Tec Empresarial
P-ISSN: 1659-2395; E-ISSN: 1659-3359

MINERAL CONTENT OF SOME LEAFY VEGETABLES FROM BILASPUR, CHHATTISGARH, INDIA

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ABSTRACT:
Three different samples of leafy vegetables (Kumda Bhaji, Barre Bhaji, and Methi Bhaji) were purchased at the local market in Bilaspur, Chhattisgarh, and analyzed for their micronutrient content using a digital spectrophotometer. The highest concentrations of Fe, Cu, and Zn were found in three leafy vegetables, with amounts of 20.46 mg/100 g (Methi Bhji), 4.09 mg/100 g (Barre Bhaji), and 6.3 mg/100 g (Barre Bhaji), respectively. Barre Bhaji, Kumda Bhaji, and Methi Bhaji were found to have the lowest concentrations of Fe (8.76 mg/100 g), Cu (1.84 mg/100 g), and Zn (1.93 mg/100 g), respectively. Average metal concentrations were present in leafy vegetables in the following order: Cu (2.91 mg/100 g), Zn (4.04 mg/100 g), and Fe (13.95 mg/100 g). Fe, Cu, and Zn concentrations were less than the FAO/WHO recommendations for metals in vegetables. The absence of harmful metal impacts from these plants is supported by the consistently low levels of Cu, Fe, and Zn across all samples. According to the findings, these vegetables are among the best sources of these vital trace elements. Human daily metal intakes have also been calculated, and they're below the threshold set by the FAO and the WHO.
Keywords: Minerals, leafy vegetable, analysis, Micronutrients, public health.

INTRODUCTION:

The plant kingdom is the starting point for the vast majority of food webs on Earth. Vegetables are important for both human and animal diets since they are a source of many nutrients and trace elements that are otherwise difficult to obtain. They play a crucial role in disease prevention and treatment, making them essential to healthy living. They provide substantial defense as a food source. Vitamins, fibers, and minerals are just few of the many nutrients that may be found in vegetables. In addition, studies have shown that a diet high in vegetables helps protect against the negative effects of oxidative stress. [1–3]

The edible components of green leafy vegetables have a significantly greater potential for mineral buildup than those of fruit or grain crops. The xylem channels permit the passive movement of minerals from the plant's roots to its leaves and blooms, as has been discovered in studies on how plants absorb heavy metals.[4-5] Vegetables can either take in minerals from the dirty soil in which they are cultivated, or they can take in minerals from deposits that have developed on different parts of the vegetable after it has been exposed to the air. There may be negative consequences from ingesting heavy metals in large enough numbers. However, there is a clear risk to human health from consuming plants that have been contaminated with heavy metals. Heavy metals have a tendency to build up in living organisms, and in high enough quantities, they can be toxic.[6-7]

Pollution contaminated soils, but irrigation with tainted water mixes heavy metals in agricultural land. Heavy metals accumulate more in crops and vegetables growing on contaminated soils. Heavy metals that plants can tolerate but are harmful to animals and people are easily transferred to consumers through the food chain, posing health risks.[8] It is vital to conduct an analysis of the quantity heavy metal is present in regularly eaten vegetables and to report any potential contamination that could pose a threat to public health. This study measured heavy metal (minerals e.g., Fe, Cu and Zn) concentrations in a variety of green leafy vegetables purchased at a local market in Bilaspur, Chhattisgarh, and compared them to an international organization's safety level.

MATERIAL AND METHOD

All of the chemicals that were utilized in the analysis were of an analytical grade, and they were purchased from E-Mark in Germany, Qualigens in Mumbai, India, and Loba. In every stage of the manufacture of the solution, distillation and deionized water were utilized. After being washed with a detergent solution and then nitric acid (20% v/v), followed by cleaning with distilled deionized water after rinsing with tap water, all of the glass goods and plastic containers that were utilized were sterilized. It was also necessary to make stock solutions of the various metal salts and other reagents.

Study area

This investigation focused on the local market of Bilaspur city (Budhwari Bazar), which is located in the Indian state of Chhattisgarh. It is positioned between the coordinates 22°03'32.12" and 22°06'27.58" north and 82°06'20.08" and 82°11'40.29" east, and is 110 km east of the state capital of Raipur on the banks of the Arpa River at an altitude of 262 m above sea level. The average rainfall here is 1220 mm.

Sample and sampling:

Three different green leafy vegetable samples have been chosen namely, Kumda Bhaji (*Cucurbita maxima* Duch.), Barre Bhaji (*Carthemnus tinctorium L.*) and Methi Bhaji (*Trigonella foenum graceum* L.). Samples were collected in the month of February 2021 from the Budhwari Bazar in Bilaspur (Fig. 1). The information concerning these leafy vegetables are presented in the following Table 1:

Table 1: Depiction of Leafy Vegetables [9]

S.N.	Common Name	Botanical Name	Family	Habit	Ethnobotanically significance plant part
1	Kumda Bhaji	*Cucurbita maxima* Duch.	Cucurbitaceae	Cultivated	Leaves, stem and fruits
2	Barre Bhaji	*Carthemnus tinctorium* L.	Asteraceae	Weeds	Leaves

3	Methi Bhaji	*Trigonella foenum graceum* L.	Fabeceae	Cultivate d	Leaves and seeds

Fig. 1: Leafy vegetables

Sample treatment:

Fresh tap water was used to wash the leafy vegetables, and then deionized, distilled water was used to rinse them. These materials were divided into bits and dried in an oven at 105°C for about 24 hours after being air-dried for 4 days in the lab. In a mortar and pestle, the samples were reduced to powder. The samples were then transferred into a labeled plastic container for examination after being filtered over a 2 mm nylon sieve. [10-11]

Sample digestion:

After adding 20 ml concentrated HNO_3, 2 ml $HClO_4$ and HCl (10:1), 1 g. of vegetable samples were digested on a hot plate for ten minutes at 70 to 80ºC. After all of the tissue had been digested, the solution was brought to 105°C, the volume was reduced to 0.5-1.0 ml by adding 10 ml of distilled water, and the residues were boiled after being allowed to evaporate to dryness. At room temperature, the mixture was poured into a 100 ml volumetric flask, filtered it with Whatman No. 541 filter paper, and diluted it with deionized water to the desired concentration. [10-11]

Sample analysis:

Using a digital spectrophotometer (Systronic, Model No.118) and a standard curve constructed from working standards prepared by a serial dilution approach, the amounts of metal ions in the digests of the various samples were calculated. The spectrophotometer was utilized to analyze the samples. The spectrophotometric methods of determining Fe, Cu, and Zinc used were 510 nm for the 1, 10 phenonthroline technique, 457 nm for the Neocuproine method, and 620 nm for the dithiazone method, respectively. [12]

Daily intake minerals from vegetables

For this purpose, the following equation was utilized to enumerate the amount of heavy metals that a person would consume on a daily basis when they ate the vegetables that were tested [13]:

Daily intake of mineral (DIM) = DVC × VMC

DVC stands for regular vegetable intake, and VMC refers to the average metal concentrations in vegetables measured in mg/day of fresh weight.
Usually, an average adult's mineral intake can be estimated using their body weight (60 kg), the FAO and WHO (1999) determined that the recommended daily diet of vegetables should be 98 g of vegetables per person, per day. [14]

RESULT AND DISCUSSION:

Table 1 presents the findings of an experiment that measured how much metal was found in each type of leafy vegetable purchased from the Bilaspur market, and a graphical depiction of the data as depicted in Fig 2. The iron content of several green leafy vegetables, such as Kumda Bhaji, Barre Bhaji, and Methi Bhaji, was determined to be 12.64 mg/100 g, 8.76 mg/100 g, and 20.46 mg/100 g, respectively. According to the results, the quantities of copper present in Kumda Bhaji, Barre Bhaji, and Methi Bhaji were, respectively, 1.84 mg/100 g, 4.09 mg/100 g, and 2.79 mg/100 g. It was determined that the Zinc levels in Kumda Bhaji, Barre Bhaji, and Methi Bhaji were 3.97 mg/100 g, 6.21 mg/100 g, and 1.93 mg/100 g, respectively.

Table 2: Amount of Fe, Cu & Zn in Leafy Vegetables (mg/100 g)

S.N.	Sample/ Metal Conc^n	Kumda Bhaji	Barre Bhaji	Methi Bhaji	FAO/WHO safe Limit
1	Fe	12.64	8.76	20.46	425
2	Cu	1.84	4.09	2.79	40
2	Zn	3.97	6.21	1.93	99.4

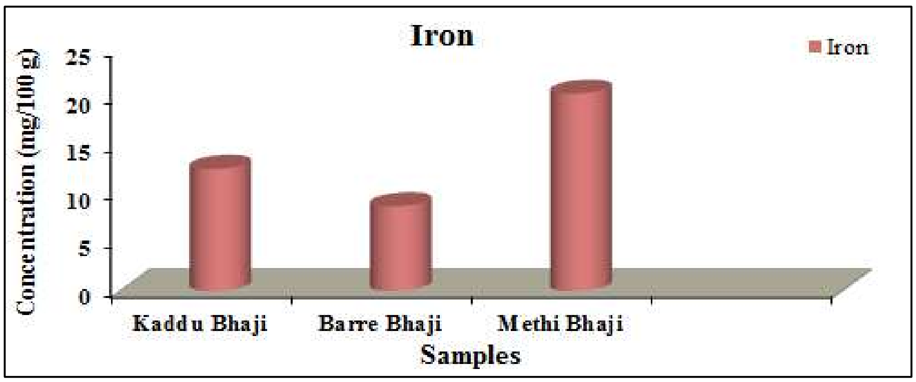
Table 3: Intake of Minerals (DIM) from Leafy Vegetables

S.N.	Minerals	Mean Metal Conc^n (mg/100 g)	Daily intake (µg/day)	FAO/WHO Limit or PTDI Limit
1	Fe	13.95	1367.43	48 mg
2	Cu	2.91	284.85	3 mg
3	Zn	4.04	395.59	60 mg

The body uses Fe for a variety of different activities. It carries oxygen from the lungs to the tissues via haemoglobin and serves as a transport pathway for electrons inside the cells, and an integral component of significant enzyme systems found in a variety of tissues. The production of chlorophyll requires Fe, and the activation of a number of respiratory enzymes in plants is dependent on Fe's presence. [15] The quantity of iron detected in Barre Bhaji was 8.76 mg/100 g, which was significantly lower than the quantity of iron found in Methi Bhaji, which was 20.46

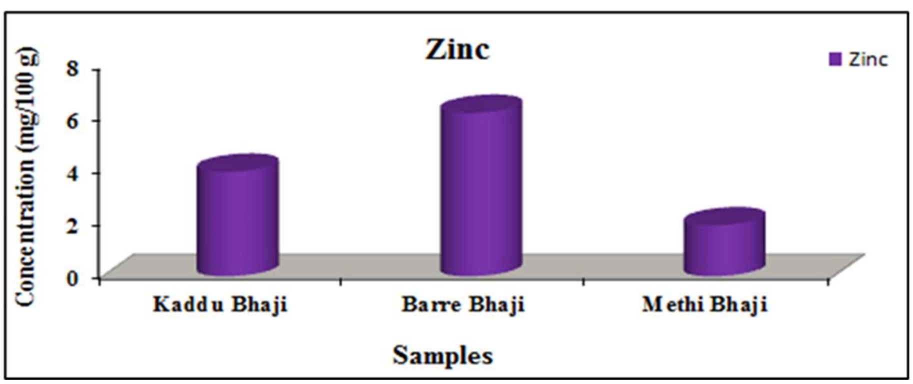
mg/100 g. Methi Bhji was found to have the highest iron concentration among vegetables, followed by Kumda Bhaji and Barre Bhaji. These plants do not exceed the FAO/WHO (2001) [16] safe level of 425.00 mg/100 g for the presence of iron, which is present in these plants. These vegetables could make a healthy addition to your daily Fe intake.

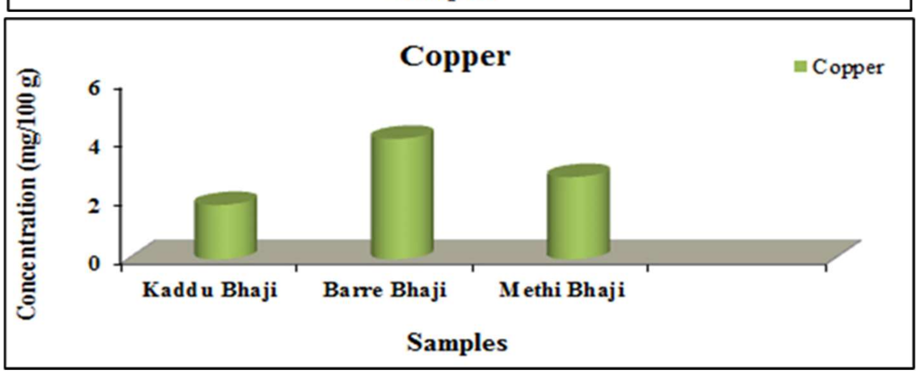
Copper (Cu) is an important component for plant development and the production of many enzymes; nevertheless, the amount of copper that is contained in most plants is insufficient for proper growth, which is typically ensured through the application of either synthetic or organic fertilizer. [17] The Kumda Bhaji had the lowest content of copper at 1.84 mg/100 g, while the Barre Bhaji had the greatest concentration of copper at 4.09 mg/100 g. Both of these concentrations were measured. Among the vegetables tested, Barre Bhaji had the highest copper level, followed by



Kumda Bhaji and Kumda Bhji. As a result of this study, it was determined that the amounts of copper in leafy vegetables are much below the FAO and WHO's safe intake recommendations.

Fig. 2: metal content in Leafy vegetables





Zinc is both the least poisonous and most important element for humans to consume. It is found in all living cells and has a widespread distribution in the tissues of both plants and animals. It contributes to the activity of enzymes by acting as a cofactor and is a component of many enzymes. According to the Agency for Toxic Substances and Disease Registry, the zinc intake that should be consumed should not exceed 15 mg per day for men and 12 mg per day for women. [18-19] The highest level of zinc that was discovered to be present in Barre Bhaji was 6.21 mg/100 g, while the lowest level of zinc that was discovered in Methi Bhaji was 1.93 mg/100 g. Zinc levels are highest in Barre Bhaji, followed by Kumda Bhaji, and finally Methi Bhaji. Table 2 shows that the average zinc content of the plants tested was significantly lower than the upper limits suggested by the FAO and WHO (2001) for green leafy vegetables. Consuming these leafy vegetables on a regular basis may assist to inhibit the harmful effects of zinc deficiency, which can lead to stunted growth and delayed sexual maturation. [20]

In most cases, the provisional tolerated daily intake is used to describe the level of consumer exposure as well as the associated hazards to their health. The FAO and the WHO (1999) [14] established a limit for the heavy metal consumption based on the body weight of a typical adult. This limit was set at 60 kg, which is the average adult body weight. Every day, the average person incorporates 98 g of vegetables into their diet. Table 3 displays the results of a calculation showing the percentage of the average human's heavy metal intake that comes from plant-based foods. The following is what happens to a person's body weight and biochemical processes if they consume the average amounts of Fe (13.95 mg/100 g), Cu (2.91 mg/100 g), and Zn (4.04 mg/100 g) found here every day: Both the FAO and the WHO have released reports estimating daily heavy metal consumption. For the average adult (60 kg body weight), the FAO and the WHO set the PTDI limit for heavy metal intake as shown in Table 3. Daily estimates of heavy metal mineral ingestion are shown in Table 3. [21-22}

Conclusion:

Zinc, copper, and iron are the most important minerals to take as dietary supplements since each of these elements has a distinct function in the fundamental metabolic processes of animals and humans alike. The average human body requires 17 mg of iron, 2-3 mg of copper, and 3-4 mg of zinc daily from the food for healthy function. In comparison to the standards set by the FAO and the WHO, the metal concentrations were determined to be exceptionally low. This is an important discovery due to the fact that the consumption of vegetables as food has a direct influence on the health and welfare of human beings. Because vegetables constitute the majority of the food that is ingested by humans and animals, which are represented in abiotic markers of environmental contamination, it is important to continue monitoring the amounts of minerals that are present in vegetables. Vegetables are an important part of the diet of all living things, including humans and animals.

ACKNOWLEDGEMENT

The authors are grateful to HOD, Department of Chemistry, Dr. C. V. Raman University, Kota, Bilaspur (C.G.) for providing research facilities.

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