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ELEMENTAL ANALYSIS OF FRUIT PEELS USING ATOMIC ABSORPTION SPECTROSCOPY

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ABSTRACT

Fruit Peel is a waste material of various fruit and vegetables and there was different method to obtain element concentration in fruit peel. Different papers were reviewed for elemental analysis of fruit peels using AAS as one of measurements in nutritional value determination for those fruit peels. The result shows that the concentration of the element was different even for the same fruit peels in different paper.

KEYWORDS: *Fruit Peel, AAS, Minerals, Fruit*

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INTRODUCTION

Global fruit production and consumption have experienced a remarkable increase worldwide because of taste and health benefits due to the presence of nutrients such as minerals, vitamins, fiber and other bioactive compounds needed by the human body for a healthy life (Fernandez-Hernandez1 et al 2010, Anna et al 2019) However, the increase in consumption of these fruits indicates an increase in the volume of waste generated, especially peels and seeds. Food waste is the major problem worldwide; therefore, the study of peel and seed of fruits can reveal important natural sources of nutrients and country economic indexes (Berto et al 2015). This output has been growing at an annual rate of about 3 percent over the last decade. In 2011, almost 640 million tonnes of fruits were gathered throughout the world. India is the second largest producer of fruits after China, with a production of 81,285 million tonnes of fruits from an area of 6,892 million hectares. A large variety of fruits is grown in India, among which banana (32.6 %), mango (22.1%), citrus (12.4%) and pawpaw (6.6%) are the major ones (Indian Horticulture Database, 2013). Under the recommendation of WHO, a minimum daily intake of 400 g of fruit and vegetables must be observed, based on evidence that higher levels were protective against cardiovascular diseases and some cancers. This recommendation has led to the launch of the ‘5-a-day’fruit and vegetable campaign in many countries leading to an increase in fresh fruits consumption. In the other hand, because most of the fruits are seasonal and have low shelf-life, the majority of the fruits produced are processed to extend their availability all over the year. So fruits are usually processed into bottled fruits, juices, jams, marmalades, jellies, bars, pickles, dried or crystallized fruits, etc(UNIDO (2004) However, fruits processing generates a great amount of wastes which does not used for food in different country of the world. (https://www.researchgate.net/publication/326579276_Chemical_composition_of_some elec ed_frui _peels [accessed Oct 09 2020]).

Vegetables and fruits are extremely important in human nutrition. They provide us important nutrients, minerals, dietary fiber, antioxidants and other beneficial phyto chemicals. Vegetable are available almost throughout a year in a wide variety and used fresh, cooked and pickled. A growing number of scientific investigations have revealed that vegetable consumption is clearly linked with good health and reduced risk of diseases.

However, 40% of this production is wastes; mainly (Emaga et al. 2011). Peel is a waste material of various fruit and vegetables. Therefore, it is possible to obtain banana peel sufficiently and application depends on its chemical compositions. In addition, peels and seeds can present higher nutrient content. According to Morais et al 2015 and Moo-Huchin et al 2015 *peels* are highly perishable, mainly due to the large amount of water in their composition. Moreover, they have a wide range of vitamins and minerals present in both pulps and peels.

Objective

- **General Objective**

The objective of this paper review was to review elemental analysis of fruit peels using AAS as one of measurements in nutritional value determination for those fruit peels.

- **Specific Objective**
- To show the contents and distributions of the elements like Zn, Cu, K, Ca, Mg, Mn, Pb, Cd, Cr and Se elements in different fruits peels.
- To compare values of elemental composition among different fruit peels

LITERATURE REVIEW

Fruit

In botany, a fruit is the seed-bearing structure in flowering plants (also known as angiosperms) formed from the ovary after flowering. Fruits are the means by which angiosperms disseminate seeds. Edible fruits, in particular, have propagated with the movements of humans and animals in a symbiotic relationship as a means for seed dispersal and nutrition; in fact, humans and many animals have become dependent on fruits as a source of food. Accordingly, fruits account for a substantial fraction of the world's agricultural output, and some (such as the apple and the pomegranate) have acquired extensive cultural and symbolic meanings. In common language usage, "fruit" normally means the fleshy seed-associated structures of a plant that are sweet or sour, and edible in the raw state, such as apples, bananas, grapes, lemons, oranges, and strawberries. On the other hand, in botanical usage, "fruit" includes many structures that are not commonly called "fruits", such as bean pods, corn kernels, tomatoes, and wheat grains. The section of a fungus that produces spores is also called a fruiting body. Fruit and vegetables should be an important part of your daily diet. They are naturally good and contain vitamins and minerals that can help to keep you healthy. They can also help protect against some diseases. Most Australians will benefit from eating more fruit and vegetables as part of a well-balanced, regular diet and a healthy, active lifestyle. There are many varieties of fruit and vegetables available and many ways to prepare cook and serve them. You should eat at least five serves of vegetables and two serves of fruit each day. Choose different colors and varieties. A serve of vegetables is about one cup of raw salad vegetables or 1/2 cup of cooked. A serve of fruit is about one medium piece, 2 small pieces of 1 cup canned (no added sugar).

Vitamins and Minerals in Fruit and Vegetables

Fruits and vegetables contain many vitamins and minerals that are good for your health. These include vitamins A (beta-carotene), C and E, magnesium, zinc, phosphorous and folic acid. Folic acid may reduce blood levels of homo cysteine, a substance that may be a risk factor for coronary heart disease.

Fruit Peel

It was also known as rink and skin of the fruit. It was the outer protective layer of the fruit or vegetable which can be peeled off. The rind is usually the botanical exocarp, but the term exocarp also includes the hard cases of nuts, which are not named peels since they are not peed off by hand, or peeler, but rather shells because of their hardness.

A fruit with a thick peel, such as a citrus fruit, is called hesperidium. In hesperidia, the inner layer (also called albedo or among non-botanist, pith) is peeled off together with the outer layer (called flavedo), and together they are called the peel. The flavedo and albedo respectively, are the exocarp and the mesocarp. The juicy layer inside the peel (containing the seeds) is the endocarp.

Depending on the thickness and taste, fruit peel is sometimes eaten as a part of the fruit, such as with apples. In some cases the peel is unpleasant or inedible, in which case it is removed and discarded, such as with bananas or grapefruits.

The peel of some fruits for-example pomegranate is high in tannins and other polyphenols, is employed in the production of dyes.

The peel of citrus fruit is bitter and generally not eaten raw, but may be used in cooking; although not flammable. In gastronomy, the outer most, colored part of the peel is called the zest, which can be scraped off and used for its tangy flavor. A large piece of citrus peel, called a “twist” is often used to garmish cocktails. The fleshy white part of the peel, bitter when raw in most species, is used as succade or is prepared with sugar to make marmalade or fruit soup. The peel can also be candied, or dried to produce seasoning (e.g. chenpi).

Nutrition Value of Fruit Peels

Nutritional and commercial potential knowledge of the native species could be an economic alternative to the livelihood of native population from different regions Silva et al. (2013). Fruits and vegetables are important examples of essential elements source. Minerals perform a specific function in human development and fruits are considering the mainly mineral sources which are required in the human diet Hardisson et al. (2001).

General Procedure for Sample Preparation and Elemental Analysis Using AAS

General Procedure for Sample Preparation in Dry Ashing Method

A specified amount of fruit peels can be taken and dried in an air oven at 105 °C for 3 hours. The dried sample is then ashed in a muffle furnace at 550°C to obtain a whitish or grayish ash. After cooling the ash, it is treated with concentrated hydrochloric acid and transferred to a volumetric flask and diluted with de ionized water before submission to atomic absorption spectrophotometry (AAS).

General Procedures for Analysis of Mineral Composition of Fruit Peels

For AAS analysis, standards should be prepared by suitable dilution of the stock standard solutions described under the Standard Conditions for each element. Dilute the sample solution, if necessary, to bring the concentration of the element of interest into a suitable range for analysis. To overcome potential anionic interferences when determining calcium and magnesium, the final sample dilution and all standards and blanks should contain 1% (w/v) lanthanum. Each element has its own wavelength to absorb the characterized light. Considering this the instrument is set to 422.7 nm for calcium, 279.5 nm for manganese, 248.3 nm for iron and 213.9 nm for zinc determination was used. Stock solutions (eg. 1000 ppm) of calcium carbonate, manganese, iron and zinc should be used to prepare working standard solutions with at least 4 concentrations within the analytical range. Then each element within the sample can be calculated from the standard curve prepared.

The Following Analytical Calculations Can Be Used for the Determinations of Each Element in the Sample

Elements

$$(\mu g/g) = \frac{(C)\,(V)\,(d.f)}{(W)} \quad (1)$$

Where C is the concentration of the element in the sample solution in mg/L; V is the volume of the element in the sample solution in mL; W is the sample weight in grams; and d.f. is the dilution factor:

(C) can be obtained from the linear equation of the standard curve which is ; $a = mC + b$

Where a is absorbance; m is slope of the graph; C is concentration of the sample; b is intercept of the graph.

Therefore,

$$C = \frac{a-b}{m} \quad (2)$$

$$d.f. = \frac{(volume\ of\ diluted\ sample\ solution\ in\ mL)}{(Volume\ of\ aliquot\ taken\ for\ dilution\ in\ mL)} \quad (3)$$

By using the above elemental determination procedure, literature results showed that different fruit peels have their own determined elemental composition done by many investigators.

RESULT AND DISCUSSION

Reported Result of Some Selected Mineral Composition of Fruit Peels

In Table 1 the concentration of potassium in banana peel was very high this indicates that it will help in regulation of body fluids and maintained normal blood pressure. It will also help in controlling kidney failure, heart oddities and respiratory flaw. Iron concentration was lowest, although, much lower values had been reported for the fruit. Iron carries oxygen to cell and is necessary for the production of energy, synthesis of collagen and the proper functioning of the immune system. Its low concentration implies that banana peel will be an idyllic source of iron since; its excess is implicated in abnormal functioning of the immune system, cell growth and the heart. Manganese known to aid formation of skeletal and cartilage was also found to be high affect glucose tolerance, normal reproductive, skeletal and cartilage formation. The concentration of none essential minerals bromine, rubidium, strontium, zirconium and niobium was very low.

The mineral composition (mg/100g) of corn cob, banana and plantain peels is presented in Table 2; there were significant differences in values of all the minerals for all the three samples. Plantain peel was highest in Magnesium, Phosphorus, Potassium, Iron, Lead, Cupper and Chromium, banana peel was highest in Calcium Zinc, Sodium and

Manganese, while corn cob was highest in Nickel ($P<0.05$).

PETER et al. 2013 conduct research on phytochemical screening; proximate and elemental analysis of citrus sinensis peels and obtains the concentration of some selected element in fruit peels. The result shows that The Citrus sinensis peels can serve as source of valuable nutrients required for normal functioning of the body system. The utilization of these peels will enhance conversion of waste to wealth. It will also contribute positively towards solid waste management and a cleaner environment.

Ramire-Orduna. et al 2005 conduct research on Chemical Composition of Some Selected Fruit Peels and obtain result for different selected element. Phosphorus is involved in several biological processes such as: bone mineralization, energy production,cell signaling and regulation of acid-base homeostasis. Deficiency in calcium and phosphorus inanimals will therefore result in impaired bone mineralization, reduced bone strength and poor growth(Eleazu *et al*; 2015). This is an important raw materialin soap production and in soil neutralization (Adeolu and Enesi, 2013). It is an essential element thathelps in the development of the body and muscle. Iron is an essential component of hemoglobin and it is critical to the proper functioningof the immune system and the production of energy (Chen *et al.*, 2010).Magnesium is largely(80.00 %) protein bound and is associated predominantly with the microsomes, where it functions as acatalyst of a wide array of enzymes, facilitating the union of substrate and enzyme by first binding toone or the other (Ebel and Günther, 1980). Magnesium is thus required for oxidative phosphorylation leading to ATP formation, sustaining processes such as the sodium ion/potassium ion pump; pyruvateoxidation and conversion of a-oxoglutarate to succinyl coenzyme A; phosphate transfers, includingthose affected by alkaline phosphatase. Zinc plays a key role in the regulationof insulin production by pancreatic tissues and glucose utilization by muscles and fat cells (Eleazu *etal;* 2013).Copper is present in allliving organisms and is a crucial trace element in redox chemistry, growth and development. Copper isbeing explored as treatment for a number of conditions, including degenerative neurological disorderslike Alzheimer's disease, Parkinson's disease (Tisato *et al;* 2010).Sodium helps in maintaining healthy fluidbalance (Tisato *et al;* 2010).Manganese also plays a role in fat, amino acid and carbohydrate metabolism, calciumabsorption, and blood sugar regulation. It is also necessary for normal brain and nerve function.

Table 6 shows This result indicates that Thus Minerals play a key role in various physiological functions of the body, especially in the building and regulation processes. Fruits are considered as a good source of dietary minerals (Ismail *et al*., 2011).

Table 1: Mineral Composition of Banana (Musa Sapientum) Peel

Element	Concentration (mg g^{-1})
Potassium	78.10±6.58
Calcium	19.20±0.00
Sodium	24.30±0.12
Iron	0.61±0.22
Manganese	76.20±0.00
Bromine	0.04±0.00
Rubidium	0.21±0.05
Strontium	0.03±0.01
Zirconium	0.02±0.00
Niobium	0.02±0.00

B.A. Anhwage, 2008

Table 2: Mineral Composition of Corn Cob, Banana and Plantain Peels (mg / 100g)

	Element	Corn Cob	Banana Peel	Plantain peel
1	Cupper	-150.82±0.09[c]	2.55±0.01[b]	5.82±0.03[a]
2	Nickel	150.00±0.05[a]	13.13±0.11[b]	4.92±0.02[c]
3	Zinc	-19.25±0.00[c]	150.00±0.01[a]	41.82±0.06 [b]
4	Chromium	10.97±0.00[c]	71.33±0.07[b]	73.91±0.02[a]
5	Lead	22.91±0.05[b]	3.74±0.02[c]	44.55±0.08[a]
6	Manganese	ND	27.28±0.10[a]	11.81±0.03[b]
7	Iron	26.18±0.09[c]	41.03±0.05[b]	55.08±0.07[a]
8	Phosphorus	527.33±0.58[c]	1460.00±0.30[b]	2977.33 ±1.78[a]
9	Sodium	129.19±0.06[c]	812.87±0.52[a]	672.96±0.17[b]
10	Potassium	375.25±0.76[c]	527.19±0.51[b]	854.49±0.43[a]
11	Magnesium	21.92±0.07[c]	62.53±0.01[b]	64.12±0.04[a]
12	Calcium	17.19±0.06[c]	4113.72±0.76[a]	1702.38±0.63[b]

All values were mean ± standard deviation of triplicate determinations Values in the same column with different superscript Differs significantly (P<0.05) ND=Not Determined

Abubakar et al. 2016

Table 3: World Health Organization Permissible Limits for Some Heavy Metal in ppm

Metal	Highest desirable level.	Maximum permissible level.
Fe	0.1	0.3
Pb	0.05	0.1
Zn	5.0	15.0
Mn	0.05	0.2
Cu	0.05	1.5
Cr	0.02	0.05
Cd	0.005	0.01
Ni	0.5	6.5

Source: (WHO, 1996) the acceptable micro nutrients required for normal functioning of the body systemby WHO.

Table 4: Result of Elemental Analysis of Citrus sinenesis peels in mg/L

Metal	Mean ± SE.
Zn	14.04 ± 0.96.
Cu	0.01 ± 0.001.
Cr	0.01± 0.001
Pd	0.02 ± 0.005.
Cd	< 0.001 ± 0.00.
Mg	15.55 ± 1.45.
Ni	< 0.05 ± 0.00.
Mn	0.04 ± 0.05.

Correlation is significant at the 0.01 level (2-tailed).

Source: *PETER et al. 2013*

Table 5: Mineral Composition of Banana Peel (mg/100g)

MINERAL ELEMENTS	CONCENTRATIONS	*RDA(mg/100g)
Phosphorus	211.30± 1.24	270
Magnessium	44.50 ± 0.08	170
Sodium	115.10 ± 0.26	70
Iron	47.00 ± 1.26	35
Calcium	59.10 ± 0.85	260
Copper	0.51 ± 0.02	0.9
Potassium	4.39 ± 0.15	220
Manganese	0.702± 0.09	3
Zinc	0.033± 0.04	3

Values are mean ± standard deviation (n = 5).

***Source:** *(Ramirez-Orduna et al. 2005).*

Table 6: Mineral Composition of Fruit Peels

Fruit Peel	Elements (Mg/100g Dry Peel)				Source
	Calcium	Zinc	Iron	Manganese	
Pawpaw	11.44± 2.09	2.68± 0.47	27.61± 0.15	0.52 ± 0.10	Feumba et al (2016)
Pineapple	8.30±0.54	6.46 ± 0.43	25.52± 3.38	5.32 ± 0.49	
Mango	60.63± 4.58	0.66 ± 0.06	12.79±1.56	4.77 ± 0.22	
Apple	14.89 ± 2.25	0.95 ± 0.09	25.63 ± 2.47	1.28 ± 0.10	
Banana	19.86 ± 0.24	1.72 ± 0.17	15.15 ± 0.36	9.05 ± 0.34	
Orange	162.03±7.54	6.84 ± 0.55	19.95 ± 0.50	1.34 ± 0.27	
Pomegranate	52.92±1.34	0.98 ± 0.11	9.22 ± 0.63	0.58 ± 0.08	
Watermelon	11.21±0.58	3.78 ± 0.27	45.58 ± 2.37	1.25 ± 0.34	

Values are means ± standard deviations of three replicate measurements.

Discussions on Reported Results of Mineral Composition of Fruit Peels

As we saw in different citrus fruits' peel is a rich source of potassium. B.A. Anhwenge reported that potassium content in banana peel is (78. 10 mg/ g) were as Abubakar US, et al., (2016) recorded 527.19 mg/100g amount of potassium.

For banana fruit peel the mineral composition of manganese was 76.2±0.00 according to B.A. Anhwage, 2008. But, it was 27.28±0.1 for the same fruit peel according to Abubakar et al. 2016. This shows that the mineral composition of the fruit peels are different at different places and time. There for other rest of element see table 4.1 and 4.2

Iron is an essential element that helps in the development of the body and muscle. It is an essential component of hemoglobin and it is critical to the proper functioning of the immune system and the production of energy. According to B.A. Anhwage, 2008 the concentration of Iron was 0.61±0.22 but, it was 47.00±1.26according to Ramire-Orduna et al 2005. Both of them evaluate the mineral composition of banana peels and the result was varying. For additional information see table 4.1 and 4.5

The highest desirable level and maximum permissible level of fruit peels was acceptable micro nutrients required for normal functioning of the body system. Peter et al 2013 evaluate mineral elements of fruit peels for citrus sinensis fruit and obtained their result was between the permissible limit. For example the highest desirable level and maximum permissible level of Zn concentration was 5 and 15 respectively according to WHO and the result of citrus sinensis fruit according to Peter et al 2013 was range 14.04±0.96. For other elements in the same manner see in table 4.3 and 4.4.

Zinc plays a key role in the regulation of insulin production by pancreatic tissues and glucose utilization by muscles and fat cells. As saw in table 4.5 the concentration of zinc was 0.033 ± 0.04 by Feumba et al (2016) but, in table 4.6.The concentration of zinc was 1.72 ± 0.17 according to Ramire-Orduna et al 2005. This shows that the concentration of mineral element in fruit peel was not the same in different area. See also table 4.5 and 4.6

CONCLUSIONS AND RECOMMENDATION

Conclusions

Different papers related to elemental determination of fruit peels were reviewed and the result for each paper was tabulated. The result shows that the concentration of each element in fruit peels were different for different fruit peels. The result also shows that the concentration of the same element within the same fruit peels were different for different authors.

Recommendation

Fruit peels were the most important parts of fruit containing different element concentration and this elements important constituent of bones and teeth and it is actively involved in the regulation of nerve and muscle functions and other function. So we recommend that several studies must be done to fixe exact concentration of element in fruit peel to use thus fruit peel for food.

Mineral concentration of the same fruit peels was different from place to place and time to time. So, we recommend that farther studies must be done to identify parameters that make the concentration varying.

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