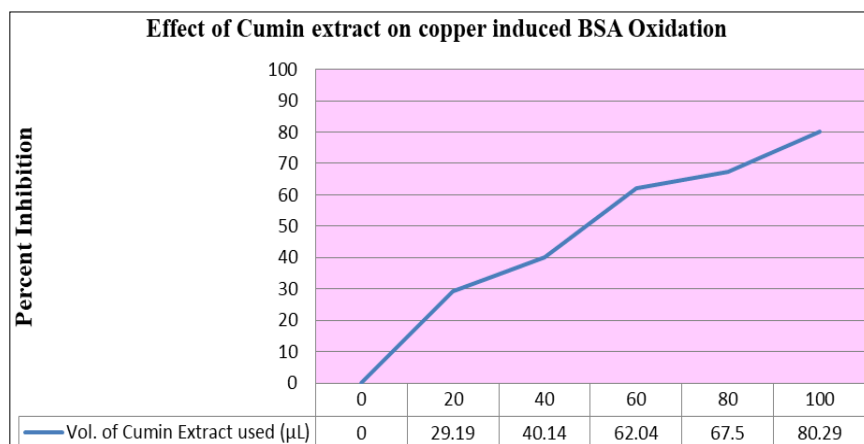
Inclusion of lower concentration of coriander had shown little inhibition of protein oxidation (Fig.1). The inhibitory effect was noticeable only at higher concentrations indicating that in coriander extract, antioxidant property is present in very low concentration but is strong enough to produce about 85 percent inhibition at 100µL.



**Fig 1:** Effect of Coriander extract on Protein Oxidative Modification induced by Copper

Continuous acceleration in percent inhibition was observed in case of cumin (Fig. 2).Cumin extract at very low volume of 20µL had shown 29.19 percent inhibition of protein

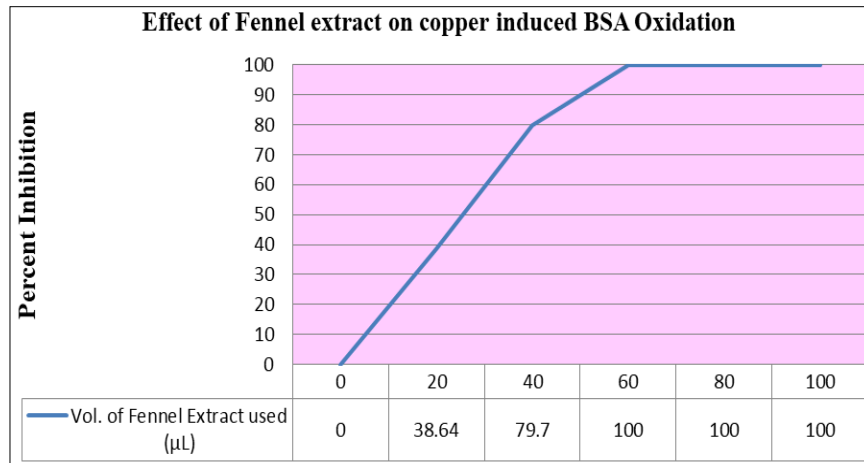
oxidation, which increased almost linearly upto 80.29 percent at 100µL. These results denote an appreciable volume dependent activity of cumin extract on protein oxidation.



**Fig 2:** Effect of Cumin extract on copper induced BSA Oxidation *in vitro*

Results observed in presence of fennel extract (Fig.3) highlight the two fold increase in percent inhibition when volume of extract was increased from 20 $\mu$ L to 40 $\mu$ L. The

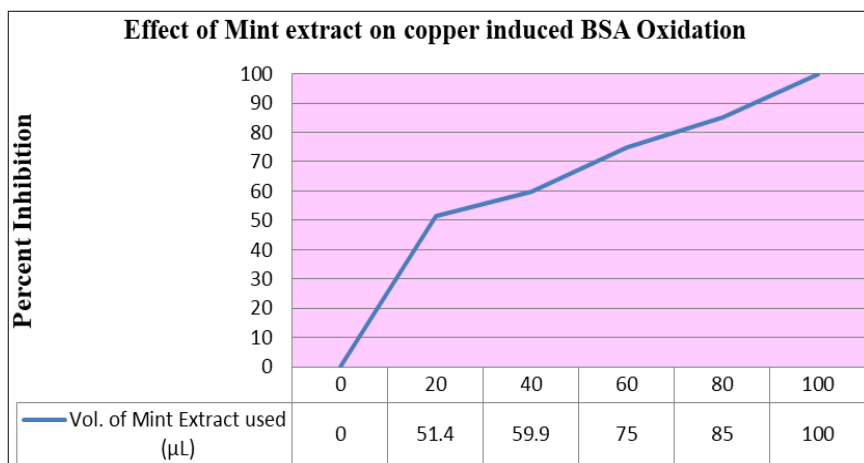
inhibition achieved was 100 percent for higher additions of amount of extract. This indicates that fennel extract has powerful antioxidant property for in vitro protein oxidation.



**Fig 3:** Effect of Fennel extract on copper induced BSA oxidative modification *in vitro*

An increase in percent inhibition of in vitro protein oxidation with increase in volume had been observed in case of extract of mint. Addition of 40, 60 and 100  $\mu$ L of extract to the assay mixture had registered inhibition of 59.9, 75 and 100 percent

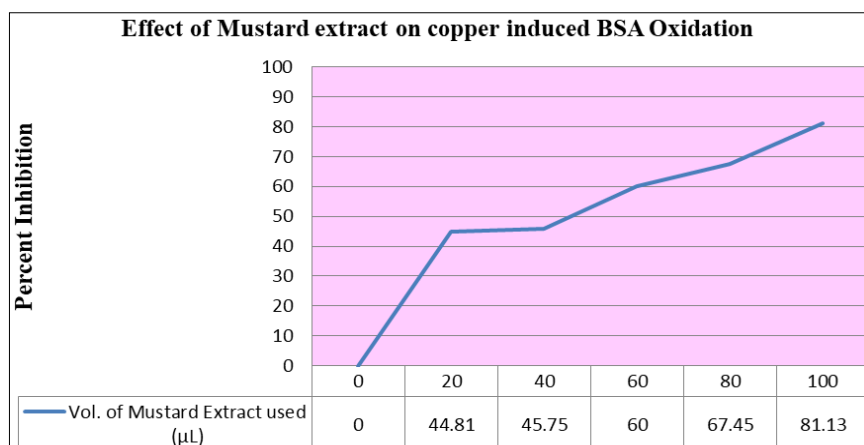
respectively (Fig.4). The results indicate that extract as low as 20 $\mu$ L is having antioxidant property enough to reduce protein oxidation by about 50 percent. This property increased linearly with volume.



**Fig 4:** Effect of Mint extract on in vitro BSA oxidation

Results of effect of varying volume of extract of mustard on percent inhibition of protein oxidation are shown in Fig.5. It has been observed that protein oxidation was considerably reduced even when the amount of extract included in assay

mixture was just 20 $\mu$ L. A sharp inhibition of about 45 percent was observed with 20-40  $\mu$ L of mustard extract in the assay mixture. Inclusion of 100  $\mu$ L of this extract had reduced the copper induced BSA protein oxidation by 81.13 percent.



**Fig 5:** Effect of Mustard extract on copper induced BSA oxidation

The results in Fig. 6 show that presence of turmeric extract in the assay mixture had exerted a strong inhibitory effect on copper induced protein oxidation. Sulphydryl group oxidation was inhibited upto 27.8 percent by inclusion of 20µl of the extract in the assay mixture. An increase in the volume of

extract had further increased the inhibition sharply and almost 100 percent inhibition was there in presence of 60µL or more of the extract. Complete inhibition of oxidative modification of BSA protein by turmeric has underlined its importance as an effective antioxidant.

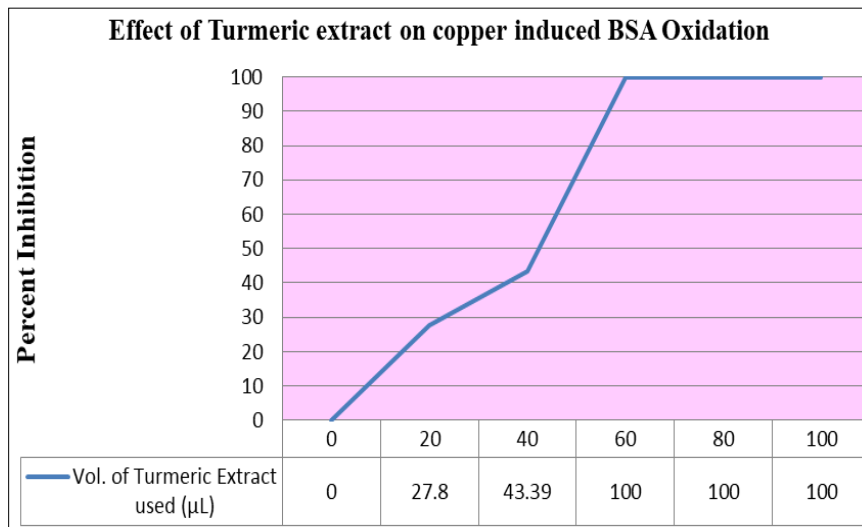


Fig 6: Effect of Turmeric extract on copper induced BSA oxidative modification *in vitro*

Mustard and cumin had shown similar increase in inhibition and similar maximum inhibitory ratio. Antioxidant principle in turmeric, fennel and mint seems to be most efficient with 100 percent inhibition, whereas antioxidants in fennel, coriander and mint seem to be more effective even at low concentrations. Antioxidant principles present in extracts of cinnamon, curry leaves, bay leaves, fenugreek seeds, nutmeg and black pepper seem to be comparatively less efficient since 30 to 35 percent inhibition observed with 60 µL extract was not further enhanced with volume. Lower concentrations of extractable antioxidants may be responsible for negligible inhibition with lower volume of extracts of pepper and ginger;

which increases with increase in volume. Ginger and onion had exhibited very low inhibitory ratio. Green cardamom, nutmeg, clove and garlic had no steam extractable antioxidant to inhibit copper induced protein oxidation. Isolation of different antioxidant principles from these spices can be done to explore their medicinal uses.

**Demographic Profile of Respondents**

Table 2 depicts the demographic profile of the respondents. The characteristics include age, qualification and occupational status of the housewives and the old ladies like mother-in laws, grandmothers etc.

Table 2: Demographic Profile of Respondents

Parameter	Frequency (N = 483)	Percentage (%)
<b>Age</b>		
20 to 35 years	n = 69	14.3
36 to 50 years	n = 217	44.9
51 to 65 years	n = 197	40.8
<b>Educational Qualification</b>		
Primary	n = 36	7.5
Middle	n = 59	12.2
Matric	n = 102	21.1
Senior Secondary	n = 87	18.0
Graduate	n = 134	27.7
Post Graduate	n = 65	13.5
<b>Occupational Status</b>		
Housewife	n = 216	44.7
Self Employed	n = 185	38.3
Salaried	n = 82	17.0

Data regarding the culinary as well as therapeutic usage of commonly used spices was collected from the respondents by administering a semi-structured questionnaire. In case of less educated subjects and old ladies, questions were asked

verbally to help them fill the questionnaire during informal visits to their households. The collected information about the therapeutic usage of the selected spices has been summarized in Table 3.

Table 3: Active ingredient and Therapeutic Potential of the Selected Spices

Spice	Active Ingredient(s)	Association with Diseases
Bay Leaves	$\alpha$ -pinene, $\beta$ -pinene, Myrcene, Limonene, Linalool, Neral, Methyl Chavicol, $\alpha$ -Terpineol, Eugenol, Geranyl Acetate	<ul style="list-style-type: none"> <li>• Promotes Digestive Health</li> <li>• Helpful for Respiratory Conditions</li> <li>• Useful for Hair Health</li> <li>• Enhances Heart Health</li> <li>• Prevents Cancer</li> <li>• Manages Anxiety and Stress</li> <li>• Aids Diabetes Management</li> </ul>
Black pepper	Piperine	<ul style="list-style-type: none"> <li>• Works in Stomach Upset</li> <li>• Aids in digestion</li> <li>• Promotes Heart Health</li> <li>• Helps in Weight Loss</li> <li>• Enhances Skin Health</li> <li>• Relieves Respiratory Disorders</li> <li>• Enhances Bioavailability</li> <li>• Cognitive Impairment and Neurological Health</li> <li>• Cures Peptic Ulcers</li> <li>• Treats Asthma and Whooping Cough</li> <li>• Prevents Ear-aches and Gangrene</li> <li>• Useful for Hernia, hoarseness and insect bites</li> <li>• Relieves Tooth decay and toothache</li> <li>• Treats Vision problems</li> </ul>
Cardamom	Alpha-terpinyl acetate, Cineole, Linalyl acetate, Limonene, Linalool, Limonene, Terpinolene and Myrcene	<ul style="list-style-type: none"> <li>• Prevents Colorectal Cancer</li> <li>• Fights against non-melanoma Skin Cancer</li> <li>• Improves Blood Circulation</li> <li>• Good for Cardiovascular Health</li> <li>• Protection against Gastrointestinal Diseases</li> <li>• Counteracts Bloating, Gas and Heartburn</li> <li>• Helpful in Loss of Appetite</li> <li>• Cures Dental Diseases</li> <li>• Prevents Asthma</li> <li>• Good for Sore Throat, Nausea and Vomiting</li> <li>• Treats Urinary Disorders</li> <li>• Remedy for Hiccups</li> <li>• Treats Bad Breath</li> </ul>
Cinnamon	Cinnamaldehyde	<ul style="list-style-type: none"> <li>• Protects Heart Health</li> <li>• Fights Diabetes</li> <li>• Helps Defend against Cognitive Decline</li> <li>• Help Lower Cancer Risk</li> <li>• Fights Infections &amp; Viruses</li> <li>• Protects Dental Health &amp; Freshens Breath</li> <li>• Help Prevent or Cure Candida</li> <li>• Benefits Skin Health</li> <li>• Helps Fight Allergies</li> </ul>
Coriander	Citronelol	<ul style="list-style-type: none"> <li>• Treats Skin disorders</li> <li>• Lowers cholesterol levels</li> <li>• Cures Diarrhea</li> <li>• Regulates Blood pressure</li> <li>• Soothes Mouth ulcers</li> <li>• Stimulates Kidneys by Diuretic Action</li> <li>• Aids in Digestion &amp; Relieves Flatulence</li> <li>• Helpful for Irritable Bowel Syndrome</li> <li>• Calms Intestinal Spasms</li> <li>• Treats Smallpox</li> <li>• Helpful in Eye care</li> <li>• Regulates Blood sugar and Diabetes</li> </ul>
Clove	Eugenol	<ul style="list-style-type: none"> <li>• Boosts Digestive Functioning</li> <li>• Useful in Gastric Irritability and Dyspepsia</li> <li>• Cures Asthma</li> <li>• Protects Heart Diseases</li> <li>• Staves off Cancer</li> </ul>

		<ul style="list-style-type: none"> <li>• Liver Protection</li> <li>• Improves Insulin Function</li> <li>• Boosts the Immune System</li> <li>• Cure for Oral Diseases</li> </ul>
Cumin	Cuminaldehyde Pyrazines	<ul style="list-style-type: none"> <li>• Regulates Digestion</li> <li>• Cures Piles</li> <li>• Prevents Diabetes</li> <li>• Treats Insomnia</li> <li>• Treats Asthma &amp; Bronchitis</li> <li>• Fights Common Cold</li> <li>• Increases Lactation</li> <li>• Prevents Anemia</li> <li>• Decreases Cognitive Disorders</li> <li>• Prevents Cancer</li> </ul>
Curry leaves	Glycosides, Carbazole alkaloids, Koenigin, Girinimbin, Iso-mahanimbin, Koenine, Koenidine and Koenimbine	<ul style="list-style-type: none"> <li>• Stops Diarrhea</li> <li>• Fights Cancer</li> <li>• Lowers Cholesterol Levels</li> <li>• Good for Hair Growth</li> <li>• Protects Against Pathogen Attack</li> <li>• Protects the Liver</li> </ul>
Fennel	Alpha pinene, beta myrcene, beta pinene, Anethole, Fenchone, Estragole	<ul style="list-style-type: none"> <li>• Prevents Anemia</li> <li>• Treats Indigestion</li> <li>• Removes Flatulence</li> <li>• Treats Constipation</li> <li>• Reduces Heart Diseases</li> <li>• Prevents Cancer</li> <li>• Regulates Blood Pressure</li> <li>• Improves Brain Function</li> <li>• Treats Diarrhea</li> <li>• Treats Colic</li> <li>• Boosts Immunity</li> <li>• Regulates Menstruation</li> <li>• Promotes Breast Enlargement</li> <li>• Treats Respiratory Disorders</li> </ul>
Fenugreek	Saponins, 4-hydroxyisoleucine, Trigonelline, Galactomannan, Trigoneosides	<ul style="list-style-type: none"> <li>• Promotes Lactation</li> <li>• Helpful for treating diabetes</li> <li>• Lowers Cholesterol Levels</li> <li>• Prevents constipation</li> <li>• Helps in flushing out harmful toxins</li> <li>• Helps counter acid reflux or heartburn</li> <li>• Helps you lose weight</li> <li>• Induces and eases child-birth</li> <li>• Helps reduce menstrual discomfort</li> <li>• Helps prevent colon cancer</li> <li>• Helps soothe skin inflammation</li> <li>• Can help resolve hair problems</li> </ul>
Garlic	Allicin	<ul style="list-style-type: none"> <li>• Treats Diabetes</li> <li>• Manages High Cholesterol Levels</li> <li>• Cures Hypertension</li> <li>• Helps in Eye Care</li> <li>• Deals with Intestinal Problems</li> <li>• Fights Cold and Sinus Infections</li> <li>• Aids Digestion</li> <li>• Treats Acne</li> <li>• Prevents Asthma</li> <li>• Rectifies Sexual Problems</li> <li>• Protection against Stomach and Colorectal Cancer</li> </ul>
Ginger	Gingerol	<ul style="list-style-type: none"> <li>• Useful for Bone Health and Joint Pains</li> <li>• Relieves Cold and Flu</li> <li>• Treats Diarrhea</li> <li>• Regulates Blood Pressure</li> <li>• Cures Excess Gas</li> </ul>



		<ul style="list-style-type: none"> <li>• Aids in Digestion</li> <li>• Prevents Cancer</li> <li>• Enhances Sexual Activity</li> <li>• Prevents Menstrual Cramps</li> <li>• Reduces Pain and Swelling in Arthritis</li> <li>• Works against Migraine</li> </ul>
Mint	Menthol, Menthone	<ul style="list-style-type: none"> <li>• Treats Indigestion, biliousness, flatulent colic, summer diarrhoea</li> <li>• Relieves Hyperacidity</li> <li>• Counteracts Painful periods</li> <li>• Cures Morning sickness and iron deficiency anaemia</li> <li>• Useful in Tuberculosis, Asthma and Bronchitis</li> <li>• Reduces Skin dryness, Pimples and Acne</li> <li>• Relieves Insect stings, eczema, scabies, contact dermatitis</li> <li>• Protects against Bad breath and gum problems</li> </ul>
Mustard	Glucosinolates like Sinigrin, Myrosin, Sinalbin	<ul style="list-style-type: none"> <li>• Prevents Cancer</li> <li>• Treats Psoriasis</li> <li>• Relieves Contact Dermatitis</li> <li>• Improves Cardiovascular Health</li> <li>• Relief from Respiratory Disorders</li> <li>• Cures Aches</li> <li>• Poison Repulsion</li> <li>• Treats Ringworm</li> <li>• Controls Diabetes</li> <li>• Cholesterol Lowering Ability</li> <li>• Treats Menopause</li> </ul>
Nutmeg	Eugenol, Myristicin	<ul style="list-style-type: none"> <li>• Pain Relief</li> <li>• Digestive Health</li> <li>• Brain Health</li> <li>• Inhibits Alzheimer's disease</li> <li>• Improves Memory</li> <li>• Insomnia</li> <li>• Leukemia</li> <li>• Skin Health</li> <li>• Blood Pressure and Circulation</li> </ul>
Onion	Quercetin	<ul style="list-style-type: none"> <li>• Good for Oral Health</li> <li>• Strengthens Immune System</li> <li>• Treatment for Heart Ailments</li> <li>• Manages Diabetes</li> <li>• Prevention of Cancer</li> <li>• Relieves Earache</li> <li>• Helps in Glowing Skin</li> <li>• Treatment for Cough</li> <li>• Boosts Sexual Drive</li> <li>• Treatment of Anemia</li> <li>• Relieves Stomach Aches</li> <li>• Treats Urinary Disorders</li> </ul>
Turmeric	Curcumin	<ul style="list-style-type: none"> <li>• Helps to treat Arthritis</li> <li>• Prevents Alzheimer's disease</li> <li>• Cures Heartburn</li> <li>• Skin Health</li> <li>• Gastrointestinal Issues</li> <li>• Menstrual Issues</li> <li>• Cystic Fibrosis</li> <li>• Cancer Treatment and Prevention</li> <li>• Heart Health</li> <li>• Cognitive Abilities</li> </ul>

### Conclusion

The expansion of nutraceutical industry is far beyond those of food and pharmaceutical industries. The customers' perception of therapeutic and curative effects of nutraceuticals will highlight their future demand. Although

nutraceuticals have significant promise in the promotion of human health and disease prevention, health professional, nutritionists and regulatory toxicologist should strategically work together to plan appropriate regulation to provide the ultimate health and therapeutic benefit to mankind. The

interaction of nutraceuticals with food and drugs is another area, which should be taken into consideration. Food based approaches for enhancing the intake of spices and phytochemicals can offer an avenue to greatly impact the onset and progression of chronic diseases, oxidant stress and ageing. Although the chemo- preventive approach is a recognized strategy, public health action should be directed at increasing the consumption of spices which possess a package of protective phyto-nutrients.

The tested spices were found to be rich in antioxidant sources. Maximum inhibition was observed with the extracts of mustard, cumin, turmeric, fennel, coriander and mint. Turmeric, fennel and mint inhibited the in vitro oxidation process completely even at 50 percent dilution indicating the presence of strong antioxidants in the extracts of these spices. Inhibitory ratio observed with cinnamon, curry leaves, bay leaves, fenugreek seeds and black pepper was 30-35 percent. Diluted extracts of cinnamon and black pepper were ineffective to prevent oxidation of BSA in the assay. Ginger and onion had exhibited very low inhibitory ratio. Inclusion of green cardamom, nutmeg, clove and garlic had not shown any protection against oxidation suggesting the absence of antioxidants or inefficiency of steam distillation process in extraction of antioxidant principles from these spices. However, all of the studied spices are known to exert several beneficial physiological effects on human body as indicated by the findings of the survey conducted for their medicinal uses. Dietary spices were found to influence various systems in the body such as gastrointestinal, cardiovascular, nervous and reproductive resulting in diverse metabolic and physiologic actions.

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