

Elemental Profile of Kinnow (*Citrus reticulata*) Growing in Sargodha District

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Abstract. Citrus is one of the most commonly used as a fruit in Pakistan. To estimate their elemental profile citrus were collected from five different tehsils of Sargodha district. Elemental analysis was carried out by atomic absorption spectrophotometer. There results showed that citrus fruits have riched source of minerals and have highest concentrations of Cu (2.71 mg/Kg), Mn (0.1633 mg/Kg) and Zn (31.72 mg/Kg) noted in T1 (Silanwali), while the maximum concentrations of Mg (65.247 mg/Kg), Cr (0.343 mg/Kg), P (1.146 mg/Kg), Co (0.536 mg/Kg), K (133.01 mg/Kg) were found in T2 (Sahiwal), T4 (Kotmomin) and T5 (Bhehra), respectively. Fluctuation in elemental profile of *Citrus reticulata* may be attributed to spatial variations or may be due to agro-climatic conditions that varies in all tehsils.

Keywords: elemental profile, *Citrus reticulata*, district Sargodha

Introduction

Citrus reticulata (Rutaceae) fruits are in Pakistan's most common edible food (Swingle, 1967) and are distributed in worldwide in temperate and tropical regions, mainly on the continents of Southern Africa and Australia (Parveen *et al.*, 2015).

Citrus is grown throughout Pakistan, but the large area under cultivation of this tree is in Punjab province (Jaskani and Abbas, 2007). Punjab's Kinnow and Feutrell grow two varieties of citrus covering the 80% of the total citrus area. The field of Sargodha and Faisalabad divisions are popularly known as Pakistan's California. Citrus fruits have rich source of ascorbic acid and not only important for domestic consumption (Ghafoor *et al.*, 2008). Citrus fruits are grown in Pakistan over an area of 183.8 thousand hectares with a total production of 1,943.7 thousand tonnes and currently 94,806 tonnes of citrus (Kinnow and others) fruits are exported to various countries (Altaf *et al.*, 2008).

Minerals are essential for plants such as potassium increases the activity of the enzymatic reaction, also involves stomata control (opening and closing of stomata), helps the plant from adverse and harsh conditions such as flooding and drought, the maximum potassium concentration in chloroplast is present and cytosol may cause soluble and often non-soluble large

molecules to be neutralised (Marschner *et al.*, 1990). While, magnesium plays a vital role in the formation of chlorophyll and plays very important role in photosynthesis, without the magnesium, the plants do not grow very well, it helping in green light absorbing pigments to catch the light energy and converting it into chemical energy for the development of lipids and proteins, carbohydrates (Cakmak *et al.*, 2010), it also plays important role in oxidation reduction processes and also helps in the electron transport chain, which is very important and essential for the photo system II, also causes the regulation of enzymes (Mousavi, 2011). Zinc is also an essential element for the formation of tryptophan and is major component of some enzymes like dehydrogenesis and involves in the metabolic process (Nagarajan *et al.*, 2014). Zn deficiency causes the plants to have intermediate chlorosis. It causes the leaves to bend and changes the colour of leaves. The reduction in fruit formation, stunted growth and chlorotic lesions are also caused by deficiency (Chatterjee *et al.*, 2018).

Minerals are important for our health and survival (Ghani *et al.*, 2017a), in human body, 5% of the body mass is consisted of mineral matter (Alexander *et al.*, 2008). As a part of hamoglobin myoglobin, it is also essential for our nervous system to severe as a trigger for many biological reactions (transmission of messages from one part of body to another), for proper food digestion (Ghani *et al.*, 2017b), metabolism, utilization

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of all nutrients in food (Alexander *et al.*, 2008). i.e. Mg for vitamin 'B' utilization, Zn for vitamin 'A', Se for vitamin 'E' absorption, Ca for ascorbic acid, also important for maintaining acid alkaline balance in our body, they are also essential for our heart proper functioning, acting as electrolytes in our body (Hall, 2015). Therefore, the purpose of the study is to find out the spatial variation in the elemental profile of *Citrus reticulata* rising in the Sargodha district's various tehsils.

Material and Method

Sample collection. *Citrus reticulata* were collected from five tehsils (Silanwali T1, Sahiwal T2, Bhalwal T3, Kotmomin T4 and Bhera T5) of Sargodha district, Punjab for elemental analysis with three replicates. Each sample was handpicked randomly, wrapped in a special brown envelope and numbered. All the samples were dried in oven for 3 days at a temperature of 75 °C.

Sample preparation for AAS analysis. The oven dried fruit samples were grinded into fine powder and then digested by wet digestion method. 0.5 g of each sample was taken into the digestion flask with 10 mL HNO₃ acid and kept them for overnight. Preparation of standards as well as subsequent samples were carried out as per AOAC (1998) methods.

Statistical analysis. Statistical analysis was carried out using Microsoft Excel 2007 (Steel *et al.*, 1997).

Results and Discussion

Results in Table 1 findings show that *Citrus reticulata* cobalt content ranged from 0.536 mg/Kg (T5) to 0.156 mg/Kg (T4) with the mean value of 0.300 mg/Kg, while Cr range from 0.343 mg/Kg (T4) to 0.03 mg/Kg (T3) with the mean value of 0.114 mg/Kg. The Cu value ranged from 2.71 mg/Kg (T1) to 2.036 mg/Kg (T5)

with an average of 2.409 mg/Kg, while K value ranged from 133.013 mg/Kg (T5) to 110.806 mg/Kg (T3) with an average value of 120.66 mg/Kg. The variation in Mg content ranged from 65.247 mg/Kg (T2) to 53.63 mg/Kg (T5) with the mean value of 59.43 mg/Kg. Mn was found to be highest 0.163 mg/Kg in (T1) and lowest 0.051 mg/Kg in (T4) with the mean value of 0.084 mg/Kg. The P value ranged from 1.146 mg/Kg (T4) to 0.153 mg/Kg (T3) with the mean value of 0.717 mg/Kg, while the Zn - value ranged from 31.726 mg/Kg (T1) to 26.463 mg/Kg (T5) with a mean of 29.75 mg/Kg.

Cobalt is an essential in our body as it is a component vitamin B12 and helpful in curing anemia is an essential improving the formation of RBCs, also good for nervous system, and our mental health. Its deficiency leads to anemia, mental disturbance, nerve disorders, vitamin B12 deficiency and abnormal cell formation (Dolara, 2014; Soetan *et al.*, 2010). The National Institute for Occupational Safety and Health explains that the usual cobalt dosage is 0.05 mg/m³, where as up to 0.1 mg/m³ can be tolerated. A dose of 20 mg/m³ is harmful to life and health (Barbera *et al.*, 1989). Results of the present study regarding cobalt concentration were higher than the Salimpour *et al.* (2010) that varied between 0.015 to 0.046 mg/Kg in different samples of citrus, while in Basil and pumpkin ranged from 0.015-0.016 mg/Kg and 0.041-0.050 mg/Kg, respectively.

Chromium is essential for the metabolism of carbohydrates and which are important for proper functioning of brain and other body processes. It also supports glucose metabolism and function of insulin. This deficiency may contribute to diabetes (Mason, 2011). The standard chromium dose for women is suggested as 14-25 µg/day, while for men, ranged from 14-35 µg/day. Children's aged with age between 1-13 years

Table 1. Comparison of means regarding elemental profile in *Citrus reticulata*

Metals (mg/Kg)	Tehsils				
	T1	T2	T3	T4	T5
Co	0.27±0.06	0.267±0.04	0.273±0.03	0.156±0.02	0.536±0.43
Cr	0.066±0.01	0.073±0.01	0.03±0.01	0.343±0.26	0.06±0.02
Zn	31.726±1.31	30.146±1.21	31.59±1.12	28.846±1.89	26.463±1.57
Mn	0.163±0.05	0.081±0.007	0.067±0.012	0.051±0.01	0.061±0.01
Mg	59.97±1.20	65.247±1.92	62.03±1.02	56.26±1.98	53.63±1.84
K	130.516±2.78	112.883±1.87	110.806±2.32	116.112±2.25	133.013±2.12
P	0.69±0.55	0.916±0.69	0.153±0.08	1.146±0.51	0.683±0.52
Cu	2.71±0.76	2.406±0.16	2.293±0.55	2.6±0.39	2.036±1.18

also need chromium ranged between 0.2 to 25 $\mu\text{g}/\text{day}$ (Institute of Medicine, 2001). Results regarding chromium concentration in *Citrus reticulata* are different from the findings of Ihesinachi and Eresiya (2014). They noted that chromium concentration in orange fruit ranged from 46.2 mg/Kg to 84.7 mg/Kg.

Phosphorus is another important element in nature which plays an important role in the structure framework of DNA and RNA and necessary for cellular processes i.e. photosynthesis, phosphorylation, key component of ATP and NADPH (Institute of Medicine, 1997), main structural component of all cellular membranes (phospholipids) and also helpful in building of bones and teeth with calcium as a calcium phosphate (Nelson and Cox, 2000). An average adult human contains about 0.7 mg/Kg of phosphorus from which 80-90% present in the teeth and bones. Normal intake of phosphorus for adults and children's should not be exceeded from 580 mg/day and 460 mg/day is suggested by (Institute of Medicine, 1997). The present results regarding phosphorus are in collaboration with the findings of Salimpour *et al.*, 2010. Who found that phosphorus varied in different samples of citrus ranged from 0.03 mg/Kg to 5.70 mg/Kg, while (Ihesinachi and Eresiya, 2014) described showed that level of phosphorus in citrus ranged from 30.0 mg/Kg to 61.5 mg/Kg.

Zinc is another important metal that strengthens the body defense system, also plays an important role in cell division, cell development and hypogonadism weak appetite, odour and taste problems. Slow growth, skin sores, dark problems, injuries and cuts recover (heal) take more time. These signs of symptoms can removed within a small period of time after intake of zinc, enrich food or supplements. (Mason, 2011; Institute of Medicine, 2001). Adequate intake of zinc is also suggested by Institute of Medicine (2001). The standard dose of zinc is suggested as 2 mg/day to 8 mg/day, while for adults is suggested as 8 mg/day to 13 mg/day. Present results regarding zinc concentration are collaborating with the findings of (Ihesinachi and Eresiya, 2014). In various citrus samples, its level varies from 1.10 mg/Kg to 30.23 mg/Kg.

Copper is an important element that acts as a catalyst in the body and also important for cell physiology, respiration, free radical scavenging, elastin cross-linking, oxidative defense system, needed for body pigmentation, maintain a healthy CNS, prevents anemia, also keeps immune system, vessels and bones healthy (Mason,

2011), while adequate copper intake of is suggested as ranging from 200 $\mu\text{g}/\text{day}$ to 220 $\mu\text{g}/\text{day}$. For adults it is suggested as 340 $\mu\text{g}/\text{day}$ to 1,300 $\mu\text{g}/\text{day}$ (Institute of Medicine, 2011). The results of the copper concentrations are in collaborating with the results of (Ghani *et al.*, 2017b). Copper content ranges from 4.043 mg/Kg to 1.403 mg/Kg, while (Dhiman *et al.*, 2011) described that concentration of copper was 5.90 ± 0.075 mg/Kg in citrus fruits.

Magnesium plays important role in metabolism, as a co-factor and several enzymes plays an essential role in metabolism which is also important in glucose metabolism, proper muscle functions and immune system, keep bones strong and healthy, regulate glucose level in blood, help in ATP synthesis and also important for proper functioning of heart (Mason, 2011). Adequate intake of magnesium for infants ranged from 30 mg/day to 240 mg/day but for adults it can be tolerated up to 400 mg/day (Institute of Medicine, 2001). Present results of the magnesium concentration are higher than the findings of (Osarumwense *et al.*, 2013). Their ranges are from 15.55 ± 1.45 mg/Kg to 21.87 ± 2.39 mg/Kg in different samples of citrus.

Manganese is a mineral which is helpful for body in formation of sex hormones, blood clotting factors, connective tissues, blood sugar regulation, calcium absorption and also component of different enzymes (Soetan *et al.*, 2010). It plays important role in delay of aging, improve health conditions including heart diseases and cancer (Aschner and Aschner, 2005). Adequate intake of manganese for infants ranged from 1.2 mg/day to 1.6 mg/day but for children of age 9 to 14, it can be tolerated up to 2.2 mg/day. However, for adults it can be tolerated up to 2.3 mg/day (Institute of Medicine, 2001). Our results regarding manganese concentration are in collaboration with the findings of (Ghani *et al.*, 2017b), who found Mn varied from 0.226 mg/Kg to 0.153 mg/Kg in different samples of citrus.

Potassium is also an essential mineral for the maintenance of several processes in our body (proper functioning of cells, tissues and organs), acting as an electrolyte in the body (Ghani *et al.*, 2017b), essential for proper heart functioning (regulating heart beat), also helpful in food digestion and muscle contraction (Hermansen, 2000), while adequate intakes potassium are 400 mg/day to 700 mg/day for infants and up to 3,000 mg/day to 4,500 mg/day for children of age up to 14 years. However, for adults it may be tolerated up

Table 2. Comparison of highest elemental profile in *Citrus reticulata* at different tehsils of Sargodha district

Metals (mg/Kg)	Tehsils				
	T1	T2	T3	T4	T5
Mg		✓			
Mn	✓				
Zn	✓				
Cr				✓	
Co					✓
K					✓
P				✓	
Cu	✓				
Total	3	1	0	2	2

to 4,700 mg/day (Institute of Medicine, 2011). Present results of potassium are in collaboration with the findings of Ghani *et al.* (2017b). The potassium content ranges from 40.681 mg/Kg to 173.42 mg/Kg with the mean value of 95.7412 mg/Kg.

Conclusion

All tehsils have good source of components, but *Citrus reticulata* of tehsil Silanwali (T1) contains the highest elemental profile as shown in Table 2. Fluctuation in the elemental profile of *Citrus reticulata* present in all tehsils may be attributed to environmental factors (soil composition, water, temperature and light), time of fruit harvest or may be due to spatial variations.

Conflict of Interest. The authors declare no conflict of interest.

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