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Energy Dispersive X-Ray Fluorescence Elemental Analysis of Roasted and Non- Roasted Ethiopian Coffee Specialty

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Abstract: *The aim of the present Investigation was to study the elemental concentration of coffee beans specialty in Ethiopia using energy dispersive x-ray florescence (EDXRF). It was found that the concentration of four major elements (P, K, Ca, S) and eight minor elements (Mn, Fe, Cu, Zn, Se, Sr, Rb, Br) from roasted and non-roasted coffee bean specialty. These samples was carried out at trace element laboratory UGC-DAE Consortium for Scientific Research, Kolkata Centre by using a Xenemetrix (erstwhile Jordan Valley) EX 3600 EDXRF spectrometer which consists of an X-ray tube with a Rh anode as the source of x-ray with a 50V, 1mA power supply, Si (Li) detector with a resolution of 143 ev at 5.9 kev and 10 sample pellets analyzing at a time. The quantitative analysis is carried out by the in- built software nEXT. The system detection calibration and accuracy check was performed through different countries reported values and analysis of certified reference materials NIST (SRM 1515) Apple leaves. The order of elements concentration from highest to lowest was K > Ca > P > S > Fe > Rb, > Mn > Cu > Zn, Sr > Br > Se for roasted and K > Ca > S > P > Fe > Rb, Mn > Cu > Zn, Sr > Br >Se for non-roasted. In addition to this researchers discussed the elemental concentration of both roasted and non- roasted coffee beans and their biological effects on human physiology.*

Keywords*: Roasted and Non-roasted, Coffee specialty, EDXRF, Elemental Analysis, Addis Ababa*.

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I. Introduction

Coffee is the fruit and dried seed of the coffee plant regardless of whether it has been toasted or ground of the plant of the genus Coffea, generally of the cultivated species, and the products of these in their different stages of the process and use intended for human consumption. It is one of the most consumed infusion drinks in the world and contains a large variety of chemical compounds responsible for their sensory qualities and their effects on the body [1]. Coffee is grown as two species: Cofea Arabica and Cofea Canephor. They are commonly known as Arabica and Robusta. These two major species are known in commerce. Some authors suggest that Arabica coffees originated in the mountain forests of Ethiopia. [2]

Coffee is one of the most an important trade commodity in the Ethiopian economy as it contributes subsistence earnings of about 25% of the population, 30% of government direct revenue, and over 60% of the national foreign exchange earnings [3].The part of the coffee which is important for household consumption and commercial purposes is the bean, which naturally contains proteins, carbohydrates, vitamins and mineral substances [4]. Its active substance is the alkaloid caffeine. Effects of coffee on human health are still under strong debate. Some authors suggest that drinking two to four cups of coffee per day benefit health, reducing the risk of colon cancer, gallstones, liver cirrhosis and Parkinson's disease, lower risk of diabetes type 2, decreased prevalence of some types of cancer [5, 6]. However, the chemical content of the coffee varies with coffee types and environment in which they are cultivated and also in raw and roasted coffee beans of the same coffee type collected from the same environment [4].

Due to the health benefits and economical relevance of coffee extensive research has been published, in particular regarding its elemental composition, of metals in green (raw) and roasted coffee varieties in different parts of the world [3] using many analytical techniques Several studies have been carried out on determinations. For instance, Vietnam Robusta Coffee was roasted at different roasting degree and roasting temperature and 9 element concentrations (K, Mg, Ca, Na, Fe, Cu, Mn, Zn and Pb) of roasted coffee were analyzed by Flame atomic absorption method (FAAS) in this study [7]. Thirty-seven coffee samples were characterized on the basis of metal concentrations. Sixteen elements including toxic and essential elements were determined by inductively coupled plasma-mass spectrometry [8]. Ca, Mg, Na, K, Fe, Mn, Zn, Cu, Ni, Co, Cr, Pb and Cd from different types of coffee; Jacobs-Aroma, Jacobes-Kronung, Doncafe-elite, Fort-Strong coffee and Nova Brasilia using

flame atomic absorption spectrometry (FASS). The experimental show that macro elements are represented 99.96% from total mass of minerals, the values decreased in the order: k > Ca > Mg >Na in all coffee assortments the rest 0.04% Microelements this elements values decreased in the order: Fe > Mn > Cu > Zn > Ni > Co > Pb > Cd, in all types of coffee. [9]

When we come to Ethiopia very few research had been carried out such as determination of concentration Ca, Cd, Co, Cu, Fe, K, Mg, Mn, Ni, Pb and Zn in raw and roasted indigenous coffee varieties in Ethiopia. The results indicated that higher concentrations of these metals in roasted coffee than in the corresponding raw varieties [10]. The other reports are concentrations of nine essential metals (K, Mg, Ca, Na, Mn, Fe, Cu, Zn, Co) and two nonessential (Pb, Cd) metals were determined in three brands of commercially available roasted Ethiopian coffee powders (Abyssinia, Alem and Pride) obtained from local markets and their infusions using flame atomic absorption spectrometry (FAAS) [3]. However, there are no literature reports on quality of Ethiopian coffee Arabica specialty (Jimma, Nekemte, Illubabor, Limu, Tepi, Bebeka, Yirgachefe, Sidamo, and Harar) using the determination of concentration of the elements which is found in the coffee Arabica by the method of Energy Dispersive X-ray Fluorescence (EDXRF).

II. Materials And Methods

1.1. Sampling and preparation

The coffee bean samples were purchased from the local markets. Coffee bean of different local coffee specialty packed in sizes of up to 1 kg is available in the local markets. The analysis was conducted on the eight types of commercially available in different parts of Ethiopia especially Eastern, Southern and South West and most commonly used Ethiopian coffee beans (Harar, Sidamo, Yirgachefe, Limu, Tepi, Bebeka, Welega and Illubabor coffee bean). Eight samples of each brand were collected from their specific sampling sites.

1. **Chiro (Harar coffee)** is a town and separate woreda (district) in eastern Ethiopia. Located in the Amhar Mountains, it has a latitude and longitude of 9°05′N 40°52′E and an altitude of 1826 meters above sea level. It is the administrative center of the West Hararghe Zone 318 km from Addis Abeba.[11]
2. **Tepi (Tepi coffee)** is a town in southern Ethiopia. Located in the Sheka Zone of the Southern Nations, Nationalities, and People's Region (SNNPR), this town has a latitude and longitude of 7°12′N 35°27′E with a mean elevation of 1,097 meters above sea level. Distance between Addis Ababa and Tepi Ethiopia is 576.5 kms or 358.2 miles [12]
3. **Aleta Wondo(Sidamo coffee)** is in the SNNP Region, Sidama Zone, Aleta Wondo Woreda. 300 miles (338km) south of Addis Ababa There are three distinct agro-ecological zones; 12 % of the Woreda is classified as Dega (highlands), 71 % as Woinadega (midlands), and 17 % dry Kolla (lowlands) situated about 7000 feet above sea level. . Located in a fertile and forested area near Lake Abaya, not far from the sources of the Ganale Dorya and Dawa Rivers this town has a longitude and latitude of 6°36′N 38°25′E with an elevation of 2037 meters above sea level.[13]
4. **Yirgachefe (Yirgachefe coffee**) is a town in central southern Ethiopia in Yirgachefe District. Located in the Gedeo Zone of the Southern Nations, Nationalities and Peoples' Region, this town has an elevation between 1,880 and 1,919 meters (6,168 and 6,296 ft) above sea level. It is the administrative center of Yirgachefe woreda (or district), an important coffee growing area .latitude and longitude 6° 10′ 0″ N, 38° 12′ 0″ E distance from Addis Abeba 409.2 km. [14]
5. **Gimbi (Wellega coffee)** is a town in western Ethiopia. Located in the West Welega Zone of the Oromia Region, it has a latitude and longitude of 9°10′N 35°50′E with an elevation between 1845 and 1930 meters above sea level. It is the administrative center of Gimbi woreda. distance from Addis Ababa to Gimbi 430.7 km. [15]
6. **Metu (Illubabor coffee**) is a market town and separate woreda in south-western Ethiopia. Located in the Illubabor Zone of the Oromia Region (or kilil) along the Sor River, this town has a latitude and longitude of 8°18′N 35°35′E and an altitude of 1605 meters. Metu has been an important market of the coffee trade, with several foreigners residing in the town as early as the 1930s to buy the crops from local farmers. distance from Addis Ababa to Metu 541.5 km[16]
7. **Mizan Tefere** (Bebeka coffee) is a town in southern Ethiopia. The largest town, and the administrative center, of the Bench Maji Zone of the Southern Nations, Nationalities, and Peoples Region (SNNPR), and located about 160 kilometers southwest of Jimma, Mizan Tefere has a latitude and longitude of 7°0′N 35°35′E and an elevation of 1451 meters. distance from Addis Ababa to Mizan Teferi 564.8 km[17]
8. **Limu Kosa(Limu coffee)** is one of the woredas in the Oromia Region of Ethiopia Part of the Jimma Zone, The altitude of this woreda ranges from 1200 to 3020 meters above sea level. Latitude: 8° 09' 60.00" N Longitude: 37° 09' 60.00" E 426 kilometers south west of Addis Ababa.[18]

First of all In a laboratory the collected coffee bean were cleaned from stones and sediments by using stainless steel forceps and next coffee beans can be washed with tap water and followed by de-ionized water to remove soil particles and dust. Later on each sample separated in to two and half of them roasted with the home roaster with a temperatures 180-200 °C for 8-12 min the other half (i.e. non- roasted) can be dried in ovens at temperatures within 60–103 °C. Finally both roasted and non-roasted coffee beans samples were powdered; homogenized using a mortar and pestle and 200mg of each powdered sample weighed and compressed using a 150 ton hydraulic press and made into pellets of 13mm diameter and 1- 2mm thickness. Triplicates of each sample were done.

1.2. **Instrumentation and Operational Parameters**

1.2.1. **Energy Dispersive X-ray Fluorescence**

EDXRF spectrometry is well recognized as a tool for the qualitative and quantitative determination of major and minor elements in a wide range of sample types. A typical spectrometer uses an X-ray tube to bombard the sample with X-rays of sufficient energy to knock out the inner shell electrons of the sample atoms. Electrons from outer shells then drop down into the vacant inner-shell positions, and characteristic X-rays are given off. This is known as X-ray fluorescence (XRF). In the energy-dispersive technique (EDXRF), the energies of the X-rays emitted by the sample are measured using a Si-semiconductor detector and are processed by a pulse height analyzer. Computer analysis of this data yields an energy spectrum which defines the elemental composition of the sample. Essentially, the energy of the peak gives the element identification, and the number of X-rays counted in the peak gives the amount of the element present in the sample.

1.2.2. Operational Parameters

These elemental analysis of roasted and non-roasted coffee bean samples was carried out at trace element laboratory UGC-DAE Consortium for Scientific Research, Kolkata Centre by using a Xenemetrix (erstwhile Jordan Valley) EX 3600 EDXRF spectrometer which consists of an X-ray tube with a Rh anode as the source of x-ray with a 50V, 1mA power supply, Si (Li) detector with a resolution of 143 ev at 5.9 kev and 10 sample pellets analyzing at a time. The quantitative analysis is carried out by the in- built software nEXT.

The working operational parameter of EX 3600 EDXRF spectrometer

Parameters	e_1	e_2	e_3
Voltage (kv)	6	14	23
Current (mA)	200	900	200
Time (sec)	200	300	600
Atmosphere	vacuum	vacuum	vacuum
Energy range (kev)	10	10	40
Through put	low	low	low
Filter	none	Titanium	Iron

Where e_1 , e_2 , e_3 is spectrum 1, 2, 3

III. Results And Discussion

Minerals are inorganic substances, vital to the human body, present in all body tissues and fluids and their presence is necessary for the normal growth, maintains of the body and certain physicochemical processes which are essential to life. They help form bones and teeth, aid in normal muscle and nerve activity, act as catalysts in many enzyme systems, help control water levels in the body and are components of such compounds in the body as hemoglobin and the hormone thyroxin. The Minerals we get from our different diets has chemical constituents used by the body in many ways. However, our body does not require large stores of minerals. We can get the proper amounts of most minerals from the foods we eat. This makes supplements often unnecessary and, if we get too much of any one mineral, supplements can be dangerous. [19] [20][21]. When cooking or roasted food (coffee beans), the minerals are not changed or destroyed by mixing with other substances, exposure to air, or extreme heat. From the time a mineral is ingested into the body, to the time it is excreted, it is never changed into anything else. However, some minerals in boiled foods may be lost because they attach to water molecules. [21] Green and roasted coffee beans have the same elemental composition, indicating that the roasting process did not eliminate any of the elements [46] in this research work also similar as it.

Depends on the amount of essential mineral needed by the body mineral can be broadly classified in to two categories major (macro) and minor (micro) minerals. Major minerals are needed in amounts greater than 100 mg/day and include Calcium (Ca), Phosphorous (P), Potassium (K), Sulfur (S), Sodium (Na), Chloride (Cl), Magnesium (Mg). Minor minerals are trace elements needed in amounts of less than 100 mg/day and include Zinc(Zn), Iron (Fe), Manganese (Mn), Copper (Cu), Silicon(Si), Molybdenum (Mo), Chromium (Cr), Selenium

(Se), Iodine (I). These all minerals vital to the human body are important because they serve necessary functions. [20][22]

In this study total 12 elements were determined four major elements like Calcium (Ca), Phosphorous (P), Potassium (K), Sulfur (S) and eight minor elements like Zinc(Zn), Iron (Fe), Manganese (Mn), Copper (Cu), Selenium (Se), (Br), (Rb), (Sr) had been analyzed by Energy Dispersive X-ray Fluorescence (EDXRF) in green coffee beans and roasted coffee beans. It is noticed that the order of elements concentration from highest to lowest are K > Ca > P > S > Fe > Rb, > Mn > Cu > Zn, Sr > Br > Se for roasted and K > Ca > S > P > Fe > Rb, Mn > Cu > Zn, Sr > Br >Se for non-roasted. The table below shows quantitative analysis of 12 different elements of average elemental concentration (n = 3) with ± standard deviation in ppm

Coffee brand	Roasted coffee bean specialty					
	P	S	K	Ca	Mn	Fe
Tepi	1425.01 ± 154.4	1258.1± 70.8	16286.9 ± 1105.8	2479.3 ± 165.2	24.36 ± 2.16	125.2 ± 5.1
Bebeka	1492.9 ± 76.7	1292.4 ± 932.6	15738.8 ± 321.04	2348.8 ± 134.3	27.4 ± 2.9	4149.7 ± 118.2
Limu	1471.7 ± 76.6	1213.6 ± 40.1	15783.4 ± 539.9	2359.4 ± 88.4	24.98 ± 1.7	221.3 ± 12.4
Yirgachefe	1571.6 ± 36.1	1202.8 ± 26.4	16505.35 ± 411.2	2450.5 ± 132.3	30.5 ± 2.7	408.97 ± 14.82
Sidama	1686.3 ± 43.9	1238.8± 2.2	17862.01 ± 113.8	2648.7 ± 44.7	35.6 ± 1.0	225.2 ± 7.9
Harare	1226.4 ± 34.71	1135.5 ± 51.9	16023.8 ± 834.9	2360.4 ± 159.4	25.8 ± 1.89	239.17 ± 12.07
Gimbi	1638.4 ± 53.75	1251.22± 46.04	16806.9 ± 51.97	2510.03 ± 58.35	25.65 ± 1.0	152.0 ± 21.86
Standards NIST(1515)	1590	1800	16100	15260	54	83

Coffee brand	Roasted coffee bean specialty					
	Cu	Zn	Se	Br	Rb	Sr
Tepi	13.55 ± 1.5	4.6 ± 2.78	2.8 ± 4.26	1.58 ± 1.56	25.18 ± 0.87	9.03 ± 1.5
Bebeka	13.24 ± 1.46	7.2 ± 1.3	0.14 ± 0.03	1.83 ± 0.12	30.33 ± 1.46	4.22 ± 0.51
Limu	12.89 ± 0.81	5.88 ± 0.84	0.66 ± 0.93	1.0 ± 1.05	57.48 ± 3.43	4.61 ± 4.52
Yirgachefee	15.34 ± 0.47	6.47 ± 0.85	0.15 ± 0.04	2.49 ± 1.01	20.4 ± 3.11	3.78 ± 3.52
Sidama	13.97 ± 0.38	5.62 ± 0.34	0.91 ± 0.74	3.24 ± 2.39	24.53 ± 1.64	5.56 ± 1.8
Harare	14.45 ± 1.14	2.87 ± 0.6	0.23 ± 0.15	3.07 ± 0.5	28.86 ± 0.96	4.09 ± 3.43
Gimbi	16.66 ± 1.06	3.79 ± 1.38	0.29 ± 0.22	0.64 ± 1.0	46.84 ± 2.49	5.45 ± 1.92
Standards NIST(1515)	5.64	12.50	0.05	1.80	10.20	25.00

Table -1; Average elemental concentration with (±) standard deviation in ppm of Roasted Coffee Bean

Coffee brand	Non - Roasted coffee bean specialty					
	P	S	K	Ca	Mn	Fe
Tepi	921.18 ± 350.86	1209.41 ± 115.09	13531.62 ± 1437.59	2048.27 ± 249.75	25.25 ± 0.74	216.19 ± 4.11
Bebeka	1149.83 ± 61.39	1320.83 ± 58.93	14121.43 ± 551.99	2304.04 ± 85.21	44.23 ± 2.64	291.68 ± 7.518
Limu	1209.06 ± 60.14	1234.09 ± 48.06	13792.33 ± 384.04	2198.19 ± 76.52	22.96 ± 1.81	139.85 ± 0.88

Yirgachefe	995.27 ± 231.1	1095.95 ± 140.96	12503.92± 1553.21	1945.67 ± 282.23	23.51 ± 3.08	155.49 ± 17.31
Sidama	976.31 ± 291.22	1150.65± 139.5	14071.6 ± 1765.53	2184.0 ± 199.3	39.3 ± 2.46	296 ± 22.75
Harare	1125.2 ± 30.3	1214.2± 16.08	14700.42 ± 248.51	2265.26 ± 60.68	28.85 ± 1.09	209.35 ± 15.17
Gimbi	1490.09 ± 16.29	1249.07± 26.02	15419.99 ± 200.36	2309.41 ± 38.3	27.84 ± 0.57	181.86 ± 3.92
Metu	1272.55 ± 57.9	1247.3± 52.44	14015.78 ± 586.11	2190.98 ± 101.21	28.42 ± 1.47	185.34 ± 5.02
Standards NIST(1515)	1590	1800	16100	15260	54	83

Coffee brand	Non-Roasted coffee bean specialty					
	Cu	Zn	Se	Br	Rb	Sr
Tepi	12.67 ± 1.12	5.10 ± 1.18	0.29 ± 0.30	2.64 ± 0.82	18.87 ± 0.38	8.13 ± 0.67
Bebeka	14.72 ± 0.95	6.28 ± 0.97	0.15 ± 0.05	1.47 ± 0.69	28.91 ± 1.45	5.58 ± 0.76
Limu	13.92 ± 1.02	4.98 ± 1.14	0.16 ± 0.06	2.09 ± 0.27	49.27 ± 0.77	7.78 ± 4.09
Yirgachefe	14.32 ± 2.47	6.75 ± 0.78	0.35 ± 0.28	1.49 ± 0.38	24.79 ± 3.84	4.76 ± 0.66
Sidama	12.47 ± 0.56	5.72 ± 1.99	0.73 ± 1.02	2.03 ± 1.30	20.16 ± 2.23	6.13 ± 1.14
Harare	13.84 ± 1.67	8.36 ± 0.69	0.34 ± 0.19	2.15 ± 0.42	29.60 ± 0.82	5.13 ± 4.21
Gimbi	15.18 ± 1.55	5.09 ± 1.5	0.46 ± 0.57	0.88 ± 0.82	38.21 ± 2.03	3.17 ± 2.48
Metu	15.35 ± 0.24	5.7 ± 0.74	0.34 ± 0.38	2.13 ± 0.66	44.88 ± 2.63	6.62 ± 2.09
Standards NIST(1515)	5.64	12.50	0.05	1.80	10.20	25.00

Table -2; Average elemental concentration with (±) standard deviation in ppm of Non-Roasted Coffee Bean

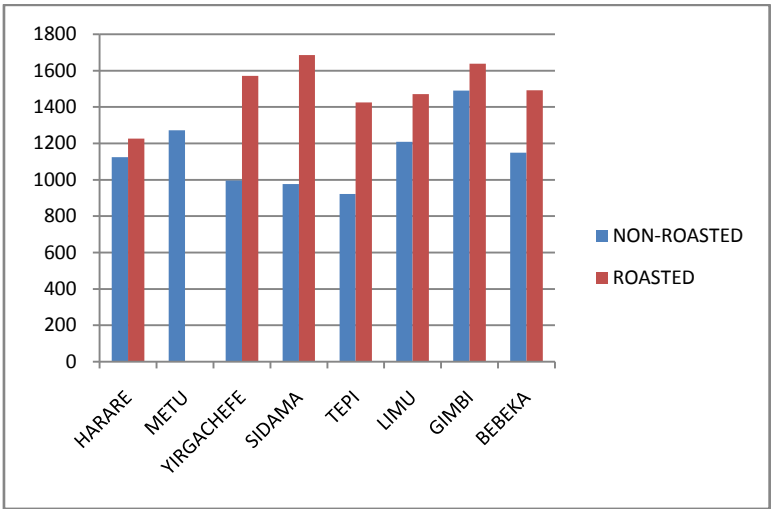

Figure 1. Phosphorous (P) concentration in ppm

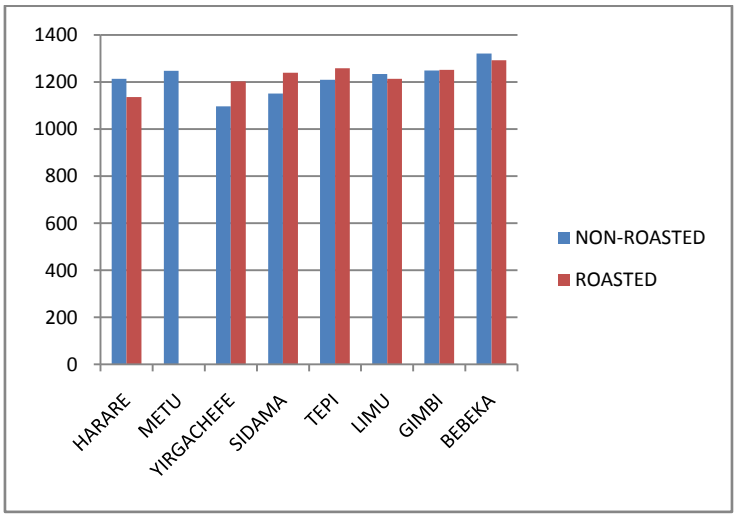

Figure 2. Sulfur(S) concentration in ppm

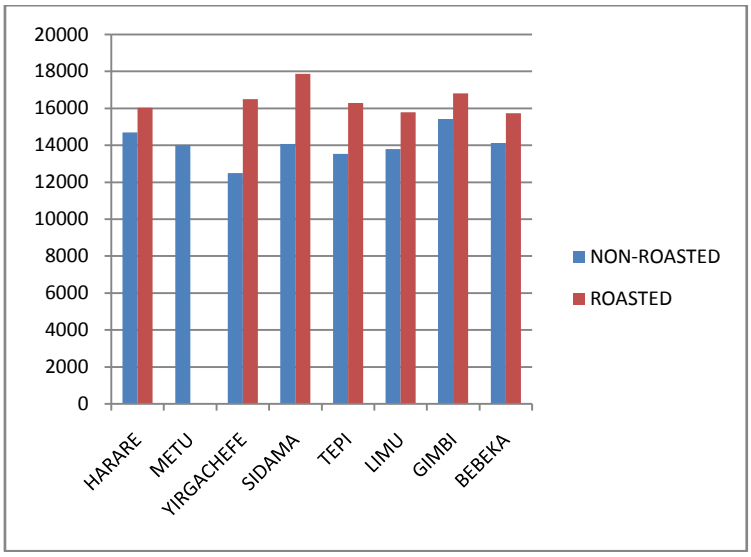

Figure 3. Potassium (K) concentration in ppm

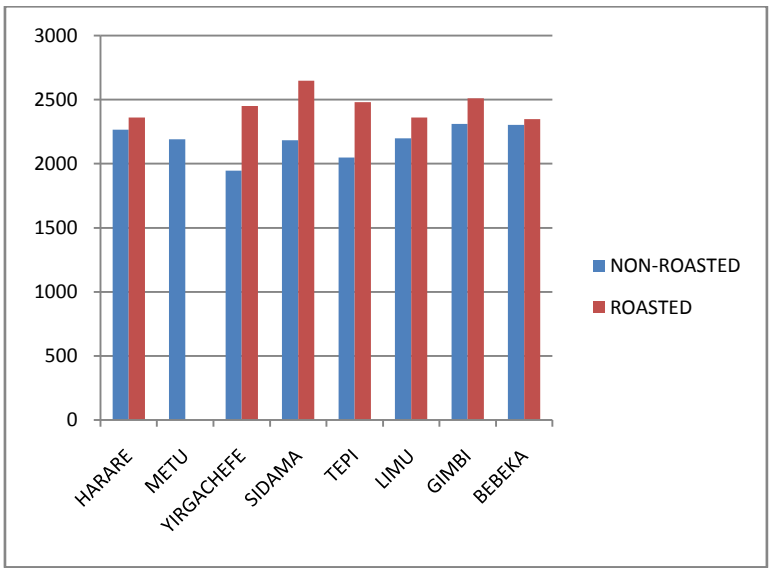

Figure 4. Calcium (Ca) concentration in ppm

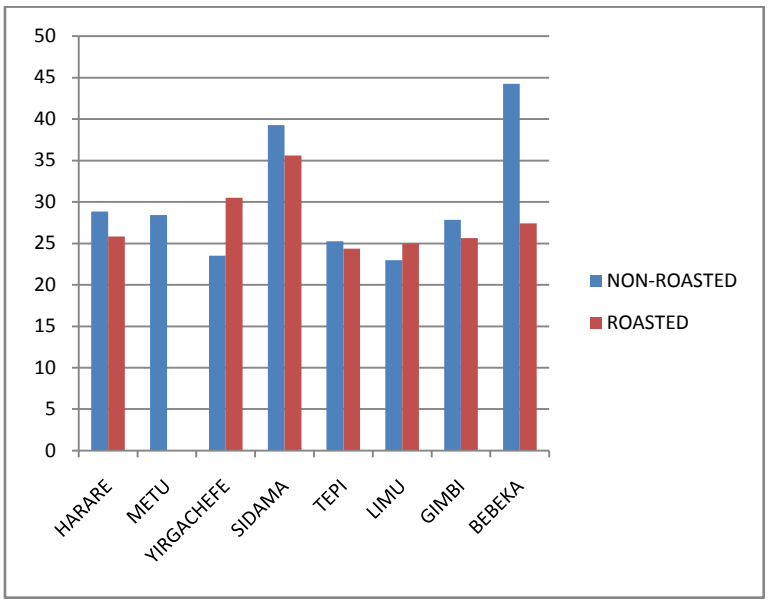

Figure 5. Manganese (Mn) concentration in ppm

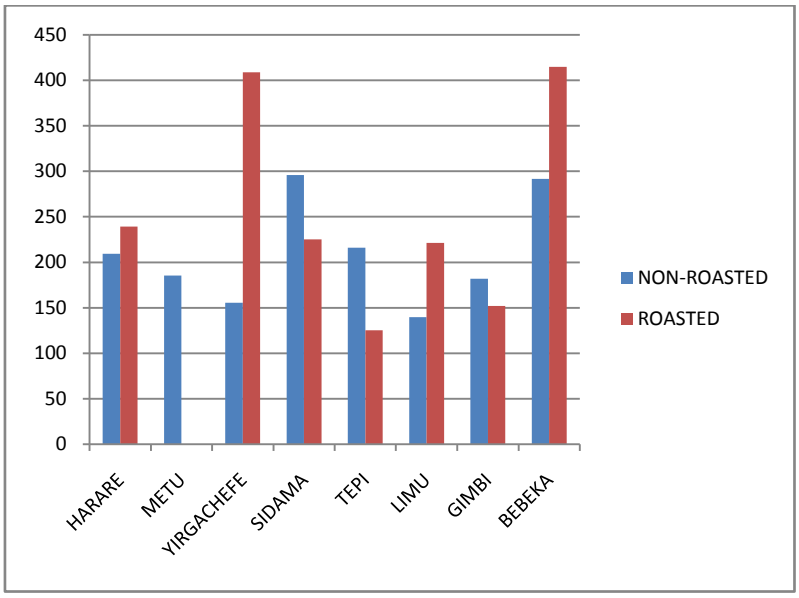

Figure 6. Iron (Fe) concentration in ppm

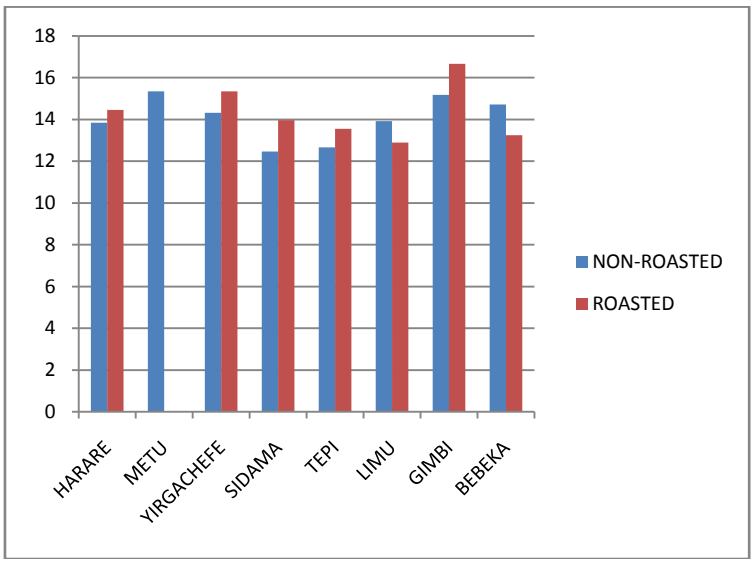

Figure 7. Copper (Cu) concentration in ppm

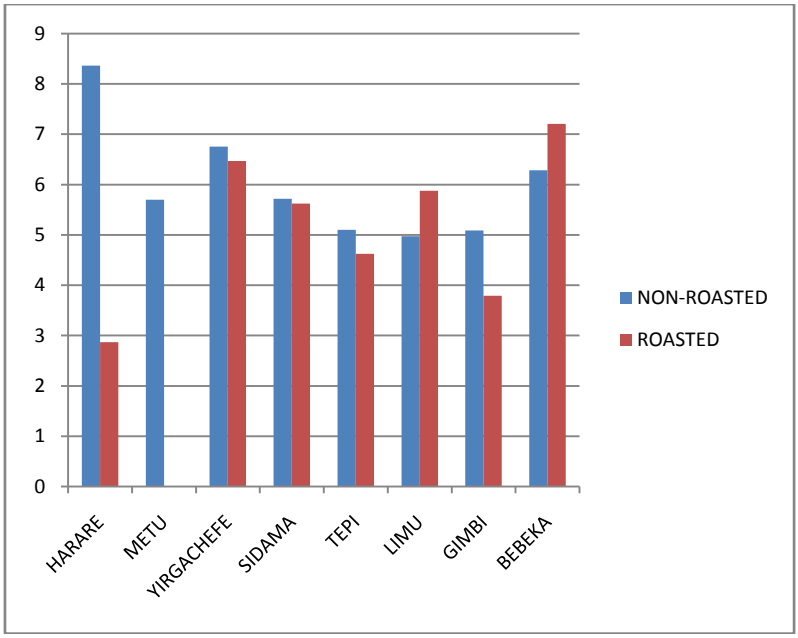

Figure 8. Zinc (Zn) concentration in ppm

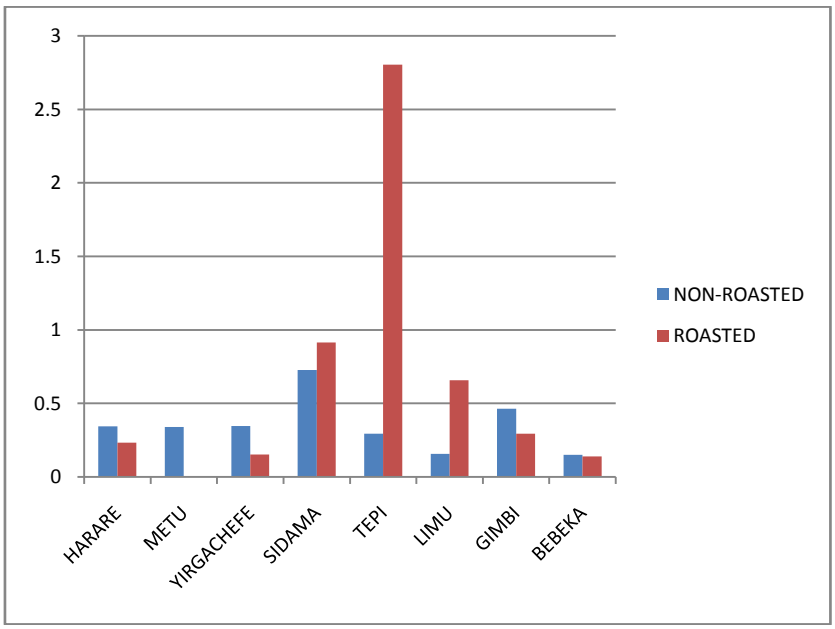

Figure 9. Selenium (Se) concentration in ppm

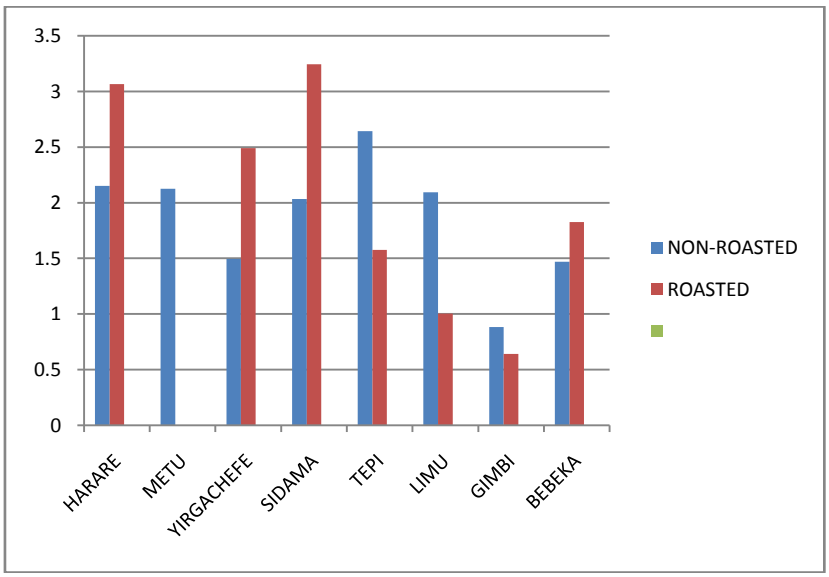

Figure 10. Bromine (Br) concentration in ppm

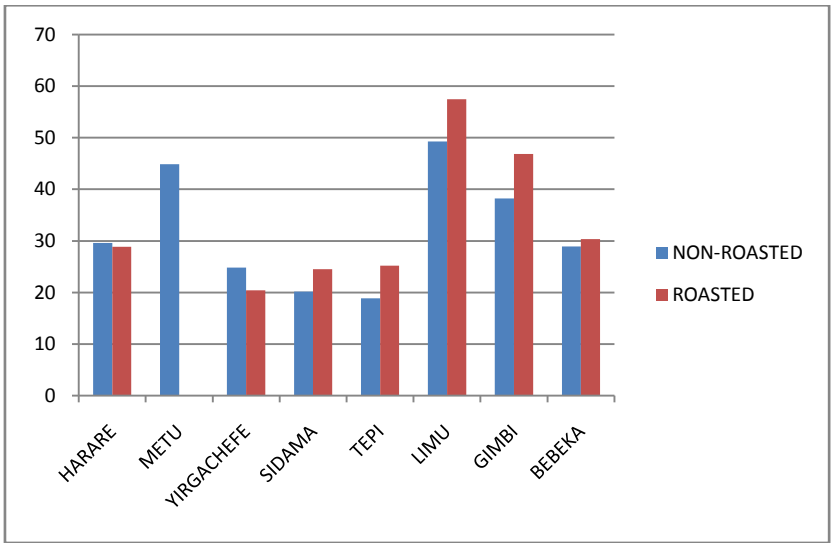

Figure 11. Rubidium (Rb) concentration in ppm

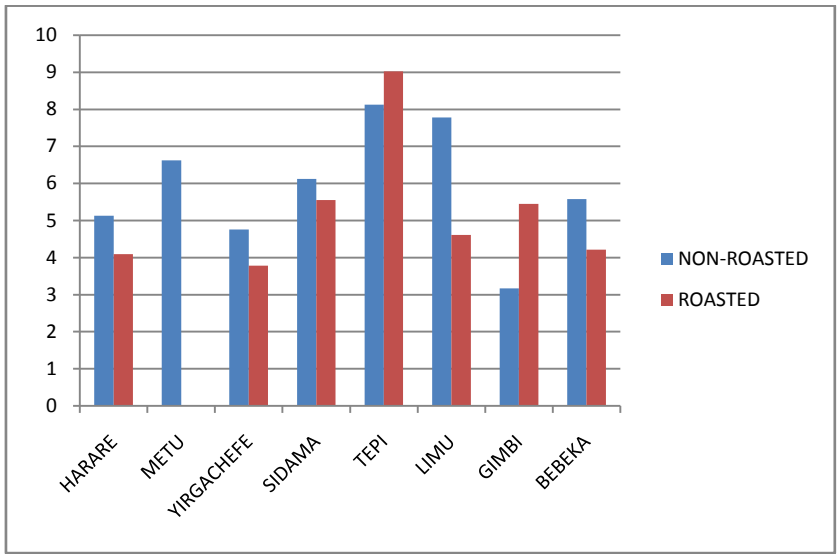

Figure 12. Strontium (Sr) concentration in ppm

Phosphorus (P) is the second most plentiful mineral in your body next to calcium. Your body needs phosphorus for many functions, such as filtering waste and repairing tissue and cells. In addition it is a vital part of the growth process, as well as the maintenance of bones and teeth. It works in association with calcium to create strong bones, which can withstand the normal wear and tear of human life. People get the amount of phosphorus mineral that they need to our body. The most important sources of phosphorus are Foods that are

rich in protein are excellent sources of phosphorus. These include: meat and poultry, fish, milk and other dairy products, eggs and nuts seeds and beans. Some non-protein food sources also contain phosphorus such as whole grains, potatoes, garlic, dried fruit, and carbonated drinks (phosphoric acid is used to produce the carbonation). After your body digests food, the phosphorus is absorbed into the blood. The blood then takes it to your bones to make them strong along with calcium. Extra phosphorus is filtered out of the body by healthy kidneys. [23][24]. If Phosphorus levels that are too high or too low can cause medical complications, such as heart disease, joint pain, or fatigue. Phosphorus can be found in the human body as a form of phosphates. Phosphate is a dietary requirement, the recommended intake is 800 mg/day, a normal diet provides between 1000 and 2000 mg/day, depending on the extent to which phosphate rich foods are consumed. [25]

From the table 1 and 2 the concentration of phosphorus in roasted and non- roasted coffee beans specialty the result shows that the roasted coffee beans higher phosphorous concentration than non-roasted. In this study phosphorus is the 3rd major mineral in roasted but the 4^{th} in non-roasted. The maximum amounts of phosphorus (1686.26 ± 43.86244) was found from Sidama coffee specialty and the minimum was found Harare (1226.433 ± 34.70926) in roasted coffee beans. On the non-roasted Gimbi (1490.093 ± 16.29002) has highest and Tepi (921.1833 ± 350.8612) has the lowest concentration. When we Comparison of Observed phosphorous concentration with standards and Reported Values for row and roasted coffee beans, respectively, the phosphorous contents observed are more or less comparable with the standards NIST (1590) specially Yirgachefe coffee beans specialty **(**1571.61 ± 36.13521**).** However, relatively lower concentration of phosphorus observed in this study in comparison to different countries reported values (1710 ± 140 – 2110 ± 160)[26].

The order roasted and non-roasted coffee specialty concentration from highest to lowest are

Roasted: Sidama (1686.26 ± 43.86244) > Gimbi (1638.403 ± 53.75799) > Yirgachefe **(**1571.61 ± 36.13521**)** > Bebeka (1492.873 ± 76.68784) > Limu (1471.743 ± 76.6493) > Tepi (1425.013 ±154.3752) > Harare (1226.433 ± 34.70926)

For Non-Roasted: Gimbi (1490.093 ± 16.29002) > Metu (1272.547 ± 57.93175) > Limu (1209.063 ± 60.13699) > Bebeka (1149.827 ± 61.39093) > Harare (1125.203 ± 30.30493) > Yirgachefe (995.2667 ± 231.0785) > Sidama (976.31 ± 291.2224) > Tepi (921.1833 ± 350.8612)

Sulfur(S) is an essential component of all living cells and critical to help us detoxify and regenerate new tissue. It is the seventh or eighth most abundant element in the human body by weight, about equal in abundance to potassium, and slightly greater than sodium and chlorine. . It is especially important for humans because it is part of the amino acid (the building block of protein) methionine, which is an absolute dietary requirement for us. The amino acid cytosine also contains sulfur. The average person takes in around 900 mg of sulfur per day, mainly in the form of protein. [27][28]. Sulfur is found in a large number of foods, and, as a consequence, it is assumed that almost any diet would meet the minimum daily requirements. Excellent sources are eggs, onions, garlic, and leafy dark green vegetables like kale and broccoli. Meats, nuts, and seafood also contain sulfur. [29]

From the table 1 and 2 the concentration of Sulfur in roasted and non- roasted coffee beans specialty the result shows that the roasted and non-roasted sulfur concentration more or less similar. In present investigation Sulfur is 4th major mineral in roasted but the 3^{rd} in non-roasted. The maximum amounts of Sulfur (1292.383 ± 932.5906) was found from Bebeka coffee specialty and the minimum was found Harare (1135.533 ± 51.91361) in roasted coffee beans. On the non-roasted Bebeka (1320.83 ± 58.92707) has highest and Yirgachefe (1095.947± 140.9638) has the lowest concentration. When we Comparison of Observed Sulfur concentration with standards and Reported Values for row and roasted coffee beans, respectively, relatively lower concentration of Sulfur in comparison to both standards NIST (1800) and different countries reported values (1420 ± 97 – 1640 ± 55)[26] .

The order roasted and non-roasted coffee specialty concentration from highest to lowest are

Roasted: Bebeka (1292.383 ± 932.5906) > Tepi (1258.123 ± 70.80098) > Gimbi **(**1251.217± 46.04205**)** > Sidama (1238.843± 2.211274) > Limu (1213.647± 40.09989) > yirgachefe (1202.853± 26.35896) > Harare (1135.533 ± 51.91361)

For non-roasted: Bebeka (1320.83 ± 58.92707) > Gimbi (1249.067± 26.02347) > Metu (1247.343 ± 52.44017) > Limu (1234.087± 48.05796) > Harare (1214.163± 16.08239) > Tepi (1209.41 ± 115.0927) > Sidama (1150.647± 139.4998) > Yirgachefe (1095.947± 140.9638)

Potassium (K) is one of the seven essential macro minerals that need to our body to work properly. It isn't produced naturally by the body, so it's important to consume the right balance of potassium-rich foods and beverages. Many people get all the potassium minerals they need from what they eat and drink. Potassium-rich sources include: root vegetables (like carrots, and potatoes), fruits (likes bananas, avocados grapes and like), leafy greens (such as spinach and collards) whole grains, beans and nuts, lean meats etc…There are so many reasons you need to make sure you consume an adequate amount of potassium-rich foods daily. Because Potassium supports blood pressure, cardiovascular health, bone strength, muscle contractions, normal water

balance, nerve impulses and digestion heart rhythm. Potassium deficiency and consuming too much potassium can be harmful to the people and the cause for hypokalemia and Hyperkalemia respectively. Therefore The World Health Organization (WHO) recommend an intake of 3,510 mg per day.[30][31]

From the figure 3 concentration of potassium of roasted and non-roasted coffee beans the experiment was showed the concentration of roasted coffee beans higher than non-roasted. In general in this study it is the 1st major mineral in roasted and in non-roasted. The maximum amounts of potassium (17862.01 ± 113.7653) was found from Sidama coffee specialty and the minimum was found Bebeka (15738.77 ± 321.0416) in roasted coffee beans. In non-roasted Gimbi (15419.99 ± 200.3618) has highest and Yirgachefe (12503.92 ± 1553.209) has the lowest concentration. When we Comparison of Observed potassium concentration with standards and Reported Values for row and roasted coffee beans, respectively, the potassium contents observed are more or less comparable with the standards NIST (16100) specially Harare coffee beans specialty **(**16023.77 ± 834.875**)** and other reported values(14520 ± 428, 14361 ± 478, 14583 ± 495)[3], (11750 - 15850)[32] **.** However, relatively lower concentration of potassium observed in this study in comparison to different countries reported values (17500 ± 1030 – 19600 ± 1400) [26], (19610 ± 343, 19471 ± 392), (18754 ± 462, 18563 ± 477) [33]. The order of roasted and non-roasted coffee specialty concentration from highest to lowest are

Roasted: Sidama (17862.01 ± 113.7653) > Gimbi (16806.94 ± 51.97366) > **Yirgacheffe (**16505.35 ± 411.1679**)** > Tepi (16286.92 ± 1105.829) > Harare (16023.77 ± 834.875) > Limu (15783.39 ± 539.9007) > Bebeka (15738.77 ± 321.0416)

Non-Roasted: Gimbi (15419.99 ± 200.3618) > Harare (14700.42 ± 248.5128) > Bebeka (14121.43 ± 551.9988) > Sidama (14071.62 ± 1765.526) > Metu (14015.78 ± 586.1147) > Limu (13792.33 ± 384.0423) > Tepi (13531.62 ± 1437.588) > Yirgachefe (12503.92 ± 1553.209

Calcium (Ca) is the fifth most abundant element in the human body and an essential element needed in large quantities. Calcium ions play a vital role in human health in order to building bones, helps our blood clot, health of the muscular, circulatory, digestive systems, nerves send messages and muscles contract etc…. About 99 percent of the calcium in our bodies is stored in our bones and teeth. Each day, we lose calcium through our skin, nails, hair, sweat, urine and feces, but our bodies cannot produce new calcium rather it is taken from our bones. There are many good source of calcium food and beverages which we eat and drink such as Dairy products (like Milk, Cheese and Yogurt), Vegetables (like Broccoli, Kale, and Chinese cabbage), and other foods contains calcium in smaller amounts Fortified cereals, juices, soy products, snacks, and breads. The recommended daily intake (RDI) of calcium is 1,000 mg per day for most adults and for women over 50 years and everyone over 70 get 1200mg per day, while children aged 4-18 years are advised to get 1,300mg.[34][35]. From the figure 4 concentration of calcium of roasted and non-roasted coffee beans the experiment was showed the concentration of roasted coffee beans higher than non-roasted. In this study Calcium is 2nd major mineral in both roasted and in non-roasted coffee beans. The maximum amounts of calcium (2648.683 ± 44.66317) was found from sidama coffee specialty and the minimum was found Bebeka (2348.797 ± 134.2805) in roasted coffee beans. On the non-roasted Gimbi (2309.41 ± 38.30384) has highest and Yirgachefe (1945.673 ±282.231) has the lowest concentration. When we Comparison of Observed calcium concentration with standards Values for row and roasted coffee beans, respectively, the calcium contents observed are very less comparable with the standards NIST (15260)**.** However, relatively higher concentration of Ca observed in this study in comparison to different countries reported values (934 ± 120 – 1234 ± 290)[26], (943 ± 29, 931 ± 17)(1009 ± 18, 976 ± 24)[33], 1259.44 [7], (940 ± 48, 1045 ± 77, 843 ± 70)[3] , (513 - 1620)[32]

The order of roasted and non-roasted coffee specialty concentration from highest to lowest are

Roasted: Sidama (2648.683 ± 44.66317) > Gimbi (2510.033 ± 58.35065) > **Tepi (**2479.35 ± 165.1651**)** > Yirgachefe (2450.533 ± 132.341) > Harare (2360.413 ± 159.4063) > Limu (2359.44 ± 88.42021) > Bebeka (2348.797 ± 134.2805).

Non-Roasted: Gimbi (2309.41 ± 38.30384) > Bebeka (2304.043 ± 85.21007) > Harare (2265.257 ± 60.67798) > Limu (2198.187 ± 76.52463) > Metu (2190.98 ± 101.2133) > Sidama (2184.003 ± 199.2744) > Tepi (2048.267 ± 249.75) > Yirgachefe (1945.673 ±282.231)

Manganese (Mn) is a naturally occurring mineral in our bodies in very small amounts (around 20mg). It is found mostly in bones, the liver, kidneys, and pancreas. Manganese helps the body form connective tissue, helping to create essential enzymes for building bones, blood clotting factors, and sex hormones. It also plays a role in fat and carbohydrate metabolism, calcium absorption, and blood sugar regulation. Manganese is also necessary for normal functioning of brain, nerve function and helps to fight free radicals. Supplements and dietary intake of manganese together should not exceed 10 milligrams per day because of the risk whether to much or low level manganese in our diet. However the symptoms of manganese deficiency include high blood, bone malformation, weakness, muscular contraction, high cholesterol, poor eyesight, hearing trouble, severe memory loss, shivers, and tremors. If too much manganese in the diet it could lead to high levels of manganese in the body tissues. Abnormal concentrations of manganese in the brain, especially in the basal ganglia, are associated with neurological disorders similar to Parkinson's disease. Early life manganese exposure at high

levels, or low levels, may impact neurodevelopment. Elevated manganese is also associated with poor cognitive performance in school children. There are some rich sources of manganese include whole grains, nuts, leafy vegetables, raspberries, pineapples, garlic, grapes, rice, peppermint, oats, nuts, watercress, watercress, mustard greens, strawberries, blackberries,tropical fruits, lettuce, spinach, molasses, cloves, turmeric , , bananas, cucumbers, kiwis, figs, almonds, and Foods high in phytic acid, such as beans, seeds, and soy products, or foods high in oxalic acid, such as cabbage, spinach, and sweet potatoes, may slightly inhibit manganese absorption. Although teas are rich sources of manganese, the tannins present in tea may moderately reduce the absorption of manganese and hazelnuts since they maximize the absorption of this important mineral. [36][37] From the figure 5 concentration of Manganese of roasted and non-roasted coffee beans the experiment was showed more or less similar. In general in this study Manganese is 2nd or 3rd minor mineral next to iron and/or rubidium in both roasted and non-roasted. The maximum amounts of Manganese (35.59667 ± 1.000117) was found from Sidama coffee specialty and the minimum was found Tepi (24.36 ± 2.160486) in roasted coffee beans. On the non-roasted Bebeka (44.23 ± 2.636987) has highest and Limu (22.96333 ± 1.810672) has the lowest concentration. When we Comparison of Observed Manganese concentration with standards Values for row and roasted coffee beans, respectively, the Manganese contents observed are less comparable with the standards NIST (54)**.** However, concentration of Manganese observed in this study more or less similar in comparison with different countries reported values (19 ± 5 – 39 ± 11)[26], (23 ± 0.5, 21 ± 0.3)(20 ± 0.1, 19 ± 0.2)[33], 20.97[7], (24.0 ± 0.6, 24.0 ± 1.5, 22.0 ± 0.5)[3], (16.5 – 40.6)[32]

The order of roasted and non-roasted coffee specialty concentration from highest to lowest are

Roasted: Sidama (35.59667 ± 1.000117) > Yirgachefe (30.52 ± 2.668277) > Bebeka (27.41667 ± 2.89139**)** > Harare (25.84333 ± 1.890776) > Gimbi (25.64667 ± 1.002314) > Limu (24.98333 ± 1.679891) > Tepi (24.36 ± 2.160486).

For Non-Roasted: Bebeka (44.23 ± 2.636987) > Sidama (39.26333 ± 2.45895) > Harare (28.85 ± 1.093435) > Metu (28.42333 ± 1.469569) > Gimbi (27.84333 ± 0.568888) > Tepi (25.25333 ± 0.744737) > Yirgachefe (23.51 ± 3.081412) > Limu (22.96333 ± 1.810672)

Iron (Fe) is biologically important essential transition metals for most life on Earth, including human beings. It is one of the few trace elements needed for human body to sustain life. There are varies biological role of iron to our body such as Improves brain function, muscle function, immune system, concentration, oxygen transportation from lungs to cells and production of energy and Catalase. However if low level of iron to our body can cause many health problems, including impaired cognitive function, gastrointestinal disturbances, poor exercise and work performance, lowered immune function and poor body temperature regulation. In order to avoid iron deficiency we should have use iron rich source foods include red meat, Beef liver, Cereal, soybean, white beans and flour products, seafood, sunflower seeds and so on .if an excess amount of iron can cause to the human body such as it causes the enzyme to malfunction, it also causes inflammation. Iron attracts oxygen and when in excess, the free radical oxygen damages the surrounding body tissue. In addition, as a carrier for oxygen, iron promotes bacterial growth by feeding it oxygen, leading to chronic infections. Iron can mostly be found in the pancreas, joints, liver, and intestines. The tolerable upper intake level for iron is between 40-45 milligrams [38]

From the figure 6 concentration of iron of roasted and non-roasted coffee beans the experiment was showed more or less similar except roasted Bebeka. In general in this study iron is 1st minor mineral in both roasted and non-roasted. The maximum amounts of iron (414.9667 ± 118.2001) was found from Bebeka coffee specialty and the minimum was found Tepi (125.1833 ± 5.081499) in roasted coffee beans. On the non-roasted Sidama (296 ± 22.75277) has highest and Limu (139.8467 ± 0.880928) has the lowest concentration. When we Comparison of Observed iron concentration with both standards and reported Values for row and roasted coffee beans, respectively, the iron contents observed are higher comparable with the standards NIST (83) and with different countries reported values (12 ± 3 – 31 ± 7)[26], 53.44[7] (52.0 ± 4.0, 53.0 ± 5.0, 52.0 ± 3.0)[3]

The order of roasted and non-roasted coffee specialty concentration from highest to lowest are

Roasted: Bebeka (414.9667 ± 118.2001) > Yirgachefe (408.9733 ± 14.81943) > Harare **(**239.17 ± 12.07383**)** > sidama (225.2033 ± 7.904052) > Limu (221.3033 ± 12.40336) > Gimbi (152.0133 ± 21.85786) > Tepi (125.1833 ± 5.081499)

For Non-Roasted: Sidama (296 ± 22.75277) > Bebeka (291.6833 ± 7.517908) > Tepi (216.1867 ± 4.114661) > Harare (209.3467 ± 15.17246) > Metu (185.34 ± 5.019333) > Gimbi (181.8633 ± 3.925714) > Yirgachefe (155.4933 ± 17.3093) > Limu (139.8467 ± 0.880928)

Copper (Cu) is a trace element also essential for the human body to function properly. Copper is present in all body tissues and plays a role in the formation of connective tissue, and in the normal functioning of muscles and the immune and nervous systems. The human body requires copper for normal growth and health. Copper, along with iron, is a critical component in the formation of red blood cells. Copper also influences the functioning of the heart and arteries, helps prevent bone defects such as osteoporosis and osteoarthritis, and promotes healthy connective tissues (hair, skin, nails, tendons, ligaments and blood vessels).

(Source: Dr. Andrew Weil, Internet). Good Food sources of copper are Whole grains, vegetables, nuts, beans, seeds, mushrooms, potatoes and organ meats. Supplements and dietary intake of copper together should not exceed 0.9 milligrams per day because of the risk whether to much or low level copper in our diet. If you suffer from a copper deficiency, the normal and healthy growth of organs and tissues, as well as their proper oxygenation from an ample red blood cell concentration, would be impossible. Copper is a vital component of the natural dark pigment, melanin, which imparts coloration to the skin, hair, and eyes. Excessive copper levels have been linked to schizophrenia, learning disabilities, premenstrual syndrome, and anxiety. From the figure 7 concentration of Copper of roasted and non-roasted coffee beans the experiment was showed more or less similar. In general in this study Copper is 4th minor mineral in both roasted and non-roasted. The maximum amounts of Copper (16.66333 ± 1.058411) was found from Gimbi coffee specialty and the minimum was found Limu (12.89667 ± 0.809341) in roasted coffee beans. On the non-roasted Metu (15.35 ± 0.238956) has highest and Sidama (12.46667 ± 0.561555) has the lowest concentration. When we Comparison of Observed Copper concentration with standards Values for row and roasted coffee beans, respectively, the Copper contents observed are higher comparable with the standards NIST (5.64). However when we compared with different countries reported values more or less similar (12.5 ± 3.4 – 18.1 ± 2.6) [36], (12 ± 0.3,13 ±0.2), (9 ± 0.3, 10 ± 0.1) [33], 13.15[7], (17 ± 0.2, 14 ± 0.8, 11.0 ± 0.7) [3], (12.1 – 20.1) [32]

The order of roasted and non-roasted coffee specialty concentration from highest to lowest are

Roasted: Gimbi (16.66333 ± 1.058411) > Yirgachefe (15.34 ± 0.475079) > Harare **(**14.45333 ± 1.142337**)** > Sidama (13.97 ± 0.385876) > Tepi (13.54667 ± 1.500478) > Bebeka (13.24 ± 1.464616) > Limu (12.89667 ± 0.809341)

For Non-Roasted: Metu (15.35 ± 0.238956) > Gimbi (15.17667 ± 1.549462) > Bebeka (14.72 ± 0.947787) > Yirgachefe (14.32 ± 2.471922) > Limu (13.92333 ± 1.023442) > Harare (13.84333 ± 1.668725) > Tepi (12.67 ± 1.1253) > Sidama (12.46667 ± 0.561555)

Zinc (Zn) is one of the essential trace elements and vital micronutrients with diverse physiologic and metabolic functions [39]. It is important in helping the body to make new cells, process food and heal wounds. The health benefits of zinc include a proper functioning of the immune and digestive systems, controlled diabetes, reduction in stress levels, improvement in metabolism,. Also, it is helpful in terms of pregnancy, hair care, eczema, weight loss, night blindness, cold, eye care, appetite loss, and many other conditions. A lack of zinc can make a person more susceptible to disease and illness. It is responsible for a number of functions in the human body, and it helps stimulate the activity of at least 100 different enzymes. Only a small intake of zinc is necessary to reap the benefits. Currently, the recommended dietary allowance (RDA) zinc for men needs 5.5-9.5mg per day and women need 4-7mg a day. The zinc element is naturally found in many different foods, such as red meat, poultry, oysters, seafood, fortified cereals, whole grains, beans and nuts [40][41]

From the figure 8 concentration of Zinc of roasted and non-roasted coffee beans the experiment was showed more or less similar. In general in this study Zinc is 5th minor mineral in both roasted and non-roasted. The maximum amounts of Zinc (7.203333 ± 1.323077) was found from Bebeka coffee specialty and the minimum was found Harare (2.87 ± 0.602578) in roasted coffee beans. On the non-roasted Harare (8.363333 ± 0.699809) has highest and Limu (4.976667 ± 1.137776) has the lowest concentration. When we Comparison of Observed Zinc concentration with standards and reported Values for row and roasted coffee beans, respectively, the Zinc contents observed are less comparable with the standards NIST (12.5) and with some countries reported values (14 ± 0.3, 15 ± 0.2)(17 ± 0.2, 18 ± 0.3)[33], (13.0 ± 0.7, 19.0 ± 0.8, 12.0 ± 0.8)[3], (3.2 – 16.2)[32]. However in few reported values more or less similar (6.51 ± 1.1 – 8.03 ± 1.4) [26], (5.97-6.89) [7]

The order of roasted and non-roasted coffee specialty concentration from highest to lowest are

Roasted: Bebeka (7.203333 ± 1.323077) > Yirgachefe (6.47 ± 0.855804) > Limu **(**5.88 ± 0.844808**)** > Sidama (5.623333 ± 0.343123) > Tepi (4.626667± 2.786707) > Gimbi (3.793333 ± 1.384245) > Harare (2.87 ± 0.602578)

For Non-Roasted: Harare (8.363333 ± 0.699809) > Yirgachefe (6.753333 ± 0.783603) > Bebeka (6.283333 ± 0.969141) > Sidama (5.72 ± 1.987788) > Metu (5.7 ± 0.735119) > Tepi (5.103333 ± 1.182469) > Gimbi (5.09 ± 1.512481) > Limu (4.976667 ± 1.137776)

Selenium (Se) is an essential element for humans and animals that is required for key antioxidant enzyme glutathione peroxides, works with vitamin E in preventing free radical damage to cell membranes [42]. But can be toxic if the daily intake at high concentrations in excess of 2 mg. mainly human exposed to selenium through our food and water, because selenium is naturally present in grains, nuts, cereals, mushrooms and meat. Humans need to absorb certain amounts of selenium daily, in order to maintain good health. Food usually contains enough selenium to prevent disease caused by shortages. If Low levels of selenium render people at higher risk for cancer; cardiovascular disease; inflammatory diseases, such as asthma; and other conditions associated with increased free radical damage, including premature aging and cataract formation. [43]

From the figure 9 concentration of Selenium of roasted and non-roasted coffee beans the experiment was showed more or less similar except roasted Tepi coffee beans. In general in this study Selenium is least minor mineral in both roasted and non-roasted. The maximum amounts of Selenium (2.803333 ± 4.263899) was found from Tepi coffee specialty and the minimum was found Bebeka (0.14 ± 0.034641) in roasted coffee beans. On the non-roasted Sidama (0.726667 ± 1.024906) has highest and Bebeka (0.15 ± 0.051962) has the lowest concentration. When we Comparison of Observed Selenium concentration with standards Values for row and roasted coffee beans, respectively, the Selenium contents observed are higher than with the standards NIST (0.05**).** However their where not found reported values of selenium concentration before.

The order of roasted and non-roasted coffee specialty concentration from highest to lowest are;

Roasted: Tepi (2.803333 ± 4.263899) > Sidama (0.913333 ± 0.741912) > Limu **(**0.656667 ± 0.929534**)** > Gimbi (0.293333 ± 0.219393) > Harare (0.233333 ± 0.147422) > Yirgachefe (0.153333 ± 0.040415) > Bebeka (0.14 ± 0.034641)

For Non-Roasted: Sidama (0.726667 ± 1.024906) > Gimbi (0.463333 ± 0.568888) > Yirgachefe (0.346667 ± 0.280238) > Harare (0.343333 ± 0.195021) > Metu (0.34 ± 0.381051) > Tepi (0.293333 ± 0.300222) > Limu (0.156667 ± 0.063509) > Bebeka (0.15 ± 0.051962)

Bromine (Br) is an active non-metal, which is included in the group of halogens. It is hard to overestimate the role of bromine in the human body. It is an active part in the digestion of carbohydrates and fats, Activates pepsin production in gastritis with low acidity, Participates in the activation of certain enzymes, under the influence of bromide ions is an oppression of the thyroid gland and Regulation of the functions of the central nervous system. Low level or deficiency of bromine minerals is the cause for Seizures, insomnia, agitation, irritability, hyperthyroidism. Whereas high level or overdoses are Poor memory, possible attention deficit / hyperactivity disorder (ADD / ADHD) in children. Drowsiness, fatigue, nausea, vomiting, acne, skin rash, blurred vision, dizziness, mania, pancreatitis, hallucinations, increased thirst, hunger and urination, muscle weakness, hypothyroidism, psychosis, coma. Daily recommended intake of bromine from our food and water is 2 – 8 mg per day. The bromine rich source of food is Crops, Bread, Nuts, Kelp, seaweed and fish. [33]

From the figure 10 concentration of Bromide of roasted and non-roasted coffee beans the experiment was showed more or less similar. In general in this study bromide is least minor mineral but higher than selenium in both roasted and non-roasted. The maximum amounts of bromide (3.243333 ± 2.387139) was found from Sidama coffee specialty and the minimum was found Gimbi (0.64 ± 1.00638) in roasted coffee beans. On the non-roasted Tepi (2.643333 ± 0.8188) has highest and Gimbi (0.883333 ± 0.816354) has the lowest concentration. When we Comparison of Observed bromide concentration with standards Values for row and roasted coffee beans, respectively, the bromide contents observed are more or less similar with the standards NIST (1.8) especially with Bebeka**.** However their where not found reported values of bromide concentration before. The order of roasted and non-roasted coffee specialty concentration from highest to lowest are;

Roasted: Sidama (3.243333 ± 2.387139) > Harare (3.066667 ± 0.501431) > Yirgachefe **(**2.49 ± 1.009505**)** > Bebeka (1.826667 ± 0.120554) > Tepi (1.576667 ± 1.562189) > Limu (1.003333 ± 1.053107) > Gimbi (0.64 ± 1.00638)

For Non-Roasted: Tepi (2.643333 ± 0.8188) > Harare (2.15 ± 0.416773) > Metu (2.126667 ± 0.662596) > Limu (2.093333 ± 0.275923) > Sidama (2.033333 ± 1.305731) > Yirgachefe (1.496667 ± 0.379781) > Bebeka (1.47 ± 0.697782) > Gimbi (0.883333 ± 0.816354)

Rubidium (Rb) is found in animal tissue and it resembles potassium in its distribution and excretory pattern. Relatively high levels can be found in the soft tissue, while the skeletal tissue contains low level. The additions of rubidium or cesium (Cs) to potassium-deficient diets prevent the lesions characteristic of potassium depletion in rats and supports near normal growth for short periods of time. [45]

From the figure 11 concentration of Rubidium of roasted and non-roasted coffee beans the experiment was showed more or less similar. In general in this study Rubidium the 2nd minor mineral next to iron in both roasted and non-roasted coffee beans. The maximum amounts of Rubidium (57.48333 ± 3.426432) was found from Limu coffee specialty and the minimum was found Yirgachefe (20.4 ± 3.106751) in roasted coffee beans. On the non-roasted Limu (49.27333 ± 0.77436) has highest and Tepi (18.87 ± 0.379868) has the lowest concentration. When we Comparison of Observed Rubidium concentration with standards Values for row and roasted coffee beans, respectively, the Rubidium contents observed are higher than the standards NIST (10.2**).** However their where not found reported values of Rubidium concentration before.

The order of roasted and non-roasted coffee specialty concentration from highest to lowest are;

Roasted: Limu (57.48333 ± 3.426432) > Gimbi (46.84 ± 2.497539) > Bebeka **(**30.33 ± 456159**)** > Harare (28.85667 ± 0.958454) > Tepi (25.18333 ± 0.870766) > Sidama (24.53 ± 1.636429) > Yirgachefe (20.4 ± 3.106751)

For Non-Roasted: Limu (49.27333 ± 0.77436) > Metu (44.88333 ± 2.626906) > Gimbi (38.21 ± 2.030345) > Harare (29.60333 ± 0.825974) > Bebeka (28.91333 ± 1.453008) > Yirgachefe (24.79333 ± 3.836748) > Sidama (20.15667 ± 2.234107) > Tepi (18.87 ± 0.379868)

Strontium (Sr): The omission of strontium caused an impairment of the calcification of the bones and teeth and a higher incidence of carious teeth. It has promoting action on calcium uptake into bone at moderate dietary strontium levels, but a rachitogenic (rickets-producing) action at higher dietary levels. 90Sr is one of the most abundant and potentially hazardous radioactive byproducts of nuclear fission and plants are more efficient than animals in the absorption of strontium. Radioactive strontium is absorbed and deposited in tissues especially the bones, and is also readily transmitted to the fetus and secreted in the milk. Strontium is preferentially excreted, especially in the urine, thereby providing some means of protection against Sr. [19][45]

From the figure 12 concentration of strontium of roasted and non-roasted coffee beans the experiment was showed more or less similar. In general in this study strontium is the 5^{th} minor mineral in both roasted and non-roasted coffee beans. The maximum amounts of strontium (9.026667 ± 1.500544) was found from Tepi coffee specialty and the minimum was found Yirgachefe (3.78 ± 3.518622) in roasted coffee beans. On the non-roasted Tepi (8.13 ± 0.667757) has highest and Gimbi **(**3.17 ± 2.485619**)** has the lowest concentration. When we Comparison of Observed strontium concentration with standards Values for row and roasted coffee beans, respectively, the strontium contents observed are less than the standards NIST (25.00). However their where not found reported values of strontium concentration before.

The order of roasted and non-roasted coffee specialty concentration from highest to lowest are;

Roasted: Tepi (9.026667 ± 1.500544) > Sidama (5.556667 ± 1.800287) > Gimbi **(**5.453333 ± 916255**)** > Limu (4.61 ± 4.517997) > Bebeka (4.216667 ± 0.509542) > Harare (4.093333 ± 3.428197) > Yirgachefe (3.78 ± 3.518622)

For Non-Roasted: Tepi (8.13 ± 0.667757) > Limu (7.78 ± 4.096572) > Metu **(**6.62 ± 2.087989**)** > Sidama (6.126667 ± 1.137072) > Bebeka (5.58 ± 0.764461) > Harare (5.13 ± 4.212553) > Yirgachefe (4.76 ± 0.664605) > Gimbi **(**3.17 ± 2.485619**)**

IV. Conclusions

The analysis of 15 raw and roasted coffee bean specialty samples using energy dispersive x-ray florescence technique showed that determined the concentration of four major elements (P, K, Ca, S) and eight minor elements(Mn, Fe, Cu, Zn, Se, Sr, Rb, Br) . This investigation showed that roasted and non-roasted coffee beans have more or less doesn't change elemental concentration of the following elements (like S, Mn, Fe, Cu, Zn, Se, Sr, Rb, Br) but the concentration of P, K, and Ca elements does increase due to roasting process. In general these results indicating that roasting process did not eliminate any of the elements studied in this work.

The present investigation disclosed that the major and minor elemental contents of coffee beans varied with a multiple factors such as geographical origin, mineral contents of soil on which coffee plants grow and blends of different coffee variety. The order of elements concentration from highest to lowest are K > Ca > P > S > Fe > Rb, > Mn > Cu > Zn, Sr > Br > Se for roasted and K > Ca > S > P > Fe > Rb, Mn > Cu > Zn, Sr > Br >Se for non-roasted. In this research the highest contents of P, K, Ca, Mn, Br elements in roasted and Fe, Se elements in non-roasted coffee beans was observed in sidam coffee beans specialty and Similarly the highest contents of S, Fe, Zn in roasted and S, Mn in non-roasted coffee of Bebeka. In Gimbi coffee bean also observed highest content Cu in roasted and P, K, Ca in non-roasted coffee meanwhile Se, Sr in roasted and Br, Sr in non-roasted coffee of Tepi. The highest contents Rb observed for both raw and roasted coffee of Limu. Finally the highest contents Cu and Zn observed in non-roasted coffee beans of Metu and Harare respectively.

Finally I conclude that the level of both major and minor minerals investigated in roasted and non-roasted coffee beans were comparable with standards and reported values of different countries. Researcher could be suggested that roasted and non –roasted coffee beans under investigation could be a source of dietary minerals and complementing food composition

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