ELEMENTAL ANALYSIS OF LAYERS OF ONION

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Abstract

The individual layers of an onion have been analysed using EDX-7000 to study the elements contained in each layer and the change in concentrations of elements according to layer positions. The major elements found in each layer are potassium, sulphur and copper.

Keywords: Onion, EDXRF, Elemental Analysis

Introduction

Minerals are important for our body to stay healthy. Our body uses minerals for many different jobs, including keeping our bones, muscles, heart, and brain working properly. Minerals are also important for making enzymes and hormones.

There are two kinds of minerals: macrominerals and trace minerals. We need larger amounts of macrominerals. They include calcium, phosphorus, magnesium, sodium, potassium, chloride and sulfur. We only need small amounts of trace minerals. They include iron, manganese, copper, iodine, zinc, cobalt, fluoride and selenium. Most people get the amount of minerals they need by eating a wide variety of foods.

Onions are cultivated and consumed across the world. They are usually served cooked. They can also be eaten raw and are used in pickles and chutneys. The onion has a strong taste and a sharp, pungent flavor. Though it is a temperate crop, it can be grown under a wide range of climatic conditions.

Onions are super-healthy. They are excellent sources of vitamin C, sulphuric compounds, flavonoids and phytochemicals. They contain sulfur**,** potassium**,** protein**,** vitamin A, vitamin C, calcium and iron**.** Onions' sulfurs may be effective anti-inflammatory agents. Onions encourage a healthy heart in many ways, including lowering blood pressure and lowering heart attack risk.

We have tried to embody the concentrations of elements in various layers of onion and how the value changes from outer layer to inner layer. Interestingly it is found that onion contains precious macrominerals and the concentration changes from layer to layer.

Theoretical Background

X-ray Fluorescence Analysis

X-ray fluorescence (XRF) analysis is a powerful analytical tool for the elemental analysis of almost all the elements present in a sample. XRF radiation is induced when photons of sufficiently high energy, emitted from an x-ray source, impinge on a material. These primary x-rays undergo interaction processes with the analyte atoms. High-energy photons induce ionization of inner shell electrons by the photoelectric effect and thus electron vacancies in inner shells (K, L, M,…) are created.

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The creation of a vacancy in a particular shell results in a cascade of electron transitions, all correlated with the emission of photons with a well-defined energy corresponding to the difference in energy between the atomic shells involved. The family of characteristic x-rays from each element including all transitions allows the identification of the element.

The working principle of XRF analysis is the measurement of wavelength or energy and intensity of the characteristic x-ray photons emitted from the sample. This allows the identification of the elements present in the sample and the determination of their mass or concentration. All the information for the analysis is stored in the measured spectrum. In energy dispersive x-ray fluorescence analysis (EDXRF), the result is an x-ray energy vs intensity spectrum [Jekins RE 1999].

X-Ray Fluorescence (XRF) Instrumentation

The incident x-ray beam is typically produced from a Rh target. Various types of detectors are used to measure the intensity of the emitted beam. The flow counter is commonly utilized for measuring long wavelength (> 0.15 nm) x-rays that are typical of K spectra from elements lighter than Zn. The scintillation detector is commonly used to analyze shorter wavelengths in the x-ray spectrum (K spectra of element from Nb to I; L spectra of Th and U). X-rays of intermediate wavelength (K spectra produced from Zn to Zr and L spectra from Ba and the rare earth elements) are generally measured by using both detectors.

The x-ray tube consists of a vacuum enclosure containing an electron source and target anode. A thin window is mounted in the vacuum wall to allow the x-rays to exit the tube enclosure. Commercial tubes are typically manufactured from glass, although metal tubes with glass or ceramic electrical insulators are common. The exit window is typically a thin beryllium (Be) foil. The electron beam is generated using a thermionic cathode and is accelerated toward the anode by an electrostatic potential of typically 30-100 keV. In most applications the acceleration voltage is achieved with the anode assemble at ground potential and with the insulated cathode assembly at the appropriate negative high voltage.

EDXRF is relatively simple and inexpensive compared to other techniques. It requires and x-ray source, (50-60) kV, (50-300) W x-ray tube. The second major component is the detector, which must be designed to produce electrical pulses that vary with the energy of the incident x-rays. Most laboratory EDXRF instruments use liquid nitrogen or Si(Li) detectors [Rene E, Van Grieken, Andrzej 1993.].

Main Specifications of Shimadzu EDX-7000 Spectrometer

Measurement principle	X-ray fluorescence spectrometer
Measurement method	Energy dispersive
Target samples	Solids, liquids, powders
Measuring range	11 Na to 92 U

X-ray Generator (EDX-7000)

X-ray tube	Rhodium (Rh) target
Voltage	4 kV to 50 kV
Current	1μA to 1000 μA

Cooling method	air cooling (with a fan)
Irradiated area	10 mm diameter (standard)
Primary filters	Automatic selection from among 5 types of filter

Detector

Type	Silicon drift detector (SDD)

Sample Chamber

Measurement Atmosphere	Air, vacuum, helium
Sample replacement	12- sample turret
Sample observations	Semiconductor camera

Sample Collection and Preparation

Red onions, cultivated in Myit-Thar region, were bought from local market. Onion layers were cut into small round pieces of 1 cm diameter. The bottom of the cell is covered with film, and the samples were put into the cell, and covered with film again. The cells were put into chamber and analysed.

Results and Discussions

The elemental concentrations of various layers of onion are shown in Table 1 and the respective graph is shown in Figure 1. Major elements found are potassium, sulfur and calcium. The minor element found is copper.

The comparison of potassium contained in individual layers of onion is shown in in Figure 2. Potassium concentration becomes larger from outer layer to inner layer. The highest concentration of potassium is found in second innermost layer.

The comparison of calcium contained in individual layers of onion is shown in Figure 3. Calcium concentration becomes smaller from outer layer to inner layer. Calcium is not detected in the two innermost layers.

The comparison of sulfur contained in individual layers of onion is shown in Figure 4. Sulfur concentration becomes larger from outer layer to inner layer. The highest concentration of sulfur is found in second innermost layer.

The comparison of copper contained in individual layers of onion is shown in Figure 5. Copper concentration is the same in all layers. The concentration is greatest in third layer.

Conclusion

Potassium lowers blood pressure, protects against loss of muscle mass, preserves bone mineral density, and reduces the formation of kidney stones.

Our body needs calcium to build and maintain strong bones. Our heart, muscles and nerves also need calcium to function properly.

Sulfur makes up vital amino acids used to create protein for cells, tissues, hormones, enzymes, and antibodies. Sulfur is needed for insulin production.

Copper is essential for infant growth, bone strength, red and white blood cell maturation, iron transport, cholesterol and glucose metabolism, heart muscle contraction and brain development.

From our study, onion is found to contain essential macrominerals. Minerals concentration changes from layer to layer. Doing more research on this may develop a relation between the layer position and mineral concentration.

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Table 1 Elemental Concentration (W%) of Onion layers

Element	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
K	0.042	0.058	0.088	0.113	0.069
Ca	0.018	0.017	0.015	0.000	0.000
S	0.046	0.046	0.049	0.053	0.050
Cu	0.001	0.001	0.002	0.001	0.001

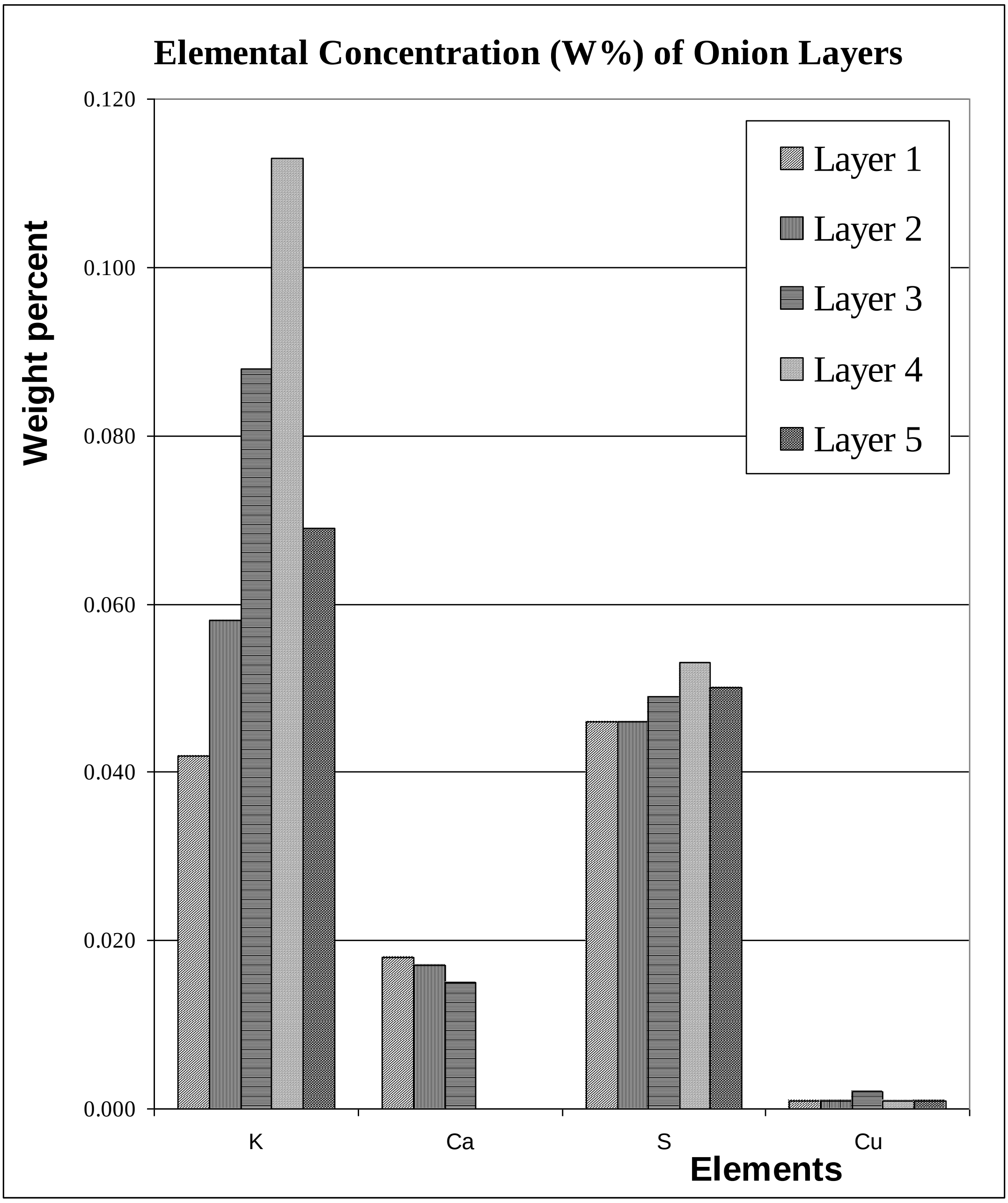


Figure 1 Elemental Concentration (W%) of Onion layers

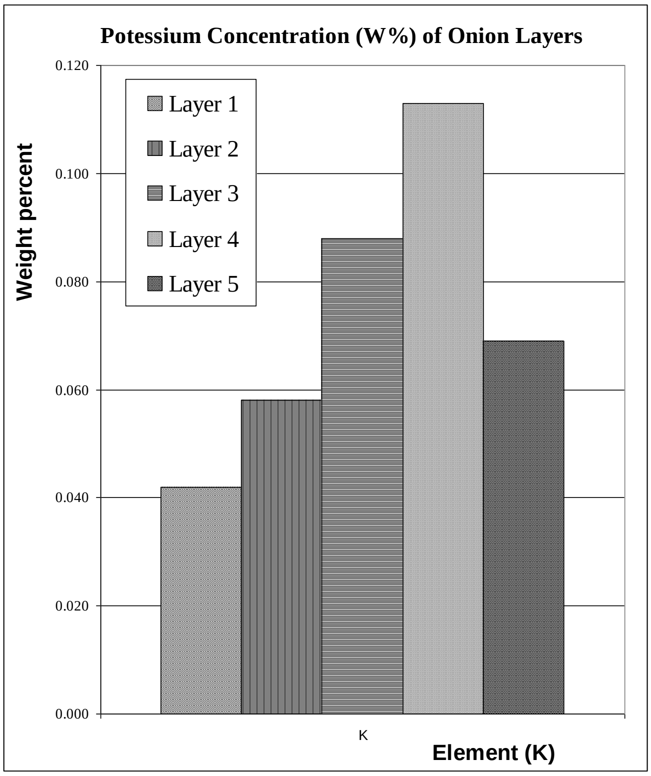


Figure 2 Potassium Concentration (W%) of Onion layers

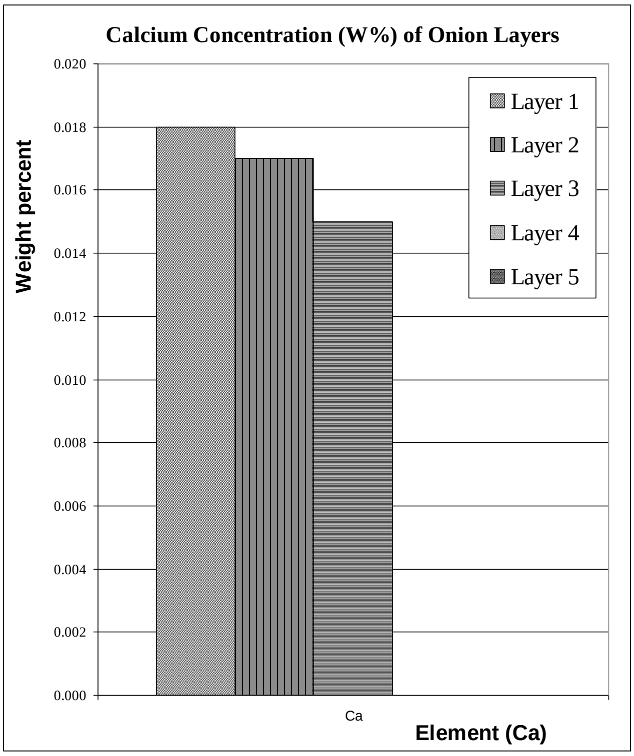


Figure 3 Calcium Concentration (W%) of Onion layers

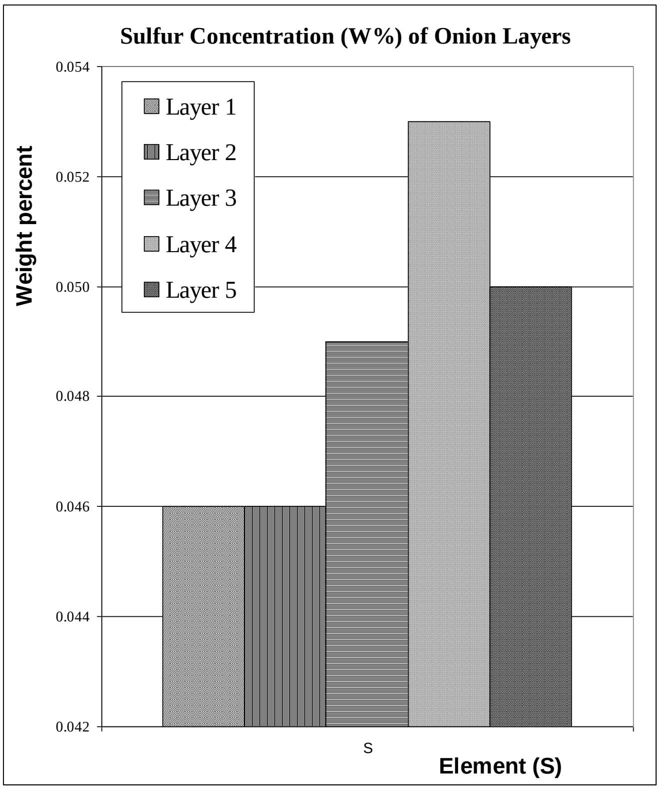


Figure 4 Sulfur Concentration (W%) of Onion layers

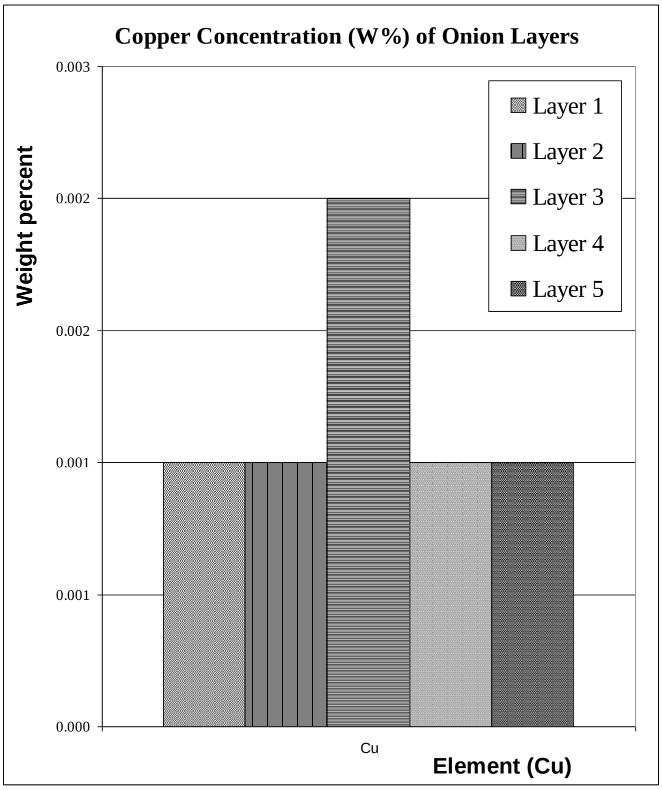


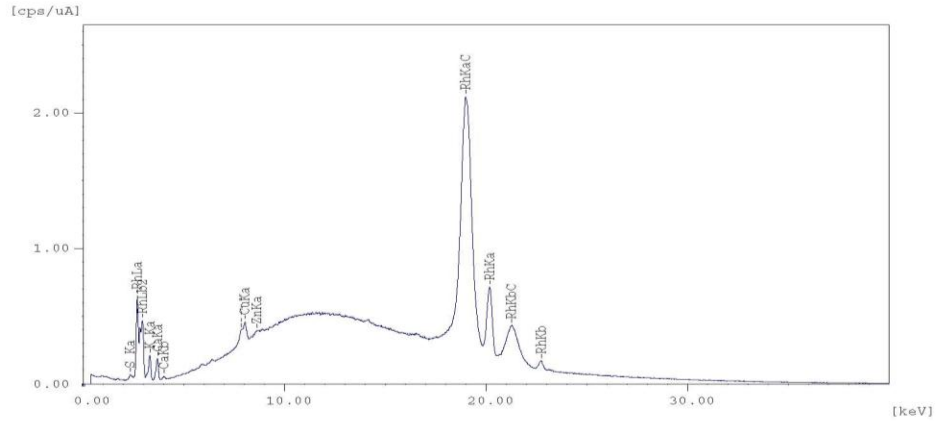
Figure 5 Copper Concentration (W%) of Onion layers

Sample : Onion Shell-1
Operator: DRWLO
Comment : with mylar film
Group : FP Balance_5mm
Date : 2019-01-10 12:55:46

Measurement Condition

Instrument: EDX-7000 Atmosphere: Air Collimator: 5(mm) Sample Cup:Mylar

Analyte	TG	kV	uA	FI	Acq.(keV)	Anal.(keV)	Time(sec)	DT(%)
Al-U	Rh	50	137-Auto	----	0 - 40	0.00-40.00	Live- 100	29



Qualitative Result

Element: S , Rh, K , Ca, Cu, Zn

Quantitative Result

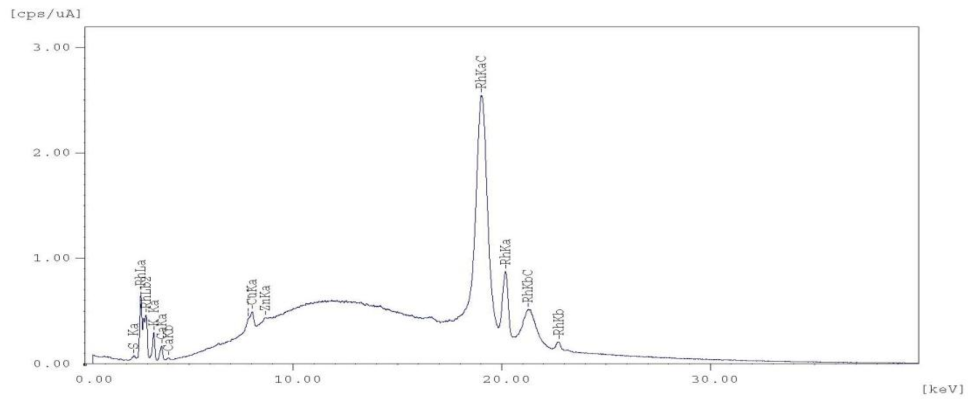
Analyte	Result	[3-sigma]	Proc.-Calc.	Line	Int.(cps/uA)
S	0.046 %	[0.004]	Quan-FP	S Ka	0.2669
K	0.042 %	[0.001]	Quan-FP	K Ka	1.0781
Ca	0.018 %	[0.000]	Quan-FP	CaKa	0.9367
Cu	0.001 %	[0.000]	Quan-FP	CuKa	1.5772
Zn	0.000 %	[0.000]	Quan-FP	ZnKa	0.3821
CH	99.892 %	[------]	Balance	--------	--------

Sample : Onion Shell-2
Operator: DRWLO
Comment : with mylar film
Group : FP Balance_5mm
Date : 2019-01-10 12:58:25

Measurement Condition

Instrument: EDX-7000 Atmosphere: Air Collimator: 5(mm) Sample Cup:Mylar

Analyte	TG	kV	uA	FI	Acq.(keV)	Anal.(keV)	Time(sec)	DT(%)
Al-U	Rh	50	118-Auto	----	0 - 40	0.00-40.00	Live- 100	29



Qualitative Result

Element: S , Rh, K , Ca, Cu, Zn

Quantitative Result

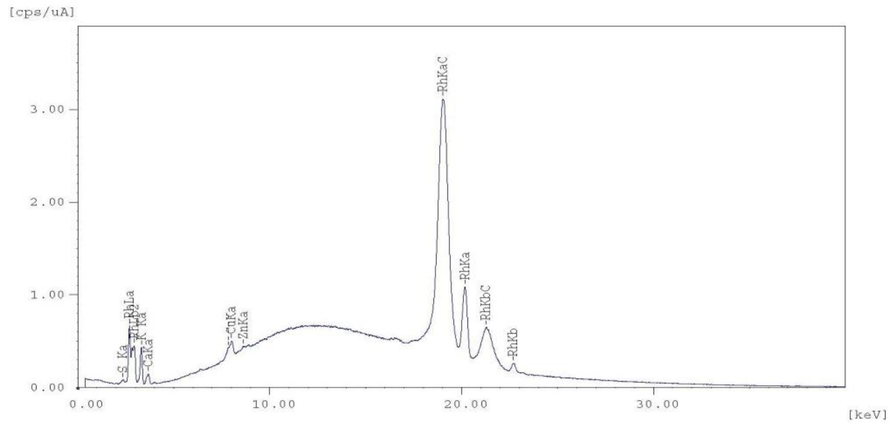
Analyte	Result	[3-sigma]	Proc.-Calc.	Line	Int.(cps/uA)
K	0.058 %	[0.001]	Quan-FP	K Ka	1.4955
S	0.046 %	[0.004]	Quan-FP	S Ka	0.2670
Ca	0.017 %	[0.001]	Quan-FP	CaKa	0.8426
Cu	0.001 %	[0.000]	Quan-FP	CuKa	1.7414
Zn	0.000 %	[0.000]	Quan-FP	ZnKa	0.4861
CH	99.877 %	[------]	Balance	--------	--------

Sample : Onion Shell-3
Operator: DRWLO
Comment : with mylar film
Group : FP Balance_5mm
Date : 2019-01-10 13:01:00

Measurement Condition

Instrument: EDX-7000 Atmosphere: Air Collimator: 5(mm) Sample Cup:Mylar

Analyte	TG	kV	uA	FI	Acq.(keV)	Anal.(keV)	Time(sec)	DT(%)
Al-U	Rh	50	104-Auto	----	0 - 40	0.00-40.00	Live- 100	30



Qualitative Result

Element: S , Rh, K , Ca, Cu, Zn

Quantitative Result

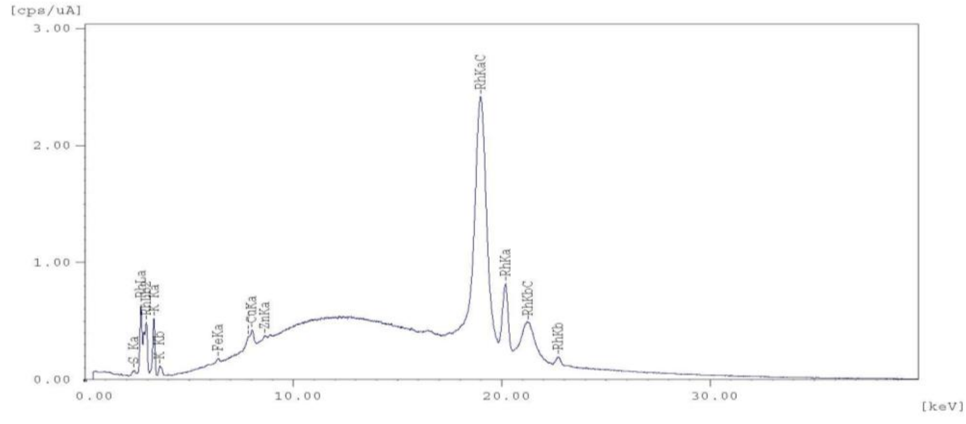
Analyte	Result	[3-sigma]	Proc.-Calc.	Line	Int.(cps/uA)
K	0.088 %	[0.002]	Quan-FP	K Ka	2.2576
S	0.049 %	[0.005]	Quan-FP	S Ka	0.2801
Ca	0.015 %	[0.001]	Quan-FP	CaKa	0.7620
Cu	0.002 %	[0.000]	Quan-FP	CuKa	1.7792
Zn	0.000 %	[0.000]	Quan-FP	ZnKa	0.4276
CH	99.847 %	[------]	Balance	--------	--------

Sample : Onion Shell-4
Operator: DRWLO
Comment : with mylar film
Group : FP Balance_5mm
Date : 2019-01-10 13:03:36

Measurement Condition

Instrument: EDX-7000 Atmosphere: Air Collimator: 5(mm) Sample Cup:Mylar

Analyte	TG	kV	uA	FI	Acq.(keV)	Anal.(keV)	Time(sec)	DT(%)
Al-U	Rh	50	130-Auto	----	0 - 40	0.00-40.00	Live- 100	30



Qualitative Result

Element: S , Rh, K , Fe, Cu, Zn

Quantitative Result

Analyte	Result	[3-sigma]	Proc.-Calc.	Line	Int.(cps/uA)
K	0.113 %	[0.002]	Quan-FP	K Ka	2.8956
S	0.053 %	[0.004]	Quan-FP	S Ka	0.3042
Cu	0.001 %	[0.000]	Quan-FP	CuKa	1.4763
Fe	0.000 %	[0.000]	Quan-FP	FeKa	0.2513
Zn	0.000 %	[0.000]	Quan-FP	ZnKa	0.3786
CH	99.833 %	[------]	Balance	--------	--------

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Sample   : Onion Shell-5
Operator: DRWLO
Comment  : with mylar film
Group    : FP Balance_5mm
Date     : 2019-01-10 13:06:12
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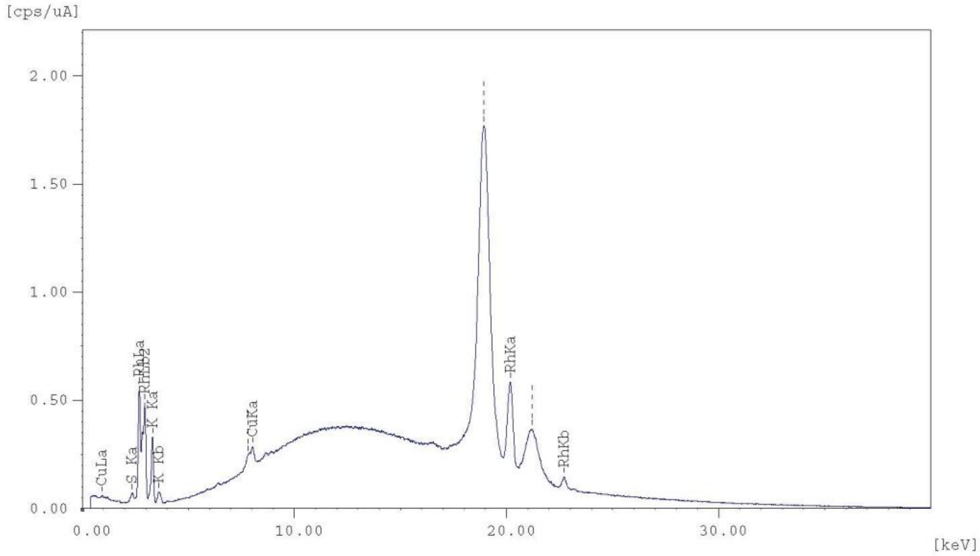
Measurement Condition

Instrument: EDX-7000	Atmosphere: Air	Collimator: 5(mm)	Sample Cup:Mylar					
Analyte	TG kV	uA	FI	Acq.(keV)	Anal.(keV)	Time(sec)	DT(%)
Al-U	Rh 50	171-Auto	----	0 - 40	0.00-40.00	Live- 100	29



Qualitative Result

Element: Cu, S , Rh, K

Quantitative Result

Analyte	Result	[3-sigma]	Proc.-Calc.	Line	Int.(cps/uA)
K	0.069 %	[0.001]	Quan-FP	K Ka	1.7709
S	0.050 %	[0.003]	Quan-FP	S Ka	0.2905
Cu	0.001 %	[0.000]	Quan-FP	CuKa	0.9096
CH	99.880 %	[------]	Balance	--------	--------