ANALYSIS AND COMPARATIVE STUDY OF ESSENTIAL HEAVY METALS IN BRANDED AND LOCAL SPICES (REWARI), INDIA

[1]Manoj Kumar Maurya, [2]Tarun Gupta, [3]Kesana Veekshitha, [4]Renu Sharma, [5]Raghev Langeh
[1]Research Scholar, [2]PG Student, [3]PG Student, [4]Professor and Head of Department, [5]Research Scholar
[1, 5] Department of Advanced Science and Technology, NIET, Nims University, Jaipur, Rajasthan, INDIA
[2, 3] Department of Biotechnology, Mohanlal Sukhadia University, Udaipur, Rajasthan, INDIA
[4]Department of Chemistry, NIET, Nims University, Jaipur, Rajasthan, INDIA

Abstract- The local and branded spices sample (Turmeric, Black Pepper, Coriander, Dry Ginger and kasuri Methi) have been collected from Rewari (Haryana). The collected samples were analyzed for various essential element viz., Zinc, Copper and Iron. The samples were grinded, digested and analyzed by Atomic Absorption Spectrometer. In this study we compared the concentration of essential metals in local and branded samples of spices. The concentration of Zinc is higher in local samples of spices. The total concentration of Zinc in local spices samples has been found in the range between 74.9µg/g and 105µg/g. The total concentration of Copper in local spices has been found in the range between 0.3µg/g and 15.5µg/g. The total concentration of Iron in local spices has been in the range between 383.8µg/g and 3802.5µg/g. The concentration of copper is nearly same in both local and branded spices samples. The concentration of Iron is higher in local spices samples whereas lower in branded spices samples. After comparing local and branded spices sample we found that copper levels nearly same in both local and branded spices samples.

***Index term*- heavy metals, AAS, Wet digestion.**

1. INTRODUCTION-

Spices have been a fundamental part of the Indian diet and the interest for Spices has been developing quite a long time. India has been sure normal relative favorable position regarding generation and use of spices ; these incorporate various agro-climatic creation situations, accessibility of multitudinous assortments and cultivars of each zest appropriate for various climatic conditions, huge domestics advertise and solid conventions of utilizing flavors and their sustenance, drugs and beautifying agents.

The Spices Board of the Government of India has categories the spices into 52 kinds and five broad categories in terms of their origin and features [1]. A study on spices research in India and Japan, a comparative report in terms of their publication output, the priorities they have assigned to different fields in spices research during the last three-decade was studied using Hort-CD database. India, s research output in the field of Spices Research is found to be considerably more than the Japanese output. However, quantitative analysis indicates that Japan publish more papers in the field in relation to its total output than average in the field of Spices than India [2].

Spices grown in various regions of the world have been used for several purposes since ancient times. Several uses of these plants are for culinary purposes [3-6]. Although a few dose not different spices plants are of global importance, many more are used as condiments locally, in the regions of their natural occurrence. Some of these are traded in small quantities and used in ethnic restaurants. Spices have been recognized to have some medical properties due to antioxidant and antimicrobial action [7-9].

Many common spices have outstanding antimicrobial effects. On the other hand, the process of preparation and handling can make them a source of food poisoning addition of spices that may be contaminated with trace and heavy metals to food as a habit may be in accumulation of these metals in human organs and lead to different health troubles [10].

The study of these heavy metals is crucial because they have potential hazardous effect, not only on compounds but human health as well. In Ghana, spices have varied uses [11], however, there is little information available about the safety of these spices with respect to heavy metal contamination.

2. SCENARIO OF SPICES IN INDIA REGION

India is not only the largest producer but also the largest consumer of spices in the world. There has been a steady increase in the area and production of spices in India over the year. In the year 2002, the production of spices in India had reached a level of 3.08 million hectares of land [12]. The major contributors to the area and production of spices in the country include ginger, turmeric, black pepper, cardamom, and kasuri methi.

The pattern of spices production has been changing over time in different regions. The shift in preferences of domestics consumers, increasing urbanization, rising incomes, demographics and social factors and the changes in productivity of spices have brought about changes in the pattern of consumption and hence the demand spices. Liberalization of trade under the WTO regime is expected to have a significant impact on the international demand pattern of spices. Relatively little work has been done to comprehensively study the dynamics of demand for spices in India.

3. CHARACTERISTICS AND PROPERTIES OF SPICES-

Spices have been recognized to have some medicinal properties due to antioxidant and antimicrobial action. Many spices have been found to possess anti-diabetic, anti-inflammatory and anti-hypersensitive capacity [13, 7]. Several studies were done to determine the concentration of heavy metals in spices and to study their harmful effects. Heavy metals beyond the permissible limits affect the human health and may lead to illness of human fetus, preterm labour and mental retardation in children. Adults may suffer from fatigue, high blood pressure and kidney troubles [14].

Spices, a major group of the food additives is a vegetable substance of indigenous or exotic origin has a hot, pigment taste, used to enhance taste of foods or to add to them the stimulant ingredients contained in them. It can also be defined as a dried seeds, fruits, root, bark or vegetative substances derived from the non-leafy parts of plant. It is used as a food additive for the purpose of flavoring or food flavoring, and sometimes as a preservative by killing or preventing the growth of harmful bacteria [15].

The bulk of the dry material of spices contains carbohydrates and organic compounds having different functional groups [16-17]. Heavy metals are chemicals that are known to be toxic to human and are often impossible for the human body metabolise. They are extremely persistent in the environment. They are non-bio-degradable and thermo-stable and thus readily accumulate to toxic levels [18].

Spices are being used as diet components often to improve color, aroma, palatability and acceptability of food. Most people love spices of one kind or another. Spices are among the most versatile and widely used ingredients in food processing. As well as their traditional role in food flavoring and coloring, they are increasingly used as natural preservatives in active packaging [19].

Spices which are dried plants parts can be easily contaminated by heavy metals forms type of soil for cultivation, fertilizer and source of water used for irrigation [20]. Herbs and spices grown in various regions of the world have been used for several purposes since ancient times. Several uses of these plants are of culinary purposes [21-23, 5].

A spice is a seed, fruits, roots, bark, berry, bud, or vegetable substance primarily used for flavoring, coloring, or preserving food. Many spices have antimicrobial properties. Most of these are fragrant, aromatic and pungent. The addition of spices that may be contaminated with trace and heavy metals to food as a habit may result in accumulation of these metals in human organs and lead to different health troubles.

The World Health Organization (WHO) defines health as a state of “complete physical, mental and social well-being and merely the absence of disease and infirmity.” A good health may be considered as that situation in which all of the many thousand intra and extracellular reaction that occur in the body are proceeding at rates commensurate with the organism’s maximal survival in the physiologic state [24].
There is no doubt that spices do have value far beyond enhancing the taste of food. However, besides adding to the taste, spices have multifarious functions that include combating food borne microorganism, reducing food poisoning, antioxidant function and antimicrobial activity [25-27]. Spices and herbal plants may contain heavy metal ions over a wide range of concentration [28-29]. Due to the significant amount of spices consumed, it is important to know the toxic metal concentration in them [30].

Heavy metal are those with atomic weight from 63.546 to 200.59, and specific weight higher than 4. These metals may reach and contaminate plants, vegetable, fruits and canned foods through air, water and soil during cultivation and also during industrial processing and packaging. A spice may be available in several forms: fresh, whole dried or pre-ground dried. The flavor of spices is derived in part forms compound that oxidize or evaporate when exposed to air. Some flavor element in spices are soluble in water, many are soluble in oil or fat.

Only a small fraction of the many biochemical found in plants are relevant for the quality of spiciness; many classes are hardly ever found in spices, as their taste in or they are not safe at all. Even though spices have many benefits, they can also contain some toxic chemicals derived from the environment of their production, processing and storage conditions.

The aim of this study was to determine the safety of the most popular species of herbs used in polish cuisine, as determined by heavy metals (Pb, Cd, Zn, Cu and Fe) residue.

4. TYPES/EXAMPLES OF SPICES WHICH CAN SERVE DIFFERENT ROLE IN DIFFERENT CONDITION.

All the medicinal importance of spices is not yet known. Nevertheless, we know certainty that spices can be used in treatment of various ailments like cancer, fever, malaria, nausea and many more. The medicinal values of spices in both dental and skin care related condition. Fennel is uses the treatment of glaucoma and other eye problem. To be on a safer side, spices should not be used for medicine without the prober guidance and recommendation from a qualified person.

- Turmeric is a rhizomatous herbaceous perennial plant of the ginger family, Zingiberaceae. It is native to southwest India, requiring temperatures between 20 and 30°C.

- Coriander is a strong smelling annual herb extensively grown in many climates throughout the world. In commerce, coriander is broadly divided into two types according to the size of the fruits, which in turns determines the volatile oil content an end use.

- Black pepper is a perennial vine, which produces a small berry fruits, which is dried to become pepper. Pepper is a plant of the humid tropics requiring adequate rainfall and warmth for its growth.

- Popularly known in the Indian subcontinent as Kasuri Methi, fenugreek leaves are an ancient spice used for flavoring various dishes. The leaves have a bitter taste, but when added to the recipe, titillate the taste buds. Apart from the dried leaves, the green leaves and the seeds are also commonly used while cooking.

- Ginger possible health benefits include relieving nausea, loss of appetite, motion sickness, and pain. The root or underground stem (rhizome) of the ginger plant can be consumed fresh, powdered, dried as a spice in oil form, or as juice.

The objective of present study is to determine the content of some heavy metals Lead (Pb), Cadmium (Cd), Zinc (Zn), Copper (Cu), Iron (Fe) in some common spices available in local market of Rewari and compared them with branded spices.

5. PREVIOUS WORK DONE ON THE SPICES IN RESPECT TO METAL CONTENTS-

Z.Krejpcio *et al.* [31] determined Pd, Cd, Zn and Cu content in the most popular spices and herbs used in polish cuisine. The content of these metals was assayed by the AAS method. The results were compared with the safety standards establish by the National Ministry of Health. Pdwas found in 40% of basil, 42% of cinnamon, 25% of savory and 6% of dried onion samples. Increased levels of Cd were detected in 20% of basil, 25% of savory and 42% of cinnamon samples. Zn and Cu level in all herbs and spices were within the safe limits.

P.Senthilkumaran *et al.* [32] were investigated on the spices for the period 1968 to 2002 with respect to Asia and India using HORT-CD database. Identifies the distribution of spices literature by categories of spices, from of publication, core journals, prime authors and institutions. Reveals that India dominates research and development activities on the spices in the Asian continent and Indian Institute of Spices Research is a significant whose scientists top the list of prolific authors.

M. A. Nkansah *et al.* [33] was interested in monitoring of heavy metal contamination of spices. The concentration of some heavy metal (lead, zinc, copper, iron, and mercury) in 15 common spices available at local market in the Kumasi Metropolis was determined using Atomic Absorption Spectroscopy (AAS) from October 2008 to February 2009. Most of the levels in the spices were acceptable with the exception of lead which was above the standard limits approved by WHO and FAO for some samples. Zinc, Nickel, Copper, Iron and Mercury are concerned.

V.C. Mathur *et al.* [34] studied that India is the largest producer, consumer and exporter of spices in the world. The demand scenario for major spices in has been comprehensively examined in the study. The shift in preferences of domestic consumers for food items, increasing urbanization and rising incomes, altered demographic and social factors and the changes in productivity of spices have brought about changes in the pattern of their consumption and demand. Also, the household consumption demand projections for important spices in the country for the year 2005, 2010, 2015 show that the domestic demand foe spices would increase further in the coming year.

D Azans *et al.* [35] collected twenty sample comprising ten different spices were purchased from different trader in the selected market. Some of the spices were obtained in the powered form and other in the raw form as their powered from were not available. Some sample solutions were analyzed using an Automatic Mercury Analyzer Model HG-5000 and for the other using SHIMADZU Flame Atomic Absorption Spectrometer (AA 240 FS). The oregano chlorine pesticides were determined with Shimadzu gas chromatograph GC-2010 with ECD. The Cd concentrations were found below detectable limit to 0.47 ppm, and 25% of the samples were above the EU maximum limit in food (0.05). Lindens concentration (ug / kg) for all spices ranged from 10 to 180, HCB range from below detectable limit (1 ppm) to 166 ppb.

FarhinInam *et al.*[36] carried out five of the most popularly used spices and herbs were studied to determine Pd, Cd, As, Hg, Cu, Co, Ni and Cr content them. This was analyzed using Atomic Absorption Spectrophotometer (AAS). The results were compared with safety standards World Health Organization (WHO). The average concentration of heavy metal as Pd detected ranged from 3.3ppm-4.59ppm, Cd ranged from 0.04ppm-0.4ppm, Concentration of As was from 0.7ppm-1.5ppm, Ni was found to range between 2.82 ppm-5.76 ppm, Cu was found to be in a range of 2.30 ppm -19.69 ppm In C.Zeylanicum, Myristicafragrans, Osmium sanctum, Syzygium aromatic and Cinnamomum tamale and most of them were well within the permissible limits.

Oyez Ahemd Asimi *et.al.,* [37] were studied on the concentration of heavy metal content in spices and samples (Turmeric, Cinnamon, Ginger, Black pepper, kooseri methi) from local market in Srinagar, Kashmir. The result found that Cinnamon had the highest antimicrobial effects (12) at maximum concentration on the growth of bacterial strains Vibrio vulnificus and Micrococcus lutes followed by cumin (9 mm), Ginger (8mm) and Turmeric (7 mm).

B. Darko *et al.* [38] were collected twenty two different powdered samples from the local shops and hawkers of the Asafo (A), Railway (R) and Central market (C) in Kumasi. Ashanti Region of Ghana located in the transition forest zone about 270 km north of the national capital, Accra. The main purpose of this study was to determine the heavy metal content in spices in mixed and unmixed seasonings. The result showed that Fe, Zn and Cu below permissible levels whereas Pb and Cd were above permissible levels.

C. T. Onyema *et al.* [39] studied on the concentration of heavy metal content in spices and samples were collected from the Nnamdi Azikiwe University, Awka and Anambra state. The concentration (mg/kg) on dry basis for the metals; Cd, Cr, Cu, Fe, Ni, Pb and Zn are as (0.025-0.138), (0.337-2.323), (0.050-0.401), (1.175-16.04), (0.05-1.374), (0.055-0.956) and (0.488-7.294). The result obtained showed limit approved by World Health Organization (WHO).

M. A. Umar *et al.*[40] have collected eleven samples of spices different market of Abuja named as a Abuja north, South, East, West and Abuja Central and the concentration of heavy metal (Zn, Ni, Mn, Cu, Pb, Cd, Fe and Cr) in eleven spices from FCT Abuja, Nigeria have determined by using Flame Absorption Spectrophotometer (FAAS). The mean concentration of Zn, Ni, Mn, Cu, Pb, Cd, Fe and Cr in the sample is 52.458±458, 4.37±0.459, 178.617±18.901, 15.512±1.266, 11.233±1.807, 0.428±0.067 and 516.666±78.877 mg/kg, respectively. The showed that only the value of Pd , Cd and Fe measure above the WHO Maximum permissible limits (MPL) for various elements while other are below the MPL.

Mohamed Ziyaina *et al.* [41] collected the samples of spices named as *Capsicum frutescsens*, *Piper nigeum*, and *Curcuma longa* and mixed spices. Spices were analyzed by Atomic Absorption Spectroscopy after digestion with nitric acid/*Capsicum frutsescens* in wholesale markets (1.05± 0.01 mg/kg, 0.96 ± 0.06 mg/kg). Cadmium levels exceeded FAO/WHO permissible limits. *C. Longa* and *P. Nigrum* sold in retail markets had a high concentration of Cd (0.36 ± 0.09, 0.35 ± 0.07 mg/kg) followed by 0.32 ± 0.04 mg/kg for *C. Frutescens*. Mixed Spices purchased from wholesale markets also had high levels of Cd (0.31 ± 0.08 mg/kg). C. Longa and C. Frutescens may pose a food safety risk due to high levels of lead and cadmium.

6. METHODOLOGY-

I. Analytical Procedure

The determination of essential element viz. Copper, Zinc and Iron were carried out with the help of Flame Atomic Absorption Spectrometer School of chemicals science, Department of chemistry, St. John's College, Agra.

II. Basic principle of AAS

The basic principle of Atomic Absorption Spectrometry (AAS) is the absorption of radiant energy by atoms. Atom production from various element and compound requires energy input, usually supplied by a flame or heated graphite road in case of Atomic Absorption Spectrometer. Absorption of thermal energy from a flame with subsequent emission of energy as a spectral line is atomic emission, while atomic absorption corresponding to energy absorption from a source other than a flame with a concomitant decrease in signal from the source.
The relationship between these spectroscopic phenomena is given by:

$$\underset{\text{(Unexcited)}}{\text{Atom}} + \underset{\text{(Photon)}}{h\nu} \underset{}{\overset{\text{Absorb}}{\rightleftharpoons}} \underset{\text{(Excited)}}{\text{Atom}}$$

Photon absorbtion by a ground state is atomic absorption, while photon emission by an excited atom with return to the unexcited ground is atomic emission. For most elements the spectral resonance line is the characteristic wavelength used in both atomic absorption and emission, which is to say the transmission to the lowest excited state from the ground state. Relationship of atomic absorption to atomic concentration is that within a given range there is a linear quantitative correlation of an element in a solution and atomic absorption.

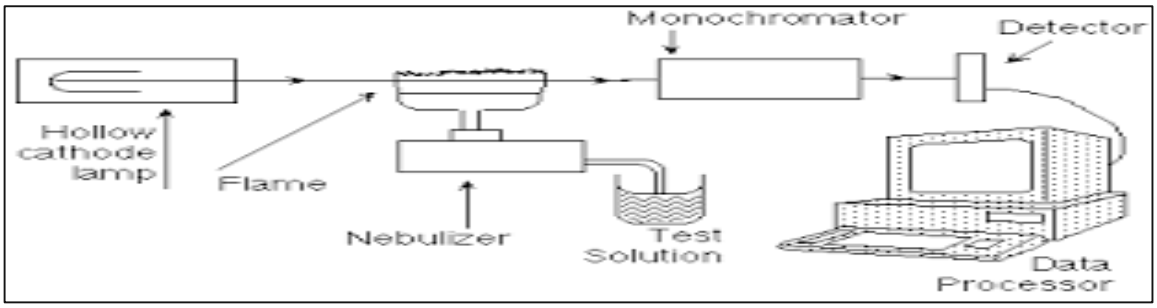

Fig.1 Setup of AAS

III. Double Beam Atomic Absorbtion Spectrometer-

The light from the source lamp is divided into a sample beam which is focused through the sample cell and a reference beam, which is directed around the sample cell. In a double system, the read out represent the ratio of sample and reference beam. Therefore, fluctuations in source intensity do not become fluctuations in instrument readout and stability is enhanced. Generally, analyses can be performed immediately with no lamp warm-up required.

The concentrations were measured in ppm using the formula given below:

$$\text{Ppm} = \mu g / g = \text{concentration in mg / l} \times \frac{\text{volume of sample taken in ml}}{\text{Weight of Sample in gram}}$$

IV. Wet Digestion

For determination of heavy metal concentration, wet digestion of the dried samples, was done by aqua regia (1.3 nitric acid-hydrochloric acids) in on open flask. A 0.5 g of dry spice sample was placed in 100 ml beaker and added 20 ml of freshly prepared aqua regia (5 ml HNO_3 + 15 ml HCl). The content of the beaker was heated to 100°C and the temperature was gradually increased to 250°C and the left at this temperature for 30 min. The beaker was cooled and again 1o ml of aqua-regia (ratio 1:3 HNO_3 + HCl) was added to the digestion mixture and the contents were reheated again. The digestion process was required more than one time until clear solution was obtained. The mixture allowed to cool and then filtered through a Whatman filter paper into a 50 ml standard volumetric flask. The filtrate was diluted to 50 ml with de-ionized distilled water.

V. Analysis of Metals

Zinc

Zinc was determined by Atomic Absorption Spectrometer with air-acetylene flame at wave length 213.9nm.

Copper

Copper was determined by Atomic Absorption Spectrometer with air acetylene flame at wavelength 488nm.

Iron

Iron was determined by Atomic Absorption Spectrometer with air acetylene flame at wave length 372nm.

7. RESULTS AND DISCUSSION-

The results obtained after the analysis of different essential metals in spices are summarized in tables and in figures as follows:

Table 1: Spices collected from Rewari (Haryana)

S.No.	Type of spices samples
1.	Turmeric
2.	Black Pepper
3.	Coriander
4.	Dry Ginger
5.	Kasuri Methi

Table: 2 WHO value for Metals in Spices

Metal	Permissible Limits (µg/g)
Zn	100
Cu	50

Fe	300

Table 3. Concentration of Zinc in local spices collected from Rewari, Haryana

Local Spices		
Sr. No.	**Sample**	**Zinc (µg/g)**
1.	Turmeric	74.9
2.	Black Pepper	NA
3.	Coriander	91.8
4.	Dry Ginger	NA
5.	Kasuri Methi	105

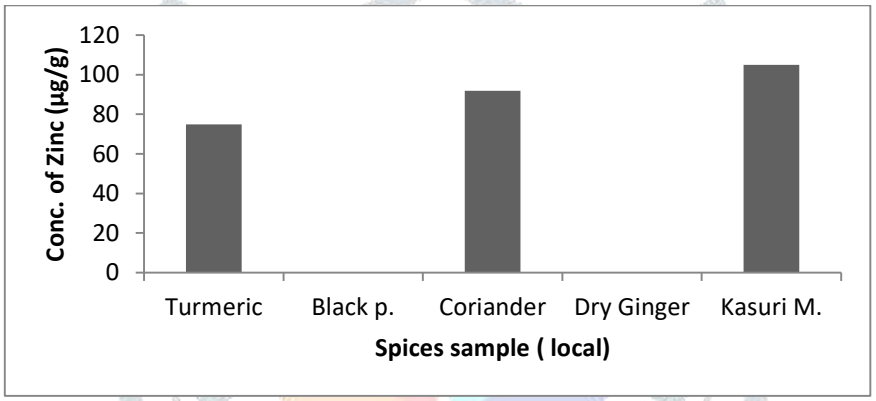

Fig. 2: Concentration of Zinc in local spice samples

The maximum concentration (105 µg/g) of Zinc was found in the sample of Kasuri Methi (LKMRS-10). While no Zinc concentration observed in the Black Pepper and dry ginger. All samples found within the permissible limits except in Kasuri Methi in which the values slightly higher than permissible limits.

Table 4. Concentration of Copper in local spices collected from Rewari Haryana

Local Spices		
Sr. No.	**Sample**	**Copper (µg/g)**
1.	Turmeric	6
2.	Black Pepper	5.9
3.	Coriander	NA
4.	Dry Ginger	15.5
5.	Kasuri Methi	0.3

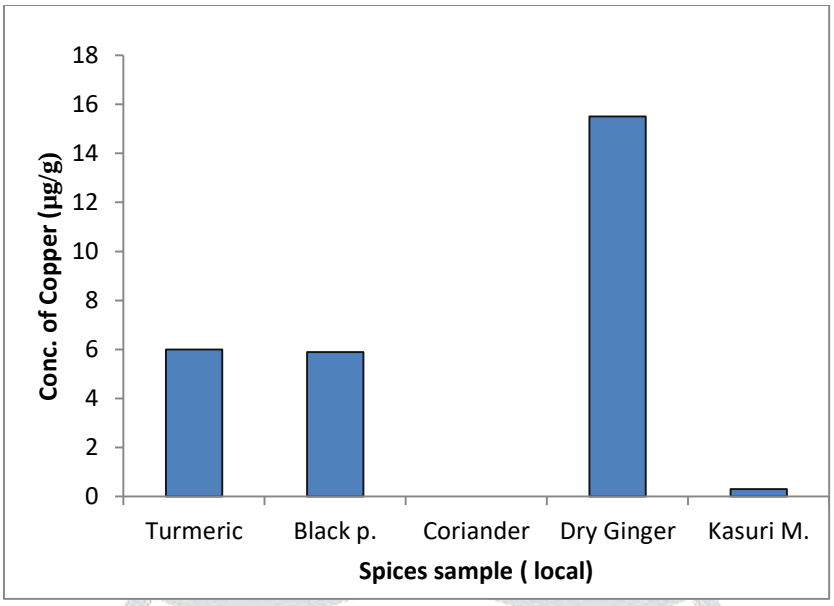

Fig. 3: Concentration of Copper in local spice samples

The maximum concentration (15.5µg/g) of copper was found in the sample of Dry Ginger (LDGRS-6) whereas no level for copper found in the sample of LCRS-8. The copper levels have been found within the permissible limits in all samples.

Table 5. Concentration of Iron in local spices collected from Rewari, Haryana

Local Spices		
Sr. No.	**Sample**	**Iron (µg/g)**
1.	Turmeric	2050
2.	Black Pepper	3802.5
3.	Coriander	631.7
4.	Dry Ginger	383.8
5.	Kasuri Methi	200

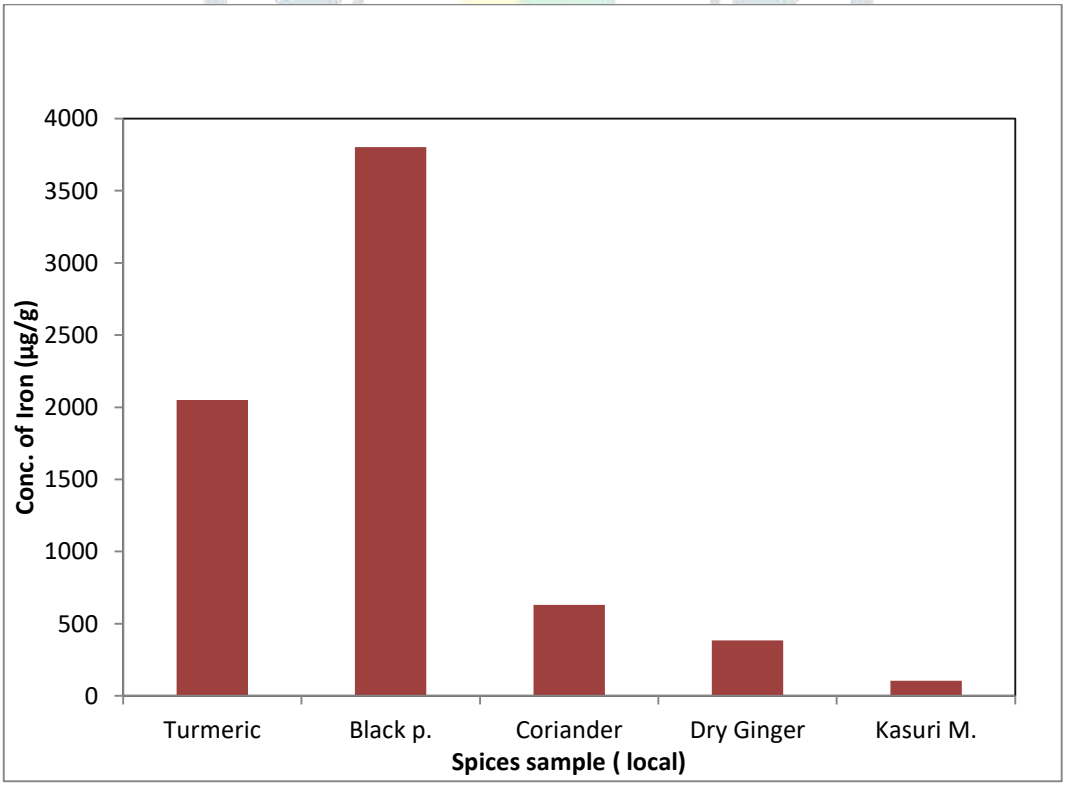

Fig. 4: Concentration of Iron in local spice samples

The maximum concentration (3802.5 µg/g) of Iron was found in the sample of Turmeric (LTRS-9). All the samples contain higher level of Iron.

Table 6. Concentration of Zinc in branded spices collected from Rewari, Haryana

Branded Spices		
Sr. No.	**Sample**	**Iron (µg/g)**
1.	Turmeric	60.9
2.	Black Pepper	61.8
3.	Coriander	NA
4.	Dry Ginger	59.2
5.	Kasuri Methi	82.6

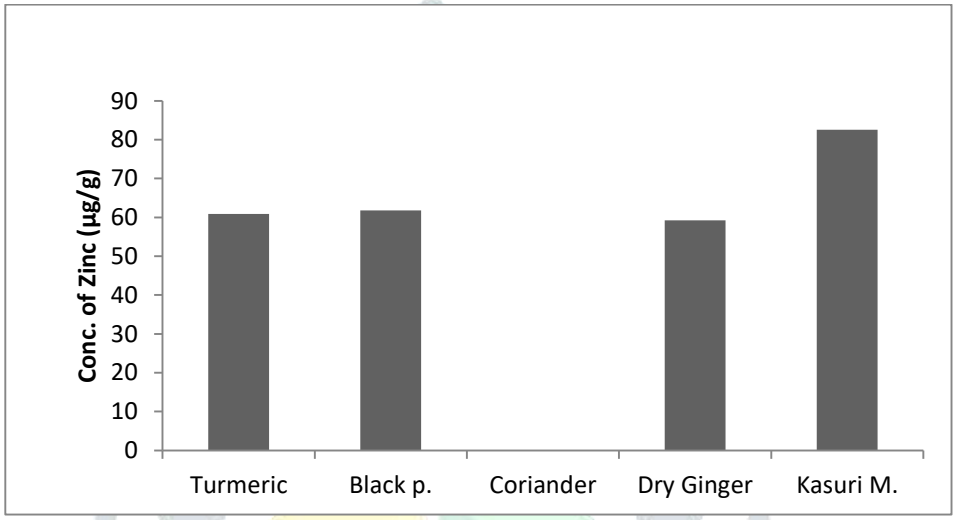

Fig. 5: Concentration of Zinc in branded spice samples

The maximum concentration (82.6 µg/g) of Zinc was found in the sample of Kasuri Methi (BKMRS-3). The sample BCRS-5 do not contains Zinc level. All the samples contain Zinc concentration within the permissible limits.

Table 7. Concentration Copper in branded spices collected from Rewari, Haryana

branded Spices		
Sr. No.	**Sample**	**Iron (µg/g)**
1.	Turmeric	1.2
2.	Black Pepper	18.5
3.	Coriander	7.4
4.	Dry Ginger	5.2
5.	Kasuri Methi	3.8

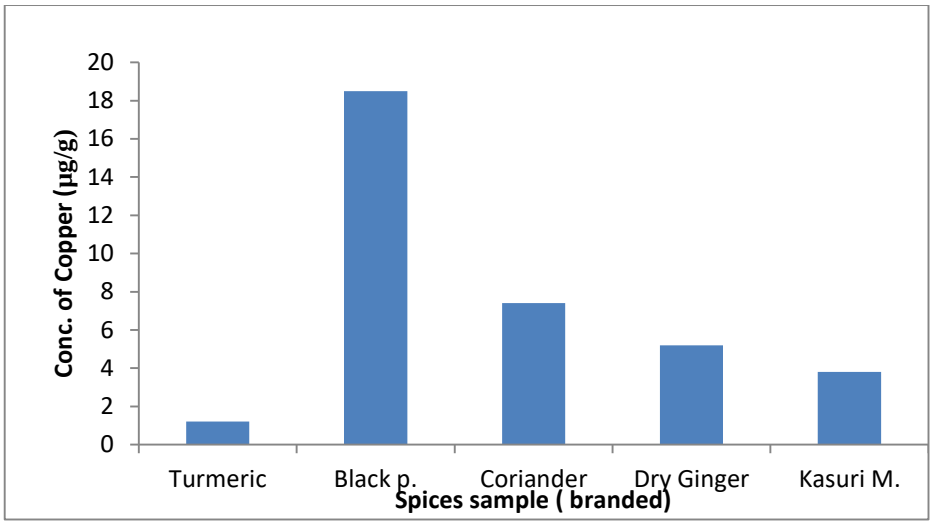

Fig. 6: Concentration of Copper in branded spice samples

The maximum concentration (18.5 µg/g) of Zinc was found in the sample of Black Pepper (BBPRS-1). The minimum concentration (1.2 µg/g) found in the sample of BTRS-4. All the samples of Copper found within the permissible limits.

Table 8. Concentration of Iron in branded spices collected from Rewari, Haryana

Branded Spices		
Sr. No.	**Sample**	**Iron (µg/g)**
1.	Turmeric	756.6
2.	Black Pepper	3863
3.	Coriander	561.5
4.	Dry Ginger	874.4
5.	Kasuri Methi	862.7

Comparasion of Metals between Local and Branded Spices

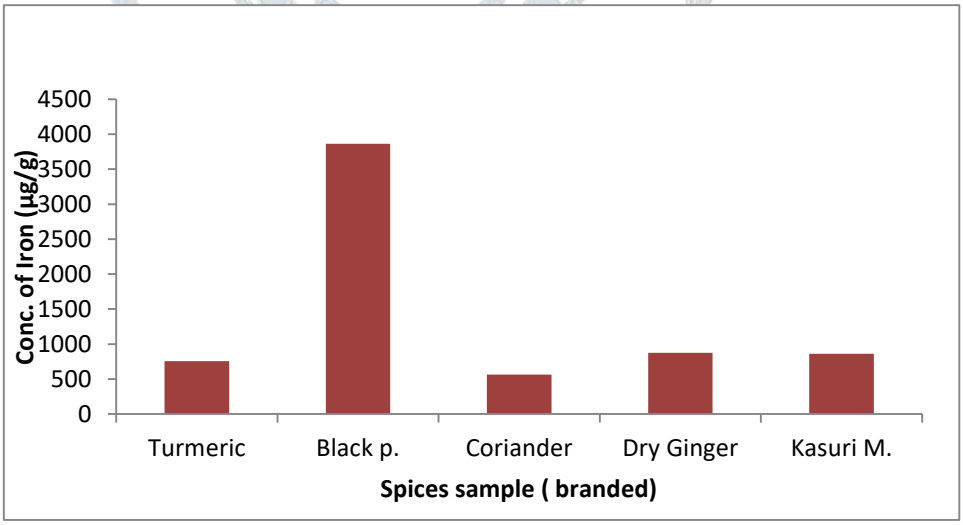

Fig. 7: Concentration of Iron in branded spice samples

The maximum concentration (3863µg/g) of Iron was found in the sample of Black Pepper (BBPRS-1) whereas minimum values (561.5µg/g) obtained in the site of BCRS-5. All the samples found higher than permissible limits.

Table 9. Concentration of Zinc in local and branded spices From Rewari (Haryana)

Sr.No.	Sample	Local (µg/g)	Branded (µg/g)
1.	Turmeric	74.9	60.9
2.	Black Pepper	NA	61.8
3.	Coriander	91.8	NA
4.	Dry Ginger	NA	59.2
5.	Kasuri Methi	105	82.6

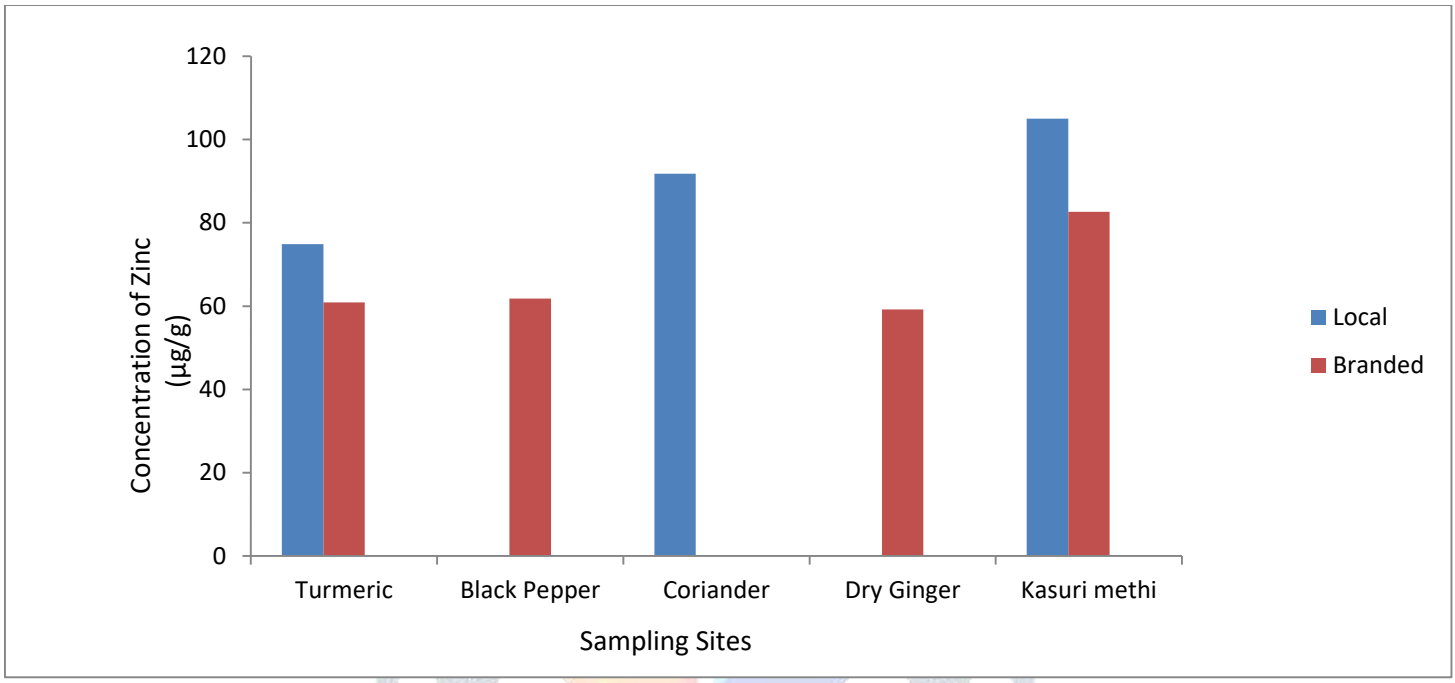

Fig 8.concentration of Zinc in local and branded samples

Table 9.and Fig 8. shows that Zinc levels are found higher in (Kasuri Methi , Coriander and Turmeric). Overall, the branded spices contain less zinc levels than local spices.

Table 10. Concentration of Copper in local and branded spices From Rewari (Haryana)

Sr.No.	Sample	Local µg/g	Branded µg/g
1.	Turmeric	6	1.2
2.	Black Pepper	5.9	18.5
3.	Coriander	N.A.	7.4
4.	Dry Ginger	15.5	5.2
5.	Kasuri Methi	0.3	3.8

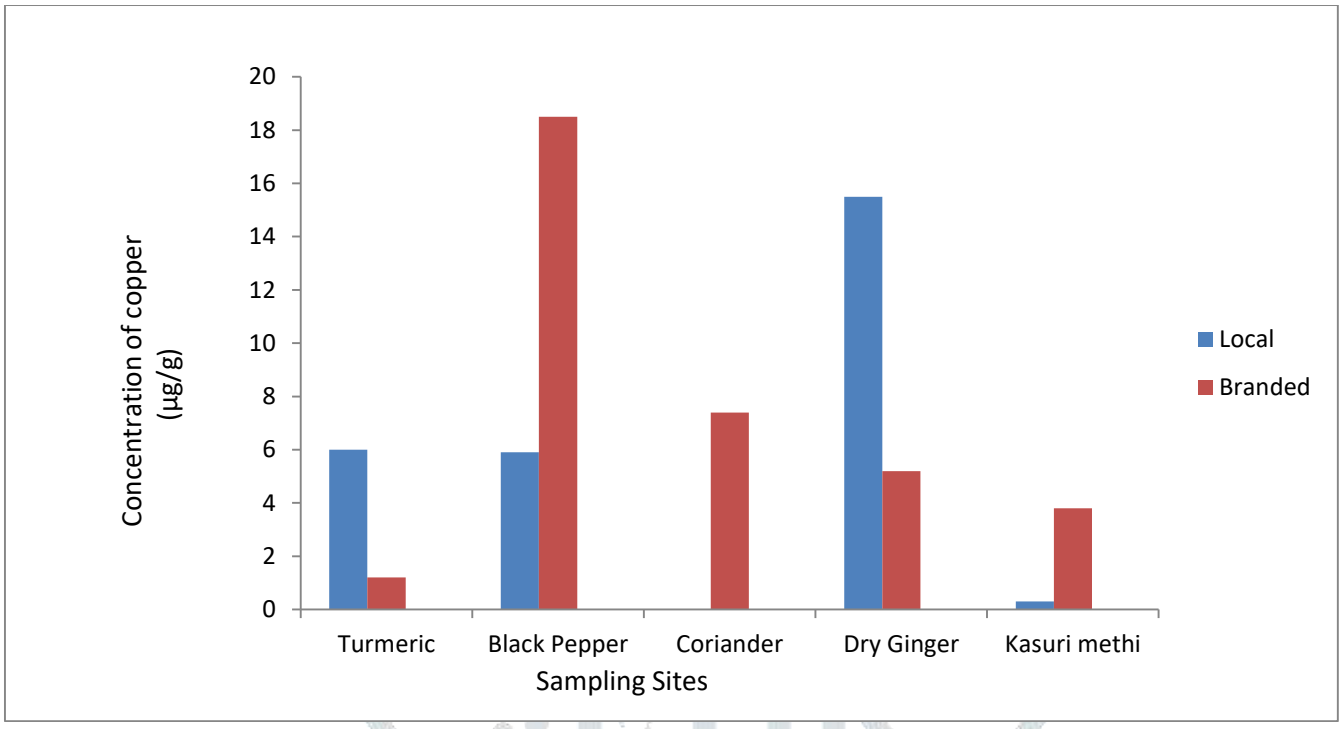

Fig 9. Concentration of Copper in local and branded spices samples

Table 10.and Fig.9 Shows that Turmeric and Dry Ginger from local market contain high Cu concentration is compared is branded spices. Branded Black Pepper contains much higher Cu concentration as compared to local Black Pepper.

Table 11. Concentration of Iron(Fe) in local and branded spices from Rewari (Haryana)

Sr.No.	Sample	Local µg/g	Branded µg/g
1.	Turmeric	2050	756.6
2.	Black Pepper	3802.5	3863
3.	Coriander	631.7	561.5
4.	Dry Ginger	383.8	874.4
5.	Kasuri Methi	2000	862.7

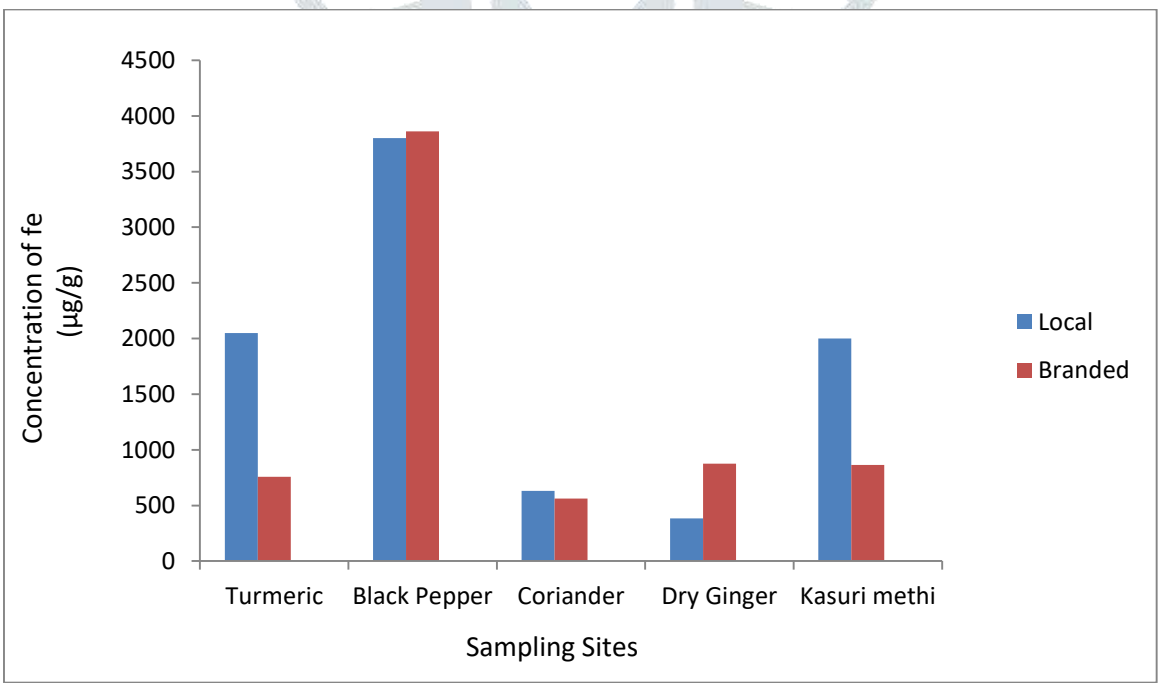

Fig 10. Concentration of Iron in local and branded spices samples

Table 11.and Fig. 10 shows that Black Pepper, Turmeric and Kasuri Methi from local market contain high Fe concentration than branded spices. Branded Black Pepper contains much higher Fe concentration than local Black Pepper.
Overall, all the local and branded samples, higher iron concentration have been found as compared to the permissible limits.

8. CONCLUSION-

- The total concentration of Zinc in local Spices sample has been found in the range between 74.9 µg/g and 105µg/g.
- The total concentration of Copper in local spices has been found in the range between 0.3µg/g and 15.5µg/g.
- The total concentration of Iron in local spices has been in the range between 383.8µg/g and 3802.5µg/g.
- The total concentration of Zinc, Copper and Iron in the branded spices has been found in the range of 59.2µg/g-82.6µg/g and 1.2µg/g-18.5µg/g and 561.5 µg/g 3863µg/g.
- The study concludes that Zinc is more in local spices sample and less in branded spices sample.
- The branded spices contain less zinc levels than local spices.
- Branded Black Pepper contains much higher Cu concentration as compared to local Black Pepper.
- Overall, all the local and branded samples, higher iron concentration have been found as compared to the permissible limits.

REFERENCES-

1. George, C.K. 2000. Spices of India: an overview. In Recent Trend in Spices and Medicinal Plants Reseaarch. *New Delhi Association Publishing* Corporation. 162-73.
2. Senthilkumaran P. and Vadivel P. 2004. "A Bibliometric Apprasial, SRELS.Journal of spices and Aromatic Crops, 41(1): 121-131.
3. Foley C., Nice J., Webb M.A. "New herbs bible", Muza S.A., Warszawa.2002.
4. Norman J. The complete Book of spices. Muza S.A. Warszawa. 1992
5. Ozcan M. 2004.Mineral contents of some plants used as condiments in Turkey. Food Chemistry. 84(3): 437-440.
6. Arora D.S., Kaur J.1999. Antimicrobial activity of spices. International Journal of Antimicrobial Agents. 12(3): 257-262.
7. Hinneburg I., Damien dorman H.J., Hiltunenr. 2006. Antioxidant activites of extracts from selected culinary herbs and spices.Food Chemistry. 97(1): 122-129.
8. Samotyja U., Urbanowicz A. 2005.Antioxidant properties of commercial extract of rosemary. Zywnose.43:184.
9. Abebe, W.2006. Potential health benefits of spices used in Ethiopiasn Cuisines. Ethiopian medical journal.
10. Al-Eed, M. A. Assubaie, F.N., EI-Garawany, M.M., EL-Hamshary, H and EIT ayeb, Z.M. Determination of heavy metal levels in common spices. Journal of Applied Science. 1-11.
11. FAO.Corporate documents repository plants as storage pesticides.2009.
12. Dey M.M.2000. Analysis of demand for fish in Bangladesh. Aquaculture Economics and Management.4(1/2): 63-81.
13. Krejpcio Z., Krol E. and Sionkowski S.2006. Evaluation of Heavy Metals Contents in Spices and Herbs Available in the Polish Market. Polish Journal of Environmental Studies.16(1): 97-100.
14. Oehme, F.1989.Toxicity of heavy metals in the environments Marcel Dekker. New York.
15. *Adamson M.W. Food in Medieval Times. ISBN. 2006.*
16. Singh V. and Garg A.N.2006. Availability of essential trace element in Indian cereals, vegetables and spices using INAA and the contribution of spices of daily dietary intake. Food Chemistry. 94(1):81-89.
17. Ajasa A., Bello M.O., Ibrahim A.O., Ogunwande I.A. and Olawore N.O.2004.Heavy trace metals and micronutrients status in herbals plants of Nigeria.Food Chemistry. 85(1):67-71.

18. Sharma R.K., Agarwal M. and F. Marshall . 2007. Heavy metal Concentration of soil & vegetable in suburban areas of Varanasi, India. Ecotoxicology and Environmental Safety.66(2):258-266.

19. Mubeen H., Naveem I. Taskeen A.& Saddiqe Z.2009. Investigation of heavy matals in commercial Spices Brands. New York Science Journal. 2(5): 155-200.

20. Abdullahi M.S., Uzairu A. and Okunola O.J. 2004. Determination of some trace metal levels in onion leaves from irrigated farmlands on the bank of River Challawa, Nigeria. African Journal of Biotechnology. 7(10):1526-1529.

21. Bailey A., Ortiz L.E. 1992 .The book of ingredients .Wiedzai Zycie.

22. Foley C., Nice J., Webb M.A. "New herbs bible", Muza S.A., Warszawa . 2002.

23. Norman J. "The complete Book of spices". Muza S.A. Warszawa.1992.

24. Harpers illustrated biochemistry (28th Edition) 2002.

25. Sherman P.W. and Billing J.1993.Darwinian gastronomy: why we use apices-spices taste good because they are good for us. Bioscience. 49(6):453-463.

26. Pokorney J.1991.Natural antioxidants for food use, Trends in Food Science and Technology.9: 223-227.

27. Shelef L.A.1983. Antimicrobial effects of spices", Journal of Food Safety. 6(1):29-44.

28. Gupta K. K., Bhattacharjee S., Kar S., Chakrabarty S., Thakar P., Bhattacharjee G. and Srivastava S.C. 2003. Mineral Compositions of Eight Common Spices. Communication in soil science and Plants Analysis. 34: 681-693.

29. Ansari T.M., Ikram N., Najam-ul-Haq M., Fayyaz O., Ghafoor I. and Khalid N.2007. Essential trace metals(Zinc Magnese Copper Iron) level in plant of medicinal importance.Journal of Biological Science.4(2):95-99.

30. Choudhary R.P. and Garg A.N.2007. Variation in essential, trace and toxic elemental contents in *Murraya koenigii* – A spice and medicinal herb from different Indian state. "Food Chemistry", 104(4):1454-1463.

31. Krejpcio Z., Krol E.and Sionkowski S.2007. Evaluation of Heavy Metals Contents in Spices and Herbs Available on the Polish Market. Polish Journal of Environmental Studies.16(1):97-100.

32. P. Senthilkumaran and A. Amudhavali. 2007. "A quantitative analysis of the spices literature in India", Annals of Library and Information Studies. 54:152-157.

33. Nkansh M.A. and Amokako C. O. 2010. "Heavy metal content of some common spices available in market in the Kumasi metropolis of Ghana" American Journal of Scientific and Industrial Research, 1(2):158-163.

34. Mathur V.C. and Shinoj P. 2006. "Analysis of Demand for Major Spices in India", Agricultural of Economics Research Review, 19:367-376.

35. Azanu D., Acheampong M. A. and Martin Wood Y.2014. Heavy Metals and Organochlorine Pesticides Residue Levels in Natural Spices Sold in Kumasi, Ghana. International Journal of Environmental Science and Toxicology, 2(6): 130-135.

36. Inam F., Deo S. and Narkhede N. 2013. Analysis of minerals and heavy metals in some spices collected from local market. IOSR Journal of Pharmacy and Biological Sciences (IOSR-JPBS).8(2); 40-43.

37. Asimi O.A., Sahu N.P. and Pal A.K. 2013. Antioxidant activity and antimicrobial property of some Indian spices .International Journal of Scientific and Research Publication, 3(3):1-8.

38. Darko B., Ayim I. and Voegborlo R.B.2014. Heavy metal content in mixed and unmixed seasonings on the Ghanaian market .African Journal of Food Science, 8(1): 14-19.

39. Onyema C.T., kpunobi U.E.E. and Ndigbo E.O.2015. Evaluation of the Heavy Metals Level in Selected Industrially Packaged Food
Spices. Amercian Association for Science and Technology, 2(2):35-40.

40. Nkansh M.A. and Amokako C. O. 2010. "Heavy metal content of some common spices available in market in the Kumasi metropolis of Ghana" American Journal of Scientific and Industrial Research, 1(2):158-163.

41. Ziyaina M., Rajab A., Alkweldi K., Algami W., Toumi O.Al. and Rasco B.2014. Lead and cadmium residue determination in spices available in Tripoli City markets (Libya). African Journal of Biochemistry Research, 8(7):137-140.