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# MICROBIAL AND NUTRITIONAL EVALUATION OF BISCUITS PRODUCED FROM BLENDS OF WHEAT, ORANGE PEEL, PLANTAIN PEEL AND PINEAPPLE PEEL FLOURS

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## ABSTRACT

This study utilized composite flour from Orange peel, Pineapple peel, Plantain peel and Wheat for the production of biscuit with the bid to increase the protein quality, lipid and crude fibre content of biscuit and promote the utilization of composite flour. Different blends of composite flour and wheat with appropriate quantity of other ingredients were mixed to produce biscuits. The flour and biscuits produced were subjected to microbial, sensory and nutritional evaluations. The total viable counts of the samples ranged from 1.5 x $10^7$ CFU/g to 3.6x$10^7$ CFU/g. Isolated organism from the biscuit samples were characterized and identified to be *Aeromonas hyrophylia, Pseudomonas fluorescens, Bacillus subtilis, Bacillus licheniformis* and *Bacillus megaterium*. The nutritional evaluation of the biscuit samples showed that the different blends of wheat and composite flour biscuit had the highest content of protein, crude lipid, crude fibre and carbohydrate when compared to 100% wheat biscuit. Wheat flour could be fortified with composite flour (at different ratio) to produce acceptable biscuits with improved nutritional composition at reduced cost.

## INTRODUCTION

Biscuits are popular cereal foods consumed by all age groups, especially pre-school and school age children. They are a type of confectionery item dried to low moisture content (Okoye and Okaka, 2009). They are prepared to-eat, helpful and modest nourishment snacks delivered from the unpalatable batter that is changed into a light-permeable promptly edible and tantalizing item through the use of heat. Wheat flour which is the significant element for the creation of these prepared items, for example, scones is rich in sugars that produce a high glycemic reaction after ingestion (Ade *et al*., 2012). Biscuits are consumed extensively all over the world as snack foods and on a large scale in developing countries, Nigeria inclusive, where protein and caloric malnutrition are prevalent (Chinma and Gernah, 2007). With the increased advocacy on the consumption of functional foods by world nutrition bodies due to different health problems related with food consumption such as celiac diseases, diabetes and coronary heart diseases, World Health Organization (WHO) recommended reduction in the overall consumption of sugars and foods that promote high glucose response (WHO/FAO, 2003). A current trend in nutrition is the consumption of low-carbohydrate diets, including slowly digestible food products, as well as an increased intake of functional foods. Food professionals/industries are therefore faced with the challenge of producing food products containing functional ingredients in order to meet the nutritional requirements of individuals with health challenges. This has prompted research into the production of biscuits from non-wheat flour blends containing functional ingredients such as high dietary fiber and resistant starch (Adeoye *et al.,* 2017).

Composite flours are mixtures of different vegetable flours, with or without wheat flour. In most parts of the world, baked goods based on wheat flour in particular, are a popular foodstuff. Thus much research involving the use of non-wheat flours has been carried out and a good deal of success achieved. In addition, nutritional enhancement is frequently another goal in the development of such materials (Okaka, 1997). Milligan *et al*. (1981) characterized composite flour as a blend of flours, starches and different fixings planned to supplant wheat flour absolutely or halfway in bread kitchen and baked good items. Shittu *et al.* (2007) likewise concurred that as the composite flours utilized were either parallel or ternary blends of flours from some different yields with or without wheat flour. Composite flour is considered advantageous in developing countries as it reduces the importation of wheat flour and encourages the use of locally grown crops as flour (Hugo *et al.*, 2000; Hasmadi *et al*., 2014). Local raw materials substitution for wheat flour is increasing due to the growing market for confectioneries (Noor and Komathi, 2009). Thus, several developing countries have encouraged the initiation of programs to evaluate the feasibility of alternative locally available flours as a substitute for wheat flour (Abdelghafor *et al*., 2011).

Fruits are produced in considerable quantities and consumed locally, but are seldom processed in order to add value. Fruits exhibit relatively high metabolic activity compared with other plant derived foods such as seeds and tubers. These metabolic activities continue after harvesting, thus making most fruits highly perishable commodities (Offia-Olua and Ekwunife, 2015). Therefore, there is need for diversity in commercial utilization of fruits into different forms. There are numerous ways of utilizing and processing fruits such as processing into juice, jams, concentrates, jellies and dehydrated products. The introduction of fruit based composite flour is novel, as recently, fruits and vegetables have received much attention as a source of biologically active substances because of their anti-oxidant, anti-carcinogenic and anti-mutagenic properties (Tortoe *et al*., 2014). Hence, this study looks into the quality attributes of biscuit produced from wheat and composite flour from orange, pineapple and plantain peel.

## MATERIALS AND METHODS

### Sample Collection

The fruits (pineapple, orange and plantain) were purchased from Arada market in Ogbomoso, Oyo state. The wheat, margarine and sugar were purchased from Sabo market Ogbomosho, Oyo state.

### Processing of Composite Flours

The fruits were washed thoroughly with water to remove dirt and adhering extraneous materials, peeled manually with a sharp kitchen knife. The peels were separated and washed with 0.1% of KMS for 5 minutes. The peels were left to dry for 3 days to constant weight using sun drying method. The composite flours were prepared by grinding the dried peels in a flour mill and sieved with muslin cloth to obtain the flour samples. The flours were kept in a sterile polyethylene bag so as to prevent moisture absorption for biscuit production.

### Processing of Wheat Flour

Wheat seeds were examined carefully so as to remove all the dirt or foreign bodies from it. The wheat flour was prepared by grinding the wheat seeds in a flour mill.

### Culture Media

The different media used for the isolation and culturing includes nutrient agar which is a general purpose media (Nutrient agar) for total bacteria counts; differential media (MacConkey) for total enterobacteriacae counts; potato dextrose agar for fungal counts. These were prepared and sterilized at a temperature of 121°C for 15 minutes according to the manufacturers' specifications.

### Microbial Evaluation of flours

One gram of each flour sample was dissolved into 9ml of sterilized distilled water and shaken thoroughly to homogenize. Ten folds' serial dilution was carried out for each sample and aliquot was drawn from $10^{-6}$ which was then introduced into petri dishes containing appropriate sterilized agar medium. It was then incubated at 37ºC for 24 hours.

### Biscuit Production

### Formulation of Blends

The composite flours: (orange, pineapple and plantain) peels and wheat flour blends were made at varied ratios to give four blends of each flour respectively. The ratios were (wheat flour: composite flour) 100:0, 50:50, 70:30, 90:10 and 0:100. This was done using a measuring cup.

### Preparation of Biscuits

The various blends formulated from a mixture of wheat and composite flours were mixed separately with the same quantity of other ingredients (margarine, sugar and water). The measurements were carefully weighed using kitchen weighing balance according to the different blend ratios. The measured quantities of margarine and granulated sugar were mixed well in a rubber bowl to a creamy consistency. The flour was then added to the creamy mixture and kneaded until dough of plastic but not sticky consistency was obtained. Kneading continued for 5 min to obtain smooth, plastic dough. The dough was rolled into a long strip and cut into some small pieces with a kitchen knife, rolled into balls then pressed lightly with a fork. Then placed in a baking tray and baked for 15minutes at minimal temperature, checking at intervals till the biscuits were done. They were allowed to cool on a rack after which they were packed in packaging nylon and sealed with an impulse (nylon) sealer machine and kept in a cool, dry place.

### Organoleptic Evaluation

Sensory evaluation of biscuits samples was conducted using a 10-member sensory panelist, made up of males and females from the Department of Science Laboratory Technology, Ladoke Akintola University of Technology Ogbomoso, Oyo state. Degree of acceptance or likeness or preference was expressed on a 5-point hedonic scale quality analysis with 1 = dislike extremely, 2 = dislike, 3 = like slightly, 4 = like and 5 = like extremely was used. Biscuits prepared from the flour blends were coded and presented in plates.

### Microbial Evaluation of Biscuits

One gram of each sample (composite and wheat flour) biscuit was dissolved (differently) into 9ml of sterilized water and shaken thoroughly to homogenize. Ten folds' serial dilution were carried out from each samples and aliquot was drawn from $10^{-6}$ which was then introduced into petri dishes containing appropriate sterilized agar medium. It was then incubated at 37ºC for 24 hours.

**Isolation of Microorganisms**
One gram of each sample was weighed into 9 ml of sterile distilled water and homogenized by shaking; the resulting solution was then serially diluted. 1ml was drawn from the six-fold dilution which was then introduced into the already prepared solidified agar inside the sterile Petri dish.

**Culture Examination**
The incubated isolates were checked after 24 hours for visible colonies. There was no growth for the first 24 hours and later left for another 24 hours before visible and viable growth was observed.

**Sub culturing**
Fresh medium was prepared and sterilized at 121$^0$C for 15 minutes and allowed to cool and poured aseptically into the sterilized petri dishes. The inoculums were sub cultured on new plate by streaking in other to get a pure distinct colony. The plates were incubated at 37$^0$C for 24 hours. The plates were observed for pure and distinct colony.

**Culture Preservation**
Distinct pure colony was picked from the plate and inoculated on an already prepared sterilized Potato Dextrose agar and Nutrient agar slant. The slants were incubated at 37$^0$C for 24 hours. Slant with visible growth were then preserved in the refrigerator at -4$^0$C.

**Proximate Analysis of the Sample**
**Determination of moisture content**
Moisture content was determined adopting AOAC (2005) method. About 5g was taken in a pre-weight crucible (provided with cover) which was previously heated to 130$^0$C. The sample was dried for 24 hours in an air oven maintained at temperature 105$^0$C. The crucible was covered while still in oven then transferred to desiccators and weighed immediately after reaching room temperature. The loss of weight from sample was determined and the percent of moisture was calculated as follows:

$$\text{Moisture content}\left(\frac{g}{100g}\right) = \frac{loss\ in\ weight\ (w2-w3)}{(w2-w1)} \times 100$$

Where; $W_1$= initial weight of empty crucible,
$W_2$= weight of crucible + food before drying,
$W_3$= final weight of crucible + food after drying.
% Total solid (Dry matter) (%) = 100- moisture (%)

**Determination of Ash content**
Total ash content was determined using AOAC (2005) method. 2g sample was weighed into clean, dry porcelain ashing dish which was previously heated to remove moisture. The sample was then ignited with a gas burner until white smoking stopped. The sample was then placed in a muffle furnace at 550$^0$C and ignited until light grey ash resulted (or to constant weight). The sample was then cooled in desiccators and weighed. The ash content was calculated by following expression:

$$Ashcontent = \frac{Weight\ of\ ash}{Weight\ of\ original\ sample\ used} \times 100$$

**Protein determination**
Protein content was determined using AOAC (2005) method. A 5g digestion mixture was weighed accurately and transferred into a dry 300ml Kjeldahl flask. A suitable quantity of the sample (1 g for each) was transferred into the flask. 20ml of sulphuric acid was added, heated continuously until frothing ceased and then simmered briskly. The solution became clear in 15-20 min, heating continued for 45 min. After cooling, 1000ml water was added, and transferred quantitatively to a 1-litre round-bottom flask; the final volume was about 500ml. Sodium hydroxide solution was added gently to form a precipitate of cupric hydroxide and immediately the flask was connected to steam-trap and condenser. Then 50ml of boric acid solution, 50ml distilled water and 5 drops of indicator solution were added to a 500ml conical receiving flask. Positioning the condenser distillation was carried out for 40 to 45 minutes or until about 250ml of distillate was obtained. The contents of the receiving flask were titrated with 0.1 N hydrochloric acid; the end point was marked by a brown colour. A reagent blank was also determined and deducted from the titration. 1ml of 0.1N hydrochloric acid is equivalent to 1mg of nitrogen. A protein conversion factor of 5.7 was used to calculate the percent protein from nitrogen determination. Percentage of nitrogen and protein calculated by the following equations:

$$\%\ protein = Vs - Vb \times 0.01401 \times Nacid\ (6.25) \times 100\ (original\ weight\ of\ sample\ used)$$

Where Vs = Volume (ml) of acid required to titrate sample,
Vb = Volume (ml) of acid required to titrate blank,
N acid = normality of acid.

**Determination of total carbohydrate**
Total carbohydrate content of the sample was determined as total carbohydrate by difference, which is by subtracting the measured protein, fat, ash and moisture from 100.

$$Available\ carbohydrate(\%) = 100 - protein(\%) + Ash(\%) + Fibre(\%) + Fat(\%)$$

$$EnergyorCalorificValue(KJ/Mol) = (Protein \times 16.7) + (Lipids \times 37.7) + (Carbohydrate \times 16.7)$$

**Crude Fibre Determination**
The bulk of roughages in food is referred to as fiber and is estimated as crude fiber. Twenty grams (20 g) of the different samples were defatted with diethyl ether for 8

hours and boiled under reflux for exactly 30 min with 200ml of 1.25% H2SO4. It was then filtered through cheese cloth on a flutter funnel. This was later washed with boiling water to completely remove the acid. The residue was then boiled in a round bottomed flask with 200ml of 1.25% sodium hydroxide (NaOH) for another 30 min and filtered through previously weighed couch crucible. The crucible was then dried with samples in an oven at 100°C, left to cool in a desiccator and later weighed. This was later incinerated in a muffle furnace at 600°C for 2 to 3 hours and later allowed to cool in a desiccator and weighed.

$$\% \, fibre = \frac{Weightoffibre}{Weightoforiginalsample} \times 100$$

## RESULTS AND DISCUSSION

The orange, pineapple and plantain peel samples after washing and peeling, took about 3 days to dry and it was further grinded into powder (Figure 1). The orange peel powder had a grainy texture and yellowish appearance; pineapple peel powder had smooth texture with brownish appearance while plantain peel powder had a dark brown colour as reported by Adeoye *et al*. (2017). The wheat was purchased, sorted and milled into powder as shown in Figure 2. The wheat flour had a smooth texture and whitish appearance after milling as reported by Chu and Michael (2004).

Table 1 shows the microbial analysis of the composite and wheat flour. Total viable counts are used as a measure of microbiological quality with respect to the levels of the general microbial contamination. The total viable counts for the flours ranged from 0.4 x $10^7$ to 3.0 x $10^7$ CFU/g. Wheat flour had the highest total viable count and orange peel flour had the lowest. The fungal counts of pineapple peel flour and plantain peel flour is 0.1 x $10^7$CFU/g, there was no fungal count for orange peel flour and wheat flour. The result also indicated that there was no enterobacteriaceae (coliform) count for all the flour samples. Center for food safety (2014) reported that bacteria are used as indicators to reflect the hygienic quality of food. Enterobacteriaceae is a large group of biochemically and genetically related bacteria used to assess the general hygiene status of food product. Their presence in heat treated food indicates inadequate cooking or post processing contamination.

The sample of the biscuits of various blends is shown in Figure 3. It was observed that 90:10 (wheat: orange peel) biscuit had a smooth texture and 0:100 (wheat: orange peel) biscuit had a rough texture. Pineapple peel incorporated biscuits had smooth texture and brownish color, 90:10 (wheat: pineapple peel) biscuits had a lighter brownish color than 0:100 (wheat: pineapple peel). Adeoye *et al.* (2017) reported that change in color observed could be as a result of heat applied during processing which causes browning reaction as a result of the sugar contained in the pineapple peel. It was noted that the higher the ratio of Plantain peel flour incorporated into biscuits the darker the colour of the biscuits produced. 90:10 (wheat: plantain peel) biscuit had a dark brown color and 0:100 (wheat: plantain peel) biscuit had a deeper brown color. There was significant decrease in lightness with increase in the percentage fibre in the cookies. These reactions are influenced by many factors like pH, temperature, available water, sugar, protein and amino acids, etc. It is reported that Milliard reaction between reducing sugars and protein during baking mainly determine the color of the cookies (Chevallier *et al*., 2000).

The statistical analysis of the sensory evaluation of the biscuits is shown in the Table 2. The attributes evaluated include appearance, taste, texture, and general acceptability of biscuits produced from blends of wheat and composite flour. The blend with 100% wheat flour was most preferred by the 10 panelists of sensory assessors. Samples D (90%wheat: 10% orange peel) biscuit, H (90%wheat: 10%pineapple peel) and M (100% wheat) were significantly different from other samples in appearance and texture. Sample M (100%wheat) which was the control scored the highest in all the attributes evaluated and was above four on a 5-point scale. Taste and general acceptability varied significantly in all the samples however in terms of general acceptability, there was no significant difference between sample M (100% wheat) and H (90%wheat: 10%pineapple peel). Among the biscuit made from composite of orange peel flour, sample D (90%wheat: 10% orange peel) biscuit was most preferred in all attributes and this is in agreement with the results of Zaker *et al*. (2016). Sample A (100% orange peel) was the least accepted as compared to other samples in terms of taste and general acceptability. This may be as a result of the bitter taste of the biscuit because of the higher quantity of orange peel in the blend. The bitterness may have been caused by a compound called Limonin in sweet orange (Maier and Dreyer, 1965). The bitterness caused by limonin is referred to as delayed bitterness since it not detected in fresh juice but develops gradually and slowly during storage or with heat treatment (Maier and Beverly, 1968).

Among the biscuit made from composite pineapple peel flour, difference ($p<0.05$) was observed between samples F (50%wheat: 50%pineapple peel) and H (90%wheat: 10%pineapple peel) whereas no significant difference was observed between sample E (100% pineapple peel) and G (70%wheat: 30%pineapple peel). Sample H scored the highest in all attributes which is similar to the result of Adeoye *et al.* (2017) who reported that the scores for overall acceptability decreased with increase in the amount of the pineapple peel flour in the blend as indicated by most of the sensory properties. The difference observed between sample F and H may be due to the increase in level of pineapple flour, thereby reducing the crispness of the biscuits.

Among the biscuit made from composite plantain peel flour, there was no significant difference ($p<0.05$) in the appearance and texture of the different blends of plantain peel biscuits. Taste and general acceptability varied significantly in all the samples however there was no significant difference between sample J (70% wheat: 30% plantain peel), K (70% wheat: 30% plantain peel) and L (90% wheat: 10% plantain peel). Differences ($p<0.05$) were observed between samples I (100% wheat) and K (70% wheat: 30% plantain peel) whereas no significant difference was observed between sample J (70% wheat: 30% plantain peel) and L (90% wheat: 10% plantain peel) as well as sample K (70% wheat: 30% plantain peel). Arun *et al.* (2015) reported that acceptable cookies were produced by replacing wheat flour with plantain peel flour at 10 % level.

Table 3 shows the total viable and fungal counts of the biscuits produced. The total viable count of all the samples ranged from $1.5 \times 10^7$ to $3.6 \times 10^7$, the 90:10 (wheat: orange peel flour) biscuit had the lowest viable count ($1.5 \times 10^7$) and the 50:50 (wheat: plantain peel flour) biscuit had the highest viable count ($3.6 \times 10^7$). There were no fungal counts for samples except 50:50 (wheat: plantain peel flour) and 70:30 (wheat: plantain peel flour) that had $0.1 \times 10^7$ respectively. Food production cannot be 100% free from microorganisms but can be controlled and minimized. Microorganisms have great importance and impact on our lives; they are fundamental for obtaining some food products like yogurt, cheese etc. However, they are also the main cause of food and cultivar deterioration (Oladipo *et al.*, 2018). There are many factors that contribute to the presence of microorganisms in foods; the endogenous presence and cross contaminations being the most important (Adams and Moss, 1995). Microorganisms isolated often get into food through poor and non-hygienic handling of equipment and materials used in food production, for example, contaminations through wrapping and packaging (FSA, 2013).

The isolated organisms were identified to be *Aeromonas hydrophila*, *Pseudomonas flourescens*, *Bacillus subtilis*, *Bacillus alvei*, *Bacillus licheniformis* and *Bacillus megaterium* Bacteria also have a potential to contaminate baked products although their growth is more restricted by low water activity and low pH (Saranraj and Geetha, 2011). The spores of *Bacillus subtilis* for examples are heat resistant; 55 per cent remain active in amylase after 20 minutes at 65°C. This microorganism, which is present in raw ingredients, e.g., flour, sugar, and yeast, causes rope in bread. Ropiness can develop very rapidly under warm and humid conditions. So, it is a common problem in the warm climates of Mediterranean countries, Africa and Australia. A major source of *Bacillus* contamination is from the raw ingredients so ideally it would be profitable for bakeries to use only ingredients with low level of contamination (Saranraj and Geetha, 2011). *Pseudomonas* spp. causes food spoilage in specific food groups such as milk and dairy products, meat, fish, water, fruit and vegetables. *Pseudomonas* spp. does not constitute a serious risk to public health (Antonio *et al*., 2016).

Pineapple peel flour contained 5.11% of protein, 55.52% of carbohydrate which is less compared to wheat flour that had 11.27% of protein, 72.91% of carbohydrate (Table 4). Wheat flour had the lowest crude lipid content of 0.53% and orange peel flour had the highest crude lipid content of 8.74% which is lower than 9.52% Magda *et al.* (2008) previously reported for the peel of navel orange. Orange peels contain essential oils and this may have contributed to its higher lipid content (Njoku and Evbuomwan, 2014). The composite flours had higher percentage of crude fibre than wheat flour which makes it suitable to produce fibre rich biscuits. Dietary fibre is a group of food components which is resistant to hydrolysis by human digestive enzymes and necessary for promoting good health (Prakongpan *et al.*, 2006). It is known to enhance digestive process, stimulates bowel movements, lowers cholesterol, and exerts a positive influence on blood sugar levels (Higgins, 2004). The importance of dietary fibre in the prevention of *Diabetes* mellitus, obesity, coronary heart diseases, colon cancer and diverticular diseases among others, has caused more awareness on the essence of consuming foods with high fibre content (Rehinan *et al.*, 2004).

It was observed that 100% wheat biscuit had 5.85% of crude lipid while the orange peel biscuits had the highest crude lipid values which ranged between 11.46- 12.39% with 0:100(100% orange peel flour) biscuit having the highest crude lipid content (12.39%). Fats are integral part of biscuit, being the second largest component after flour in soft dough biscuits (Okaka, 1997). Fats shorten dough by weakening the dough gluten network. This results in soft biscuit which breaks easily and with a more tender mouth feel. Fat also gives a softer texture to biscuits and helps prevent the $CO_2$ bubbles from escaping from the dough too soon (Czernohorsky and Hooker, 2009). Biscuits are a rich source of fat and carbohydrate, hence are energy giving foods (Kure *et al*., 1998). It was observed that 100% wheat biscuit had the highest moisture content while orange peel biscuits had moisture content that ranged between 5.36-5.42%. The moisture contents of these biscuits were lower than 6.40% reported by Youssef and Mousa (2012) for biscuit supplemented with 10% orange flour. Biscuits are generally low in moisture. The low moisture levels of the orange based biscuits would ensure shelf stability. The moisture content of a food is of significance to shelf life and packaging (Nwosu, 2015). It was observed that 100% wheat biscuit had a low protein content of 5.64% while the biscuits that contained orange peel flour had the highest protein content that ranged between 12.36-13.17%. The protein content of the biscuit containing 90:10 (wheat: orange peel flour) had 12.36% which was higher than 7.44% reported by Youssef and Mausa (2012) and 10.98% by Magda *et al*. (2008) for biscuit containing orange peel flour. These differences may be attributed to the differences in the recipes used for the production of the different biscuits (Nwosu, 2015). It was also noted that the 100% wheat biscuits had a higher value of 72.57% carbohydrate content than orange peel biscuits that had carbohydrate content which ranged from 57.47-61.67% (Table 5). Biscuit is an energy food which is taken mostly in between meals by both young and old (Giwa and Ikejenlola, 2010).

It was observed that pineapple peel biscuits had protein content ranging from 5.79- 6.43% which is not significantly different from the value of protein content of 100% wheat biscuit that had 5.64%. Adeoye *et al.* (2017) reported that there is a gradual increase in protein with increase in the level of pineapple peel flour with 100% wheat flour biscuit having the lowest protein content. This could be as a result of high nutrient content (protein) in pineapple peel as reported by Slavin and Lloyd (2012). Pineapple peel biscuits had the highest carbohydrate content ranging from 73.40- 76.98% which is more than that of orange and plantain peel biscuits but not significantly different from that of 100% wheat that contained 72.57% of carbohydrate. It was observed that the higher carbohydrate content of the pineapple peel biscuits may be due to the increasing ratio of wheat flour (72.91% of carbohydrate) that supplemented the initial carbohydrate content of the pineapple peel flour (55.52% of carbohydrate). The crude lipid content of pineapple peel biscuits ranged 5.24-5.84%(which is significantly different from orange and plantain peel biscuits) with 100% pineapple peel biscuits having a closer value of 5.84% when compared with 100% wheat biscuits (5.85%). This observation differs to that of Adeoye *et al.* (2017) who reported that the pineapple peel biscuits had higher crude lipid content than 100% wheat biscuits. According to Kadam *et al.* (2012), nutritional composition of pineapple powder however depends on the variety, maturity, size of the fruit, harvesting interval and climatic conditions of the growing area.

It was observed that 100%wheat biscuit had a moisture content of 6.68% which is higher than plantain peel biscuits that had moisture content ranging between 4.87-5.36% with 100% plantain peel having the highest value of 5.36%. It was noted that moisture content of the cookies increased with an increase of plantain peel flour in the biscuit. This may be due to the higher water absorption and water holding capacity of plantain fibre (Arun *et al.*, 2015). Moisture content is a critical parameter as far as the texture, acceptability and shelf life of cookies is concerned. It is reported that moisture content of cookies increases with the increase in fibre content (Chung *et al.*, 2014; Sharma and Gujral, 2014). Plantain peel biscuits had lower carbohydrate content that ranged between 62.42-66.89% when compared with 100% wheat biscuit (72.57%). Plantain peel flour biscuits contained the highest values of crude fibre ranging from 7.98- 9.76% with 100% plantain peel flour having the highest value (9.76%) higher than orange and pineapple peel biscuits but significantly different from 100% wheat biscuits (6.72%). It was noted that crude fibre content increased progressively when the wheat flour was partly replaced with plantain peel flour which may be due to the high fibre content of plantain peel. Arun *et al.* (2015) reported that plantain peel biscuits had higher fibre content but low carbohydrate content when compared with 100% wheat biscuits. Fibre promotes glucose attenuation and laxation, and can reduce the risk of coronary heart disease, colon cancer and obesity (Threapleton *et al.* 2013; Aune *et al.* 2011). As there is an increase in demand for foods with increased dietary fibre content, plantain peel flour can be a potential source for dietary fibre in these products. Plantain peel flour could be used as a suitable source of dietary fibre with associated bioactive compounds and could be incorporated as ingredients in a large variety of food products such as making biscuits, cakes etc. Since functional foods are an effective way to deliver beneficial agents aimed at reducing disease risk, the value addition of plantain peel in the form of a functional food ingredient can bring remarkable socio-economical change in the region (Arun *et al.*, 2015).

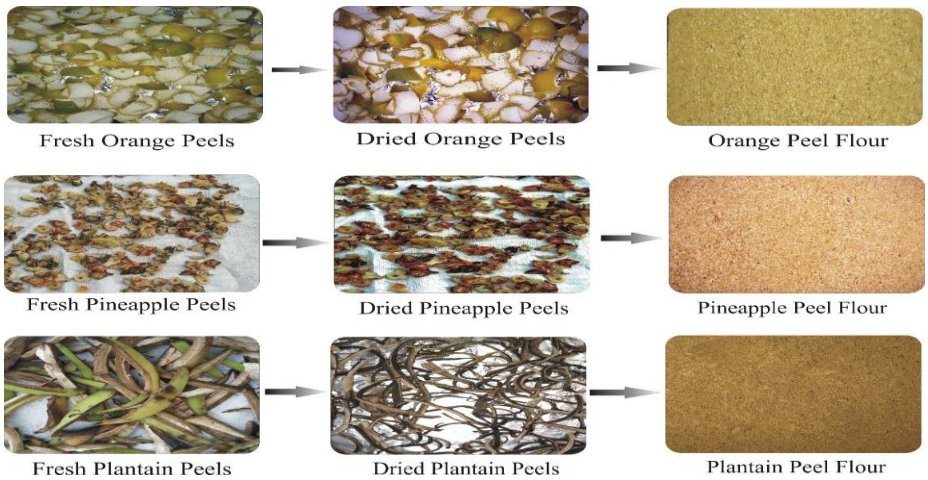


**Figure 1: Processing of Composite Flours.**


**Figure 2: Processing of Wheat flour.**

**Table 1: Microbial Evaluation of the Flours (in CFU/g).**

| SAMPLE | TVC | FC | TEC |
|---|---|---|---|
| WF | 3.0 x $10^7$ | - | - |
| PAPF | 1.6 x $10^7$ | 0.1 x $10^7$ | - |
| OPF | 0.4 x $10^7$ | - | - |
| PPF | 1.4 x $10^7$ | 0.1 x $10^7$ | - |

**Keys:** TVC (Total viable counts), FC (Fungal counts), WF (Wheat flour), PAPF (Pineapple peel flour), OPF (Orange peel flour), PPF (Plantain peel flour).


**Figure 3: Biscuits Produced from different Blends of Wheat and Composite flours.**

**Table 2: Mean Scores of Sensory Evaluation of the Biscuits Produced.**

| Sensory Parameters | Appearance | Taste | Texture | General Acceptability |
|---|---|---|---|---|
| A | 4.0±0.26$^{b}$ | 1.2±0.13$^{d}$ | 3.4±0.27$^{b}$ | 1.4±0.16$^{d}$ |
| B | 4.0±0.21$^{b}$ | 2.2±0.29$^{c}$ | 4.1±0.10$^{b}$ | 2.1±0.35$^{c}$ |
| C | 4.1±0.18$^{b}$ | 2.3±0.26$^{c}$ | 4.1±0.23$^{a}$ | 2.3±0.26$^{c}$ |
| D | 4.6±0.16$^{a}$ | 2.9±0.43$^{bc}$ | 4.1±0.10$^{b}$ | 2.6±0.48$^{c}$ |
| E | 3.5±0.27$^{b}$ | 3.8±0.20$^{b}$ | 3.9±0.10$^{b}$ | 3.7±0.21$^{b}$ |
| F | 3.9±0.28$^{b}$ | 4.1±0.28$^{b}$ | 3.7±0.21$^{b}$ | 3.9±0.35$^{b}$ |
| G | 3.9±0.18$^{b}$ | 4.0±0.21$^{b}$ | 3.8±0.20$^{b}$ | 4.0±0.15$^{b}$ |
| H | 4.7±0.15$^{a}$ | 5.0±0.00$^{a}$ | 4.9±0.10$^{a}$ | 5.0±0.00$^{a}$ |
| I | 3.5±0.31$^{b}$ | 2.6±0.37$^{c}$ | 3.4±0.34$^{bc}$ | 2.9±0.28$^{c}$ |
| J | 3.3±0.21$^{bc}$ | 3.8±0.13$^{b}$ | 3.9±0.10$^{b}$ | 3.8±0.13$^{b}$ |
| K | 3.9±0.23$^{b}$ | 3.6±0.16$^{b}$ | 3.8±0.20$^{b}$ | 3.7±0.15$^{b}$ |
| L | 3.7±0.26$^{b}$ | 4.1±0.18$^{b}$ | 3.7±0.15$^{b}$ | 3.8±0.13$^{b}$ |
| M | 5.0±0.00$^{a}$ | 5.0±0.00$^{a}$ | 4.9±0.10$^{b}$ | 5.0± 0.00$^{a}$ |

**Key:** Data represent the mean± standard error of mean(SEM). Values with the same superscript alphabet letters along the same column are not significantly different ($p<0.05$), TVC (Total Viable count), FC (Fungal count), A (100% Orange peel flour biscuit), B (50% wheat: 50% Orange peel flour biscuit), C (70% wheat: 30% Orange peel flour biscuit), D (90% wheat: 10% Orange peel flour biscuit), E (100% Pineapple peel flour biscuit), F (50% wheat: 50%

pineapple peel flour), G (70% wheat: 30% pineapple peel flour biscuit), H (90% wheat: 10% Pineapple peel flour biscuit), I (100% Plantain peel flour biscuit), J (50% wheat: 50% plantain peel flour biscuit), K (70% wheat: 30% Plantain peel flour biscuit), L (90% wheat: 10% Plantain peel flour biscuit), M(100% Wheat flour biscuit).

**Table 3: Microbial Evaluation of the Biscuits (in CFU/g).**

| SAMPLE | TVC | FC | TEC |
|---|---|---|---|
| A | $2.7 \times 10^7$ | - | - |
| B | $3.1 \times 10^7$ | - | - |
| C | $2.0 \times 10^7$ | - | - |
| D | $1.5 \times 10^7$ | - | - |
| E | $2.0 \times 10^7$ | - | - |
| F | $1.7 \times 10^7$ | - | - |
| G | $2.2 \times 10^7$ | - | - |
| H | $2.5 \times 10^7$ | - | - |
| I | $2.0 \times 10^7$ | - | - |
| J | $3.6 \times 10^7$ | $0.1 \times 10^7$ | - |
| K | $2.1 \times 10^7$ | $0.1 \times 10^7$ | - |
| L | $1.9 \times 10^7$ | - | - |
| M | $2.5 \times 10^7$ | - | - |

**Keys:** TVC (Total Viable count), FC (Fungal count), A (100% Orange peel flour biscuit), B (50% wheat: 50% Orange peel flour biscuit), C (70% wheat: 30% Orange peel flour biscuit), D (90% wheat: 10% Orange peel flour biscuit), E (100% Pineapple peel flour biscuit), F (50% wheat: 50% pineapple peel flour), G (70% wheat: 30% pineapple peel flour biscuit), H (90% wheat: 10% Pineapple peel flour biscuit), I (100% Plantain peel flour biscuit), J (50% wheat: 50% plantain peel flour biscuit), K (70% wheat: 30% Plantain peel flour biscuit), L (90% wheat: 10% Plantain peel flour biscuit), M(100% Wheat flour biscuit).

**Table 4: Nutritional Evaluation (Proximate analysis) of the Flours.**

| Samples | %Moisture | %Ash | %Protein | %CF | %Carbohydrate | %CL |
|---|---|---|---|---|---|---|
| WF | 14.23 | 0.68 | 11.27 | 0.38 | 72.91 | 0.53 |
| OPF | 5.45 | 5.17 | 9.73 | 14.19 | 56.72 | 8.74 |
| PAPF | 14.87 | 4.39 | 5.11 | 14.80 | 55.52 | 5.31 |
| PPF | 5.78 | 3.43 | 10.3 | 15. 34 | 60.13 | 5.02 |

**Key:** WF (Wheat flour), OPF (Orange peel flour), PAPF (Pineapple peel flour), PPF (Plantain peel flour), CF (Crude fibre), CL (Crude lipid)

**Table 5: Nutritional Evaluation (Proximate Analysis) of the Produced Biscuit.**

| Samples | %Moisture | %Ash | %Protein | %CF | %Carbohydrate | %CL |
|---|---|---|---|---|---|---|
| A | 5.42 | 3.48 | 13.17 | 8.07 | 57.47 | 12.39 |
| B | 5.39 | 3.24 | 13.04 | 7.78 | 58.30 | 12.25 |
| C | 5.41 | 2.89 | 12.24 | 7.64 | 60.25 | 11.57 |
| D | 5.36 | 2.56 | 12.36 | 6.59 | 61.67 | 11.46 |
| E | 4.39 | 2.82 | 6.43 | 7.12 | 73.40 | 5.84 |
| F | 4.25 | 2.74 | 6.41 | 7.05 | 73.79 | 5.76 |
| G | 3.83 | 2.52 | 6.34 | 6.73 | 75.16 | 5.42 |
| H | 3.74 | 2.43 | 5.79 | 5.82 | 76.98 | 5.24 |
| I | 5.36 | 3.34 | 12.25 | 9.76 | 62.42 | 6.87 |
| J | 5.27 | 3.17 | 11.46 | 9.54 | 62.09 | 8.47 |
| K | 4.96 | 2.85 | 11.27 | 8.89 | 64.29 | 7.74 |
| L | 4.87 | 1.94 | 10.75 | 7.98 | 66.89 | 7.57 |
| M | 6.68 | 2.54 | 5.64 | 6.72 | 72.57 | 5.85 |

**Keys:** CF (Crude fibre), CL (Crude lipid), A (100% Orange peel flour biscuit), B (50% wheat: 50% Orange peel flour biscuit), C (70% wheat: 30% Orange peel flour biscuit), D (90% wheat: 10% Orange peel flour biscuit), E (100% Pineapple peel flour biscuit), F (50% wheat: 50% pineapple peel flour), G (70% wheat: 30% pineapple peel flour biscuit), H (90% wheat: 10% Pineapple peel flour biscuit), I (100% Plantain peel flour biscuit), J (50% wheat: 50% plantain peel flour biscuit), K (70% wheat: 30% Plantain peel flour biscuit), L (90% wheat: 10% Plantain peel flour biscuit), M(100% Wheat flour biscuit)

## CONCLUSION

The effect of proportion of blend on the quality of biscuits made from orange, pineapple, plantain peel flour and wheat flour had been examined. This research study indicates that biscuits produced from composite flour and wheat flour contain sufficient percentage of protein, lipid, fibre, and carbohydrate compared to biscuits from 100% wheat flour. The judicious use of composite flour in the diet in suitable proportions enhanced dietary quality. Nutritional value of the biscuit was increased by addition of the peel powder. Fruit peels are considered as having certain vital nutrients and having certain properties which make the gastro intestinal tract function well and it is excellent for the diabetic and heart patient. High fibre diets are associated with the prevention, reduction and treatment of some diseases, such as constipation, High blood pressure, morning sickness and stomach disorder diseases. Results show the potential of incorporating orange, plantain and pineapple peel flour into baked products. This would be of economic importance in many developing countries such as Nigeria in promoting the utilization of fruit peels and at large, enhance waste management generated from the peels. The results obtained could be very valuable in decision making for industries that would want to take nutritional advantage of indigenous cereal crops to partially or completely substitute wheat flour in baking.

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