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Application of atomic absorption spectroscopy to food sciences (A study on *Persea americana* Mill – Avocado)

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ABSTRACT

Our health is very much dependent to our balance meals. The body needs different kinds of minerals for its different functions. Keeping this idea in mind the spectroscopic study on *Persea Americana* Mill (Avocado Fruit) has been taken into account. The investigation shows that the avocado (*Persea Americana* Mill) is an ideal food for the balance of minerals in our body. The quantitative investigation using atomic absorption spectroscopic technique shows the presence of Ca, Cd, Co, Cu, Fe, Mg, Mn, Pb and Zn elements in seed (nut), leaf and flesh of avocado. The concentration of Ca and Mg were found very high in nut, leaf and flesh; out of which the concentration of Mg (100809 mg/Kg) was highest in leaf followed by flesh and nut.

***Keywords*:** Avocado; *Persea Americana* Mill; AAS; Elemental Analysis; Element-Concentration

1. INTRODUCTION

The avocado (*Persea Americana* Mill) is a nutritious fruit. It has been reported that there are around 150 varieties; out of which a few are more common, though all of them have very similar physical and chemical properties. It is cited that avocado is rich in unsaturated fatty acids and hydro-soluble vitamins, specially A and C. It contains very low level of sugar. The avocado is an energy food and recommended for diabetic persons [1].

Fig. 1. Avocado Fruit Unmatured

Fig. 2. Avocado Fruit Matured

Fig. 3. Avocado Tree

Avocado trees (*Persea Americana* Mill) can be found in both standard and dwarf varieties. Guatemalan, West Indian and Mexican are the three main species of standard avocado trees. They vary in fruit size, texture and maturity rate. All types of trees reach an average height of between 30 and 40 feet; though they can grow up to 80 feet tall. Dwarf varieties, such as the Wurtz avocado is the only true dwarf variety of avocado tree. At full maturity, a Wurtz tree is about one-fourth the size of standard avocado trees

Parts of an Avocado Fruit

Although all avocados may initially appear to be the same, there are three races of avocados to consider: West Indian, Guatemalan and Mexican. In addition to these three races there are also hybrids and many different varieties that vary in size, shape and even taste. Despite these differences, all avocados are made of the same basic parts.

The Exocarp

The exocarp of an avocado is commonly referred to as the skin. Depending on the type of avocado, the skin color and thickness will vary. For example, Gwen avocados have green skin that is thick with a pebbled appearance, while Zutano avocados have thin skin that is yellow-green and shiny. The exocarp of certain avocados may also change in appearance as the fruit ripens. Hass avocados start with green skin that darkens to a purple-black color when ripe. The Fuerte avocado, which has thin green skin, does not change in appearance when ripe.

The Mesocarp

Fig. 4. Pieces of Avocado Flesh (Mesocarp)

The mesocarp is also known as the flesh of the avocado, and this is the edible and most abundant part of the fruit. The flesh of the fruit also varies in appearance depending on the variety of avocado. The Bacon variety of avocado has flesh that is a greenish-yellow, while the Pinkerton variety has pale, creamy green flesh. The Zutano avocado has flesh that is light in texture with a pale green color.

The Endocarp

The endocarp is the thin inner layer of the avocado that is found between the flesh of the avocado and its seed. It is often difficult to differentiate the endocarp from the flesh of the avocado fruit. When the seed is ripe, the endocarp may appear to be a film over it, giving it a frosty or whitish appearance.

The Seed (Nut)

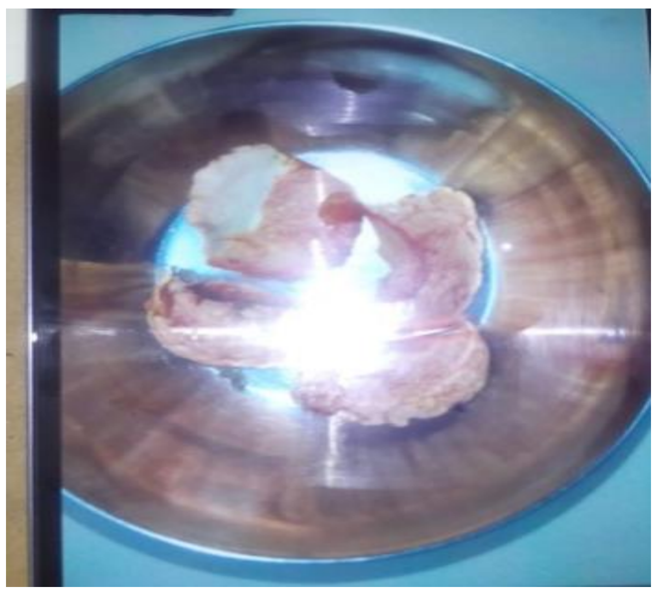

Fig. 5. Pieces of Avocado Seed

At the center of the avocado is its seed. It is the seed that makes the avocado a fruit as opposed to a vegetable and it can vary in size from small to large. The variations in seed size are dependent on the type of avocado. The Pinkerton, which is a winter variety avocado, has a small seed at its core. Reed avocados, a summer variety, and Lamb Hass, which is a California summer variety, both have medium seeds. The mid-winter variety Bacon avocado has a medium to large seed. The quality of fruit is considered in terms of nutritional, microbiological, technological and sensorial properties such as aroma, flavor, appearance and texture [2].

It has been found that the flesh becomes dark brown very quickly after peeling off the skin and to avoid this problem avocado is kept in a sealed container in an environment of cut pieces of onion. The reason is not yet known.

The appearance is the first factor to determine the choice of the foods. Therefore, the maintenance of the original color during the entire processing of the food is the biggest, most difficult and crucial objective for the processors [3,4]. The darkening catalized by the polyphenol oxidage (PPO) and peroxidases is one of the main problem in the preservation of avocado pulp [5]. POP is an enzyme that in the presence of oxygen catalizes the oxidation of phenolic substrats in quinone, these later are polymerized forming brown, red or black pigments [3]. An other kind of process also take place for dark coloration by the hydrogen peroxide as an electron donor giving rise to quinones which once polymerized [6-7].Further physic-chemical properties and nutritional contents such as pH, Moisture,Protein, Fat, Fibre and carbohydrate of avocado (persea America Mill) have been reported [8].

Fig. 6. Avocado leaves

Table 1. Recommended amount of elements for a normal body on daily basis

Elements	Amount	Elements	Amount	Elements	Amount
Ca	1300 mg	Cr	35 mcg	Cu	900 mcg
Fe	8 mg	Mg	320 mg	Mn	1.8 mg
Ni	1 mg	Na	2.3 g	Se	400 mcg
Zn	8 mg				

Recommended by Institute of Medicines, Food and Nutrition Board (mcg = microgram)

Table 2. Importance and Functions of Different Elements.

Elements	Importance
Ca	Construction and maintenance of teeth and bones
Co	Component of cobalamine known as vitamin B2
Cu	Development of connective tissues, nerve coverings and bone
Fe	Functioning of red blood cells to transport oxygen to the body
Mg	Healthy bones and blood vessels, muscle and energy formation
Mn	Bone development
Pb	Influences biological enzyme systems by limited amount
Zn	Supports normal growth and development in pregnancy and involves in activities of many enzymes

2. EXPERIMENTAL

The leaf and fruit were chosen from a locally avocado tree. Both were properly washed with deionized water and then placed in the oven to dry. They got dried at the temp of 70 °C for 20 minutes. 5.0 g of leaf in a crucible was placed in

the oven again at a temperature of 100 °C for 30 minutes to fully dry. A fine powder of the leaf was made by crushing in a mortar and pestle.

The total skin of the fruit was removed gently with a plastic knife and then flesh and nut were separated. A quantity of 5 g of flesh and 5 g of nut were cut with the plastic knife into small pieces and kept in the separate crucibles and then placed in the oven to fully dry at the temperature of 100 °C for 60 minutes. After getting cooled the flesh and nut were crushed to powder separately with a mortar and pestle.

2.0 g of each powder were kept in separate conical flasks and 50ml of aqua regia was added in each flask and placed on a heater at a mild temperature for 30 minutes to dissolve properly. Further deionized water was added in each conical flask to make a total volume of 100ml. These prepared samples were used to record the atomic absorption spectrum of each elements present there. The details of the theory and instrumental procedure to record the atomic absorption spectra are given below.

The most of the atoms for elemental analysis cannot exist in the free, ground state at room temperature and therefore heat must be applied to the sample to break the bonds combining atoms in molecules. In flame atomic absorption spectroscopy a liquid sample is aspirated and mixed as an aerosol with combustible gasses (acetylene and air or acetylene and nitrous oxide.) The mixture is ignited in a flame of temperature ranging from 2100 to 2800^0 C (depending on the fuel gas used.) During combustion, atoms of the element of interest in the sample are reduced to the atomic state.

The Varian AA 240 series Atomic Absorption Spectrophotometer was used to record the spectra. The liquid sample is fed into the flame via a nebulizer where the sample is converted into atom at approximately 2300 °C. The radiation from the cathode lamp passes through the flame. Some of the radiation is absorbed by the atomized element and then passes through the monochromator. It is important and necessary to choose a compatible hallow cathode lamp of the same metal for which the investigation is desired. The radiation that reaches the detector is then measured to the intensity of the radiation that hit the detector when the sample was not present. The processor then calculate the results obtained by the detector and the amount is outputted on the display screen.

The characteristic wavelengths are element specific and accurate to 0.01-0.1 nm.

Line source are lamps that emit very narrow bands of radiation. The most common source is the hallow cathode lamp (HCL). The lamps are encased in a cylinder made of glass and a quart end cap. These cylinders are filled with a noble gas (Ne or Ar) to a pressure of 1-5 torr. The HCLS also contain a tungsten as a anode, a cathode is made of the metal of interest. Lamps of multi element in their cathode are also available. But most FAAS instruments can only measure one element at a time.

To provide element specific wavelengths, a light beam from a lamp whose cathode is made of the element being determined is passed through the flame. A device such as photonmultiplier can detect the amount of reduction of the light intensity due to absorption by the analyte and this can be directly related to the amount of the element in the sample. Only those atoms that are the same as those in the lamp will absorb the light from the lamp. A reduction in the amount of light reaching the detector is seen as a measure of the concentration of that element in the original sample.

One by one the sample flask (test solution) was connected to the tubing of the nebulizer to proceed to supply the sample in the flame. The other necessary settings were made and then the spectral data were recorded.

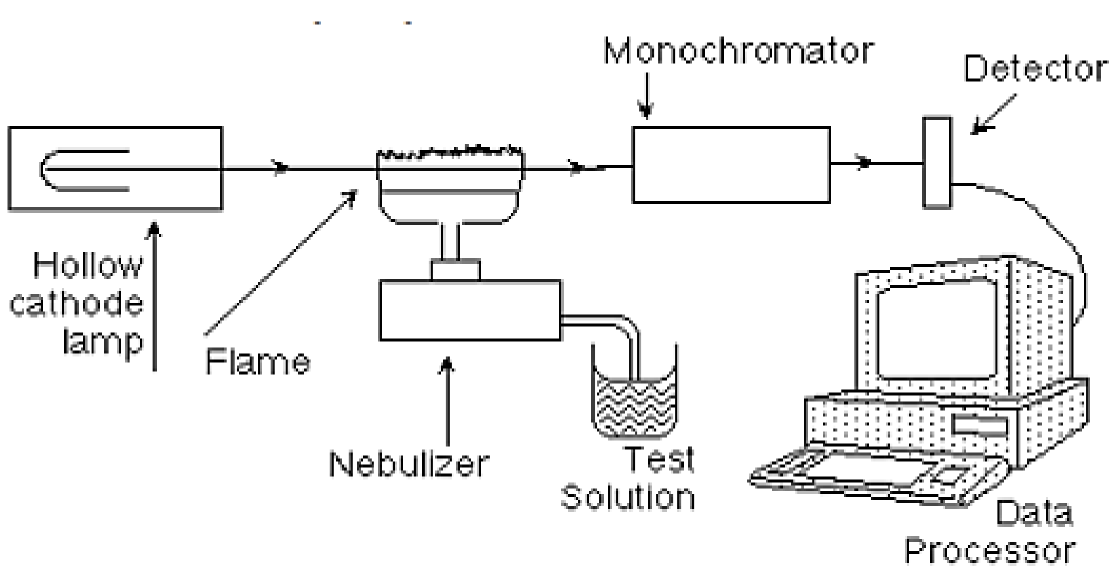

Fig. 7. Experimental design of Atomic Absorption Spectrophotometer.

3. RESULT AND DISCUSSION

Table 3. Concentration of Different Elements in Avocado Fruit

Samples Description	PARAMETERS								
	Ca (mg/Kg)	Cd (mg/Kg)	Co (mg/Kg)	Cu (mg/Kg)	Fe (mg/Kg)	Mg (mg/Kg)	Mn (mg/Kg)	Pb (mg/Kg)	Zn (mg/Kg)
Avocado-Nut	1122.00	0.40	10.30	14.20	41.30	4644.00	8.63	ND	11.10
Avocado-Leaf	3024.00	ND	10.50	13.70	14.87	100809.00	42.60	ND	21.90
Avocado-Flesh	1148.00	ND	10.70	10.40	56.60	8717.00	11.20	ND	15.90

ND = Not detected

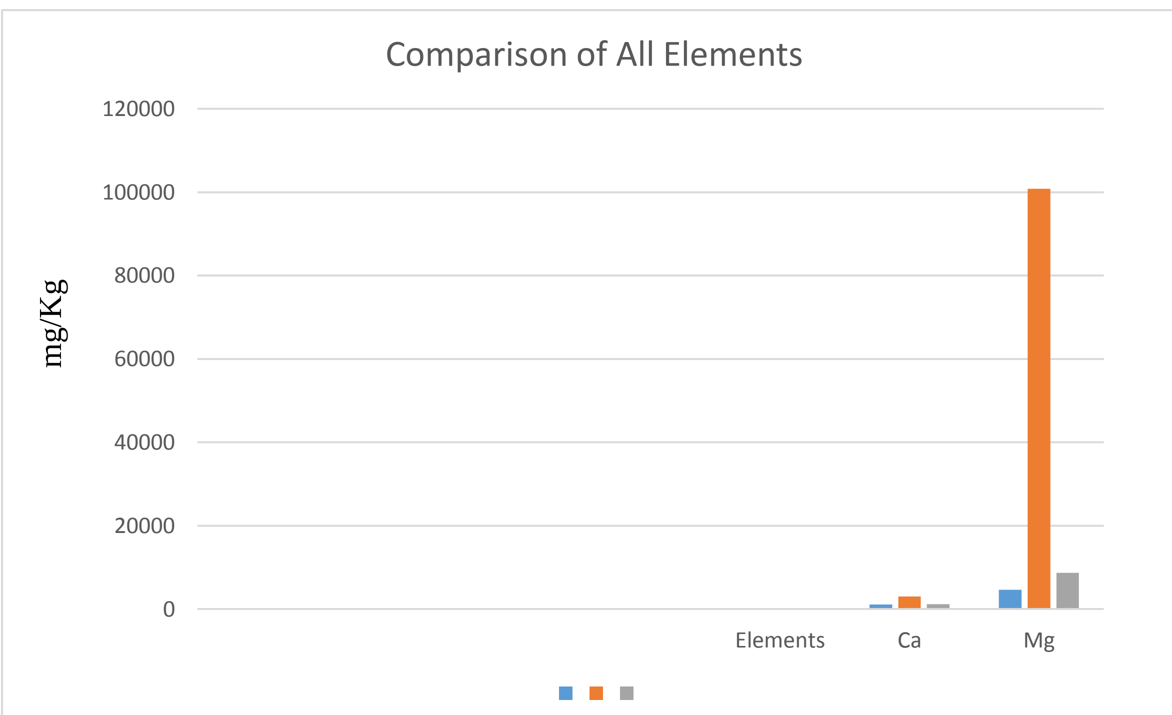

Fig. 8. Comparison of Concentration among all Elements

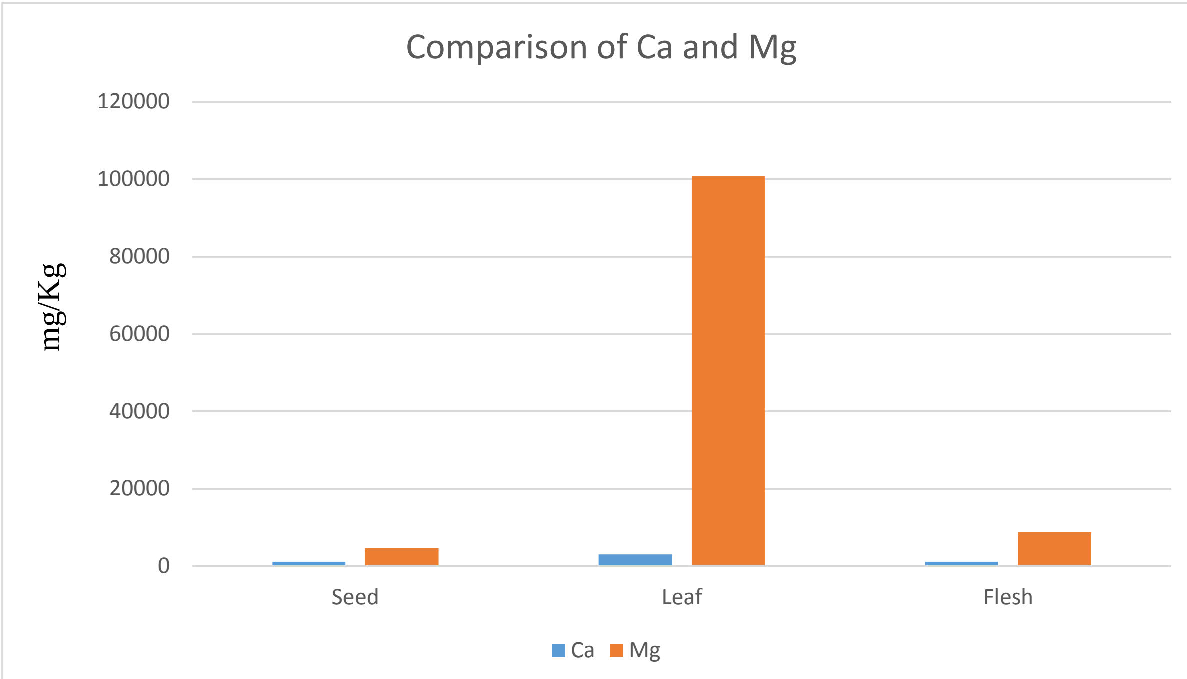

Fig. 9. Comparison of Concentration between Ca and Mg.

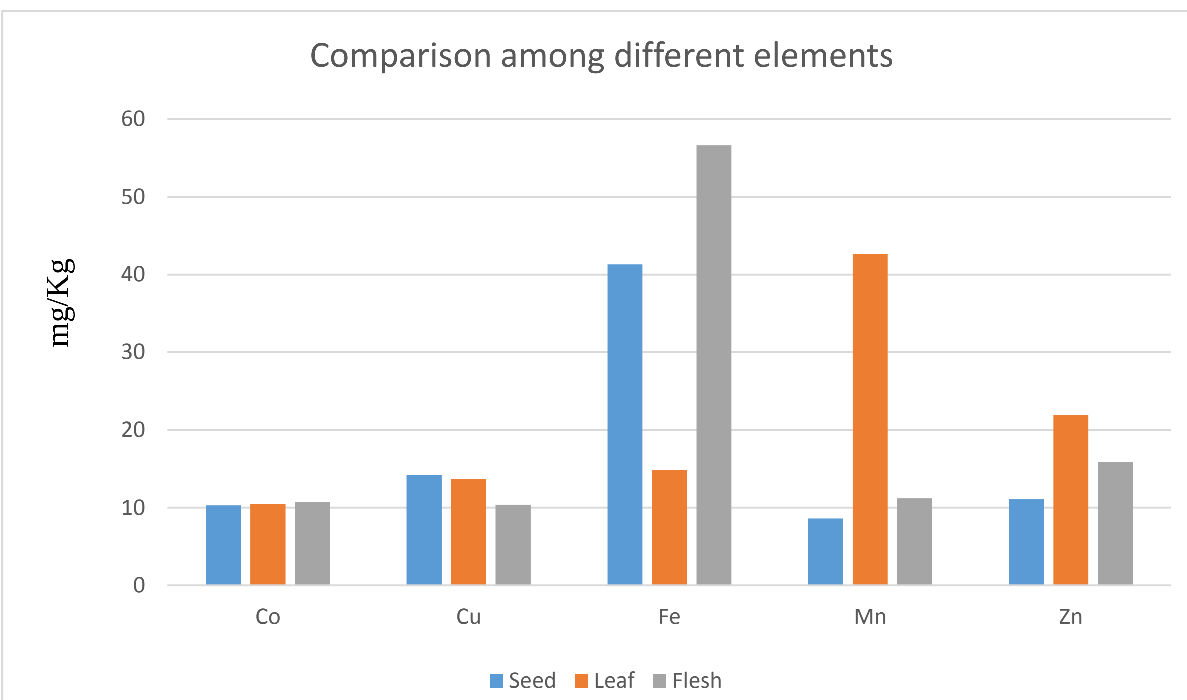

Fig. 10. Comparison of Low Concentration Elements

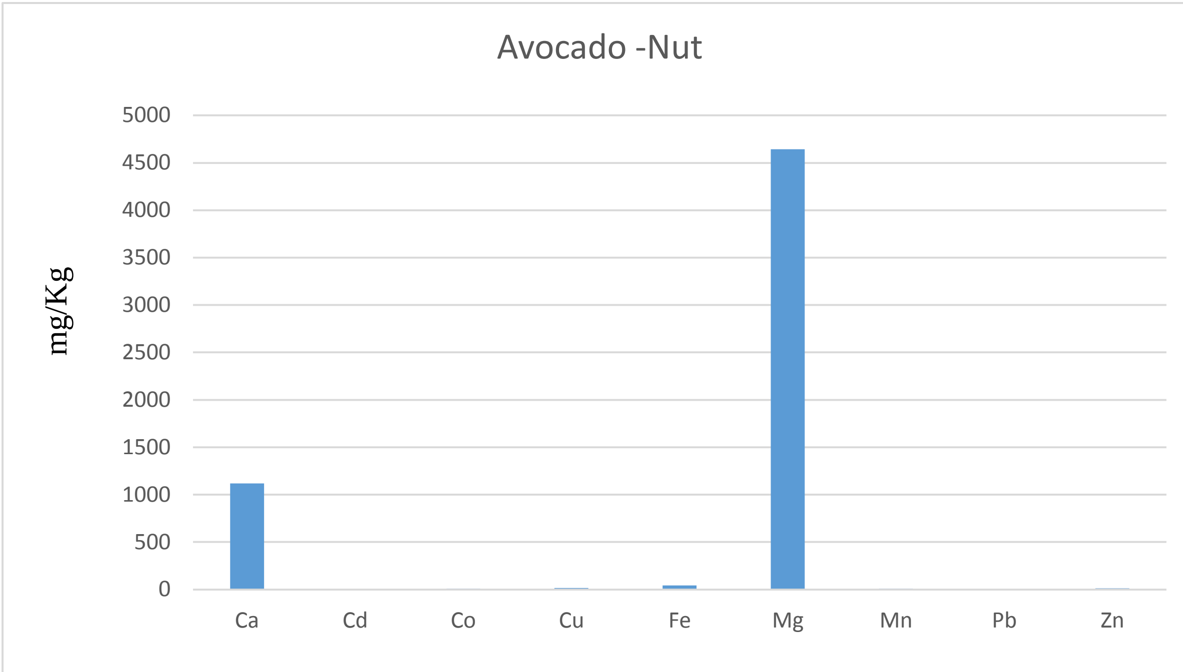

Fig. 11. Concentration of Different Elements in Avocado Seed (Nut)

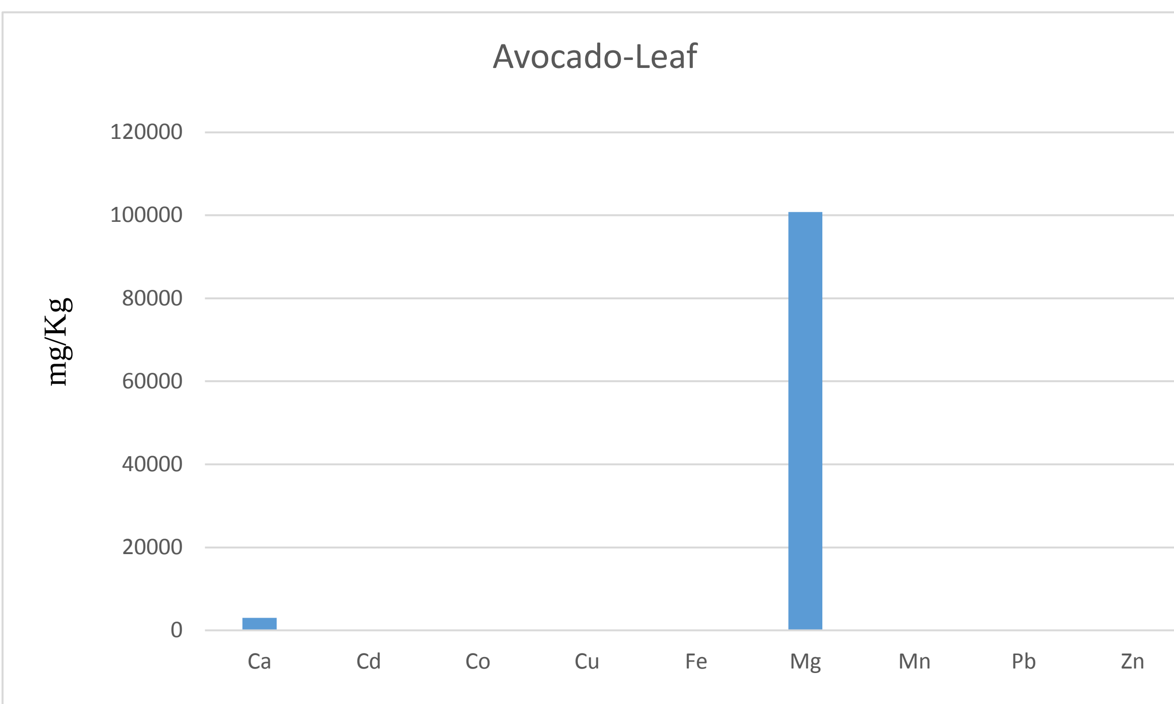

Fig. 12. Concentration of Different Elements in Avocado Leaf

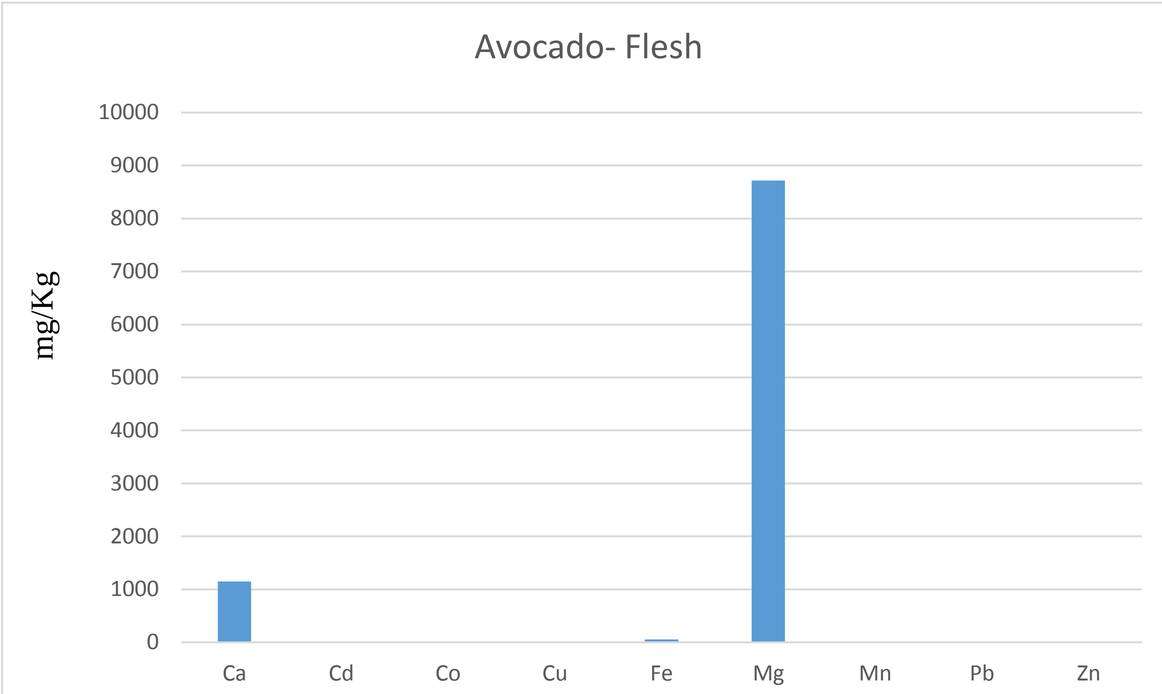

Fig. 13. Concentration of Different Elements in Avocado Flesh

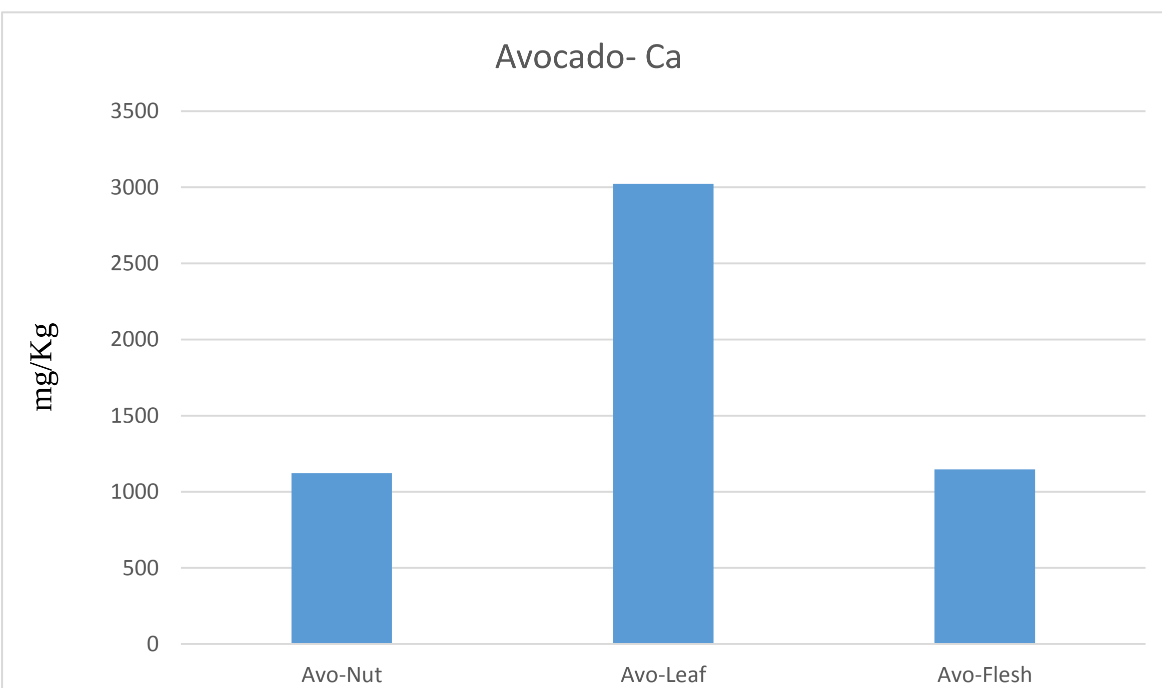

Fig. 14. Concentration of Calcium in Different parts of Avocado Fruit

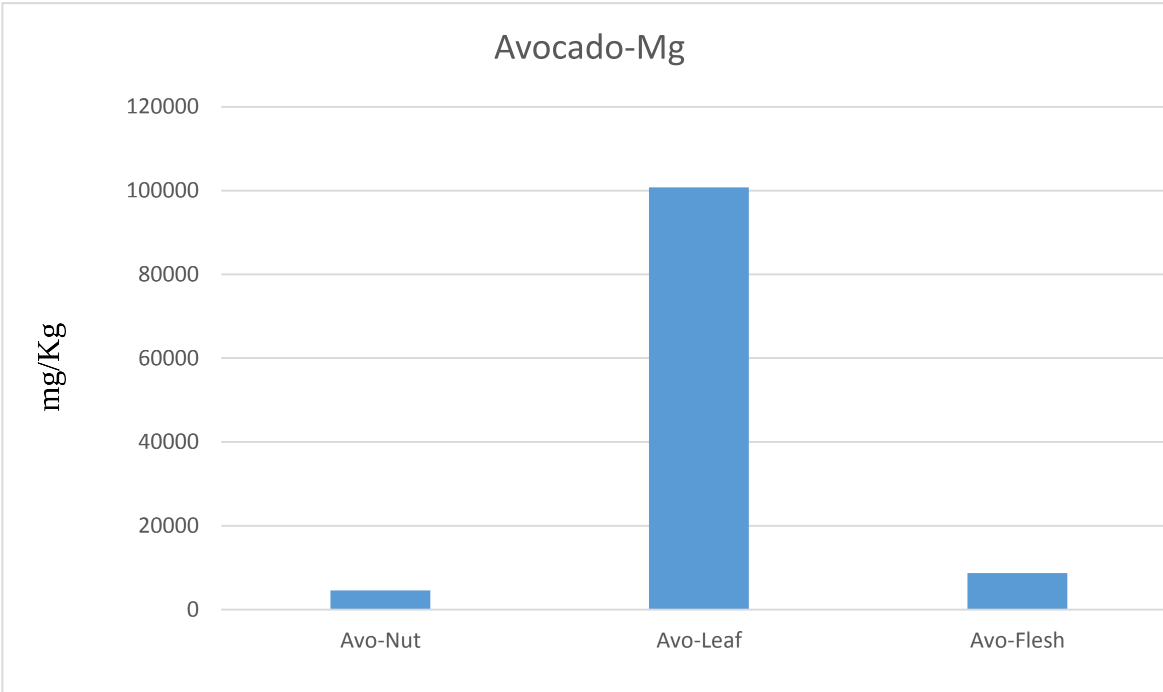

Fig. 15. Concentration of Magnesium in different parts of Avocado

The analysis of the data of table 1 shows that there are number of elements present in the different parts of avocado which are very essential for better health. Some of them the quantity is very limited such as Co, Cu, Fe, Mn and Zn. But at the same time calcium has enough concentration in all parts, seed, leaf and flesh. The most interesting observation is found here that the magnesium has very high concentration in all parts, nut, leaf and flesh, nut (4644 mg/Kg), leaf (100809 mg/Kg) and flesh (8717 mg/Kg). Thus the leaf has very high concentration as 100809 mg/Kg. These findings has been shown in figures 8-15 above and they are self-explanatory. The cadmium and lead have been found absent in avocado.

4. CONCLUSION

The investigation shows that the avocado (*Persea Americana* Mill) fruit is a good food supplement for human consumption for better health as a natural source of nutrients and shares in many enzymatic reactions in body.

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