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Interdisciplinary Comparative Study of the Techniques used for tracing the Metal Content in Fruit

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Abstract

This paper discusses the detail about fruits metal such as essential metal content of fruits and vegetable. The daily recommended allowances or daily intake capacity of essential metal in fruits and vegetable according to the National Institute of Health (NIH), Food and Nutrition Board of the Institute of Medicine (FNB), World Health Organization (WHO) and Food and Agriculture Organization (FAO) and Indian Council of Medical research (ICMR).

Keywords: Atomic Absorption Spectroscopy, Trace Metal Element, Ca, Pb, Cd.

1. INTRODUCTION

When Fruits are superb gift to the mankind truly they are life improving medicines packed with vitamins, minerals as well as anti-oxidants. They are absolute feast to our sight, not just only for their color and flavor but for their unique profile also it help human body free from diseases and stay it healthy! Identification of micro nutrient and necessary trace element level of fruits is a growing trend in nutritional studies all over the world. Eating grater amount of fruit can increased the mineral regulation as well as decreased the cardiovascular diseases at certain cancer risks. Minerals are just like vitamin and it help human body to grow, develop and stay healthy. Minerals can be classified into three parts such as Major Elements, Trace Elements and Ultra-trace Elements. Major Element are also known as Micro-Minerals they are Na, K, Ca, Mg,

Cl, P, and S are needed more than 50 mg/day. Trace Element are Fe, I, Fe, Zn, Se, Cu, Mn, Cr, Mo, Co, Ni are required less than 50 mg/day. Trace elements do not provide any calorie but they play an important role in the metabolic regulations of the human body. Ultra-trace Element are Al, As, Ba, Bi, Br, Cd, Cs, Ge, Hg, Li, Pb, which are not essentials. Trace minerals consistency of fruits is based on the various parts for example whether soil and the supply of their market. Trace metals in the body keep up body PH, osmotic regularity and used as coenzyme which make regular metabolic reactions.

2. LITERATURE OF ESSENTIAL ELEMENTS

Some essential element with their Daily intake limit are explain as follows:

2.1 Calcium (Ca)

Calcium is essential element human nutrition. The human body need calcium to maintain strong bones the strong bones and carry out many useful function Also needs calcium for muscles to move and for nervous to carry message between and every body part. It used to development and growth of the skeletons e.g. bones teeth as well as coenzyme in metabolic regulation of biomolecules. The average daily recommended amount of calcium by National Institute of Health (NIH) for age of 0-6 month baby are 200 mg/day. For 6-12 month 260 mg/day. For 1-3 year old child are 700 mg/day. For 4-8 year old child are 1,000 mg/day. For 9-18 year old is 1,300 mg/day. For 19-70 year old are 1,000 mg/day and the upper limit is 2,500 mg/day and 19-50 year pregnant woman and Lactation needs 1,000 mg/day. [1]

2.2 Copper (Cu)

Copper is one of the essential trace element. It useful for nerve function, bones growth and to help your body use sugar lack of copper may lead to anemia and osteoporosis. Its insufficiency shows unsatisfactory feature in connective tissue that generate vascular and skeleton problem as well as anemia associated inadequate iron metabolism. It can be also disturb the central nervous system and the immune cardiovascular. The daily recommended average limit of copper according to National Institute of Health (NIH) as the age of 0-6 month child are 0.20 mg/day. For 7-12 month old are 0.22 mg/day. For 1-3 year old child is 0.7 mg/day and the upper limit is 1 mg/day. As the age of 4-8 year old child is 1.0 mg/day and the upper limit is to 3 mg/day. For the 9-13 year old is recommended as 1.3 mg/day for boys and 1.1 mg/day for and girl and the upper limit is 5 mg/day. Like the age of 14-18 year old boys and girl are 1.5 mg/day and 1.1 mg/day respectively and the upper limit is to 8 mg/day. As the age of 19 to greater the 70 year old men as 1.7 mg/day and for woman is 1.2 mg/day and upper limit is 10 mg/day. As well as the 1.3 mg/day for pregnant woman. [2]

2.3 Magnesium (Mg)

Magnesium is abundant mineral element in human body. Is a substance whose presence is essential for the activity of an enzyme that balanced disparate biochemical reaction in body along with protein synthesis, muscles and nerve function, blood glucose control in blood pressure regulation? The daily recommended allowances of magnesium according to National Institute of Health (NIH) is for the age of 0-6 and 7-12 month child is to 30 mg/day and 75 mg/day. For the age of 1-3 and 4-8 year old is 80 mg/day and 130 mg/day respectively. As the age of 9-13 year old is 240 mg/day and 410 mg/day as a male as well as 360 mg/day for female for the age of 14-18 year old. For the age of 19-30 year old is allow the 400 mg/day for male and 310 mg/day for female as well as 350 mg/day for pregnant woman and 360 for lactation. For the age of 31-50 year old is to 420 mg/day for male as well as 320 for female for the pregnant woman 360 mg/day and 320 mg/day for lactation.420 mg/day for male and 320 mg/day for female as a age above 51 year old. [3]

2.4 Potassium (K)

Potassium is an essential minerals required for normal functioning of human body. Although potassium has a role in the synthesis of protein and muscles tissue. Potassium also work inside every cell to maintain the PH level and acts as an electrolyte a molecules that transmits electrical activity between cells. The daily recommended limit for potassium according to Food and Nutrition Board of the Institute of Medicine (FNB) for the age of 0-6 and 7-12 month baby are 400 mg/day are 700 mg/day. For the 1 – 3 year old child is 3,000 mg/day. And the 3,800 mg/day for the age of 4-8 year old. For the 9-13 year old is 4,500 and for above 4,700 mg for pregnant as well as the 5,100 mg/day for breastfeeding mothers. [4][5]

2.5 Iron (Fe)

Iron is a necessary element in hemoglobin for erythrocyte protein which is used to provide the red color to blood, and transport oxygen and carbon dioxide from lungs to the tissue. Iron is also useful for growth improvement regular cellular working and synthesis of some hormones and connective tissue. Iron useful deficits related with anemia content gastrointestinal disorders and damaged cognation function, immune function, task or work achievement as well as body temperature regulations. The average daily recommendation for Iron according to National Institute of Health (NIH) is for the infants such as 0-6 month and 7-12 month are 0.27 mg/day and 11 mg/day. For the year of 1-3 and 4-8 year old child is of 7 mg/day and 10 mg/day. Likewise for the age of 9-13 year old as well as 14-18 year old are 8 mg/day and 11mg/day for boys as well as 15 mg/day for girl. For the age of 19-50 year old is 8 mg/day for male as well as 18 mg/day for female like 27 mg/day for pregnant woman and 10 mg/day for lactation respectively. [6]

2.6 Manganese (Mn)

Manganese is one of the essential element required in carbohydrate metabolism. It is required very in very less quantity and its deficiency is rarely occurs. It is used to formation of bones and necessary for connective tissues. The daily recommended limit of manganese according to National Health and Medical Council (NHMRC) is for infants as the age of 0-6 month and 7-12 month are 0.003 mg/day and 0.600 mg/day. For the children between the age of 1-3 and 4-8 year old is 2.0 mg/day and 2.5 mg/day. For the adolescent's age as the 9-13 year old are 3.0 mg/day for male as well as 2.5 mg/day for female and the age for 14-18 year old is 35. Mg/day for male and 3.0 mg/day for female. For the age of 19 to above 70 is 5.5 mg/day for men and 5 mg/day for woman as well as the pregnant and lactation is also 5 mg/day. [7]

2.7 Zinc (Zn)

Zinc is one of the less toxic metal and is essential for proper maintenance of body function example is immune system, proper brain functioning and vital for development of fetal growth. The higher uptake of zinc can lead to muscles, cramps, kidney damages and digestive problem. The daily recommended limit of zinc according to World Health Organization (WHO) and Food and Agriculture Organization (FAO) is for the children having the age of 1-3 year, 4-6 year and 7-9 year is 5 mg/day, 7 mg/day and 8 mg/day. For the age of 10-12 year, 13-15 year and 16-17 year old is 9 mg/day, 11 mg/day and 12 mg/day. For the adult man and woman are 12 mg/day.

2.8 Sodium (Na)

It regulates the blood pressure and in nervous system for transmitting signaling pathway of the body as well as stabilize the water in our cell. Lower level of sodium can caused confusion seizures the increase level of sodium content has direct link to the high blood pressure. The daily recommended limit of sodium based on Indian Council of Medical research (ICMR) is for Infants of 0-6 and 7-12 month are 407 mg/day. For the age of 1-3 year and 4-6 year old children is 589 mg/day and 1005 mg/day. For adult is 2092 mg/day for men and 1902 mg/day for woman. [8]

2.9 Cobalt (Co)

Cobalt is a needed metal it is a factor of vitamins B-12 this vitamins is important for creating red blood cell and maintain the nervous system. Cobalt is used by the human and other living organism in having good health. As per the supplement cobalt is expressed in amount of microgram (mcg). The average intake of cobalt in adult are 5-8 mcg/day as per the university of Utah Health care. If you have a deficiency in cobalt this means that you have a deficiency in vitamin B-12. Anemia main cause of cobalt deficiency as well as cobalt is toxic to heart muscles it can be caused hearts muscles diseases. [9]

2.10 Nickel (Ni)

Nickel is one of the trace mineral element. It is mostly available in soil, water and air due to the both natural and human processes. Less quantities of nickel are available in food by virtue of its absorption and metabolism by plants and microorganism. According to Food Standards Australian New Zealand the estimated mean level of dietary intake of nickel are for infants are 0.3 mcg/day. For the age of 2-3 year children is 91 mcg for male and 83 mcg/ day for female. For the age group 4-8 is 100 mcg for male and 89 mcg/day for female. For the age of 9-13 year old is 117 for male and 93 mcg/day for female. The age between the 14 to 18 and 19 to 29 is 152mcg, 107 and 156, 112 mcg/day for both male and female. For the age 30-49 and 50-69 is 154,149 mcg/day for male and for female is 117 mcg/day. For the age of above 70 year is 143 mcg/day as a male and 113 mcg/day for female. [10]

3 COMPARATIVE STUDY

The Following table shows the literature work done by various authors. It consist of methods and results that are used by the author for study of tracing metals element in fruits.

Table 1: Comparative Study of Various Author with Methods and Result.

SR. NO.	AUTHOR	METHODS	RESULT
1	Rabia Naimat, Mir Ajeb Khan, Kiran Yasmin khan, Mushtaq Ahmod et al.[11]	Atomic Absorption Spectroscopy (AAS). Also Wet digestion method is used.	Na, K, Mg and Ca are richer in part of leave bark and fruit gives concentration 1 to 13 mg/g. The element Co, Cr, Mn, Zn and Fe are in medium range of 0.006-1.69 mg/gram and the Cd, Ni and Pb are the toxic elements with high concentration due to atmospheric effect and industrial fallout these found in 0.0001-0.0052 mg/gram level.
2	Ligang Fang, Hongli Li, Zhaobin Liu, Xuefeng Xian [12]	The Spectral measurement was done by using ASD FieldSpec 3 Portable Spectroradiometer and the pre –processing was carried out using ViewSpec Pro V 5.6 software. As well as for the analysis the Multiple Linear Regression calibration algorithm is used.	The result of this analysis is shows that the statistics on the four quality parameters content in yellow peach different maturity for Total Sugar Content (TSC) range is 3.828-26.370 %, mean is 10.516 % and the Total Acid Content (TAC) range is 0.383-0.961, mean is 0.607 and variation is 0.015 %. For the Soluble Solid Content (SSC) range is 9.100-12.900, mean is 11.360 %, variation is 0.715 %. For the Water Content range is 81.210-90.750, mean is 83.725 %, and the variation is 2.229 %.
3	Tilahun Belayneh, Zemene Atnafu, Alle Madhusudhan	Flame Atomic Absorption (FAAS) and Flame Photometry (FP) technique.	The result shows that all of them contain considerable concentration of trace metal expect Cd among the

	[13]	The Optimization wet digestion procedure was evaluated using Standard Addition (Spiking) method	leveled metal. Calcium was observed at highest level similarly Iron accumulated in high level among the micro metal. While the obtained result is also compared with international guidelines for rice. On this basis the levels of Ca, Cu, Cr, Mn, K, Na, Mg, Fe, Ni, Zn and Ag in the analyzed rice samples were found below the guide lines, while the levels of Pb was above the value given by WHO.
4	F. Ismail, M.R. Anjum, A.N. Mamon and T.G. Kazi [14]	Atomic Absorption spectroscopy (AAS). After the wet digestion method is used	Result shows that the Co was analyzed 0.1038-0.126 mg/100 gm., Zn was 0.44-0.55 mg/100 gm., K 2.3-38.5mg/100 gm., Na was 1.5-2. Mn was 0.0526-0.1435 mg/100 gm., Ca 0.3-3.35 mg/100 gm., Mg 1.191-32.0 mg/100 gm. while Cu 0.1-1.9 mg/100 gm. and Ni 0.05-0.18 mg/100 gm. whereas Fe was found 1.5-29.0mg/100 gm.
5	M. R. Rahman, M. A. Shariff, M. O. Rahman, M.S. Uddin, A. K. M. Shafiq, Ullah, M. A. Shameem, M.M. Hasan, S.J. Hasan and M. A. Huq [15]	particle induced X-ray emission (PIXE) technique	Result shows that the highest Cl content is found in Malabar spinach as 32005 ppm. And lowest in jujube in 1913 ppm. K and Ca are most abundant element in sample. Observed that radish spinach contain the height amount of K 91627 ppm. And Ca 89570 ppm. The lowest amount of K and Ca are in jujube as 16303 ppm and green banana as 5222 ppm. The Fe is fairly good in all sample varied from 148.0 ppm. In green banana to 6136 ppm in onion. Zn content in radish spinach are 80.36 ppm is the highest among the studies sample. Mn was found in radish spinach contain highest amo0unt are 209.8 ppm. Cu was found in eggplant with conc. 41.26 ppm.
6	Chaitali V. Mohod [16]	Atomic Absorption Spectroscopy And also the wet digestion method is used.	The result shows that. The heavy metal like Pb for Spinach is found in 5.5 mg\kg-1 and for tomato is 5.5mg/kg-1. For Cd is Spinach was 0.3 mg/kg-1 and Tomato were found to be 0.2mg/kg-1. For remaining heavy metals as Cu for Spinach is 0.03 mg/kg-1, tomato is 0.045 mg/kg-1 respectively and Zn for Spinach is 2.0 mg/kg-1and for tomato is 3.8 mg/kg- 1 respectively and the found result is also compare with the International organization like FAO and WHO. And shows that the heavy metal of Pb and Cd found more than

			the maximum Permissible limit according to the International organization like FAO and WHO. As well as the remaining heavy metals as Cu and Zn are found in within the permissible Limit as compared with the FAO.
7	Iftekhar Hussain Bukhari, Muhammad Ramzan, Muhammad Riaz, Tanveer Hussain Bokhari, Ghana Rehman, Shahida Munir. [17]	Wet digestion method and atomic Absorption Spectroscopy for metal detection.	The result is shows that the Mn was analyzed as 0.220-3.334, Ni is 0.117-1.190, Zn are 0.245-3.873,Cu is , 0.109-0.401,Co is 0.007-0.462, Cr as 0.211-1.298, Fe are 3.447-41.283, Cd is 0.002-0.627 and Pb was analyzed as 0.046-1.159mg/100g.[17]
8	Mohamed H.H. Ali, Khairia M. Al-Qahtani [18]	Using Acid digestion method and metal content determine using Atomic Absorption Spectroscopy. In statistical analysis the analysis of Variance (ANOVA) is used.	Leafy vegetables were found to contain The highest metals values especially parsley 543.2 and 0.048 l mcg/g for Fe and Hg respectively, Jews Mallow 94.12 and 33.22 mcg/g for Mn and Zn respectively, spinach 4.13 mcg/g for Cd. While peas In legumes group maintained the highest Zn content 71.77 mcg/g and finally cucumber had the highest Pb content 6.98 mcg/g on dry matter basis.
9	Mohamed A. Radwan , Ahmed K. Salama [19]	Atomic absorption spectrometry was used to estimate and evaluate the levels of These metals. The measurement were down using hallow cathode lamp as well as the Limit Of Detection (LOD) and Limit Of Quantification (LOQ) is used	The result shows that the level of Pb in all commodities were between 0.0 mg/kg in potatoes and 0.87 mg/kg in strawberries with the range of 0.007-0.012 and 0.17-1.08 respectively. Cd content varied from no detectable amount in melon to 0.15 mg/kg ranged from 0.09-0.25 in cucumber. The mean level of Cu were ranged from 0.83 to 18.3 mg/kg the highest in found in date and the lowest in potatoes. Maximum quantity of Zn was detected in spinach is 20.9 mg/kg while the apple had the lowest concentration 1.366 mg/kg.
10	Rajesh Kumar Sharma , Madhoolika Agrawal , Fiona M Marshall [20]	The Acid Digestion method is used. For determine the metals Atomic Absorption Spectroscopy is used and for the Statistical analysis the Analysis of Variance (ANOVA) is used.	The result is shows that the concentration of heavy metal in agricultural soil collected from different crop production site are ranged from the Cu is minimum to maximum are 9.80 to 19.30 mcg/g, for Cd is 0.60 to 2.30 mcg/g, 83.00 to 133.00 mcg/g for Zn and the 2.90 to 19.30 mcg/g for Pb. As well as the level of heavy metal in vegetable at the Production site are the range for Palak, lady's finger and Cauliflower for Cu is

			12.8 to 25.6, 9.5 to 21.8 and 9.8 to 2.41 mcg/g respectively. For Zn is 30.1 to 45.5, 29.6 to 39.2 and 38.6 to 63.3 mcg/g for Cd is 0.4 to 1.5, 0.5 to 1.2 and 0.6 to 2.1 mcg/g. and for Pb is 0.7 to 1.4, 0.3 to 1.2 and 0.2 to 1.8 mcg/g. The level of heavy metal in vegetable for market site is range is for Palak, Lady's finger and Cauliflower is 20.10 to 40.10, 12.20 to 27.10 and 21.20 to 56.30 mcg/g for Cu. For Zn range is 42.30 to 92.30, 32.50 to 66.20 and 25.20 to 94.30mcg/g. The range for Cd is 0.80 to 3.80, 0.10 to 2.60 and 0.80 to 4.30 mcg/g. For the Pb is 1.10 to 1.90, 0.20 to 2.56 and 0.90 to 2.40 mcg/g. The average mean of heavy metal in vegetable for production site for Palak, Lady's finger and Cauliflower is 20.27, 16.07 and 16.63 mcg/g for Cu respectively. For Zn is 38.40, 34.69 and 51.52 mcg/g. For Cd is 0.98, 0.90 and 1.26 mcg/g. For Pb is 1.00, 0.88 and 1.02 mcg/g. the average mean of heavy metal in vegetable for market site for Palak, Lady's finger and Cauliflower is 27.59, 18.02 and 35.72 mcg/g for Cu respectively. For Zn is 57.56, 45.96 and 63.63 mcg/g. for Cd is 1.96, 1.41 and 2.57 mcg/g. for Pb is 1.44, 1.03 and 1.56 mcg/g.

The above table shows the comparative study done by the various author using different methods and shows the obtain result.

In 2011, Rabia Naimat et al. was work to determine the minor and trace element such as Co, Cu, Ni, Pb, Mg, Na, K, Zn, Cr, Cd, Mn and Fe. Concentration in 14 sample of 5 plant genus Zizyphus from different region of Pakistan. Using Atomic absorption spectroscopy.

In 2011, Ligang Fang and et al. studied for the determination of Soluble Solid Content (SSC), Total Sugar Content (TSC), Total Acid Content (TAC), and Water content in yellow peach. There are total 60 yellow peaches in different maturity were collected from an Orchard in Suzhou city (China). And spectral measurement is done by ASD FieldSpec 3 Portable spectroradiometer is wavelength is 350-2500 nm.

In 2015, Tilahun Belayneh et al. is investigate the concentration of essential metals such as Ca, Cu, Fe, Mn, Ni, Zn and non-essential metals such as Cd, Ag and Pb in rice and soil sample collected from Gonder city (Ethipia) and metals determine by using the Flame Atomic Absorption (FAAS) and Flame Photometry (FP).

In 2011, F. Ismail et al is work on the trace metal contents of vegetables and fruits of Hydrabad (Pakistan) retail market. The study is to determine the trace metal are Co, Zn, K, Na, Fe, Mn, Ca, Mg, Cu and Ni is analyzed in 15 vegetable using Atomic Absorption Spectroscopy (AAS).

In 2014, M. R. Rahman et al. studies of essential and trace elements in some fruits and vegetable of southwestern Bangladesh. sample of various fruit such as Papaya, Tomato, Okra, Guava, Banana raw, Green banana, Tamarind and vegetable are Potato, Onion, Root turnip, Radish Spinach, Red spinach, Malabar spinach, etc. and determine the Cl, K, Ca, Ti, Mn, Fe, Co, Cu, Zn, Br using Particle – Induced X-ray Emission (PIXE) technique.

In 2015, Chaitali V. Mohod. Studies of the concentration of heavy metals such as Pb, Cd, Cu, Zn using Atomic Absorption Spectroscopy on vegetables sample as Spinach (leaf) and Tomato grown near the area of Amba Nalla of Amaravati city.

In 2013, the author Iftikhar Hussain Bukhari determine the seven essential metal including Cr, Mn, Fe, Co, Cu, and Zn, two toxic metals Pb and Cd with wet digestion method and Atomic Absorption Spectroscopy. The determination of heavy metals of different varieties of vegetables including Radish, Carrot, Spinach, Garlic, and Methi (leaves), Turnip, coriander, Greens (Saag) and three varieties of fruits like Oranges, Berry Fruits and Guava collected from the local market of Shokot City (Pakistan).

In 2012, Mohamed H. H. Ali assess the some heavy metals like Cu, Zn, Pb and Cd in vegetables, cereals and fruits in Saudi Arebian markets. More than 240 sample collected and classified into Legumes in which the Haricot, Kidney bean, Peas, and beans. In Cereals class Rice, Wheat, and Barley. In leafy vegetable class are Jews mallow, Spinach, Arugula, Parsley, and Cabbage. Sweet potatoes, Carrot, and Turnip in Root class. In Stem class are Potatoes and Onions. Tomato and Cucumber are in Fruit class. And the metals content is determine by using Atomic Absorption Spectroscopy.

In 2006, Mohamed A. Radwan is study to assess the level of Pb, Zn, Cu and Cd in various fruits and vegetables sold in Egyptian market. Atomic Absorption Spectroscopy is used to determine these metals on 330 sample of fruits and vegetables.

In 2009, Rajesh Sharma et al. determine the heavy metals Cu, Zn, Pb and Cd in some key Indian vegetables such as Lady's finger, Palak and Cauliflower sample are collected from the both the market and production sites of Varanasi in India. And heavy metals determined by using Atomic Absorption Spectroscopy.

4 CONCLUSION

Fruits are very important part of the human diet as they provide vitamins and minerals that are essential for human health. Consumers looks for variety in their diets and are aware of the health benefits of fresh fruits and vegetables. In addition to meeting

nutrient intake levels a greater consumption of fruits and vegetables is associated with the reduced risk of cardiovascular diseases, stroke and cancer of the mouth and so on. Most of the studies shows that fruits and vegetables are the rich sources of nutrients as well as non-nutrient molecules with antioxidants. The determination of fruits metals content is growing trend throughout the world. The many of the researcher have contributed to find the mineral content using atomic absorption spectroscopy device with the wet digestion method and shows the result below the permissible limit.

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