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Investigation of Nutrient Elements in Cucurbita pepo Using Atomic Absorption Spectrometry

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ABSTRACT

There are a number of factors to keep our health in good condition. One of them is the role of the proper amount of nutrient metals which play the important role in many reactions in the body and it becomes increasingly evident that keeping a balance level of nutrient metals in every organ is very important for maintaining a healthy body, although metals comprise only a fraction of total body weight (mg). They play crucial role for many body functions in the metabolic regulations of the human body including transporting oxygen, normalizing the nervous system. The present investigation is focused to find out the different nutrient metals that exist in the vegetable Cucurbita pepo (squash) a source of natural nutrient metals abandance and to determine the relative concentration of each metal element. Investigation has been performed on the skin, the flesh, the seed, the leaves, the stems and the roots of squash to determine the relative levels of concentrations of various metals such as elements such as Al, Ca, Cd, Co,Cr, Fe,K, Mg, Mn, Na, Ni, Pb and Zn. The Atomic Absorption Spectrometry technique is used. The proper vegetable consumption can improve the mineral and trace metal regulation and reduce cardiovascular diseases and certain cancer risks.

Keywords: AAS, Cucurbita pepo, Metals

1. INTRODUCTION

It has been reported that trace elements such as Iron (Fe), Iodine (I), Zinc (Zn), Selenium (Se), Copper (Cu), Manganese (Mn), Chromium (Cr), Molybdenum (Mo), Cobalt (Co), Nickle (Ni) are needed less than 50 mg/day for a healthy metabolism [1]. Metals in the body maintain the body pH, osmotic regularity and used as coenzyme which regularize the metabolic reactions.

There is no work so far done on the squash. A few other vegetables have been investigated only for a few trace elements by Zahir, Naqvi and Mohiuddin [2].

2. EXPERIMENTAL

2. 1. Description of experiment

1. Accurately weigh 5.00g of dried and ground seed sample in a porcelain crucible.
2. Ash sample for two and a half (2:30Hrs) hours at 500 ºC, then allow to cool.
3. Wet ash with 2.00ml Deionised water, and carefully add 15 – 16ml HNO_3.
4. Evaporate excess HNO_3 on hot plate at 100 – 120 ºC.
5. Return crucible to furnace and ash for an additional one (1) hour at 500 ºC.
6. Cool crucible, dissolve ash in 50ml HCl and transfer quantitatively to 250ml volumetric flask.
7. Run analysis on sample.

The samples for all other seed, flesh, skin, stem and root were prepared separately using the same procedure. Atomic Absorption Spectrometry measures the discrete radiation absorbed when ground state atoms are excited to higher energy levels by the absorption of a photon of energy [3]. The radiant power of the absorbed radiation is related to the absorption coefficient of the ground state atoms using the Beer Lambert equation.

Flame Atomic Absorption Spectrophotometry quantifies the concentration of the element on the basis of the absorption of radiant energy by ground state atoms and the analytical response is based on the difference between the incident and transmitted radiation, i.e., the difference between two large signals. The technique of flame atomic absorption spectroscopy (FAAS) requires a liquid sample to be aspirated, aerosolized, and mixed with combustible gases, such as acetylene and air or acetylene and nitrous oxide. The mixture is ignited in a flame whose temperature ranges from 2100 to 2800 ºC. During combustion, atoms of the element of interest in the sample are reduced to free, unexcited ground state atoms, which absorb light at characteristic wavelengths.

2. 2. Instrumentation

The light source is a cold cathode lamp that produces the light that would be naturally emitted by the element to be measured at a high temperature. A large range of such lamps are available that includes the vast majority of the elements of general analytical interest. Consequently, the light will contain specifically those wavelengths that the element in the flame will selectively absorb.

The light passes through the flame, which is usually rectangular in shape so as to provide an adequate path length of flame for the light to be absorbed, and then into the optical system of the spectrophotometer. The flame is fed with a combustible gas, customarily air/acetylene, nitrous oxide/acetylene or air/propane or butane. The sample, dissolved in a suitable solvent, is nebulized and fed into the gas stream at the base of the burner.

The light, having passed through the flame, can be focused directly onto a photo-cell or onto a Diffraction Grating by means of a spherical mirror (Fig. 1). The Diffraction Grating can be made movable, and so it can be set to monitor a particular wavelength that is characteristic of the element being measured, or it can be scanned to produce a complete absorption Spectrum of the sample.

After leaving the grating, light of a selected wavelength, or range of wavelengths, is focused onto the photocell. The position of the Diffraction Grating determines the wavelength of the light that is to be monitored.

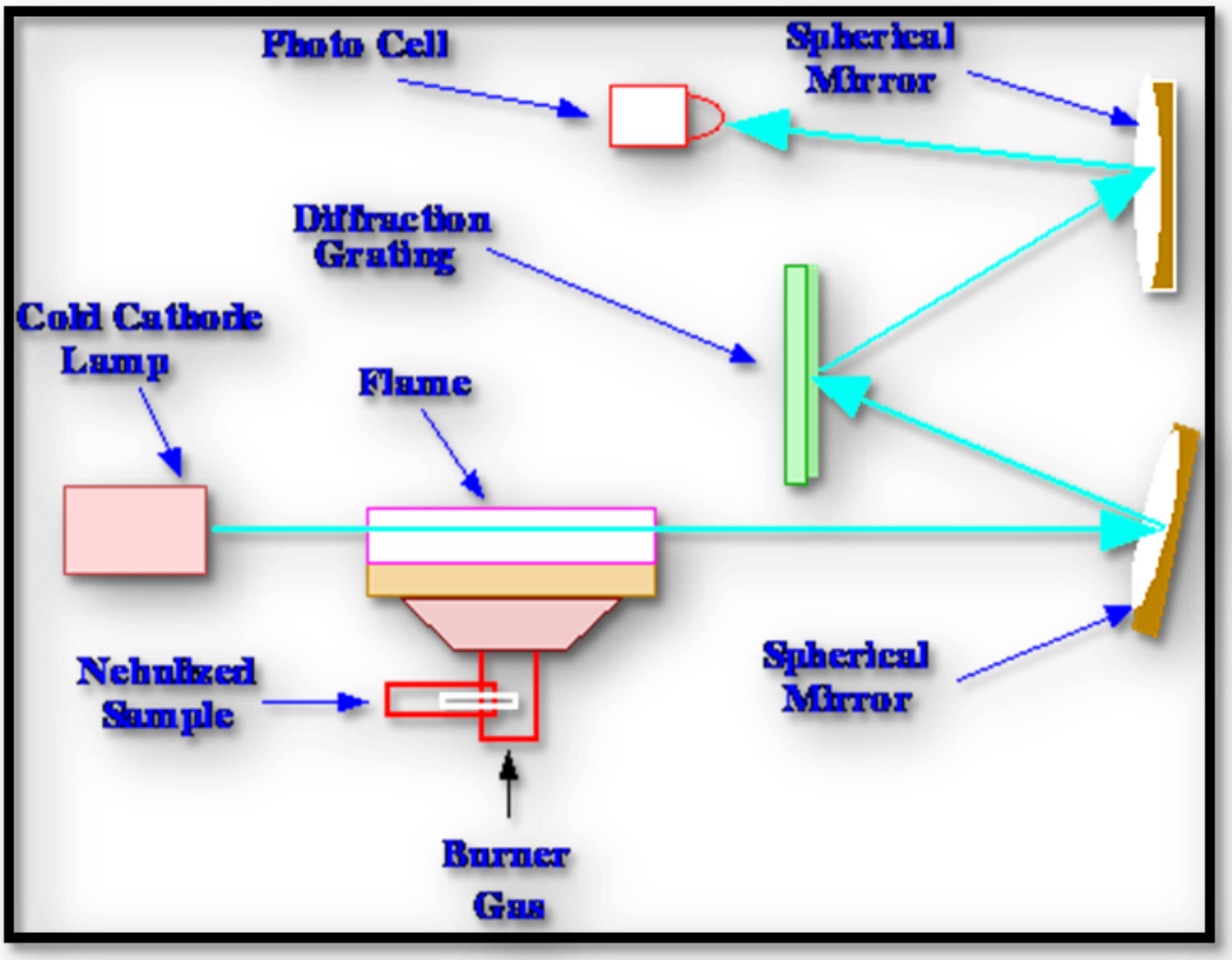

Fig. 1. Block diagram of the experimental arrangement

Table 1. Showing the readings of metal concentration from the atomic absorption spectrophotometer in part per million [ppm]

Metal Elements (measured in parts per million, ppm)															
	Labels	**Pb**	**Fe**	**Cu**	**Mn**	**Ni**	**Co**	**Zn**	**Cd**	**Mg**	**Ca**	**Al**	**Na**	**K**	**Cr**
Skin	SK1	0.00	0.43	0.00	0.00	0.00	0.16	0.20	0.00	11.97	30.19	459.00	0.00	684.00	0.00
	SK2	0.00	0.21	0.00	0.00	0.00	0.03	0.15	0.00	16.00	36.48	480.00	686.00	588.00	0.00
	SK3	0.00	0.00	0.00	0.00	0.00	0.23	0.17	0.00	13.67	30.57	1334.00	852.00	1146.00	0.00

Stem	ST1	0.00	0.00	0.00	0.00	0.00	0.47	0.06	0.00	25.86	249.10	1607.00	820.00	1144.00	0.20
	ST2	0.00	0.00	0.00	0.00	0.00	0.57	0.00	0.00	24.81	257.70	1463.00	870.00	1174.00	0.20
	ST3	0.00	0.01	0.00	0.00	0.00	0.68	0.00	0.00	31.42	333.70	1011.00	1042.00	1274.00	0.00
Root	RT1	0.00	1.56	0.00	0.00	0.00	0.54	1.10	0.16	24.51	197.20	1039.00	308.00	418.00	0.00
	RT2	0.00	2.57	0.00	0.04	0.00	0.74	1.01	0.03	29.37	232.10	1773.00	276.00	446.00	0.20
	RT3	0.00	2.45	0.00	0.02	0.00	0.57	1.23	0.16	28.21	214.50	1739.00	0.00	350.00	0.20
Leave	LE1	0.00	0.82	0.00	0.01	0.00	0.70	0.43	0.24	44.80	1784.50	305.00	0.00	608.00	0.20
	LE2	0.00	0.95	0.00	0.02	0.45	0.65	0.50	0.29	50.47	1492.00	1018.00	0.00	608.00	0.00
	LE3	0.00	0.81	0.00	0.00	0.53	0.68	0.30	0.34	49.09	1355.00	762.00	134.00	646.00	0.00
Flesh	FL1	0.00	4.63	0.00	0.00	0.00	0.76	0.00	0.39	23.95	413.00	421.00	906.00	2134.00	0.00
	FL2	0.00	8.24	0.00	0.00	0.25	0.69	0.00	0.47	26.76	424.00	302.00	0.00	936.00	0.20
	FL3	0.00	3.88	0.00	0.00	0.00	0.68	0.14	0.49	28.97	438.50	447.00	0.00	628.00	0.20
Seed	SD1	0.00	0.00	0.00	0.00	0.00	0.72	0.07	0.53	31.12	256.50	299.00	626.00	1512.00	0.00
	SD1	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.59	26.72	220.50	346.00	800.00	510.00	0.00
	SD1	0.00	0.00	0.00	0.00	0.00	0.64	0.04	0.62	28.86	212.00	324.00	988.00	548.00	0.00

The table below shows the concentration level of metals - in milligram per 100 gram of fresh sample - present in the different part of the *Cucurbita pepo*. It was calculated from the above table by taking the mean of the triplicates, it must be noted that in the triplicates where only one replicate showed a detection of metal, above in the various section of Cucurbita pepo.

Table. 2. Showing the readings of metal concentration from the atomic absorption spectrophotometer in milligram per 100 gram of fresh sample

Mean of the Concentrations of Metal Elements present in Fresh sample, mg/100g														
Part of plant	**Pb**	**Fe**	**Cu**	**Mn**	**Ni**	**Co**	**Zn**	**Cd**	**Mg**	**Ca**	**Al**	**Na**	**K**	**Cr**
Skin	0.0000	0.1015	0.0000	0.0000	0.0000	0.0657	0.0818	0.0000	6.6056	15.428	360.636	244.0136	383.6412	0.0000
Stem	0.0000	0.0026	0.0000	0.0000	0.0000	0.1866	0.0207	0.0000	8.8652	90.7686	440.7216	295.0383	387.9127	0.0432
Root	0.0000	1.1353	0.0000	0.0102	0.0000	0.3193	0.5763	0.0592	14.1598	111.0495	785.004	100.735	209.4039	0.069
Leave	0.0000	0.4606	0.0000	0.0062	0.1753	0.3622	0.2186	0.1544	25.7431	825.9073	371.8148	71.6900	332.0415	0.1070
Flesh	0.0000	0.9212	0.0000	0.0417	0.0417	0.1168	0.0000	0.0742	4.3815	70.1488	64.3462	149.4780	203.3778	0.022
Seed	0.0000	0.0000	0.0000	0.0000	0.0000	0.3502	0.022	0.3301	16.5028	131.1469	184.4429	459.489	489.1858	0.0000

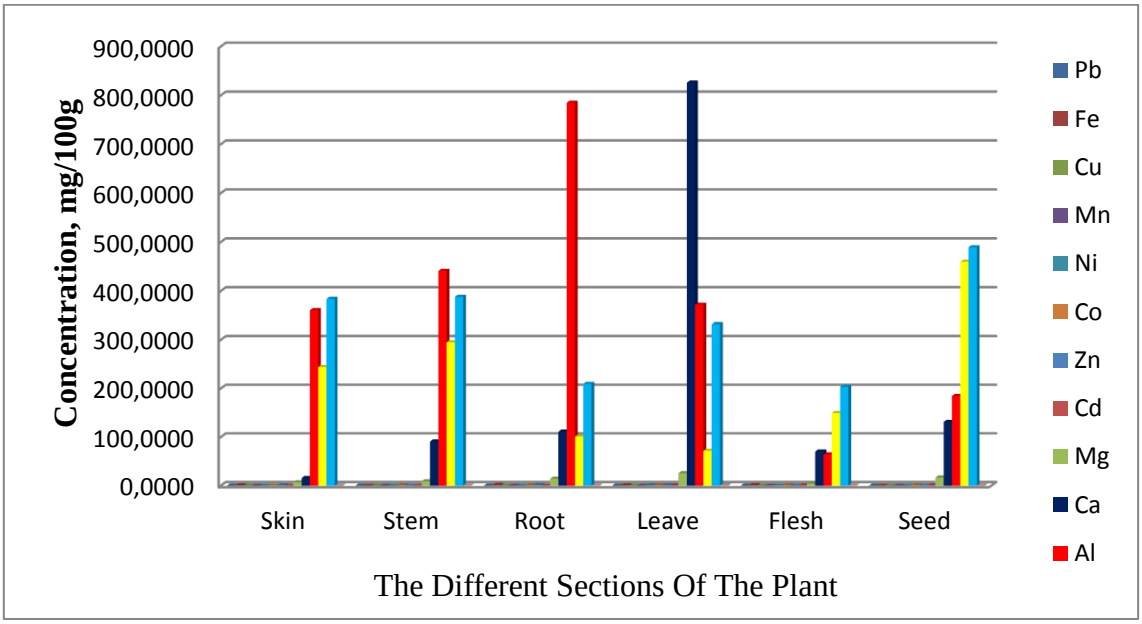

Fig. 2. Graph showing the concentration of all metals elements in various section of Cucurbita pepo.

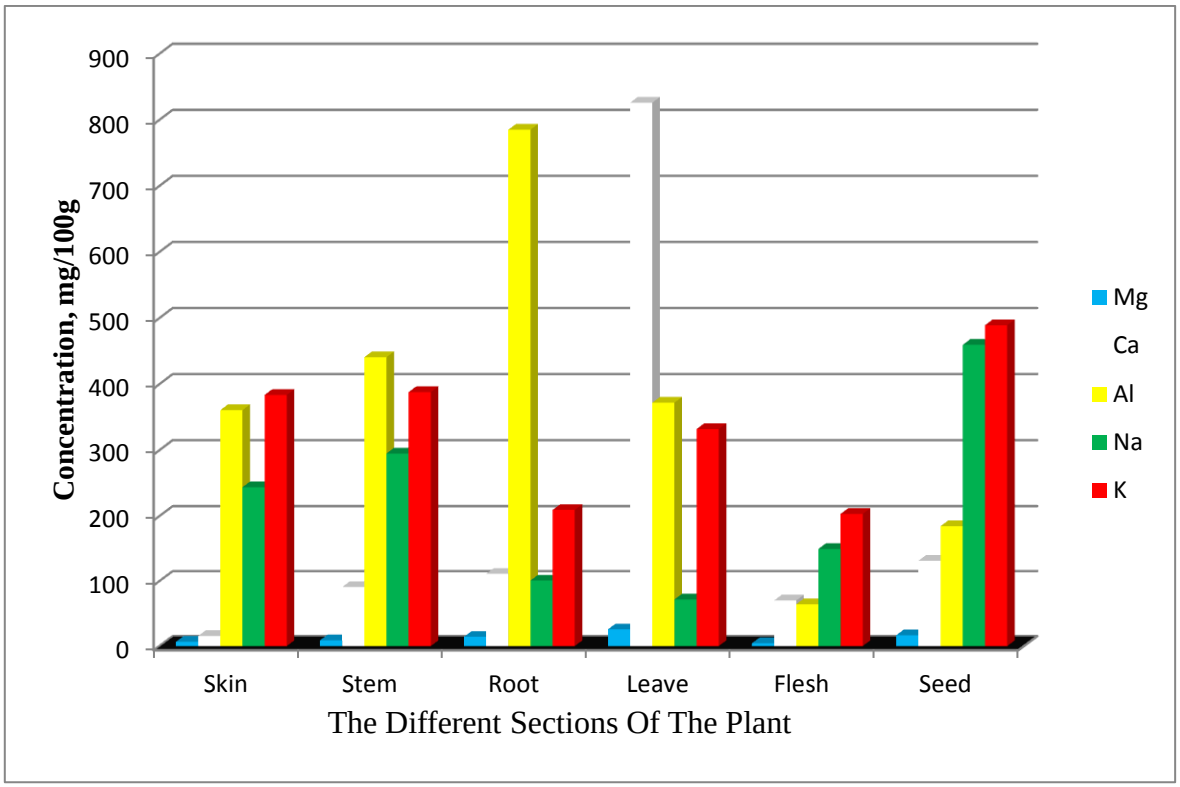

Fig. 3. Graph showing the concentration level of metal elements that are in the 1mg/100g above in the various section of Cucurbita pepo.

3. RESULTS AND DISCUSSION

The graph above shows the concentration level of the metal elements that are higher in concentrations that are present in above 1mg per 100g of fresh sample. These elements are magnesium Mg, calcium Ca, aluminum Al, sodium Na and potassium K. Note that four of the five elements found in this proportion are macro-nutrients and are present in high concentration in the soil. However, aluminum Al is not a macro-nutrient but is found to be very abundant in the soil, so it is accumulated quite easily in plants and vegetables.

A close analysis of the tables 1 shows that the amount of calcium is varying in amount 438 – 413ppm in flesh for different samples but found very high in leaves ranging from 1355 – 1784ppm. This indicates that the leaves are a good source of calcium. The amount of aluminum is normally very high in all samples up to the level of 1739ppm. The other remarkable finding is about potassium which has an amount up to 1274ppm and found in each sample.

4. CONCLUSION

It can be concluded from the data shown above that there was a significant difference in the mean concentration level of metals in the different parts of Cucurbita pepo.

The concentration of Aluminum Al, Magnesium Mg, Calcium Ca, Sodium Na and Potassium K were present in the highest concentration in all the different parts of Cucurbita pepo, while the concentration level of Iron Fe, Manganese Mn, Nickel Ni, Cobalt Co, Zinc

Zn, Cadmium Cd and Chromium Cr were present in minute amounts in all the different parts of Cucurbita pepo. Copper Cu nor Lead Pb were detected in the plant Cucurbita pepo.

Although Aluminum Al was present in such high concentration, it is not toxic because the body readily excretes it as it is ingested. The root cause of this high concentration of Aluminum is because the earth's layer is abundant with this metal.

Magnesium Mg, Potassium K and Calcium Ca were also the highest concentration level to be detected in the squash. However, Potassium K was more prevalent in the squash.

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