COMPARATIVE ANALYSIS OF ELEMENTAL PROFILE OF *Citrus sinensis* COLLECTED FROM FIVE DIFFERENT TEHSILS OF DISTRICT SARGODHA, PAKISTAN

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ABSTRACT: Citrus is one of the most commonly used fruit in Pakistan. The study was conducted to evaluate the elemental profile (Mineral matter) of *Citrus sinensis* collected from five tehsils of District Sargodha *i.e.* Silanwali (T1), Sahiwal (T2), Bhalwaal (T3), Bhehra (T4) and Sargodha city (T5). Each tehsil consists of three replicates. Elemental analysis was carried out according to (AOAC, 1998). Results showed that T1 and T2 contain slightly higher concentration of minerals (Cr 0.066, Pb 1.676, Mg 71.667 and Cu 4.043, Zn 66.273, K 173.42 mg/Kg), respectively than T3, T4 and T5. Fluctuation in elemental profile in *C. sinensis* collected from five tehsils may be due to environmental factors (soil composition, water, temperature, light, different cultivars, etc.) or may be due to spatial variation.

Keywords: Spatial variation, Elemental profile, *Citrus sinensis* and Sargodha.

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INTRODUCTION

Citrus is well known as world's important fruit crop, that are produced in lot of parts of the world with different environmental conditions. Pakistan is the one of important major Citrus producer's country in the world. Citrus production is assessed to be 105 MMT per annum, Pakistan with an annual production 1.76 MMT of Citrus fruits, stands among the top ten Citrus producing countries of the world (Mahmood *et al*., 2005; Khan, 2005).

Citrus has a dominant position in the fruit industry of the world including Pakistan. Pakistan establishes about 30% of the area under all fruit orchards (Khalid *et al*., 2012; Ashraf *et al*., 2010**).** In Pakistan, Citrus is represented by 11 genera and 27 species (Khan *et al*., 2014)**.** Citrus is a most important fruit crop in Pakistan both in the area under cultivation (199.9 thousand hectares) and fruit production (2.132 MMT) as well as of Punjab province. Most of area of Punjab is cultivated for Citrus fruit trees. In Punjab, major citrus varieties are kinnow, Musambi and lemon covers eight percent of the total are grown on citrus (Altaf, 2006)**.** One of its important variety *C. sinensis* (Musambi) is admirable due to its flavor, taste as well as nutritional value. Crop nutrition and disease management are of vital importance for plant health and orchard viability in terms of yield and quality (Muhammad *et al*., 2011).

Minerals are important for our health and survival, in human body, just 5% of the body mass is consisted of mineral matter (Alexander *et al*., 2008). as part of hemoglobin, myoglobin., acting as a catalyst in many biological reactions, are also important for our nervous system (Transmission of messages from one part of body to another), also important for proper food digestion (Ghani *et al*., 2017), metabolism, utilization of all nutrients in food (Alexander *et al.,* 2008; Ahmad *et al*., 2013). *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 (Seifter, 2016).

Minerals are also vital to our mental health, important for our memory and learning. Helpful in curing headache (Peikert *et al*., 1996) migraine and pain (Anonymous, 2015), good in sadness by reducing tension (Eby *et al*., 2006), weakness, stress, asthma (Cheuk *et al*., 2005), nervousness, diabetes (Mason, 2016), cerebral palsy, chronic fatigue (Rouse, 2009), sleep disorder, hypertension, blood pressure, heartbeat (Anonymous, 2015), fibromyalgia, osteoporosis (Salwen, 2011), digestive system, helpful in building proteins, carbohhydrates metabolism, build muscles, control acid base balance in the body (Seifter, 2016), reduce risk of fractures, diabetes (Wildman, 2016), eclampsia (Euser and Cipolla, 2009), arthritis, lacunar strokes, TBI, aneurysmal subarachnoid hemorrhage, mental problems (Mottaghi *et al*., 2013), kidney problems (stones) (Mason, 2016), cancer, premenstrual disorders, also important for our hearing, take part in membrane stability (Anonymous, 2015), carbohydrates metabolism, ATP formation, cell proliferation (Seifter, 2016). These are very vital in continuing of our biological processes (Roohani *et al*., 2013), are also part of our bones, teeth,

enzymes, hormones, tissues, muscle, and nerve cells. (Mason, 2016; Pravina *et al*., 2013).

The objective of the study was to evaluate elemental profile of *C. sinensis* collected from different tehsils of District Sargodha.

MATERIALS AND METHODS

Sample collection: Five tehsils of District Sargodha were selected for the purpose of sample collection. Fruit samples of *C. sinensis* were collected from all five tehsils *i.e.* Silanwali (T1), Sahiwaal (T2), Bhalwaal (T3), Bhehra (T4) and Sargodha (T5). Each sample from tehsils comprised over three replicates. Each sample was randomly handpicked, wrapped in a specific brown envelope, labeled and brought to the University of Sargodha for further analysis.

Elemental analysis (mg/Kg): Elemental analysis was carried out according to the method described in AOAC (1998). Following metals were studied using standard methods. Copper (Cu^{+2}), Potassium (K^{+}), Chromium (Cr^{+2}), Magnesium (Mg^{2+}), Manganese (Mn^{+2})**,** Phosphorus (P^{+3})**,** Lead (Pb^{+2})**,** Cobalt (Co^{+2}) and Zinc (Zn^{+2}).

Digestion of fruit samples: The oven dried fruit samples were grinded into fine powder and then digested by a wet digestion method. 0.5g of sample were taken into digestion flask. 10ml HNO_3 and 5ml Perchloric acid was used in the digestion process. After digestion, samples were loaded to the atomic absorption spectrophotometer for elemental analysis. Standard curve for each metal prepared by running samples. The elemental contents of the samples were estimated by standard curve prepared for each metal by running samples.

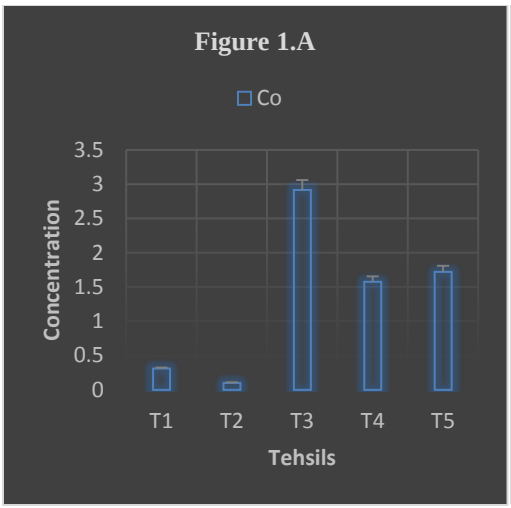
Statistical analysis: Statistical analysis (ANOVA) was carried out using Microsoft Excel 2007 (Steel *et al*., 1997).

RESULTS

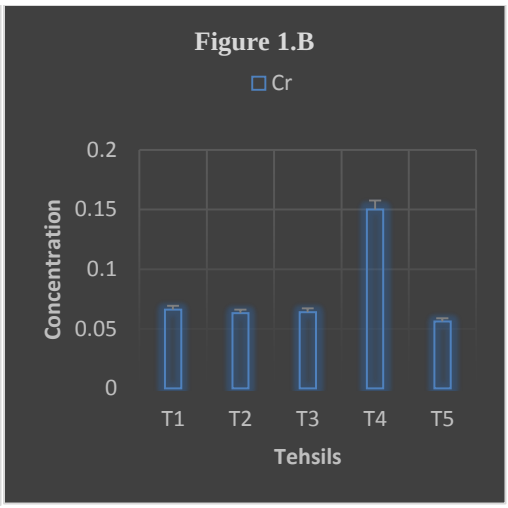
Results showed that cobalt content in *Citrus sinensis* varies from 2.916 mg/Kg (T3) to 0.103 mg/Kg (T2) with the mean value of 1.3256 mg/kg, while Cr ranged from 0.150 mg/Kg (T4) to 0.056 mg/Kg (T5) with the mean value of 0.0798 mg/kg. The Cu value ranged from 4.043mg/Kg (T2) to 1.403mg/Kg (T3) with the mean value of 2.3696 mg/kg, while the Pb value ranged from 1.676 mg/Kg (T1) to 0.113 mg/Kg (T4) with the mean value of 0.5428 mg/Kg. The variation in Mg content ranged from 71.667mg/Kg (T1) to 43.433 mg/Kg (T4) with the mean value of 58.093 mg/Kg. Mn was found to be highest 0.226 mg/Kg in (T4) to lowest 0.153mg/Kg in (T5) with the mean value 0.1842 mg/Kg. The value ranged of Zn varied from 66.273 mg/Kg (T2) to 5.534 mg/Kg (T1) with the mean value of 34.904 mg/Kg, The K varies from 173.42 mg/Kg (T2) to 40.681 mg/Kg (T5) with the mean value of 95.7412 mg/Kg, while the P content varies from 0.828mg/Kg (T4) to 0.179mg/Kg (T5) with the mean value of 0.3708 mg/Kg. variation in concentration may be due to environmental factor or may be due to spatial variation.

Table-1: Elemental profile of *C. sinensis* in different tehsils of District Sargodha.

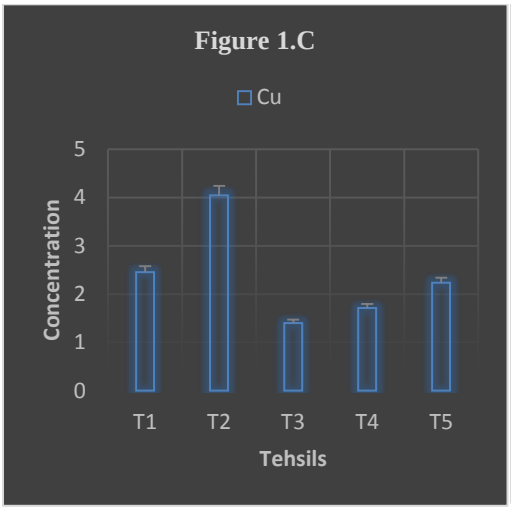
Tehsils	T1	T2	T3	T4	T5
Co (mg/Kg)	**0.31**	**0.103**	**2.916**	**1.576**	**1.723**
Cr (mg/Kg)	**0.066**	**0.063**	**0.064**	**0.15**	**0.056**
Cu (mg/Kg)	**2.456**	**4.043**	**1.403**	**1.713**	**2.233**
Pb (mg/Kg)	**1.676**	**0.313**	**0.266**	**0.113**	**0.346**
Mg (mg/Kg)	**71.667**	**55.572**	**51.573**	**43.433**	**68.22**
Mn (mg/Kg)	**0.163**	**0.193**	**0.186**	**0.226**	**0.153**
Zn (mg/Kg)	**5.534**	**66.273**	**32.268**	**45.429**	**25.016**
K (mg/Kg)	**75.735**	**173.42**	**137.06**	**51.81**	**40.681**
P (mg/Kg)	**0.183**	**0.179**	**0.33**	**0.828**	**0.334**



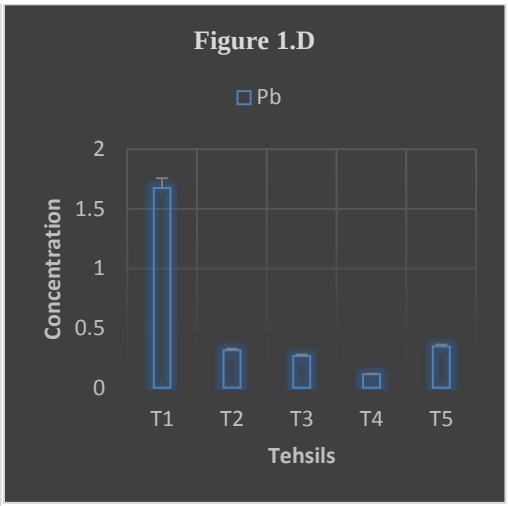
I.A Comparison of means regarding Co content



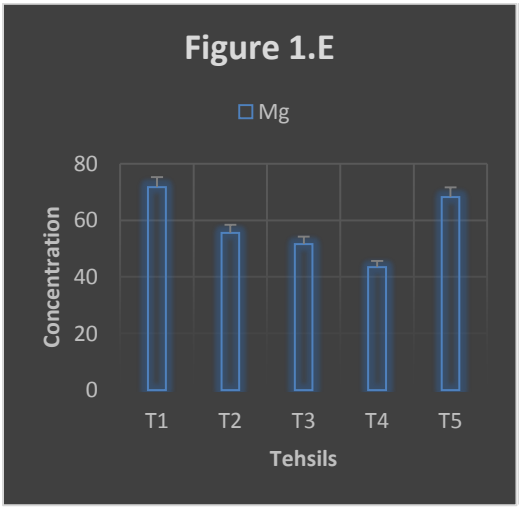
I.B Comparison of means regarding Cr content



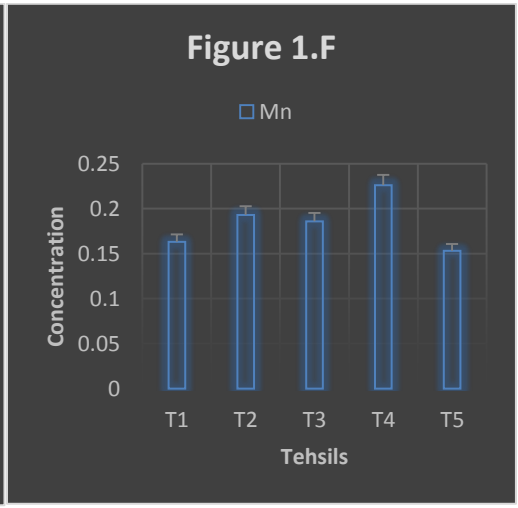
I. C Comparison of means regarding Cu content



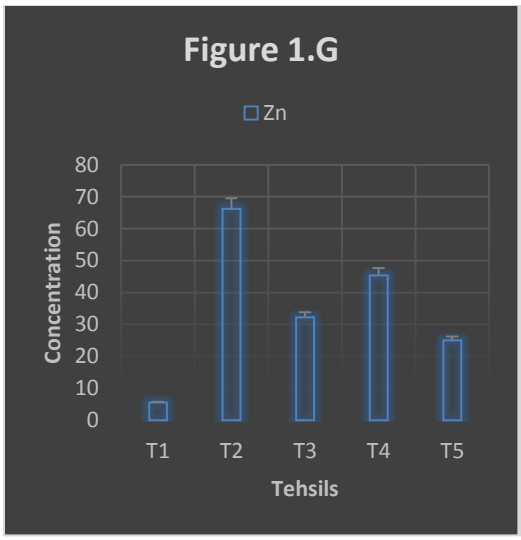
I. D Comparison of means regarding Pb content



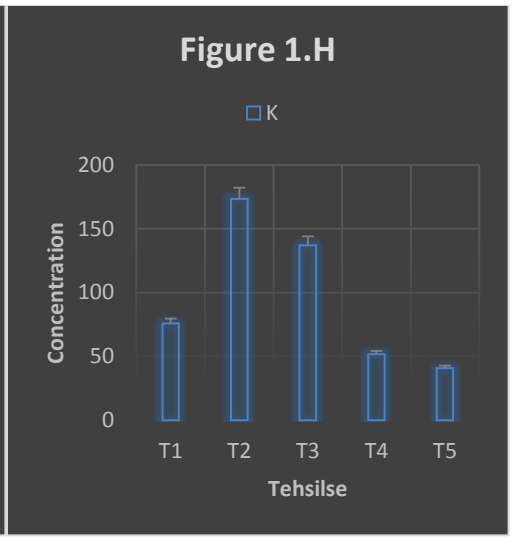
I.E Comparison of means regarding Mg content



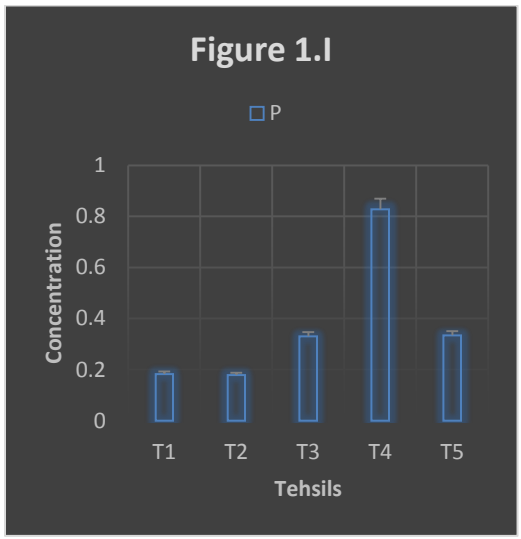
I.F Comparison of means regarding Mn content



I.G Comparison of means regarding Zn content



I.H Comparison of means regarding K content



I.I Comparison of means regarding P content

Figure-1: Comparison of means regarding elemental profile of *C. sinensis* at different tehsils of District Sargodha

Table 2: Comparison of highest elemental profile of *C. sinensis* at different tehsils of District Sargodha.

Tehsils	T1	T2E	T3	T4	T5
Co (mg/Kg)			✓		
Cr (mg/Kg)	✓				
Cu (mg/Kg)		✓			
Pb (mg/Kg)	✓				
Mg (mg/Kg)	✓				
Mn (mg/Kg)				✓	
Zn (mg/Kg)		✓			
K (mg/Kg)		✓			
P (mg/Kg)				✓	
Total	**3**	**3**	**1**	**2**	**0**

DISCUSSION

Cobalt has importance in our body as it is a part of vitamin B12, helpful in curing anemia, increase RBCs formation, also good for our nervous system, for our mental health, A deficiency lead to anemia, mental disturbance, nerve disorders, vitamin B12 deficiency, also lead to abnormal cell formation (Soetan *et al*., 2010; Taylor *et al*., 1978).

Results regarding cobalt concentration were in collaboration with Salimpour *et al*., (2010) and Thomas *et al*., (1974). Cobalt concentration in different samples vary in range from 0.01 to 0.15 mg/Kg in different vegetables. Its level varies between 0.015 and 0.046 mg/Kg. In onion, pumpkin vary from 0.015-0.016mg/Kg, 0.041-0.050mg/Kg, respectively. Variation in Co concentration may be due to nutritional composition of soil.

Chromium is necessary for carbohydrates and fat metabolism, important for proper functioning of brain and for other body processes. Also, supports glucose metabolism and insulin action. Its deficiency may lead to diabetes (Mason *et al*., 2011).

Results regarding chromium concentration were in collaboration with Ugbe *et al*., (2014) and Thomas *et al*., (1974). The Cr content range vary from 0.015 to 0.23 mg/Kg in vegetables. Cr present in soil where citrus trees are present, soil ranged between 13.9±2.6 in site 1 up to 15.8±0.75 (Vila *et al*., 2015). Variation in Cr concentration may be due to soil composition which is different in all tehsils.

Copper is an important element functioning as catalyst in the body, also important for cell physiology, respiration, free radical scavenging, elastin cross-linking, oxidative defense system so needed for body pigmentation, maintain a healthy CNS, prevents anemia, also keeps immune system, vessels and bones healthy (Mason *et al*., 2011).

Results regarding copper concentration are in collaborate with the findings of Salimpour *et al*., (2010) and Dhiman *et al*., (2013). Cu content in all samples range from 0.002 and 0.07 mg/Kg in orange and cabbage. Another also has been noted in apple range from 1.47mg/Kg,0.25mg/Kg and 0.25mg/Kg in different samples. Another have been noted in watermelon, orange and banana 1.22-2.13mg/Kg; 1.27- 2.13mg/Kg and 2.51-0.95mg/Kg, respectively. Variation in Cu concentration in all tehsils may be due to soil composition which is different in all tehsils.

Lead is a heavy metal and have adverse effects on our lives. More exposure to this metal will lead to cancer, brain problems, mental retardation, behavioral disorders, reduce learning, education and intelligence, sterility, will lead to coma, nervousness and even death (WHO. 2015-16).

Results regarding lead concentration were in collaboration with findings of Mbong *et al*., (2014). Lead contents in urban orchards (16.1±0.1) was very close to Zn in the same soil, but in rural orchards the mean value for Pb is 10.8±0.2. The levels of Pb in pawpaw (0.072 mg/Kg), 0.21 mg/Kg in pumpkin plant varies with a range of 0.021 - 0.108 and 0.15 - 0.27, respectively. The level of lead varies for watermelon (0.30 mg/Kg); apple (0.19 and 0.76 mg/Kg); banana (0.02 mg/Kg); orange (0.15 mg/Kg) Salimpour *et al*., (2010). Variation in lead concentration in all tehsils may be due to spatial variation in all tehsils.

Magnesium plays important role in metabolism, as co-factor part of many enzymes. Important in glucose metabolism, important for proper muscle functions and immune system, keep bones strong and healthy, regulate glucose level in blood, help in ATP synthesis, also important for proper functioning of heart (Mason *et al*., 2011; Yu, 2011).

Results regarding magnesium concentration were in collaboration with findings of Dhiman *et al*., (2011) and Mbong *et al*., (2014). Magnesium level vary from 54.3±1.4 and 52.9±0.1 respectively. The variation in Mg concentration may be due to difference in mineral concentration in the soil of all tehsils.

Manganese is a mineral which is helpful for body in formation of sex hormones, blood clotting factors, connective tissues, blood sugar regulation, calcium absorption, also component of different enzymes (Norvell, 1988). Also, play important role in delay of aging, improve health conditions including heart diseases and cancer (Kazi *et al*., 2008; Zota *et al*., 2009).

Results regarding manganese concentration are in collaboration with the finding of (Aref *et al*., 2012). Mn level in leaf of maize at different stages vary from 15 mg/Kg, 16 to 19 mg/Kg, 20 to 150 mg/Kg, 151 to 200 mg/Kg and 200 mg/Kg. Variation in Mn concentration may be due to difference in mineral composition of soil in all tehsils.

Zn is also very important metal that improve body defense system, also play important in cell division, cell growth, Hypogonadism, Poor appetite, trouble with the sense of smell and taste, Slow growth, Skin sores, , problem in dark, Injuries, cuts take more period of time to recover (heal). These signs of symptoms go away within a small period of time after intake of zinc, enrich food or supplements. (Mason *et al*., 2011; Anonymous, 2001).

Results regarding zinc concentration were in collaboration with (Sabukola *et al*., 2010; Mbong *et al*., 2014). Their findings indicate the concentration of zinc 16.4±0.1 and 24.4±0.2 in the rural and urban orchards. Zn concentration in basil and plumed was noted as 0.03 and 0.13 mg/Kg respectively. Their studies also revealed that level of Zn in apple varies from 2.02mg/Kg to 0.16 and 2.05 mg/Kg. Some others scientists showed zinc level

varies from 5.35 mg/kg to 1.50 for watermelon, orange and banana. However, in indian basil, zinc level varies from 0.011mg/Kg to 0.014mg/Kg (Dhiman *et al*., 2013). Variation in Zn content in fruits of *Citrus sinensis* may be due to difference in mineral composition of soil of all tehsils.

Potassium is also an important mineral for maintenance of many processes in our body (proper functioning of cells, tissues and organs). Acting as an electrolyte in the body (He *et al*., 2008), important for proper functioning of heart (regulate heart beat), also helpful in food digestion and muscle contraction (Aggett *et al*., 2012; Hermansen, 2000).

Results regarding potassium concentration were in collaboration with Razi *et al*., (2011) and Markus *et al*., (2003). Potassium concentration in banana pulp observed range from 4336–5475ppm. The central part contained the maximum mean concentrations of the analyzed mineral **(**Ukana *et al*., 2012). Potassium concentration in Star Apple Pulp was noted 5.96 mg/Kg. The changes in Potassium of kinnow are due to different fertility levels of soil (Ukana *et al*., 2012). The variation in the potassium concentration may be due difference in soil composition in all tehsils.

Phosphates are also essential for our body as part of DNA, RNA, proteins. So, used in maintenance and repair of cells and tissues of the body, with calcium also provides structure and strength as part of teeth and bones, also used for nerve signaling, regulation of heart beat, also required for pH regulation and for many biochemical processes in the body such as ATP synthesis (Mason *et al*., 2011).

Results regarding phosphorus concentration were in collaboration with findings of (Razi *et al*., 2011). Phosphorus were also noted in some fruits of citrus in between 1.1 and 18.6 mg/100g. Normal levels of phosphorus in orange was observed as 12mg/100g, 8mg/100g in grapefruit and 16.2mg/100g in lemon (Orwa *et al*., 2009). There was significant change is noted in cultivars by phosphorus applications. Plant will have increased its number flowers, hight, fruit ratio, fruit size, leaves. Plants growing on phosphorus fertilized soils were noted to be taller as compared to plants in unfertilized soils (Brenda *et al*., 2014). Variation in P concentration in fruit of *C. sinensis* may be due to difference in mineral composition of soil in all tehsils.

Conclusion: All tehsils have good source of minerals but *C. sinensis* of tehsil Silanwali and Sahiwaal contains the maximum elemental profile. Fluctuation in elemental profile of *C. sinensis* present in all tehsils due to environmental factors (soil composition, water, temperature and light) or may be due to spatial variation.

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