Quantitative Analysis of Essential Metals (Magnesium, Calcium and Iron) in Various Indian Vegetables and Fruits

Mrinal Kanti Si*, Afshin Ali, Ankush Vaidya, Sudhakar Singh, Kajal Deshmukh, Neha Bhagat,
Punam Hanwat, Nandini Sahu, Pallavi Bhagat, Sakshi Tilase, Shruti Shriwastri

Sardar Patel University, School of Science and Education, Balaghat,

Dongariya, Madhya Pradesh, India-481331

Abstract:- Calcium, Magnesium and irons are essential for normal biological functions in humans which are present in various quantities in fruits and vegetables. In this study, we have quantitatively estimated the metal ions like calcium, magnesium and iron in various fruits and vegetables which are taken daily by the Indian people. Therefore, our study can help for the common people to select the vegetables and fruits for their food regularly which can help to make them healthy.

INTRODUCTION:

Living body generally contains nearly 40 different elements. Among the essential elements, the most abundant elements in biological systems are C, H, O and N. The important bio-molecules like water, carbohydrate, protein and fat mostly contains C, H, O and N elements. The principal nutritionally important elements are Na, K, Ca, Mg, P, S and Cl which are called Macro elements. The elements are Mo, Mn, Fe, Co, Cu, Zn, F and I are called essential trace elements which are present at trace quantities. However, the elements Li, Si, V, Cr, Se, Br, Sn and W are essential at ultra trace concentrations [1]. Dried fruit, peas, asparagus, leafy greens, strawberries and nuts are enriching with Iron among the plant food source. The food sources are rich with Calcium (Ca), Magnesium (Mg) and Potassium (K). Therefore, these nutrient requirements can be meet by increasing the consumption of fruits and vegetables to [2–9] servings/day. The greater consumption of fruits and vegetables increases nutrient intake levels, which reduces risk of cardiovascular disease, stroke, and cancers of the mouth, pharynx, esophagus, lungs, stomach, and colon [10,11]. Calcium play important role in diverse physiological and biochemical functions in the human body. Previous studies reveal that adequate dietary calcium intake (DCI) and moderately increased physical activity and it help to prevent long term osteoporosis. The literature based on analysis people in Karnataka state of India reveals that the DCI of people living in Karnataka are limited. Thus, we aimed to assess DCI, physical activity, and their predictors among people living in India. [12]

Magnesium is an extremely important mineral for the body. An adult body contains 25 grams magnesium, with 50 per cent to 60 per cent of it in the bones and the rest in the soft tissues. Magnesium is required by the body for hundreds of chemical reactions and to maintain good health. While many foods and vegetables have magnesium, people don't get the reference daily intake, which is 400 mg. [13]

Iron plays important role in maintaining many body function like the production of hemoglobin, the molecule in human blood that carries oxygen. Iron is also essential to preserve healthy cells, skin, hair, and nails. In worldwide nearly 1 billion people are affected by iron-deficiency anemia [12]. Risk of low birth weight and other pregnancy-related complications are increased by the deficiency of iron [12]. The deficiency of iron in body may cause poor growth during infancy and early childhood, impaired cognition and behavior in children [12], reduced work capacity [12], and reduced productivity [12]. The national survey, conducted between 1998 and 1999 reported that there is an anemia prevalence rate of 52% among young women [12]. The survey also reveals that anemia prevalence rate for Karnataka State is 42% and the prevalence is slightly lower in urban women (36%) compared to rural women of Karnataka, India (46%). [12]

The aim of the present study was to determine the components (Ca, Mg, and Fe) from fruits, and vegetable which can help us for select the appropriate fruits and vegetable in proper amounts.

MATERIALS AND METHODS:

Five vegetables and five fruits are collected from local market of Balaghat district in Madhya Pradesh state, India for our experimental study. Five vegetables and five fruits are cabbage, Cauli flower, Pea seed, Spinach, chick Pea and Apple, Banana, Grapes, Orange, Chiku respectively. All the reagents used were chemically pure and analytical grade. Reagent grade organic solvents were purified and dried by recommended procedures [6] and degassed before use. Amonium oxalate, EDTA disodium salt, Eriochrome black-T, Potassium permanganate (KMnO4),potassium dichromate (K2Cr2O7), Aqueous ammonia, Ammonium chloride (NH4Cl), Sulphuric acid, Hydrochloric acid were purchased from Sd fine chemicals, India.

Sample preparation:
Transfer 50 g of specific food sample in a mortar and pest and ground well. Extract the sample in deionized and water and made up to 100 ml.

Estimation of Magnesium:

About 20 ml of the food sample solution was neutralized with aqueous ammonia. 2 ml of buffer solution (NH4Cl-NH4OH), a drop of Eriochrome black -T indicator were added and titrated against EDTA solution until the colour change from wine red to blue. From the titre value the strength as well as the amount of Magnesium present in the whole of the sample solution was calculated.[7]

Estimation of Calcium :

Initially, calcium oxalate is precipitated out using ammonium oxalate. Dissolve this precipitate in concentrate sulphuric acid and calcium is calculated by Permanganometric titration.

Estimation of Iron :

Dichromatometric titration was used to estimate Iron in food samples. From the titrate value the strength as well as the amount of Iron present in the whole of the food sample was calculated.

RESULTS AND DISCUSSION:

Ten different common edible Indian vegetables and fruits are collected for the present study. The macronutrients (Calcium and Magnesium) and trace elements (Iron) are estimated by using complexometric, permanganometric and Dichrometric titrations.

Table 1: Amount of metal in gm/lit. Calculated in various vegetables

Vegetable	Mg^{2+}	Ca^{2+}	Fe^{2+}
Cabbage	0.041	0.108	3.194
Cauli flower	0.248	0.117	0.239
Pea Seed	0.040	0.145	1.132
Spinach	0.041	0.135	1.747
Chick Pea	0.035	0.289	0.462

The analysis of metal ions in vegetables like Cabbage, Cauli flower, Pea Seeds, Spinach and Chick peas from Balaghat market in Madhya Pradesh State in India reveals that all vegetable rather than Chick peas contains more irons compare to magnesium and calcium.
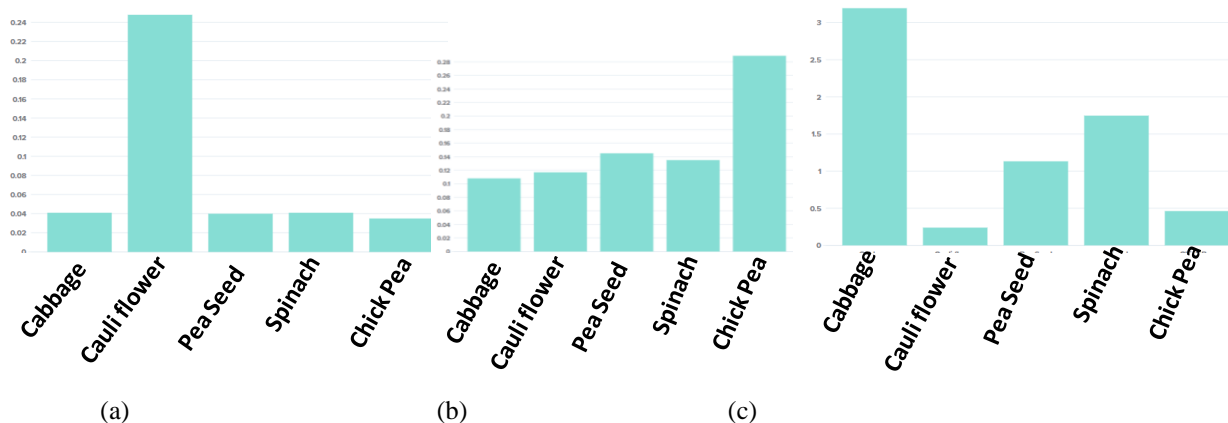

(a)   (b)   (c)

Figure 1: (a) Distribution of Magnesium (b) Distribution of Calcium (c) Distribution of Iron

Chick Pea contains more calcium among all vegetables. Cabbage contains maximum iron and cauli flower contains maximum magnesium among above vegetables. (Table 1,   Figure 1)

Our results reveal that chick pea is recommended to a person who has deficiency in calcium and cauli flower is recommended these persons who are suffering in deficiency in magnesium.

Similarly, the metal ions present in fruits have been calculated by compleximetry and redox titration.

Table 2: Amount of metal in gm/lit. Calculated in various fruits

Fruits	Mg^{2+}	Ca^{2+}	Fe^{2+}
Apple	0.068	0.288	2.512
Banana	0.669	0.336	0.323
Grapes	0.138	0.307	0.077
Orange	0.100	0.691	1.351
Chiku	0.070	1.632	0.798

Table 2 shows the amount and percentage of calcium present in five different common fruits. Calcium makes the major element of bones and teeth. It also participates in muscle contractions, conduction of nerve impulses and cell membrane permeability, where the maximum amount 1.632 g L-1 of calcium present in chiku and minimum amount 0.288 gL-1 was observed in apple (Figure 2). Shortage of calcium in children is manifested by rickets and inadequate growth.
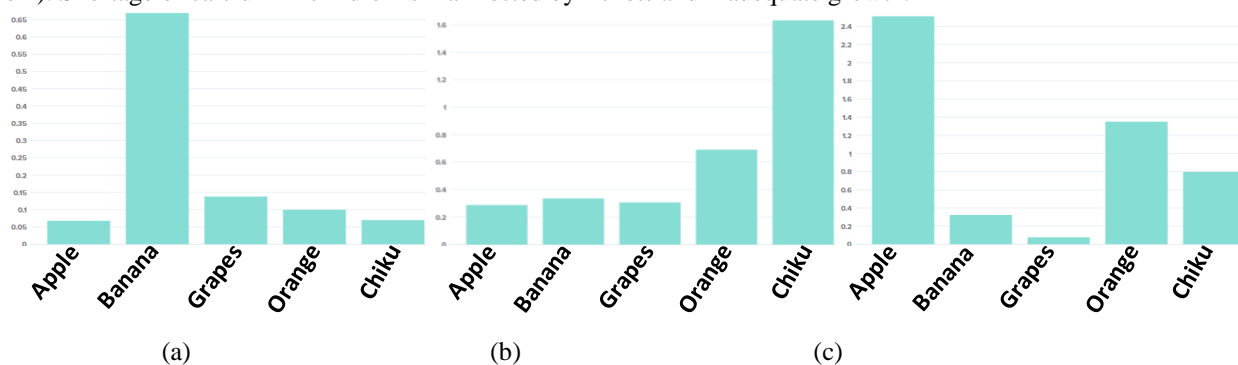

(a) (b) (c)

Figure 2: (a) Distribution of Magnesium (b) Distribution of Calcium (c) Distribution of Iron

Table 2 shows the amount and percentage of Magnesium present in five different foods samples. Among them Banna contains maximum 0.669 gL^{-1} and apple contains minimum amount 0.068 gL^{-1} of Magnesium. Magnesium is an important mineral mainly found in bones along with Calcium. Our result shows that Magnesium presents in all fruits are less than that of iron and calcium.

CONCLUSIONS

In the present study, presence of Calcium, Magnesium, and Iron are estimated in five various common vegetables (cabbage, Cauli flower, Pea seed, Spinach, chick Pea) and fruits (Apple, Banana, Grapes, Orange, Chiku) respectively. Our study reveals that all fruits and vegetables for our study contain Calcium, Magnesium, and Iron. Our analysis also shows that Coli flower contain maximum amount of Mg2+ among vegetables And Chick pea contains maximum calcium, and Cabbage contains maximum iron among studied vegetable. Among five fruits, Banana contains maximum magnesium, and Chiku contains maximum calcium. Therefore, our study can help to prescribe properly for a person who has deficiency of various metal ions like Calcium, Magnesium and Iron.

ACKNOWLEDGMENT

REFERENCES:
[1] A. K. Dhas, Bio Inorganic Chemistry- Books and Allied (p) Ltd, Kolkata-700010.
[2] The fourth National Nutrition Survey of Thailand. Ministry of Public Health, Nutrition Division, Department of Health, Thailand. 1995.
[3] V. Nour, I. Trandafir and M. M. Ionica. 2010. Compositional characteristics of fruits of several apple (Malus domestica Borkh.) cultivars. Not Bot Hort Agrobot Cluj. 38: pp 228–233.
[4] K. O. Soetan, C. O. Olaiya and O. E Oyewole. 2010. The importance of mineral elements for humans, domestic animals and plants. African Journal of Food Science. 4: pp 200–222.
[5] Agency for Toxic Substances and Disease Registry (ATSDR) 1999. Toxicological Profile for Cadmium and Nickel. Agency for Toxic Substances and Disease Registry, US Department of Health and Human Services, Public Health Service Contact No., 205–93–0606.
[6] A. I.Vogel. Text Book of Practical Organic Chemistry. fifth ed., Longman, London, 1989. pp. 43
[7] R. A. Dey. Quantitative Analysis. Jr, A. L. Underwood-prentice Hall of India Pvt. Ltd, New Delhi-110001 [10] G. D. Christian. Analytical Chemistry- John Wiley and sons INL New York.
[8] G. D. Christian. Analytical Chemistry- John Wiley and sons INL New York.
[9] A. Winiarska-Mieczan and K. Nowak. 2008. Determining the content of some minerals in fruit and vegetable baby juices. J Elementol 13: pp 433-442.
[10] S. Akhtar, S. Naz, S. M. Tuseef, S. Mahmood, M. Nasir and A. Ahmad. 2010. Physicochemical attributes and heavy metal content of mangoes (Mangifera indica) cultivated in different regions of Pakistan. Pak J Bot 42: pp2691–2702.
[11] A. Aberoumand and S. S. Deokule. 2010. Elements evaluation of some edible vegetables and fruits of Iran and India. Asian Journal of Agricultural Sciences. 2: pp 35–37.

[12] J. P. Raj, S. Venkatachalam, M. Shekoba, J. J. Norris, R. S. Amaravati, 2018, Dietary calcium intake and physical activity levels among people living in Karnataka, India – An observational hospital-based study, Journal of Family Medicine and Primary Care, 7, 1411-1416.

[13] Balk EM, Adam GP, Langberg VN, Earley A, Clark P, Ebeling PR, et al. Global dietary calcium intake among adults: a systematic review. Osteoporos Int. 2017;28:3315–24.