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BOOK OF ABSTRACT

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UNFORESEEN COVID-19 DISTRUPTIONS: SURMOUNTING THE UNINTENDED TENSION TOWARDS ECONOMIC REJUVENATION AND SUSTAINABLE DEVELOPMENT

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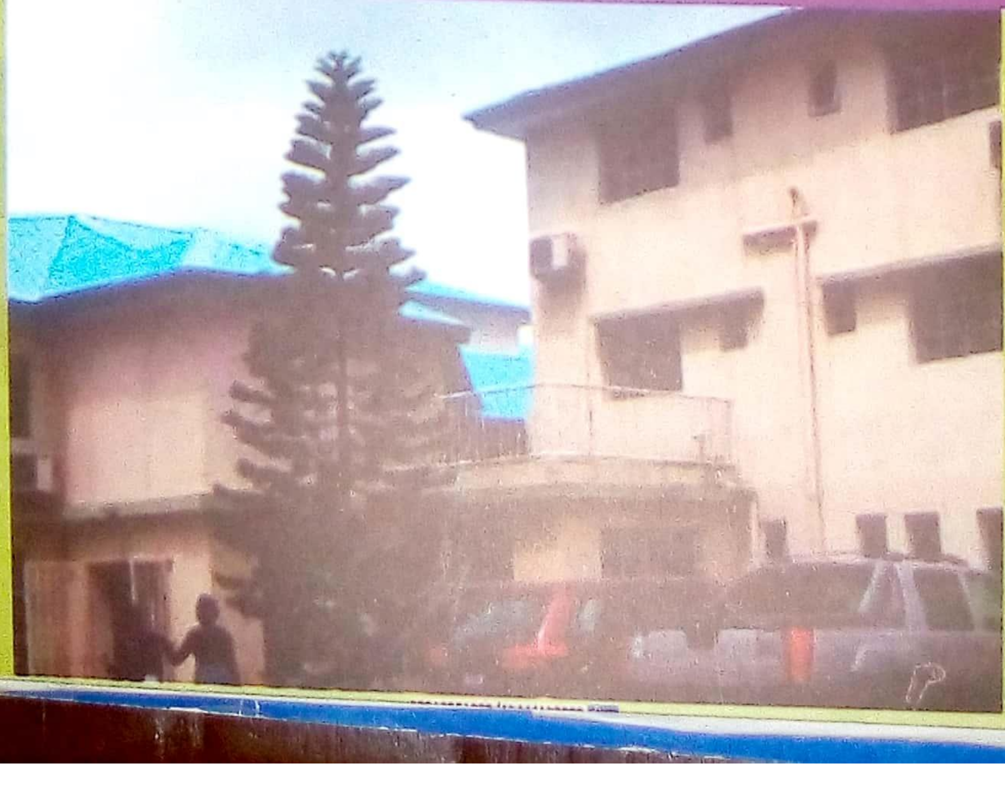

EXTRACT FROM BOOK OF PROCEEDING

BIO/FST 015

Proximate Composition And Functional Properties Of Plantain-cocoyam Flour Blend Fortified With Tiger Nut

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Keywords: Cocoyam, functional properties, Proximate composition, Plantain, Tigernut,

PROXIMATE COMPOSITION AND FUNCTIONAL PROPERTIES OF PLANTAIN-COCOYAM FLOUR BLEND FORTIFIED WITH TIGER NUT

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ABSTRACT

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Key Words: **Cocoyam, functional properties, Proximate composition, Plantain, Tigernut,**

1.0. INTRODUCTION

Plantain known as *Musa paradisiaca* is a member of *Musaceae* family and genus *Musa*. It is a staple food in the tropical regions of the world, treated in the same way as potato and yam with a similar texture and neutral flavor when the unripe fruit is cooked by steaming, boiling or frying (Aderounmu, 2006). The Musa species is likely a native to India and Southern Asia.
Most plantain foods are eaten as boiled, fried or roasted, and flour produced from unripe plantain is used traditionally for the preparation of a thick paste (Amala). Nutritionally, plantain fruit possessed carbohydrates, minerals, amino acids, fibre, and carotenoids.

Plantain contains carbohydrates (32%), protein (1%), fat (0.02%), water (60%) and some vitamins and mineral elements. The food is extremely low in fat and protein, high in fibre and starch. It is a good source of vitamin A, B6 and C which helps maintain vision, good skin and builds immunity against diseases. It is also rich in potassium, magnesium and phosphate when cooked green (Ogazi et al., 1996). Plantain meal is a food source and easily digestible with constituents such as water 10.62%, albuminoids 3.35%, fat 1.15%, carbohydrates 81.67% (more than 2/3 starch),fibre 1.15%, phosphates 0.26% sugar (sucrose) 1.60% high content of vitamin C and potassium (Chung et al, 2007). Vitamin A (fresh ripe plantain) is an antioxidant that plays valuable role in visual cycle, maintaining healthy mucosa and enhances skin complexion.

Cocoyam (*Colocasia esculenta)* is herbaceous perennial plant belonging to the *araceae* family and constitutes one of the six most important root and tuber crops world –wide. It originates from central and south America. Cocoyam is rich in digestive starch, good quality protein, vitamin C, Thiamine, riboflavin, niacin and high source of protein and essential amino acids (Onayemi & Nwigwe, N .C, 1987; Lewu, 2009). They are among the major crops grown in wetlands with minimal inputs and offer high potential for alleviating food insecurity and income constraints. (Ojinaka, M. C., Akobundu, E. N. T. Iwe, M. O., 2009). Although it is less important in than other tropical roots such as yam, cassava, and sweet potatoes, it is still a major staple in some parts of tropics and sub –tropics. (Ojinaka et al, 2009). However, in spite of its nutritional importance, cocoyam has not received any deliberate attention to address its research and development, it receives low research priority in all regional agricultural research centers therefore it contribution to food security and economy is underestimated. *Colocasia esculenta*. Cocoyam corm has a high carbohydrate content (70 – 88% on dry basis), principally in the form of starch (Bradbury & Holloway, 1988; Onwueme &Charles, 1994). Which not only imparts desirable functional properties to foods, but also provides energy and promotes satiety in consumers (Owusu-Darko, 2014).

Tigernut (*Cyperus esculentus* L.) is an edible perennial grass-like C4 plant of the sedge family (Turesson, 2010). Tigernut is tuber usable grass and also called chufa, nut grass, yellow nut sedge, earth almond, edible galingale and ground almond (Defelice, 2002; Sanchez- Zapata et al., 2012). It is widely used for human and animal consumption as a nutritious food and feed in Africa, Europe and America (Sanchez-Zapata.et al, 2012). Tigernut is rich in starch, oil, minerals, and vitamins E and C. The starch and oil are major macronutrients in the tiger nut tuber. High starch content of this plant provide unique functional properties (Manek, 2012), cold storage stabilities, and preserves organoleptic properties of foods (Jing, 2012). The tiger nut oil also has high monounsaturated fatty acids, similar to olive, avocado and hazelnut oil (Ezeh, 2014)..The nutritional profiles and unique functional properties have made tigernut as unique food (Ekeanyanwu & Ononogbu, 2010) like beverage, flour (Oladele & Aina et al, 2007) and (Chinma, 2010), edible (Muhammad, 2011; Lasekan & Abdulkarim, 2012), and a feed source (Sanchez-Zapata et al., 2012).Although there are numerous example of plants that accumulate high amount of starch or sugars in roots and tubers, tiger nut accumulates a substantial amount of oil in such tissues. As a high oil yield and more adaptable crop, tigernut have more potential usage as food and industrial materials. Tigernuts tubers appear somewhat long or round in shape with a dimension of 8mm to 16mm, smaller size however, are not used for human consumption. When hydrated, it is slightly harder (nut texture), but with a rather more intense and concentrated tasteIt is known in Nigeria as “Aya” in Hausa,”Ofio”in Yoruba and “Akiausa” in Igbo where these varieties(black, brown and yellow) are cultivated (Umerie, 1997). Among these, the yellow variety is preferred over others because of its inherent properties such as large size, attractive color and fleshier nature. It also yield more milk upon extraction, contains lower fat and higher protein and less anti nutritional factors especially polyphenols (Okafor, 2003). Recently, there is awareness for increased utilization of tigernut (Belewu, Abodunrin, 2006; Belewu & Belewu, 2007).

Tigernut has been known to contain higher essential amino acids (such as lysine, cystine, arginine, and histidine) than those proposed in the standard by FAO/WHO for satisfying human needs. It is also an excellence source of some mineral such as calcium which are essentially use for human body growth and development. It is also rich in phosphorous, zinc and trace of copper, potassium, and sodium. Tigernut has been reported to be the highest in dietary fiber content, which could be effective in the treatment of some diseases such as; coronary heart diseases, obesity, indigestion, diarrhea, diabetic and gastrointestinal disorder. Tigernut flour has a unique taste which makes it different from some other nut. It is a good alteration of other flour like wheat as it is gluten free and good for people who cannot take in gluten as a diet. It also yield more milk upon extraction containing low fat with high protein content. It was known that the sugar level is very low infact more so it is high in calcium which is valuable for human bone development which makes it more strong (Okafor, 2013). Tigernut is used as supplementary for cereal flour, in other to improve it calcium level. (Oladele & Aina, 2007). The presence of iron makes it more suitable for blood formation. It is a tuber crop that grows freely and it is consume widely in Nigeria and other part of West Africa like east Africa, in Spanish tigernut is called chufa. It was reported that tigernut drink was useful for medical drink because it is energetic for human. In Nigeria the Yoruba call tigernut ofio, Hausa call it Aya and the Igbo call it Akiausa. Tigernut was known to be a good source of vitamin C and E (Abaejoh, 2006) .it is widely used for human and animal consumption as a nutritious food and feed in Africa, Europe and America (Sanchez-Zapata,2012). The nutritional profile and unique functional properties have make tigernut as unique food (Ekeanyanwu & Ononogbu, 2010). It has some important food and in some industrial company .tigernut has the highest content of oleic acid, the nut was reported to be rich in sucrose, fat which are resistant to peroxidation and protein.). Cyperus esculentus was reported to help in preventing heart, thrombosis and activates blood circulation, responsible for preventing and treating urinary tract and bacterial infection, assist in reducing the risk of colon cancer (Adejuyitan et al., 2009). They are thought to be beneficial to diabetics and those seeking to reduce cholesterol or lose weight, the very high fiber content combined with a delicious taste make them ideal for health eating (Dianne, 1960).

Over the years unripe plantain and wheat flour were recommended for regulating blood glucose due to their high fiber content and low glycaemic index. But the cost of importation associated with wheat, the need for production of functional composite flour using other readily available and inexpensive materials such as cereal and legumes (cocoyam and tigernut) with good nutritional value of proteins, carbohydrates, fibers, fat and ash contents is necessary. Therefore the objective of this study is to determine the proximate composition and functional properties of plantain-cocoyam flour blend fortified with tigernut.

2.0 MATERIALS AND METHOD

Sample Procurement

Unripe plantain was gotten from Oja odan and Sayedero market Ilaro, Ogun state, tigernut was gotten from Agege, market (Lagos state), cocoyam gotten from Sagamu, Ogun state, Nigeria.

Preparation of Plantain Flour

The green plantain fingers (20kg) were thoroughly washed with water and sun dried for 30 minutes. The fruits were then hand peeled, sliced and stored in water to avoid browning before drying. The sliced pulp was subjected to drying for 6 hours at a temperature of 80^0C using hot air oven immediately. The resultant dried pulp slices were milled with hammer mill (Bentall Superb, Model 200L 09) and sieved through A 75 µm mesh sieve and stored in airtight plastic containers at room temperature (28±2 °C) for further use.

Preparation of Cocoyam Flour

White cocoyam (*colocasia esculenta*), sample was collected by peeling the back of white cocoyam, it was then sliced into piece using a stainless knife into 1.5mm thick slices (6.0 x4.0 mm). The sliced cocoyam was transferred into bowl containing water so that it will not oxidize and change color during the cause of the slicing, it hydrolyze in water. The sliced is allowed to dry in the sun for about 48 hours (2days), after then, it was transferred into attrition mill and grounded in order to obtain cocoyam flour and then sieved to remove the shaft (Akubo & Ukwuru, 2013).

Preparation Of Tigernut Flour

The method of Oladele and Aina (2007) was used in this process, tiger nut was picked to remove some stones, pebbles and other foreign seed before washing with water and then drained in a cabinet dryer at 60 ^{0}C for about 24hours to a moisture contents about 13 %. The dried nut were milled and sieved through mesh size in other to remove shaft.

PREPARATION OF COMPOSITE FLOUR AND FORTIFIED WITH TIGERNUT

Composite flour was prepared with plantain and cocoyam flour in different proportion. The fortification of the composite flour using tigernut was done using the method reported by (Adewale, 2012).

Table1: Composite flour fortified with tigernut

SAMPLES	PLANTAIN	COCOYAM	TIGERNUT
A	100%	0%	0%
B	75%	25%	0%
C	50%	50%	0%
D	25%	75%	0%
E	0%	100%	0%
F	95%	0%	5%
G	72.5%	22.5%	5%
H	47.5%	47.5%	5%
I	22.5%	72.5%	5%
J	0%	95%	5%

sample A=100%plantain, sample B=75%plantain and 25% cocoyam, sample C=50% plantain and 50%cocoyam, sample D=75%cocoyam and 25% plantain, sample E=100% cocoyam, sample F= 95%, 0% cocoyam and 5% tiger nut sample G=72.5% plantain, 22.5% and 5%tigernut, sample H=47.5% plantain,47.5% and 5% tigernut, sample I=22.5%plantain,72.5% cocoyam and 5% tiger nut sample J=0% plantain, 95% cocoyam 5% tigernut.

Chemical Analysis
The proximate composition of the composite flours analyzed using the procedure of the Association of Official Analytical Chemist (AOAC, 2006), and the energy value calculated using Atwater factors (Ilelaboye, 2019). Appropriate standard methods were utilized to determine the following functional properties of the flours: Water and oil absorption capacities; swelling power and solubility index by Julianti, Rusmarilin, & Yusraini (2015) procedures, bulk density by Oyeyinka et al. (2014) technique. Wettability of the flours was determined as described by Onwuka, 2005.

Statistical analysis
All analyses carried out in triplicate, with statistical significance established using one-way analysis of variance (ANOVA), and data reported as the mean ± standard deviation. Mean comparison and separation done using Duncan Multiple range (DMR) test at P≤ 0.05, described by the SPSS 16.0 statistical package. (SPSS 16, 2008).

TABLE 2: Result for proximate analysis of plantain- cocoyam composite flour fortified with tigernut**.**

Sample	Moisture content	Total ash	Crude fat	Crude fibre	Crude protein	NFE	Energy value
A	10.87±0.02	3.32±0.01	11.51±0.01	2.10±0.02	8.36±1.45	63.89±1.43	388.53±5.64
B	9.42±0.03	4.87±0.02	14.48±0.01	2.87±0.01	11.20±0.03	57.17±0.04	403.79±0.14
C	11.22±0.01	2.91±0.01	9.62±0.03	1.56±0.01	8.89±0.01	65.82±0.03	385.40±0.11
D	11.90±0.02	2.50±0.02	5.68±0.04	1.24±0.02	8.05±0.01	72.65±0.10	355.90±0.01
E	8.56±0.04	4.92±0.01	14.59±0.01	3.20±0.03	11.44±0.00	57.30±0.10	406.21±0.30
F	10.40±0.01	3.72±0.01	11.67±0.02	2.15±0.01	9.90±0.03	62.17±0.02	393.25±0.16
G	12.26±0.02	2.13±0.03	3..04±0.03	1.16±0.02	8.24±0.02	73.19±0.08	353.04±0.03
H	11.02±0.04	3.07±0.01	9.90±0.01	1.94±0.01	10.02±0.01	64.07±0.06	385.35±0.21
I	9.75±0.04	4.20±0.01	12.76±0.05	2.62±0.01	10.57±0.03	10.57±0.01	397.52±0.27
J	10.20±0.02	3.93±0.03	12.51±0.01	2.29±0.01	10.30±0.02	10.30±0.03	396.90±0.09

Sample A=100%plantain, sample B=75%plantain and 25% cocoyam, sample C=50% plantain and 50% cocoyam, sample D=75% cocoyam and 25% plantain, sample E=100% cocoyam, sample F= 95%, 0%cocoyam and 5% tigernut sample G=72.5%plantain, 22.5% and 5% tigernut, sample H=47.5% plantain, 47.5% and 5% tigernut, sample I=22.5% plantain,72.5% cocoyam and 5% tigernut sample J=0% plantain, 95% cocoyam and 5% tigernut.

3.0 RESULT AND DISCUSSION

TABLE 3: Functional properties of composite flour plantain-cocoyam fortified with tigernut.

Samples	B.D	W.A	O.C	F.C	S.P	M.C	W.A	S.V
A	0.77±0.00	0.39±0.01	2.53±0.04	2.00±0.00	2.39±0.01	11.56±0.01	0.80±0.00	2.79±0.01
B	0.76±0.06	0.29±0.01	2.01±0.01	4.00±0.00	2.38±0.01	11.69±0.01	1.00±0.00	2.95±0.07
C	0.90±0.01	1.18±0.04	1.69±0.01	1.80±0.28	2.17±0.01	11.14±0.02	1.20±0.00	2.95±0.07
D	0.86±0.03	1.40±0.01	2.10±0.00	6.00±2.82	2.68±0.35	10.37±0.02	0.80±0.00	3.20±0.00
E	0.82±0.02	1.02±0.01	2.00±0.00	6.00±2.82	4.92±0.02	10.58±0.04	1.50±0.00	3.45±0.02

F	0.80±0.00	1.07±0.01	1.90±0.14	6.00±2.82	3.22±0.03	7.39±0.01	1.15±0.07	2.78±0.04
G	0.79±0.06	1.45±0.01	1.10±0.14	3.00±1.41	2.28±0.02	13.59±0.01	1.05±0.00	2.95±0.07
H	0.80±0.00	2.09±0.14	2.99±0.01	7.00±1.41	4.42±0.02	4.17±0.02	1.10±0.00	3.40±0.00
I	0.66±0.00	0.40±0.01	1.51±0.01	7.00±1.41	2.70±0.14	5.37±0.04	0.80±0.00	3.49±0.00
J	0.85±0.02	0.57±0.01	2.50±0.00	5.00±1.41	3.27±0.04	13.93±0.04	1.50±0.00	3.40±0.00

Sample A=100%plantain, sample B=75%plantain and 25% cocoyam, sample C=50%plantainand 50%cocoyam, sample D=75%cocoyam and 25% plantain, sample E=100%cocoyam, sample F= 95%, 0%cocoyam and 5% tiger nut sample G=72.5%plantain, 22.5%cocoyam and 5%tigernut, sample H=47.5% plantain,47.5% and 5% tigernut, sample I=22.5%plantain,72.5%cocoyam and 5% tigernut sample J=0% lantain,95%cocoyam5%tigernut.

Moisture has been used as a measure of stability and susceptibility to microbial contamination (Davey, 1989). The moisture content of ranges from 8.56 % -11.90 %, the lower the moisture content of composite flour the more the shelf life would be, therefore sample E was observed to have the greatest shelf stability to others.

Ash content of the flour blend ranges between 2.13±0.03 and 4.92±0.01, ash content help us to indicate the rough estimate of mineral, therefore sample having the highest ash content indicate that it would have the highest mineral content.

Fat content of composite flour blend ranges from 3.04±0.03 -. 14.59±0.01 low fat content will help to increase the shelf life of samples by decreasing the rancidity and also contribute to low energy value of food product while high fat content produce will have high energy value and promote fat oxidation (Fasasi, 2009).

Protein is needed for normal body growth, repairs and maintenance. It ranges from 8.05±0.01 % - 11.44±0.00%. Fiber helps in the maintenance of human health and has been known to reduce cholesterol level of the body (Bello *et al*., 2008). A low fiber diet has been associated with heart disease, cancer of the colon and rectum, varicose veins, phlebitis, obesity, appendicitis, diabetes and even constipation (Saldanha 1995, Lajide*et al*., 2008). The lowest at sample G(1.16±0.02) and highest crude fibre content was observed at sample E (3.20±0.03) and Carbohydrates are predominately solid nutrient in roots and tuber crops, it a means by which energy can be generated. The carbohydrate composition of plantain-cocoyam composite flour fortified with Tigernuts ranges from 10.30 % - 73.19 % . The energy values ranges from 353.04 - 406.21kcal. The functional properties determine the use and application of food material and different type of food products in industries.

Bulk Density is used to evaluate the flour heaviness, handling requirement and the type of packaging materials suitable for storage and transportation of food materials (Oppong, Arthur, Kwando, Badu, &Sakyi, 2015). (0.91 g/cm±0.01) and the lowest was observed at sample I containing 22.5% plantain, 72.5% cocoyam and 5%tigernut (0.66 g/cm±0.00). The effect of tigernut on composite flour is to decrease the bulk density of flour. This result agreed that sample C is desirable for greater ease of dispensability and reduction of paste thickness.
The water absorption for 100%plantain sample A(0.80±0.00) was lower than sample E,100%cocoyam(1.50±0.00m and sample J ,95%cocoyam 5%tigernut (1.50±0.00ml).sample A, D, I was known to absorbed at the same rate .

The highest oil absorption was observed at 2.99±0.01%, The ability of this flour to bind with oil makes it useful in food system,where optimum oil is desired. However, the highest oil capacity was known to be useful in structural interaction in food for improvement of palatability and extension of shelf- life particularly in bakery. (Aremu, 2007).

The highest sedimentation was observed at sample I(3.49±0.00ml)followed by sample E, (3.45±0.00ml),sample H&J(3.40±0.00ml),sample D(3.20±0.00ml),and the lowest was observed at sample F(2.78±0.004ml). However, such will be easy to reconstitute to give fine consistency dough in mixing. (Kaka & Potter, 1979) reported that sedimentation and hydration of plantain cocoyam is influence by processing method affecting starch gelatinization and swelling power.

Wet Ability: The highest wet ability was observed at sample H which was found to be 47.5% plantain,47.5% cocoyam and 5% tigernut (2.09±0.14) sample G which has 72.5% plantain, 22.5% cocoyam and 5% tigernut (1.45±0.01), sample D Which has 25%plantain and 75%cocoyam (1.40±0.01),sample C which has 50%plantain and 50% cocoyam, sample f which has 95% plantain,0%cocoyam and 5%tigernut, sample J which has 0% plantain, 95% cocoyam and 5% tigernut, sample I which has 22.5%plantain,72.5% cocoyam and 5% tigernut, sample A which has 100%plantain,sample B which has 75%plantain and 25% cocoyam. It was notice that the addition of tiger nut to the sample increase the wet ability compare to ordinary cocoyam and plantain flour. It was also observed that when there is equal amount of plantain and cocoyam it wet ability also increases.

Swelling Capacity: The value for swelling power of composite flour ranges from 4.93g/g to 2.16g/g. The highest swelling power was observed at sample E(4.93g/g) which was 100% cocoyam followed by sample H(4.43g/g),sample J(3.28g/g), sample F (3.24g/g),sample I(2.80g/g),sample D(2.65g/g), sample A(2.40g/g),sample B(2.39g/g),sample G(2.29g/g) and the lowest was observed at sample C (2.16g/g).The swelling power of sample depend on the size of particles.

Foam Capacity**:** The value for foam capacity of composite flour ranges from 7.00 to1.80%. In this case sample H&I had the highest values at (7.00±1.41) and lowest value was observed at sample C (1.80±0.28).it was observed that the presence of tigernut indicate increment in the value of form capacity. Composite flour containing tigernut has the highest foam capacity due to the presence of high protein content found in it. More so higher foam capacity indicates that tigernut is a good foaming agent. Foam is known to improve texture and appearance of foods.

The result of the proximate composition of the composite flour fortified with tigernut showed that the moisture content is very essential for life maintenance and analysis, it is one of the most widely used measurements which determine the way the food will be processed and its shelf life. Moisture has been used as a measure of stability and susceptibility to microbial contamination (Davey, 1989). The moisture content of composite flour plantain-cocoyam plantain fortified with Tigernuts ranges from (11.90 % - 8.56 %) where sample D was observed to have the highest value (11.90±0.02) and sample E having the lowest values (8.56±0.04).it was state that the lower the moisture content of composite flour the more the shelf life would be, therefore sample E was observed to have the greatest shelf stability to others.

Ash content: Ash helps in the metabolism of other organic compound such as carbohydrate and fat. The increase in ash content could be attributed to the higher level of ash in cocoyam flour. The ash content of composite flour ranges from sample E(4.92±0.01) which have 100 % cocoyam and sample G(2.13±0.03) which have 72.5 % plantain 22.5 % cocoyam and 5 % tigernut. Ash content help us to indicate the rough estimate of mineral, therefore sample having the highest ash content indicate that it would have the highest mineral content (sample E).

Fat content: it was reported that low fat content will help to increase the shelf life of samples by decreasing the rancidity and also contribute to low energy value of food product while high fat content produce will have high energy value and promote fat oxidation (Fasasi, 2009). It was observed that the fat content of composite flour ranges from (14.59-3.04). Sample E (14.59±0.01) was known to have the highest fat content while sample G was observed to have the lowest.

Protein is needed for normal body growth, repairs and maintenance. A relatively high amount of protein is therefore required for functional foods and nutraceuticals, because they are used basically for supplementation. Cocoyam is a poor source of protein because tubers are very low in amino acids, sulfur but the protein in plantain flour was known to improve the nutritional quality of traditional recipes. The protein content ranges from (11.44 %-8.05 %). The highest values was observed at sample E (11.44 %±0.00) and the lowest was observed at sample D (8.05 %±0.01) .

Crude fiber is the part of food that is not digested by human but the normal Functioning of the intestinal tract depends upon the presence of adequate fiber. It increases stool bulk and decreases the time that waste materials spend in the gastrointestinal tract.

Fiber helps in the maintenance of human health and has been known to reduce cholesterol level of the body (Bello *et al*., 2008). A low fiber diet has been associated with heart disease, cancer of the colon and rectum, varicose veins, phlebitis, obesity, appendicitis, diabetes and even constipation (Saldanha 1995, Lajide*et al*., 2008).The crude fibre contributes to improve the gastrointestinal system and metabolic system of human because crude fibre consists of cellulose and lignin. Dietary fibre decreases the absorption of cholesterol from the gut .it aids at improving the conversion of starch in simple sugar. The highest crude fibre content was observed at sample E (3.20±0.03) contain 100 % cocoyam and lowest at sample G(1.16±0.02) containing72.5 % plantain 22.5 % cocoyam and 5 % Tigernuts.

Carbohydrates are predominately solid nutrient in roots and tuber crops, it a means by which energy can be generated. The carbohydrate composition of plantain-cocoyam composite flour fortified with Tigernuts ranges from (73.19 % -10.30 %). The highest value was observed at sample G (73.19 % ±0.08) containing 72.25 %plantain 22.25 % cocoyam and 5 % tigernut. The lowest value was sample J (10.30±0.03).

The energy values ranges from (406.21 -353.04). The highest value was observed at sample E (406.21kcal/g±0.30) containing 100 % cocoyam and the lowest was observed at sample G (353.04±0.03) containing 72.25 plantain 22.25 cocoyam and 5 % tigernut.

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