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ANALYSIS OF NUTRITIVE CONTENTS OF SOME NIGERIAN FRUITS

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ABSTRACT

Fruits are one of the oldest forms of food known to man and they present an important part of human diet in almost any culture of the world due to their high nutrients content. This study was undertaken to analyze the nutritive, minerals and energy values of some fruits such as banana (*Musa esculentum*), paw-paw (*Carica papaya*), pineapple (*Ananas comosus*), African mango (*Irvingia gabonensis*) and Avocado pear (*Persia americana*) that are consumed in Nigeria. The proximate composition of fruits shows that paw-paw has the highest moisture content (90.0±1.0%) while African mango has the highest ash content (13.06±1.0%). Similarly, the highest crude protein, lipid and fiber contents were recorded by avocado pear (10.0±0.2%, 2.85±0.7 and 15.81±1.0% respectively). The highest available carbohydrate content was observed in pineapple (82.57±0.8%) whereas; the highest energy values were recorded by paw-paw and pineapple (355.94±1.6 and 355.94±1.4 respectively). The results of the mineral analysis showed that Ca content was very low in all studied samples. However, appreciable amounts of K, Mg, Na and P were observed. Highest concentration of K was observed in the pulp of pineapple (436.1±4.8mg/100g) while banana pulp recorded highest amounts of Mg (81.7±1.4mg/100g). Moreover, the Na content was found to be highest in husk of avocado pear (7.3±0.7mg/100g) while the peel of banana has the highest content of P (49.0±0.5mg/100g). Comparing values of mineral elements obtained in this study with the recommended daily allowance (RDA), only K, Mg and P levels could possibly meet the stipulated requirements in these fruits. Meanwhile, the presence of mineral elements in the husks of these fruits indicates that they could be used as source of minerals in the formulation of animal feed.

Keywords: Fruits, Pulp, Husk, Proximate, Mineral elements, RDA

INTRODUCTION

Fruits are natural staple food commonly found in the tropical and sub-tropical regions of the world. They contain substantial quantities of essential nutrients in good proportion (Kalagbor *et al.*, 2014). Fruits are generally known to be excellent source of nutrients such as minerals and vitamins. Mineral ions are of prime importance in determining the fruit nutritional value. Potassium, calcium and magnesium are the major ones (Venkatesh *et al.*, 2011). Fruits are one of the oldest forms of food known to man and they present an important part of human diet in almost any culture of the world (Waziri and Saleh, 2015). The basic nutritional importance of fruits like other plants is assessed by their content of protein, carbohydrate, fats and oils, minerals, vitamins and water which are responsible for the growth and development in man and animals (Waziri and Akinniyi, 2011). In addition, fruits are commonly low in calories, contain no saturated fats or cholesterol but rich in dietary fiber and pectin which is very effective in persons with excess body weight (Kalagbor *et al.*, 2014). Apart from their nutritional benefits, fruits also have beneficial effects such as anti-carcinogenic, anti-mutagenic, anti-viral and bacterial impacts due to their biological active substances with anti-oxidant and anti-bacterial properties (Adesuyi *et al.*, 2012; Sofowora 1993).

An inverse relationship between consumption of fruits and their juice with cardio-vascular disease, arthritis

and stroke has been established (Liu, 2004). These properties are associated with the presence of biologically active phytochemicals in plants which could serve as potential sources of drugs (Waziri and Saleh, 2015). Furthermore, a few studies have shown that supplements containing extracts of African mango (*Irvingia gabonensis*) can aid in weight loss and lower blood cholesterol and that, researchers suggest the high fiber contents of the seeds competes with cholesterol and helps remove it (Kathleen, 2016). Bananas are also among the most widely consumed fruits in the planet. The fruits are high in potassium, magnesium, pectin and antioxidants that protects against free radicals (Jessie, 2014). Avocados are highly consumed types of tropical fruits in the world due to the presence of unsaturated lipids and their relevance in improving and maintaining healthy heart and circulatory system (Maitera *et al.*, 2014). *Carica papaya* (pawpaw) is a very nutritious fruit. It is high in vitamins, magnesium, iron, copper and several essential amino acids, and also contains significant amounts of riboflavin, niacin, calcium, phosphorus and Zinc. It contains nutrients in amount that is generally almost the same as mangoes, banana, apples, oranges, and pear (Wurochekke *et al.*, 2013). Considering the high nutritional and health benefits of fruits, this study was designed to determine the proximate and mineral contents of the five commonly consumed fruits in Nigeria.

MATERIALS AND METHODS

Chemical reagents

All chemical and reagents used for this study were pure and of analytical grade.

Sample collection and preparation

Fresh samples of banana (*Musa esculentum*), paw-paw (*Carica papaya*) and pineapple (*Ananas comosus*) were purchased from Na'ibawa fruits market, while avocado pear (*Persia americana*) and African mango (*Irvingia gabonensis*) were purchased from Muhammad Abubakar Rimi market all in Kano State, Nigeria. Samples were identified and the voucher number was given by a taxonomist in the Department of Biological sciences, Bayero University, Kano. Samples were also washed with tap water and later with distilled water to avoid spoilage by micro-organisms. Samples were further sliced with a knife to separate the husk from the pulp prior to drying. The sliced samples were air dried for five (5) days and then in microwave oven at 65°C until a constant weight was obtained. Finally the dried samples were ground into a powdered form using pestle and mortar and stored in a fresh plastic container prior to analysis (Afshin and Masoud, 2008).

Proximate analysis

Moisture content was determined using automated moisture analyzer (MB 23, OHAUS Corp. USA), while other parameters such as ash, crude fiber, crude protein and crude lipid content were determined using the standard method (AOAC, 1990). The nitrogen free extract, otherwise called available carbohydrate was determined by difference. Energy values in kilocalorie per gram (Kcalg^{-1}) were estimated by multiplying the percentage contents of crude protein, crude lipid and nitrogen free extract (NFE) by the recommended factor of 4, 9 and 4 respectively (NRC, 1989).

Determination of mineral contents

Five gram (5g) of fine powdered sample of each fruit segment (pulp and husk) was digested using a mixture of analytical grade acids HNO_3 : HCl (1:1). Calcium (Ca) and magnesium (Mg) was determined using atomic absorption spectrophotometer (210 VGP model). Sodium (Na) and potassium (K) was determined using flame photometric method while phosphorous (P) was determined colorimetrically with vanadomolybdate procedure (Kitson, and Mellon, 1944).

Statistical analysis

The result is presented as mean \pm standard deviation of triplicate readings. Student t-test at ($p < 0.05$) was used to compare the significant difference between the pulp and husk of the fruit samples.

RESULTS AND DISCUSSION

Proximate composition

The results for the percentage proximate compositions of different fruits are presented in Table 1. The moisture content varied between 67.3 ± 0.3 in banana and 90.0 ± 1.0 in paw-paw. The results show that orange, pineapple and African mango have over 80% moisture contents (Table 1). The result also indicates that most of these fruits have high moisture content which is an indication of water activity of a food. This is also very important especially for food

processors as certain biochemical reactions and physiological changes of food depend on it (Duru *et al.*, 2012). The ash content also varied between the studied samples (Table 1). The result shows that African mango, banana and avocado pear have ash contents above 10% of their individual proximate compositions (13.06 ± 1.0 , 12.87 ± 0.4 and 10.08 ± 0.9 respectively) while paw-paw, and pineapple all have below 5% of their proximate contents (2.43 ± 0.1 and 2.74 ± 0.1).

Similarly, all the studied fruits contained appreciable amounts of fiber. Avocado pear recorded the highest crude fiber (15.81 ± 1.0) content while banana has the lowest content (5.10 ± 0.6) of fiber among the studied samples (Table 1). Epidemiological evidences have shown that consumption of reasonable amount of dietary fiber (20 – 35g/day) lower risk of a number of chronic diet related diseases such as diverticular disease, coronary heart disease, Obesity, type II diabetes mellitus, irritable bowel syndrome and many more (Duru *et al.*, 2012).

The crude protein observed in this study ranged between 2.3 ± 0.4 in paw-paw and 10.0 ± 0.2 in avocado pear (Table 1). The values of protein obtained in this study are not very encouraging as a source of protein especially for the juvenile ones. In the same vein, the crude lipid contents obtained in this study are also low. Avocado pear has the highest lipid content (2.85 ± 0.7) followed by banana (2.09 ± 0.2) and the lowest crude lipid (1.54 ± 0.4) was observed in pineapple while the remaining samples also recorded less than 2% crude lipid in their individual proximate compositions (Table 1). Excess consumption of fat have been implicated in certain cardiovascular disorders such as atherosclerosis, cancer, and aging, whereas a diet providing 1-2% of its caloric of energy as fat is said to be sufficient to human beings (Aruah *et al.*, 2011). The highest available carbohydrate content was observed in pineapple (82.57 ± 0.8) while the lowest was recorded by avocado pear (61.26 ± 0.2). African mango, banana and paw-paw also recorded 71.84 ± 1.3 , 76.64 ± 1.3 and 82.23 ± 1.1 respectively (Table 1). The result shows that the studied fruits are high in their carbohydrate contents and can therefore serves as good sources of energy.

The energy values (Kcalg^{-1}) of fruits are shown in Table 1. The results indicated that paw-paw and pineapple have the same and of course the highest energy values with slight difference in their standard deviation 355.94 ± 1.6 and 355.94 ± 1.4 respectively. In this study, avocado pear has the lowest (310.69 ± 1.1) energy value among the studied fruits (Table 1). The calorific (energy) values of these fruits were low compared to 10,000kJ daily energy expenditure (Effiong and Udo, 2010).

Mineral element contents

The pulps and husks (peels) segments of fruits are used for the determination of mineral elements in this study and the results of the analysis are shown in Table 2. Calcium functions as a constituent of bones and teeth and also participates in activation of a number of enzymes such as adenosine triphosphatase (ATPase), succinic dehydrogenase, lipases e.t.c (Soetan *et al.*, 2010).

In this study, it was observed that the pulp and husk of pineapple has the highest (0.146 ± 0.025 and 0.189 ± 0.025 respectively) calcium content and the lowest concentration of calcium was observed in avocado pear (0.044 ± 0 and 0.058 ± 0.025) pulp and husk respectively. In the same vein, there was no much variation in the trends of Ca concentration in the remaining samples (Table 2). Moreover, there was a significant difference ($p<0.05$) between the pulp and husk of paw-paw (0.116 ± 0.025 and 0.189 ± 0.025 respectively). Calcium contents in the studied samples are obviously very poor compared to its dietary recommendations of 600mg/day (NIN, 2009), and previous literatures reported in a number of wild and cultivated fruits (Osabor *et al.*, 2008; Effiong *et al.*, 2009). However, levels of K, Mg, Na and P differ appreciably from those obtained for calcium in this study. Pineapple recorded the highest potassium content (436.1 ± 4.8 and 50.0 ± 0) in the pulp and husk respectively with significant difference ($p<0.05$) between the fruit segments (Table 2).

The husk of avocado pear recorded the lowest (8.3 ± 0) concentration of potassium among the studied samples. Moreover, with the exception of avocado pear, there was a significant difference ($p<0.05$) between the pulps and husks segments of all the studied fruits (Table 2). Udemé *et al.*, (2013), reported 1.86mg/100g potassium content in pineapple. This value is even lower than the value obtained for potassium in avocado pear which is lowest in this study. The recommended daily allowance of K is 3800mg/day (NIN, 2009). Potassium is required for glycogenesis and helps in the transfer of phosphate from ATP to pyruvic acid and probably has an essential role in many other basic cellular enzymatic reactions (Soetan *et al.*, 2010). Similarly, levels of magnesium were detected in all samples (Table 2).

Banana pulp and peel have the highest magnesium contents (81.7 ± 1.4 and 63.3 ± 1.4 respectively) whereas paw-paw has the lowest content (2.5 ± 0 and 3.3 ± 1.4) of magnesium among the studied fruits. The recommended dietary allowance of Mg is 340mg/day (NIN, 2009). In a similar event, Adeolu and Enesi (2013), also reported values (18.00mg/100g) of magnesium in banana which in contrast are lower than those obtained for banana in this study (Table 2). Magnesium plays a vital role in muscle relaxation along the airways to the lungs allowing asthma patients to breathe easily (Muhammad *et al.*, 2011). Concentrations of sodium ranged between 2.5 ± 0.3 in the pulp of paw-paw and 7.3 ± 0.7 in the husk of avocado pear making it the fruit with the highest

concentration of sodium in this study. Moreover, significant difference ($p<0.05$) was observed in paw-paw, African mango and avocado pear (Table 2). The recommended daily allowance of sodium is 1500mg/day (NIN, 2009). Othman and Mbogo (2009) reported sodium contents (2.93 ± 0.04 and 3.71 ± 0.05) in two varieties of paw-paw respectively. Their findings, although slightly different, have corroborated the results of sodium obtained for paw-paw in this study (Table 2). Sodium is involved in the maintenance of osmotic pressure of the body fluids and that change in osmotic pressure largely depends on sodium concentration (Aremu and Ibrahim, 2014; Murray *et al.*, 2000; Malhotra, 1998). Phosphorous functions as constituent of bone and teeth, nucleic acids and also a phosphorylated metabolic intermediate (Aremu and Ibrahim, 2014).

In the current study, the levels of phosphorous were detected in all samples with banana having the highest (49 ± 0.5 and 45.8 ± 0.5) concentrations in the husk and pulp respectively. This is followed by paw-paw husk, pineapple husk and the husk of African mango (Table 2). On the other hand, the pulps of African mango and avocado pear recorded the lowest phosphorous content (24.3 ± 0.6 and 28.2 ± 0.5 respectively). The recommended daily allowance of phosphorous in foods is 700mg/day as established by the Institute of Medicine (IOM, 1997). Values obtained in this study are therefore within the dietary recommendations of phosphorous. Mahmoud *et al.*, (2008), reported values of paw-paw ($35.61\text{mg}/100\text{g}$) which are somewhat different but in agreement to the values obtained for paw-paw in this study.

CONCLUSION

The nutritive analysis of the Nigerian fruits shows that the fruits are rich in carbohydrates, appreciable amounts of crude fiber and protein but low contents of crude lipid/fats. The study indicates that the studied fruits contain mineral elements necessary for support and sustenance of life. More so, the calcium contents of the studied fruits appears to be poor which means other sources of calcium must be supplied to the diets to meet the body demand of calcium. The study also reveals that a lot of nutrients are discarded and refused from the husks of fruits, which many people consider as a waste. Instead, these inedible portions of fruits should be used for the formulation of animal feeds. Furthermore, the concentrations of all the mineral elements obtained in this study are within the normal range of macro-elements recommendations in fruits. Therefore, their consumption should be encouraged.

Tables

Table 1: Proximate Composition of Fruits

Sample	%Moisture (WW)	%Ash (DW)	%CPr (DW)	%CHO (DW)	%CLi (DW)	%CFi (DW)	Energy value (Kcal/100g)
Banana	67.3±0.3	12.87±0.4	3.3±0.1	76.64±1.3	2.09±0.2	5.10±0.6	338.57±1.5
Paw-paw	90.0±1.0	2.43±0.1	2.3±0.4	82.23±1.1	1.98±0.1	11.06±0.3	355.94±1.6
pineapple	86.7±0.5	2.74±0.1	3.0±0.2	82.57±0.8	1.54±0.4	10.20±0.8	355.94±1.4
Afr. mango	83.3±0.9	13.06±1.0	4.4±0.5	71.84±1.3	1.79±0.2	8.91±0.5	321.07±2.0
Avoc. pear	74.3±0.5	10.08±0.9	10.0±0.2	61.26±0.2	2.85±0.7	15.81±1.0	310.69±1.1

Values are mean ± standard deviation of triplicate results. WW=Wet Weight, DW=Dry Weight, CPr=Crude Protein, CHO=Carbohydrate, CLi=Crude Lipid, CFi=Crude Fiber

Table 2: Mineral Element Content of Fruits (mg100g⁻¹Dry weight)

Sample	Ca	K	Mg	Na	P
Banana pulp	0.073±0.025	66.6±0.2 ^a	81.7±1.4 ^a	6.3±0.7	45.8±0.5 ^a
Banana husk	0.044±0	84.4±1.9 ^a	63.3±1.4 ^a	7.1±1.2	49±0.5 ^a
Paw-paw pulp	0.116±0.025 ^a	101.1±1.9 ^b	2.5±0	2.5±0.3 ^a	32.8±2.3 ^b
Paw-paw husk	0.189±0.025 ^a	91.4±0.5 ^b	3.3±1.4	3.9±0.3 ^a	44.8±0.5 ^b
Pineapple pulp	0.146±0.025	436.1±4.8 ^c	3.3±1.4 ^b	5.9±0	39.1±0.2 ^c
Pineapple husk	0.189±0.025	50±0 ^c	6.7±1.4 ^b	6.7±0.7	43.6±0.5 ^c
Afr. mango pulp	0.058±0.025	86.1±4.8 ^d	9.2±1.4	5.3±0.6 ^b	24.3±0.6 ^d
Afr. mango husk	0.102±0.025	108.3±0 ^d	10.8±1.4	6.9±0.3 ^b	40.3±0.6 ^d
Avoc pear pulp	0.044±0	66.7±0	21.3±0.6 ^c	3.1±0.3 ^c	28.2±0.5 ^e
Avoc pear husk	0.058±0.025	8.3±0	27.5±0 ^c	7.3±0.7 ^c	33.7±0.2 ^e

Values are mean ± standard deviation of triplicate results. Figures followed by the same superscript in the same column are statistically significant (p<0.05).

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