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QUALITY ASSESSMENT OF COMPOSITE FLOUR MADE FROM WHEAT AND PLANTAIN PEEL

[*1]Esan, Y. O., [2]Famuwagun, A. A. and [2]Adeleye, O. T.

[1]Department of Food Science and Technology, College of Agriculture and Natural Sciences, Joseph Ayo Babalola University, Ikeji-Arakeji, Osun state, Nigeria
[2]Department of Food Science and Technology, College of Science, Engineering and Technology, Osun State University, Osogbo, Nigeria
Corresponding Author's Email: yoesan@jabu.edu.ng
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Abstract

The need to find potential food uses of plantain peel, which is a major waste product of plantain fruits necessitated the development of flour blends using wheat flour and plantain peel. The plantain peel flour (PPF) was blended with wheat flour (WF) in the ratio of 100:0, 90:10, 80:20, 70:30 and 0:100 of PPF and WF. The flour blends were analysed for proximate composition, functional properties, mineral composition and colour parameters. The results of the proximate composition ranged between 6.68 to 6.86%, 3.00 to 3.16%, 0.88 to 1.21%, 3.40 to 9.25%, 1.00 to 1.13% and 78.7 to 84.7% for moisture, ash, fat, protein, fibre and carbohydrates respectively. The Mineral composition of the samples ranged between 0.75 to 7.30 mg/g for Iron, 2.60 to 7.77 mg/g for Sodium, 1020.90 to 1044.10 mg/g for Potassium, 188.50 to 1917.80 mg/g for Magnesium, and 14.65 to 137.95 mg/g for Calcium. The results of the bulk density ranged from 0.57 to 0.76 g/ml, water absorption capacity ranged from 1.23 to 3.43 g/ml and the swelling capacity ranged from 1.25 to 2.16 g/ml. There was a significant decrease ($p<0.05$) in 'L*' (lightness), 'a*' (redness) and 'b*' (yellowness) with increase in the PPF. In conclusion, the results obtained showed a detectable amount of nutrients, significantly higher amount of minerals and functional properties that could favour industrial utilization. The excellent contribution of the plantain peel to the overall nutritional properties of the flour blends suggests the potential utilization of the peel as ingredients in food.

Keywords: Plantain peels, flour blends, proximate composition, mineral composition, functional properties

Introduction

Plantain (*Musa paradisiaca*) is an herbaceous, perennial, monocotyledonous plant belonging to the genus *Musa* along with (desert) bananas (*M. sapientum*) in the family *Musacaceae* (Jesumirhewe *et al.,* 2022). It is a tropical fruit that constitute a staple food crop in Central and West Africa Region. Over 2.11 million metric tons of plantains are produced in Nigeria annually which contributes substantially to the nutrition of subtropical local populations (FAO, 2005; Akinsanmi *et al.,* 2015). Plantain provides over 10% daily calorie intake for a population of more than 70 million people across the African continent (Shadrach *et al.,* 2020).

The peels of plantain fruits are mostly regarded as waste, often discarded indiscriminately and known to constitute a menace to the society thereby adding and worsening the problem of environmental pollution particularly in places where ruminants (Sheep and Goat) are not allowed to roam about (Ogbonna, 2021). The plantain peel accounts for almost 40% of the fruit weight. Gilver *et al.* (2017) has reported that plantain peel is a potential and promising raw material which could find industrial applications especially in the agro-allied industries. Reports have shown the peels as a good potential substitute for corn starch in the diet of snails and also incorporated with other waste materials in the diet of pigs (Okareh *et al.*, 2015; Omale *et al.*, 2008). Meanwhile, in the chemical industry, the peels have shown potential for the generation of important chemicals like ethanol and also alkali for the manufacturing of soap. As a way of ensuring a safer environment, attempts have been made to use polyphenolic resol resins from the ethanol extract of plantain peels for the adsorption of heavy metals since the peels show high retention affinity for lead, nickel and chromium (Andres *et al.*, 2015). Furthermore, in the food industry, flour made from the peels has been reportedly used to enrich wheat flour at various percentages in producing snacks like cookies and sausages; serving as a good source of fibre, antioxidants and potentially benefiting humans in the management and prevention of life style related diseases (Gilver *et al.*, 2017; Arun *et al.*, 2015).

Wheat is one of the most important staple food grains in Nigeria. It is leading cereal food produced, consumed and traded in Nigeria averaging 533 metric tons annually representing almost one third of all cereal production (CBN, 2008). Wheat is the second highest contributor to the Nigeria's food import bill, putting pressure on the country's foreign reserve as over $2bn was spent annually on the importation of over five million metric tons of wheat (CBN, 2021). Globally, wheat (*Triticum aestivum*) is an important industrial and food grain. It ranks second among the most important cereal crops in the world, after rice (Najafi, 2014). It is the most important cereals traded on international markets (FAO, 2009). In Nigeria, wheat is consumed in one form or the other in virtually every home, restaurants and hotels throughout the country. Besides, the crop is the main raw material in the Nigeria flour mills. Its flour is used for making bread, confectionaries, biscuits and other snacks. The offal (residue) is used in the feed-mills in compounding livestock feeds (Ahmed *et al.*, 2014).

In all African countries, wheat consumption has been steadily increasing during the past 20 years as a result of growing population, changing food preferences and a strong urbanization trend which has led to a growing 'food gap' in all regions, largely met by imports. Hence, considerable efforts to promote the use of composite flours seem to be some of the ways to reduce the burden of wheat importation (Mongi *et al.,* 2015). Composite flour technology allows flour from locally grown crops such as cassava, yams and sweet potatoes replaces a portion of wheat flour for use in baked products. However, utilizing the plantain peel as food ingredient requires the understanding of the functional behaviors of the flours in combination with a well-known flour, this forms the basis of this study.

Methods

Preparation of plantain peel

The peels were obtained fresh from the bunch of plantain obtained from the Teaching and Research farms of Joesph Ayo Babalola University, Ikeji-Arakeji. The plantain removed from the bunch one after the other and washed in clean waters. The peel of the plantains was carefully removed to avoid the peeling the fleshy parts together with the peel. The peels were allowed to dry in a cabinet dryer at a temperature of 60°C for 24 h. The dried peel was then milled using laboratory blender and packaged.

The plantain peel produced above was co-blended with wheat flour in the ratio of wheat: plantain peel (100:0; 90:10; 80:20; 70:30 and 0:100) to obtain sample codes AO, BF, CX, DZ and EO respectively.

Analyses Carried Out on the Flour Blends

Proximate composition

The proximate compositions of the flour mixtures (moisture, crude fat, crude protein, fibre and carbohydrates) were carried out according to the standard method of AOAC, (2018). The energy value was estimated in kcal/g by multiplying the percentages of crude protein, crude lipid and carbohydrate with the recommended factors 4, 9 and 4 respectively as proposed by Martin & Coolidge (1978) and reported by Ijarotimi *et al.*, (2013).

Mineral content determination

Some mineral composition of the samples (Calcium, Magnesium, Sodium, Iron and Potassium were determined using the methods of AOAC (2018) with Atomic Absorption Spectrophotometry as reported by Ohizua *et al.* (2017).

Functional properties

Some functional properties of the wheat: plantain peel flour mixtures were evaluated and these include water absorption capacity (WAC) by the method of Sathe *et al.* (1981) as modified by Nuwamanya *et al.,* (2011), bulk density (BD), determined according to the method described by Mbaeyi-Nwaoha *et al.* (2016), swelling capacity (SC), determined by the modified method of Kulkarni *et al.* (1991) as reported by Oloniyo *et al.* (2022).

Colour properties evaluation

The colour attributes of the wheat: plantain peel flour blends were measured using a Minolta portable chroma-meter. The Hunter lab colour coordinates system L^* (100 = white, 0 = black), a^* (+ ve = red, - ve = green), and b^* (+ ve = yellow, - ve = blue) values were recorded. Each sample was measured at four spots according to Hsu *et al.* (2003). Whiteness index (WI), yellowness index (YI), and flour colour index (FCI) were determined according using the following:

$$WI = 100 - \sqrt{(100 - L) + a^{*2} + b^{*2}} \qquad \text{Equation (i)}$$

$$YI = \frac{142.86(b^*)}{L^*} \qquad \text{Equation (ii)}$$

$$FCI = L^* - B^* \qquad \text{Equation (iii)}$$

The change in colour was determined by calculating the color differential index (ΔE) using the equation below:

Total colour difference (ΔE) =

$$\sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2} \qquad \text{Equation (iv)}$$

Where;

Δ L = (L sample – L standard)

Δ a = (a sample – a standard)

Δ b = (b sample – b standard)

Statistical analysis

Data were obtained in triplicate; one-way analysis of variance (ANOVA) was used to analyze the result using Statistical Package for Social Sciences (SPSS) version 21. Means were separated using Duncan's new multiple range test (DNMRT). Statistical significance was accepted at $p \leq 0.05$.

Results and Discussion

Proximate Composition of Wheat-Plantain Peel Flour Blends

The proximate composition of the wheat-plantain peels flour blends is presented in Table 1. The moisture content of the flour samples ranges from 6.68 to 6.86 %. There was no significant difference (p>0.05) among the flour blends and the moisture content reported for all the samples; AO, BF, CX, DZ, and EO were found to be below the acceptable moisture range of 10% for flours (Omoba *et al.*, 2013). The values are therefore low enough for adequate shelf-life stability if packaged in air-tight container. The moisture content of dried products has a crucial role on the storage stability. Higher moisture content in food products tends to lead to low textural, chemical and biochemical properties, as well as promote microbial growth (Traynham *et al.*, 2007). Rodriguez-Ambriz *et al.* (2008) also reported 6.0 g/100g moisture for unripe banana flour. In the same vein, Kumar *et al.* (2019) reported a moisture range of 4.91 to 8.59 g/100g for banana and plantain peel flour while Tsado *et al.* (2021) likewise reported a moisture range of 4.38 for plantain peel flour.

Samples BF and CX have a reasonable high protein content when compared with other flour blends, indicating that the samples have the potential contribute to the daily human protein requirement (Adamu *et al.,* 2017). The crude protein contents of the composite flours was high when compared with other sources of plant protein. They are higher than that of shea butter fruit pulp (Tsado *et al.,* 2021), amaranthus and cocoyam leaves (Adepoju *et al.,* 2006). However, the crude protein content for 100% plantain peel was lesser when compared with that of widely eaten staple roots, tubers and fruits (Tsado *et al.,* 2021), fluted pumpkin pod and pulp (Esseien *et al.,* 1992) and plantain and banana peel (Tsado *et al.,* 2021). Fat contents of wheat-plantain peel flours ranged from 0.88 (DZ) to 1.21% (AO), with the highest value in 100% wheat flour (AO) and least in 100% plantain peel flour (EO). The generally low values of fat content are an indication that the samples would be slow to participate in oxidation and by implication, prolong the shelf life of the flour blends. The value is in tandem with that reported for plantain and banana peel flour by Tsado *et al.* (2021). These values is an indication that as a by-product may not be a good source of fat-soluble vitamins nor can it contribute significantly to the energy content of products produced from it.

The ash contents of the wheat-plantain peel

Table 1: Proximate composition of Wheat-Plantain Peel flour blends (g/100 g)

Sample codes	Moisture Content (%)	Crude protein (%)	Crude fat (%)	Total ash (%)	Crude fiber	Carbohydrate	Energy value (Kcal)
AO	6.86±0.04 ^{a}	9.25±0.05 ^{a}	1.21±0.04 ^{a}	2..00±0.04 ^{d}	1.00±0.01 ^{b}	79.7±0.01 ^{d}	362.69
BF	6.79±0.03 ^{a}	9.12±0.07 ^{b}	1.19±0.05 ^{a}	3.02±0.05 ^{c}	1.10±0.2 ^{b}	78.7±0.23 ^{e}	361.99
CX	6.68±0.05 ^{a}	6.33±0.08 ^{c}	1.15±0.03 ^{b}	3.00±0.03 ^{c}	1.08±0.01 ^{b}	81.4±0.02 ^{b}	361.27
DZ	6.78±0.03 ^{a}	3.40±0.06 ^{d}	0.88±0.03 ^{d}	3.12±0.88 ^{b}	1.10±0.04 ^{b}	84.7±0.01 ^{a}	360.32
EO	3.52±0.03 ^{a}	1.44±0.06 ^{d}	0.56±0.04 ^{c}	5.78±0.02 ^{a}	7.98±0.02 ^{a}	80.74±0.01 ^{c}	333.76

Values are means ± S.D. of triplicate determinations. Values in the same column with different superscripts were significantly ($p<0.05$) different.

KEY: AO = 100:0; 100 % wheat flour, 0 % plantain peel
BF = 90:10; 90 % wheat flour, 10 % plantain peel
CX = 80:20; 80 % wheat flour, 20 % plantain peel
DZ = 70:30; 70 % wheat flour, 30 % plantain peel
EO = 0:100; 0 % wheat flour, 100 % plantain peel

flour samples also ranged from 3.00 to 5.78%. No significance difference (*p>0.05*) was observed in the ash content. The presence of ash in food is an indication of mineral composition of food samples. The higher value recorded for the samples was comparative with the values reported by previous researchers for some agricultural waste (Adebowale *et al.,* 2002) and plantain peel (Tsado *et al.,* 2021). The crude fiber content of wheat-plantain peel flour ranged from 1.00 to 7.98%. Samples EO were significantly higher (*p<0.05*) when compared with the values obtained for sample AO, BF, CX and DX. The values obtained for the 100% plantain peel flour was significantly higher than the value obtained for plant products such as Ube (*Dacryodes edulis*) (2.1%) and fruit pulp (4.3%, Adepoju *et al.*, 2008) but lower than the value obtained for plantain and banana peel (8.36% and 12.36% respectively, Tsado *et al.*, 2021). However, the values obtained for all the composite samples were significantly lower (*p<0.05*) when compared with the recommended daily fibre consumption per day as pronounced by Food and Agricultural Organization/World Health Organization joint expert consultation (FAO/WHO). Fiber is important in the body as it helps in lowering blood cholesterol level and slows down the process of absorption of glucose, thereby helping in keeping blood glucose level in control (Anderson *et al.*, 2009). It is also necessary to note that consumption of fibre as part of the diet helps in smooth bowel movements and thus helps in easy flushing out of waste products from the body and also increases satiety and hence impacts some degree of weight management, hence the plantain peels will have health promoting benefits for human (Ojinnaka *et al.*, 2016).

Mineral Compositions of Wheat-Plantain Peel Flour Blends

The mineral composition of the wheat flour and plantain peel flour blends is presented in Table 2. The Sodium content of the blends of plantain peels-wheat flour ranged 2.60 to 7.77 mg/100g. There was no significant difference (p>0.05) in the content of iron obtained in the sample that contained 100 % wheat flour (AO) and 90:10 wheat and plantain peel flour (BF). Similarly, no significant difference (p>0.05) was obtained in the sample that contained 20 and 30 % plantain peel flour. The sample that contained the highest concentration of plantain peel flour (EO) had the highest sodium content (7.77 mg/ 100 g). By implication, increase in the concentration of wheat flour in the mixture increased the sodium content of the flour mixture. Sodium, as a mineral element should be moderately consumed. Moderate and adequate consumption of sodium helps in maintaining the osmotic pressure of the body and regulate transport of CO_2 in the blood (Okaka, 2010). The calcium content of the samples ranged between 14.65and 137.95 mg/ 100 g. The result showed significance difference (p<0.05) in the values of calcium obtained for the samples as reported in Table 2. The values of calcium increased as the concentration of plantain peel increased in the mixture at a decreasing rate of the wheat flour. Sample that contained 100 % plantain peel flour had the highest calcium value (137.95 mg/ 100 g) while sample AO, that contained 100 % wheat flour had the least value. This suggest that plantain peel flour contain a deposit of nutrient when compared with wheat flour, but lower than the 500 mg/ day minimum consumption as reported by Akinyemi *et al.* (2020). According to Raskh (2020), intake of calcium rich foods helps in growth and maintenance of bones, teeth and muscle.

The values obtained for the Potassium content of the flour blends ranged between 1020.90 to 1044.10 mg/100 g and the values were significantly different (p<0.05) among the samples. Increase in the concentrations of the plantain peel flour increased the potassium content of the flour blends and the highest value was obtained in the sample that contained 100 % plantain peel. The high content of potassium in flour blends that contain plantain peel suggests a potential utilization of the peel as food ingredient. Both the potassium and sodium interact to lower the high blood pressure, resulting from excess intake of sodium chloride.

According to Adeyeye *et al.* (2007), Magnesium serves as an important activator to various digestive enzymes and helps to stabilize the electrical potential in the nerve. The results obtained for the magnesium content in the study is reported in Table 2. The values ranged between 188.50 and 1917.80 mg/ 100 g. The trend of the result showed that increase in the concentration of the plantain peel in the blends increased the Magnesium content of the samples.

Table 2: Mineral compositions of Wheat-Plantain Peel Flour Blends (mg/100g)

Samples/Nutrients	Iron	Sodium	Potassium	Magnesium	Calcium
AO	7.30±0.28 ^{b}	2.60±0.00 ^{d}	1020.9±1.31 ^{bc}	188.50±0.71 ^{c}	14.65±1.20 ^{h}
BF	3.40±0.57 ^{c}	2.60±0.42 ^{d}	1021.0±1.91 ^{bc}	185.50±50.27 ^{ab}	29.10±0.14 ^{g}
CX	2.80±0.14 ^{cd}	3.65±0.21 ^{cd}	1027.0±6.86 ^{bc}	1876.40±8.20 ^{ab}	59.59±0.71 ^{f}
DZ	2.30±0.14 ^{cd}	3.65±0.21 ^{cd}	1040.6±6.86 ^{b}	1891.70±0.08 ^{ab}	67.15±0.71 ^{e}
EO	0.75±0.21 ^{d}	7.77±0.42 ^{b}	1044.1±4.38 ^{b}	1917.80±44.19 ^{a}	137.95±0.35 ^{d}
FAO/WHO	16	296	516	76	500

Values are means ± S.D. of triplicate determinations. Values in the same column with different superscripts were significantly (p<0.05) different.

KEY: AO = 100:0; 100 % wheat flour, 0 % plantain peel
BF = 90:10; 90 % wheat flour, 10 % plantain peel
CX = 80:20; 80 % wheat flour, 20 % plantain peel
DZ = 70:30; 70 % wheat flour, 30 % plantain peel
EO = 0:100; 0 % wheat flour, 100 % plantain peel

Functional properties

Figure 1 shows the values obtained for some selected functional properties of the flour blends from wheat flour and plantain peel flour. The values obtained for water absorption capacity ranged between 1.23 and 3.43 g/g. Samples BF and CX were not significantly (p>0.05) different from one another. The highest value for water absorption capacity was obtained in the sample that contained 100% plantain peel flour while the lowest value was obtained in the value that contained 100% wheat flour. The result showed that increase in the concentration of the plantain peel flour in the flour mixture increased water absorption capacity of the blends. According to Tiruneh *et al.* (2018), water absorption capacity is the ability of food powders to absorb water to improve food consistency, which is a desirable and an important property in baking and confectioneries. Tiruneh *et al.* (2018) also attributed differences in water absorption capacity of samples to differences in the carbohydrate content of the samples, which is also true for this study.

The values obtained for the swelling capacity of the samples ranged between 1.25 and 3.70 g/g. The highest value was obtained in the sample that contained 30% plantain peel flour and 70% wheat flour while the least value was obtained in the sample that contained 100% wheat flour. The swelling capacity of the sample was increased when the content of the plantain peel flour was 10 and 20% in 90 and 80% wheat flour respectively. The value was peaked at 30% plantain peel and 70% wheat flour. The value began drop when the amount of plantain peel flour was increased to 100%. Swelling capacity is the ability of the sample to absorb water uninterruptedly under room temperature. According Hoover *et al.* (2002), swelling capacity is used to assess the extent of interaction between the swollen starch granules and water. The higher the swelling capacity, the shorter the cooking time of such a blend, indicating the extent to which the starch granules have swollen and softened (Falade *et al.*, 2013; Oloniyo *et al.*, 2022)

The packed bulk density (BD) of the flour blends (AO, BF, CX, DZ and EO) varied significantly ($p \leq 0.05$) and their values are 0.76, 0.73, 0.71, 0.70 and 0.57 g/ml respectively. AO showed significantly higher bulk density while EO had the least bulk density. The bulk density reduces with increase in the plantain peel flour substitution

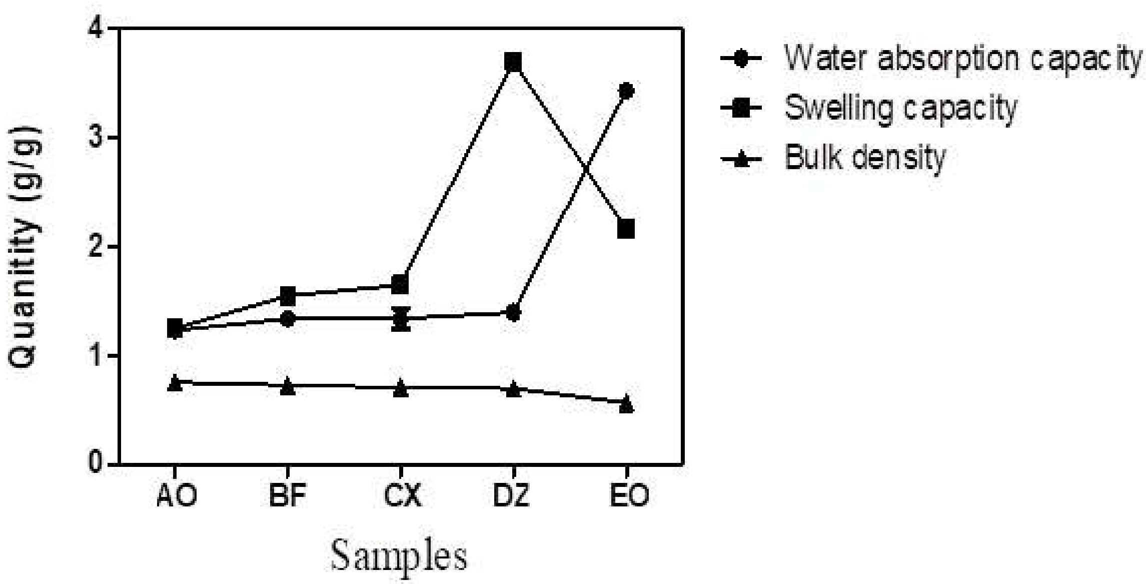

Figure 1: Some Functional Properties of the Flour Blends

KEY: AO = 100:0 ; 100 % wheat flour, 0 % plantain peel
BF = 90:10 ; 90 % wheat flour, 10 % plantain peel
CX = 80:20 ; 80 % wheat flour, 20 % plantain peel
DZ = 70:30 ; 70 % wheat flour, 30 % plantain peel

Colour characteristics of the samples

Colour is known to play a significant role in the acceptance of flour products by the consumer (Pereira *et al.*, 2016; Al-Sahlany *et al.*, 2020). It is also capable of providing information on the pigment degradation that take place during the production process

(Altan *et al.,* 2008). The colour characteristics of different wheat-plantain peel flour blends are presented in Table 3. The colour of the flour blends were significantly ($p<0.05$) affected by the substitution of the plantain peel flour. The L^* (lightness) values indicating whiteness of the flour blends decreased from 87.61 in the control flour to 81.55, 74.40, 69.99 to 49.94 for samples BF, CX, DZ and EO respectively with the increase in the addition of plantain peel flour. The a^* values with all measurements above zero, suggesting that the red zone is dominating over the green in all the flour blends. The b^* values, with all measurements more than zero, which also imply that the yellow zone is in greater expression that the blue in all the flour blends.

The L*, a* and b* values of a flour sample is strongly influenced by the genetic composition of the flour constituents (Oloniyo *et al.,* 2022). The results in this study agree with the report of Ramli *et al.* (2009), Futeri *et al.* (2014) and Al-Sahlany *et al.* (2020), that an attempt to enhance the nutrient base of food powders may affect the colour parameter and that the higher the percentage substitution, the more the colour of the resulting flour blends is impacted.

Table 3: Colour composition of wheat-plantain peel flour blends

Samples	L*	a*	b*	ΔE
AO	87.61±2.793[a]	1.62±0.212[f]	1.99±0.360[b]	0
BF	81.55±2.375[b]	2.34±0.021[de]	0.33±0.558[e]	6.33
CX	74.40±0.912[c]	3.17±0.077[bc]	0.96±0.216[d]	13.34
DZ	69.99±0.544[d]	3.40±0.989[bc]	1.27±0.989[c]	17.72
EO	49.94±0.007[e]	5.46±0.014[a]	2.05±0.183[a]	37.88

Values are means ± S.D. of triplicate determinations. Values in the same column with different superscripts were significantly ($p<0.05$) different.

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KEY: AO = 100:0; 100 % wheat flour, 0 % plantain peel
BF = 90:10; 90 % wheat flour, 10 % plantain peel
CX = 80:20; 80 % wheat flour, 20 % plantain peel
DZ = 70:30; 70 % wheat flour, 30 % plantain peel
EO = 0:100; 0 % wheat flour, 100 % plantain peel
L^* = lightness; a^* = redness; b^* = yellowness; ΔE = total colour change

The total colour differences (ΔE) for BF, CX, DZ and EO compared with AO were 6.33, 13.34, 17.72 and 37.88 respectively. The ΔE of BF has a marked difference while CX, DZ, and EO had extremely marked differences in colour when compared to AO according to Kim *et al.* (2002). Doymaz *et al.* (2018) reported that ΔE is an indicator of total colour difference used to verify whether colour changes can be perceived by humans.

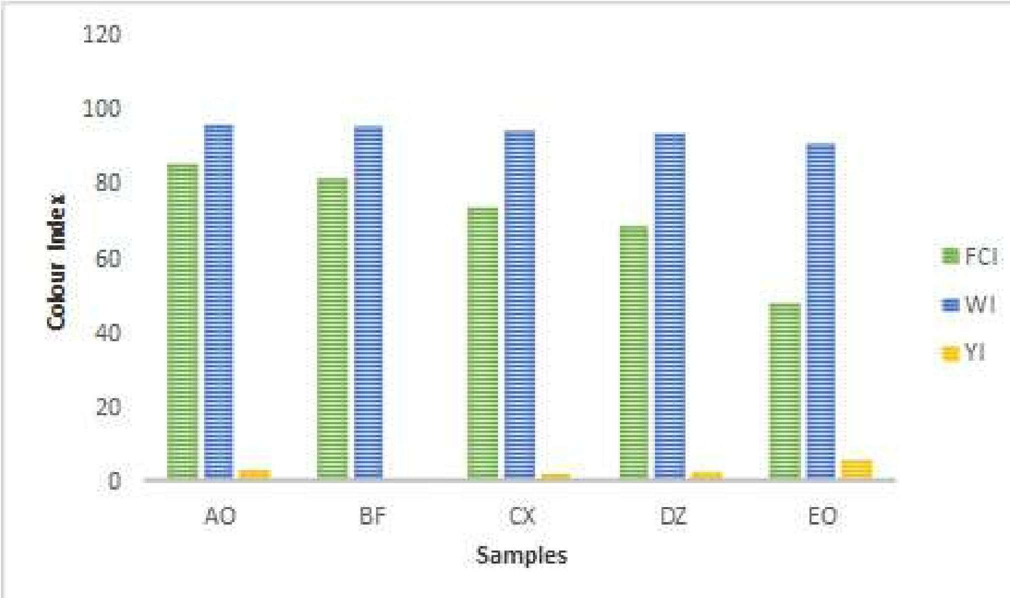

Figure 2: Flour Colour Index (FCI), Whiteness Index (WI) and Yellowness index (YI) of wheat-plantain peel flour blends.

KEY: AO = 100:0; 100 % wheat flour, 0 % plantain peel
BF = 90:10; 90 % wheat flour, 10 % plantain peel
CX = 80:20; 80 % wheat flour, 20 % plantain peel
DZ = 70:30; 70 % wheat flour, 30 % plantain peel
EO = 0:100; 0 % wheat flour, 100 % plantain peel

Flour colour index of sample BF (81.22) competed favourably with sample AO (85.62) which is the control sample. The least value was obtained in sample EO (47.89). Whiteness and Yellowness indices depicts variation in colours among the different flour blends (Figure 2). Sample EO had significantly higher yellowness index when compared with other samples probably due to the inherent presence of higher carotenoids than the other flour blends. Correspondingly, the whiteness index in sample BF compared favourably with sample AO. Whiteness index also allows selection of varied functional enrichment of processed products depending upon the purpose (Pathare *et al.*, 2013). Anyasi *et al.* (2015) supported the claim that the whiteness index of the food powders improves the acceptance of the finished products. Flour samples with high whiteness index is desirable as it would not alter the colour of the final product when incorporated in products such as cookies, bread and confectioneries.

Conclusion

The study evaluated some quality characteristics of plantain peel inclusion in wheat flour with a view to elucidating its potential in food fortification. The results concluded that inclusion of plantain peel in the wheat flour reduced the potential of the blends as a potential protein improver due to low protein content of the plantain peel. Addition of plantain peel in different composition enhanced the mineral composition of the resulting flour blends. The selected functional properties, such as the water absorption capacity, oil absorption capacity and swelling capacity increased with increasing percentage of plantain peel in the blends. However, optimum addition of the plantain peel in the flour blend would not adversely affect the colour of the resulting products. It is therefore suggested that plantain peel should not be viewed as waste material but as material that has potential as nutrient improver if carefully exploited.

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