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Photochemical Investigation of Flowers and Leaves of Cucurbita Maxima (Pumpkin)

Vishal Mahabir

Chemistry Division, University of Guyana, Berbice Campus, P.O Box 101110 Guyana, South America

Correspondence Author: Vishal Mahabir, Chemistry Division, University of Guyana, Berbice Campus, P.O Box 101110 Guyana, South America.
E-mail:- vishalmahabir19@yahoo.com

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Abstract

There are a number of nutrient metals that are essential to keeping the body healthy. Many of these nutrients are found naturally in organic vegetables and other cereals. Pumpkin is a very common vegetable available mostly throughout the year all over the world. Different parts of pumpkin have different amounts of these metals. Earlier study of the skin, flesh and seed of pumpkin has shown that K, Ca, Mg, P, Zn, Cu, Ni, Fe, Co; and heavy metals, Pb and Cd are present in different amounts (Mahabir and Verma, 2012). These elements were also found in various quantities in pumpkin leave and flower.

The present photochemical study focuses on the flowers and leaves of pumpkin because in many countries people make use of the flowers and soft leaves of pumpkin as a vegetable. The samples collected for this paper originated from three different plants directly from a vegetable farm. The samples were digested by aqua regia method. The flame atomic absorption spectroscopic method was then used to investigate the presence of nutrient elements for each digested sample. Manganese (0.35 ppm), zinc (1.55 ppm), nickel (46.83 ppm), cobalt (14.67 ppm), iron (1.55 ppm), copper (0.52 ppm), magnesium (35.40 ppm) and potassium (425.60 ppm) were found in the leaves. In addition, manganese (0.00 ppm), nickel (104.78 ppm), cobalt (61.64 ppm), iron (0.55 ppm), copper (0.12 ppm), magnesium (22.5 ppm) and potassium (166.40 ppm) were found in the flowers. The hypothesis of this paper is that the degree of naturally occurring zinc and other metals in pumpkin's leaves and flowers is significant enough to warrant special attention as a nutritional inhibitor of prostate cancer and other illnesses, respectively (Franz, 2013).

Keywords: AAS, Cucurbita Maxima, Metal Analysis

INTRODUCTION

This research entails the analysis of the trace elements, Fe, Cu, Zn, Co, Ni, Mg, K, Mn. The flower and leaf samples used are the flowers and leaves from a number of pumpkin plants on the same farm. This study aims to make inferences on whether the elements of interest are in the category of heavy metals or elements of potential nutritional and health benefits. Also, there is the intention of providing information on the percentage daily value (% DV) of the elements of nutritional importance, if any, and those that are potentially harmful. If found to be sufficiently beneficial, further studies may ultimately promote and encourage the use of pumpkin leaves and flowers in daily diet. The avenue will be explored in terms of establishing the link between the elements relative to their health benefits. Flame Atomic Absorption Spectrophotometry (FAAS) will be used for the determination of the elements under study, K, Mg, Mn Cu, Fe, Zn, Co, Ni.

METHOD

The aim of the digestion was to solubilize the elements of interest in the pumpkin leaf and flower samples. The digestion process is a combination of oxidation/destruction of organic matter and dissolution of the mineral phase to a certain extent to bring the elements into solution. In the procedure, samples were treated with a mixture of concentrated nitric acid and hydrochloric acid.

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This formed nitrohydrochloric acid (NOCl), according to equation 1, which had a strong oxidizing effect and gave almost complete dissolution of organic samples. The NOCl destroyed the organic matter to give carbon dioxide and water.

$3\ HCl + HNO_3 \longrightarrow 2\ H_2O + NOCl + Cl_2$ eq. 1

Also, as part of the digestion, hydrogen peroxide was used. Under acidic conditions hydrogen peroxide undergoes an equilibrium reaction to give hydroxyl radical (equation 2), which aided in oxidation of organic matter.

$H_2O_2 + H^+ \longleftrightarrow H_2{}^+OOH \longleftrightarrow H_2O + {}^{\cdot}OH$ eq. 2

The hydrogen peroxide was also added to remove any NOCl that was present.

COLLECTION AND PREPARATION OF SAMPLES

Samples of leaves and flowers from a number of pumpkin plants were harvested from Mr. David Lall's farm in Canefiled Canje, Berbice, Guyana, South America. The samples were washed to remove all dirt and foreign matter. A fresh sample of the leaves was dried at 105 to 110^{0}C in an oven until constant weight was achieved. The dried sample was ground and mixed thoroughly, and then three (3) 1.0 g portions were placed separately into 250 ml conical flasks. Portions of a prepared 1500 ml to 500 ml ratio of concentrated hydrochloric acid, nitric acid mixture was added periodically to each flask along with 10-15 ml hydrogen peroxide, and digestion at about 110^{0}C was allowed until there was a total volume of about 1-2 ml clear solution. After cooling, 10 ml of deionized water was added, and each sample was filtered through Whatman #1 filter paper into 100 ml volumetric flasks. These were made up to volume with deionized water that was also used to rinse the flasks and filter papers. The same procedure of digestion was repeated for the flowers. A sample blank containing all the reagents except the sample, was also digested simultaneously under similar conditions as for the samples, and made up to 100 ml with deionized water.

Identification of Elements present in the samples by Flame Atomic Absorption Spectrophotometry (FAAS)

In this technique the liquid sample was aspirated, i.e. aerosolized and mixed with combustible gases such as air acetylene. The mixture was ignited in a flame whose temperature reached from 2100 to 2800^{0}C. In the combustion process the atoms of the elements of interest in the sample were reduced to free unexcited ground state atoms that absorbed light at a characteristic wavelength as illustrated in fig. 1 below. The characteristic wavelength of the elements is specific and accurate to 0.01 to 0.10 nm. To provide the element with specific wavelengths, a light beam from a lamp whose cathode is made of the element being determined, was passed through the flame. In addition, the slit widths for each element were set. Then a device such as a photomultiplier was used to detect the reduction in the intensity of light due to absorption by the analyte, which is directly related to the concentration of the element in the sample.

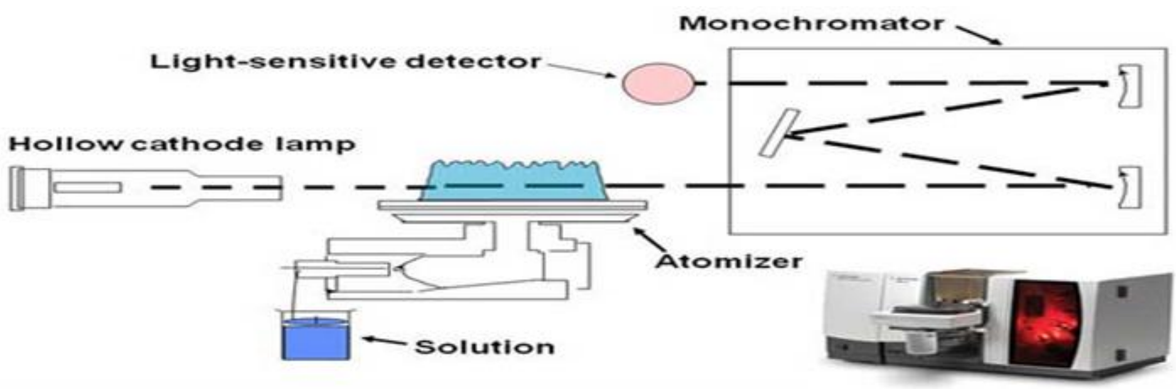

Fig. 1: Operation principle of an atomic absorption spectrometer

Apparatus

- Hot plate
- 100 ml volumetric flasks, 200 ml beakers, filter funnel and graduated cylinders, 50 and 100 ml capacity.
- Whatman #1 filter papers, teat pipette
- Analytical balance with ± 0.0001 g precision for weighing of samples
- Atomic Absorption Spectrophotometer

Materials

- Hydrogen peroxide solution, 35%
- Nitric acid, 70%
- Hydrochloric acid, 36%
- Deionized water

- Standard solutions for elements under study

RESULTS

Table 1: Showing the Distribution of Elements per 100 Grams of Fresh Leaf Sample

Elements	mg per 100 grams fresh leaf and % Daily Value (% DV)		
	Leaf	DV	% DV
Manganese	0.35	2	17.50
Iron	1.55	18	8.61
Magnesium	35.40	400	8.85
Copper	0.52	2	26.00
Zinc	0.85	15	5.67
Cobalt	14.67	No DV	Unknown
Nickel	46.83	No DV	Unknown
Potassium	425.60	3500	12.16

Table 2: Showing the Distribution of Elements per 100 Grams of Fresh Flower Sample

Elements	mg per 100 grams fresh flower and % Daily Value (% DV)		
	Flower	DV	% DV
Manganese	~	2	~
Iron	0.55	18	3.06
Magnesium	22.50	400	5.63
Copper	0.12	2	6.00
Zinc	0.05	15	0.33
Cobalt	61.64	No DV	Unknown
Nickel	104.78	No DV	Unknown
Potassium	166.40	3500	4.75

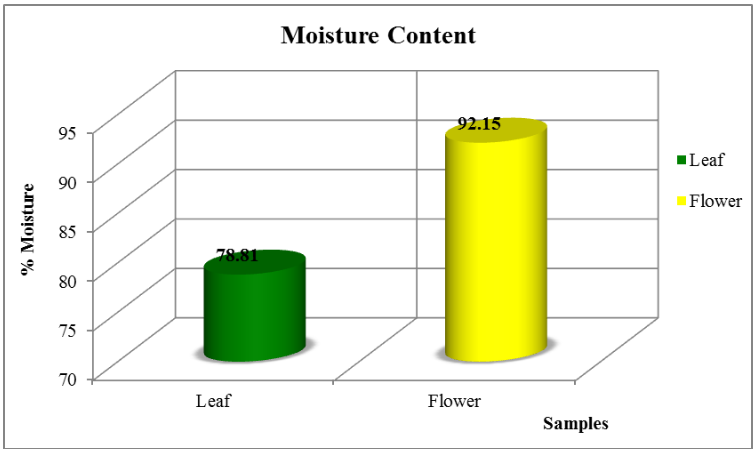

Fig. 1: Illustrating the Percentage Moisture Content

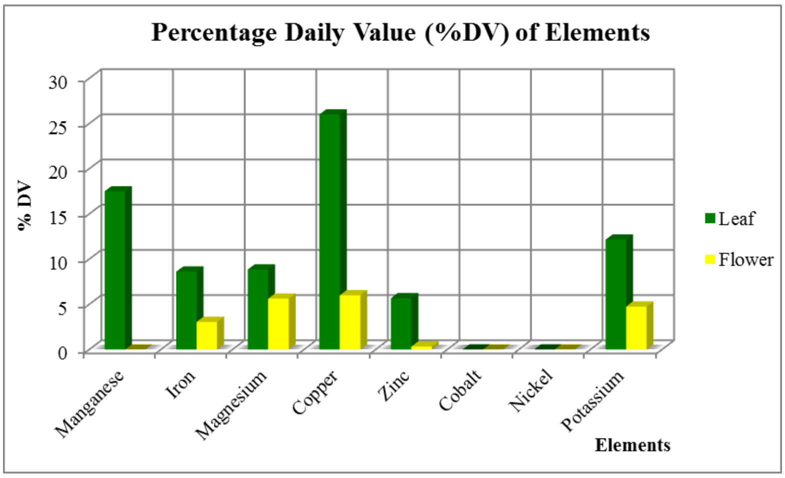

Fig. 2: Illustrating the % Daily Value of the Elements

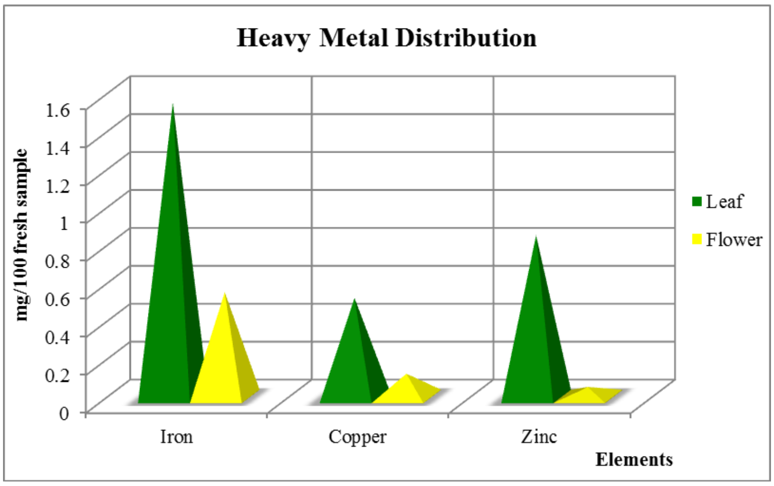

Fig. 3: Illustrating the Distribution of Iron, Copper and Zinc

DISCUSSION

Negative values were obtained for the elements, Cu, Fe and Zn in all the samples, which implied that those elements were not detected. This was a certain error because according to literature, the leaves and flowers of the pumpkin plant contain the elements, Cu, Fe and Zn. Firstly; it was suspected that it was because of the industrial grade HCl that was used for the digestions. Hence, suspected contamination with compounds containing one or more of the elements being analyzed for was possible. However, the HCl was used both in the preparation of the samples and sample blank, and in addition, the AAS instrument corrected for such, by zeroing itself after reading the sample blank. Therefore, it was observed that the range of the standards used for those particular elements, Zn, Fe, Cu, was too wide, since they were not detected (negative readings). The range being too wide would have resulted in the elements not being detected because they may have been in very small quantities and would have therefore fall out of the calibration curve initially constructed. The initial range used was 1ppm, 2ppm, 3ppm, 4ppm, and 5ppm of Zn, Fe and Cu. A smaller range of standards was prepared (0.25ppm, 0.50ppm, 0.75ppm, 1ppm, 2ppm) which resulted in positive concentration readings for Zn, Fe and Cu.

The moisture content of the flower samples were higher averaging around 90 % moisture, followed by the leaf samples which contained about 78 % moisture. This high moisture content of the flower, which can be used as a food additive, suggests a good food source in water, hence, low fat content. The significantly different moisture content of the leaf gives a good explanation of why the concentrations of the minerals were found to be higher in the leaf than flower samples. The higher the water content of the sample, the lower was the mineral content (Mahabir and Verma, 2012)

There was a small difference in the quantity of the minerals in the samples compared to those from the literature reviewed. For instance, according to extant literature, 100 grams of raw pumpkin leaves contain 436.0 mg of potassium (K) and 38.0 mg magnesium (Mg) that represents 12 % and 10 % of the daily value of K and Mg, respectively (Naste, 2012). However, this research found a quantity of 425.6 mg potassium and 35.4 mg of magnesium per 100 grams of raw/fresh pumpkin leaves that demonstrates a daily value of 12.16 % and 8.85 % potassium and magnesium, respectively.

This trend was observed for all the other elements although there were marginally smaller amounts than recorded in previous published research. The difference in soil types, use of fertilizers, like N, P, K, and various climatic conditions are possible variables for the difference. For example, Mr. David Lall cultivates only organic crops; hence, no fertilizers were used. This can account for the smaller quantity of K found in the leaves. Human activities such as farming and different levels of pollution would have had an impact on the soil's nutritive value. It should be noted that the trend explained above was similar for the flower samples. The conclusion may thus be drawn that the aqua regia method as well as the triplicate analysis employed in this research are effective research tools.

Iron (Fe) is an essential part of hemoglobin that is responsible for the transportation of oxygen to cells and tissues of the human body. It is also an important nutrient for females especially during their menstrual cycle and in post-natal circumstances because iron is known to assist in reinvigorating red blood cells. Zinc (Zn) helps to promote cell reproduction, tissue growth and repair and wound healing. Magnesium is an essential part of more than 300 enzymes in the body. Enzymes are tasked with the regulation of many body functions such as movement, digestion, and blood circulation. Copper (Cu) helps in the generation of energy in every cell throughout the body. Another important mineral, potassium (K), is responsible for the regulation of body fluids and in maintaining mineral balance within and without of body cells. Potassium is also vital in maintaining blood pressure, transmitting nerve impulses and helping fatigue-prone and non-fatigue muscles to contract.

The elements copper (Cu) and zinc (Zn) are not present in the flowers of the pumpkin plant (Naste, 2012). Hence, Cu and Zn do not exist naturally in pumpkin flowers. However, there was 0.12 mg and 0.05 mg of Cu and Zn, respectively, per 100 grams of raw flower. This suggests that there is some level of pollution by *free* Cu and Zn on Mr. David Lall's farm, whether it is soil, air or water pollution. However, these elements were in quantities that are below the level that is harmful to human beings. Quantities of Cu above 2.0 mg/L can be toxic, but the levels found in the leaves and flowers are below 2.0 mg/L. However, free Cu is toxic for aquatic life. For instance, levels of 58 mg/L and 70 mg/L are toxic for tilapia and catfish, respectively. It causes damage to the gills, liver, kidneys and nervous systems of these aquatic species. It also affects the sense of smell of the fishes, which affects mating chances. Zinc is toxic at levels of 225 mg/L. The effects of Zn toxicity are the suppression of Cu and Fe absorption in aquatic life. Free Zn is toxic to bacteria, plants, invertebrates and vertebrate fishes. The occurrence of Cu and Zn pollution in the pumpkin flower can be explained by the fact that there is a canal situated immediately along the farmland. Sugar boats frequently use this canal to transport sugar and fuels. The possible detrimental effects of fuel leakage and the pollution from these boats implications should be investigated in further research.

Scientific Pictures

Ground dry flower sample

Digestion started

Digestions approaching completion

Samples being analyzed by AAS

CONCLUSION

The elements Mn, Fe, Mg, Cu, Zn, Co, Ni, K were all present in the leaves and flowers of the pumpkin plant with the exception of Mn. Manganese, as expected was not found to be in the flower sample. The minerals were in higher concentrations in the leaf relative to those found in the flower which correlates with the moisture contents of the two samples. The flowers and leaves of the pumpkin plant studied can be of nutritional benefit since all elements were presents in safe quantities. Thus, the leaves and flowers of the pumpkin plant should be incorporated into the daily diet of Berbicians. The mere presence of the metals Cu and Zn in the flowers raise the possibility of contamination, although their quantities are within safe limits. Hence, the soil and immediate surroundings should be investigated to assess risk factors.

Finally, a significant number of health benefits and medicinal properties of the leaves and flowers are justified as a result of qualifying the elements studied.

REFERENCES

Aggett P. J, 1980. Trace Elements in Human Nutrition, Journal of Tropical Paediatrics.

Duran R. H, Shahnaz I., Shaikh G.H, 2007. Assessment of the level of trace metals in commonly edible vegetables locally available in the markets of Karachi City, Centre for environmental Studies, PCSIR Laboratories Complex, Shahrah-e-Dr.Salimuzzaman Siddiqui, Karachi-75280, Pakistan.

Hart A.D, Oboh C.A, Barimalaa I.S, Sokari T.G, 2000. Concentrations of trace metals (lead, iron, copper and zinc) in crops harvested in some oil prospecting locations in rivers state, Nigeria, African Journal of Food Agriculture Nutrition and Development.

Iva J., Patrick B., Ilse S., 2002. Determination of trace elements in pumpkin seed oils and pumpkin seeds by ICP-AES, J. Anal. At. Spectrum. 18, 54–58.

Mahabir V., Verma V. N., 2012. Application to Atomic Absorption Spectroscopy in Food Science: A Study on Cucurbita Maxima (Pumpkin), APCBEES Procedia, Elsevier, Vol 2: 135-140.

Sule D., Mustafa T., Sibel S., Mustafa S., 2008. Evaluation of various digestion procedures for trace element contents of some food materials, Science Direct, Journal of Hazardous Materials 152 1020–1026

Walter M., 1981. The Essential Trace Elements, Vol. 213, No. 4514, pp. 1332-1338, AAAS

Yusuf A. A, Adewuyi S. and Lasisi A. A, 2006. Physico-Chemical Composition of Leaves, Meals and Oils of Fluted Pumpkin (*Telfairia occidentalis*) and Melon (*Citrillus vulgaris*), Agriculture Journal 1 (1): 32-35.

http://www.nutritiondata.self.com/facts/vegetables-and-vegetable-products/2598/2 (Conde Naste, 2012)