

# QUALITY ATTRIBUTES OF COOKIES PRODUCED FROM THE BLENDS OF SORGHUM, UNRIPE PLANTAIN AND WATERMELON SEED FLOURS

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### Keywords:

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## ABSTRACT

Cookies were produced from the blend of sorghum, unripe plantain and watermelon seed flours at appropriate proportion. The cookies samples were evaluated for proximate, functional, mineral and sensory qualities. Results shows ranged of values in terms of crude protein (12.73 - 13.47%), fat (15.07 - 15.33%), crude fibre (0.47 - 0.81%), ash content (2.71 - 5.25%), moisture (5.25 - 6.17%) and carbohydrate (62.09 - 63.56%). The functional properties show that solubility index ranged from 20.10 - 51.55, oil absorption capacity (13.00 - 21.00), water absorption capacity (15.00 - 30.45) swelling capacity (29.00 - 40.50), bulk density (21.50 - 80.57). The values of zinc ranged from 0.08 - 0.14 mg/100g, iron (0.11 - 0.13 mg/100g), calcium (0.11 - 0.13 mg/100g) and phosphorous (0.17 - 0.19mg/100g). Sensory evaluation of the cookies samples showed that 100% wheat flour sample was the most acceptable followed by the 90% "sorghum", 5% plantain and 5% water melon seed sample. Cookies produced from composite flour of sorghum, unripe plantains and water melon seed flours were found to have high nutritional value that could promotes health and wellbeing of the consumers.

## 1. INTRODUCTION

Cookies are a form of confectionery product dried to low moisture content (Okaka, 2009). Compared to biscuits, cookies tend to be larger with a softer chewier texture (IFIS, 2005). Cookies are consumed extensively all over the world as snack food and on a large scale in developing countries where protein and caloric malnutrition are prevalent (Chinma and Gernah, 2007). In Nigeria, reliance on wheat flour in the pastry and bakery industries has over the years restricted the use of other tuber crops available to domestic use. In recent years, government has through intensive collaboration with research institutes encouraged the use of composite flours in the production of bread and related food products such as biscuit. This initiative has enhanced the use of flours from cassava, sweet potato, bread-fruit, plantains and other under-utilized crops that are good sources of flour. The adoption of these locally produced flours in the bakery industry will increase the utilization of indigenous crops cultivated in Nigeria and also lower the cost of bakery products (Ayo and Gaffa, 2002). This partly stimulated research into the production of cookies using non-wheat flour blends containing functional ingredients (principally those with high dietary fiber

and resistant starch). (Rehinan *et al.*,2004). Therefore, this research will investigate the effect of sorghum, unripe plantain and water melon seeds in the production of nutritional function cookies.

Sorghum (*Sorghum bicolor* L. Moench) is the world's fifth major cereal in terms of production and acreage. The crop is genetically suited to hot and dry agro-ecologies where it is difficult to grow other foods grains. Sorghum (*Sorghum* L. Moench) also known as guinea corn in West Africa and locally called Oka-baba, Dawa, and Okili in Nigeria belongs to the tribe Andropogonae (FAO. 1995). It is the fifth most important cereal crop by acreage after wheat, rice, maize, and barley globally. Sorghum grain is utilized in preparation of many traditional foods and in bakery preparations like bread, cakes cookies and biscuits (Khalil *et al.*, 1994)

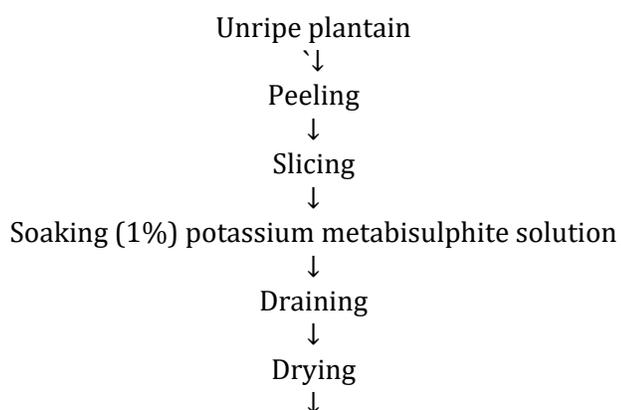
Plantain (*Musa paradisiaca*) It is one of the most important sources of food energy in West and Central Africa, where about 70 million people derive more than 25% of their carbohydrates from plantains (IITA, 2014). Plantain contains functional ingredients principally those with high dietary fiber in which when present in human diets lowers serum cholesterol, reduces the risk of heart attack, colon cancer, obesity, blood pressure, appendicitis and many other diseases (Rehianan *et al.*,2004).

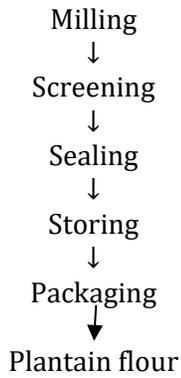
Watermelon (*Citrullus lanatus*) a fruit crop, is an herbaceous creeping plant belonging to the family *cucurbitaceae*. It is mainly propagated by seeds and thrives best in warm areas. It is a major fruit widely distributed in the tropics and requires a lot of sunshine and high temperature of over 25°C for optimum growth (Kocheki, *et al.*, 2007). Watermelon fruits is large, smooth and have different shapes varying from round to cylindrical. The fruit pulp serves as a thirst quencher and excellemt source of minerals, vitamins C and A (Gyner and Wehner, 2004; Tabiri, *et al* 2016). Researches have shown that watermelon seeds can be used considerably as a source of food for human nutrition and health: seeds are rich sources of protein, vitamins B, minerals (such as magnesium, potassium, phosphorous, sodium, iron, zinc, manganese and copper) and fat among others as well as phytochemicals and antioxidant activity phytochemicals (Braidia, *et al.*, 2012). The seeds of watermelons are known to have economic benefits especially in countries where cultivation is on the increase. The seeds are for instance used to prepare snacks, milled into flour and used for sauces. In spite of the various potential applications, the watermelon seeds are often discarded while the fruit is eaten.

## 2. MATERIALS AND METHODS

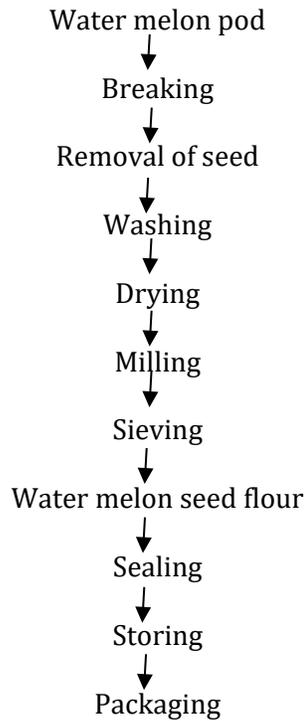
### 2.1. MATERIALS AND SAMPLE PREPARATION

The sorghum, unripe plantain and water melon were purchased from Owode market sanngo Saki Oyo State of Nigeria. The sorghum grains were sorted to remove dirt and foreign materials. They were washed severally with clean water and dried to a moisture content of 10-12% and the grains was dry milled, sieved and packaged in an air tight container until ready for used. The unripe plantain fruits were peeled and sliced to about 5 mm thin. The plantain slices were then dry in a cabinet dryer at 60C for 24 h within 15–20 min. Thereafter, the chips were milled into flour and sieved with a screen of 0.21 mm aperture size. The fresh water melon fruits were washed thoroughly in cleaned water and cut opened with a clean stainless knife and the seeds were extracted, washed severally to separate it from the juice and dried at temperature of 60°C for 6 h. The dried seeds were milled with a mechanical blender packed in an air tight container and stored at room temperature (25°C) for further analysis.

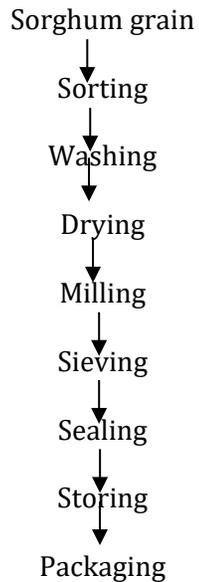




**Figure 1:** Flow chart for production of unripe plantain flour



**Figure 2:** Flow chart for production of water melon flour



**Figure 3:** Flow chart for production of sorghum flour

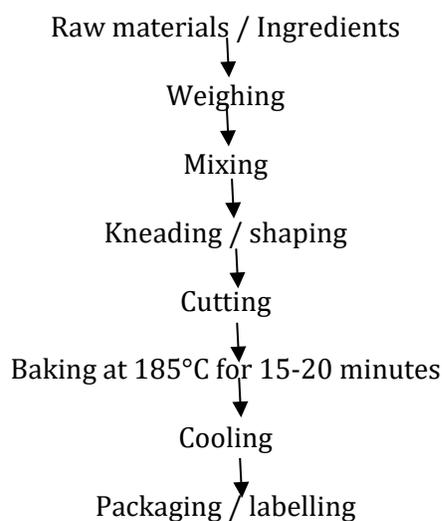
## 2.2. RECIPE FORMULATION

Composite flour with different proportion of sorghum, unripe plantain and water melon seed flour blends were prepared as shown in Table 1. The flour samples were blended into different ratios of 90: 5: 5, 85:10: 5 and 75: 15: 10% respectively. Wheat flour (100%) was used as control (Table 1)

Sample code	Wheat (%)	Sorghum flour (%)	Unripe plantain flour (%)	Water melon seed flour (%)
AOO	100	0	0	0
AOB	0	90	5	5
AOC	0	85	10	5
AOD	0	75	15	10

## 2.3. PRODUCTION OF COOKIES

The cookies were prepared using the method described by (Joel, *et al.*, 2014) with slight modifications. The flour (500 g), sugar (150 g), baking fat (200 g), baking powder (2.5 g), water (125ml), vanilla liquid (20 ml), nut meg 0.9g, powdered milk 15 g and salt (3 g). The varying proportions of flour were weighed and mixed together with the dry ingredients, mixed with butter and creamed. Water was added and mixed properly, until good textured, slightly firm dough was obtained. The dough was rolled into a sheets and cut into shapes of 6 cm diameter using the stamp cutting method. The cut dough pieces were transferred into fluid fat greased pans and baked at 185°C for 20 min, cooled and packaged in polyethylene bags until needed.



**Figure 4:** Flow chart for biscuit production. Source: Faris and Singh, 1990; Ayo et al., 2010; Odedeji and Adeleke, 2010.

## 2.4. ANALYSES

### 2.4.1. PHYSICAL PARAMETERS

The diameter from the physical parameters of cookies was determined by placing six cookies edge to edge and by measuring it with ruler of mm and by rotating at an angle of 90° and the thickness by placing six cookies on top of one another based on method of AACC (2000). Spread ratio was determined from the calculated ratio of weight to thickness.

## 2.5. PROXIMATE ANALYSES

Proximate analyses (The crude protein content, moisture content, the crude fat, crude fiber, and ash content) were determined on the cookies produced from the composite flour and wheat flour according to the standard methods of (AOAC, 2000). The carbohydrate content was determined by difference as follows:  $100 - (\text{ash} + \text{protein} + \text{fiber} + \text{fat} + \text{moisture})$ .

## 2.6. MINERAL ANALYSIS

Selected minerals including iron, calcium, zinc and phosphorus were extracted from dry ash samples and determined by atomic absorption spectrophotometer. AAS (AOAC, 2012)

## 2.7. Functional properties

### 2.7.1. WATER ABSORPTION CAPACITY

The method of Onwuka (2005) was adopted in the determination of water absorption capacity. One (1g) gram of sample was weighed into a conical graduated centrifuge tube and thoroughly mixed with 10ml distilled water for 30seconds using a warring whirl mixer. The sample was then allowed to stand for 30 minutes at room temperature and then centrifuged at 5,000rpm for 30 minutes. The volume of free water (supernatant) was read directly from the graduated centrifuge tube. Absorption capacity is expressed as grams of water absorbed (or retained) per gram sample.

Water absorption capacity = Amount of water absorbed total-free  $\times$  density water

$$\text{WAC} = \frac{\text{Weight tube} + \text{sediment} - \text{weight of empty tube}}{\text{Weight of sample}}$$

### 2.7.2. OIL ABSORPTION CAPACITY

The method of Onwuka (2005) was adopted in the determination of oil absorption capacity. One (1g) gram of sample was weighed into a conical graduated centrifuge tube and thoroughly mixed with 10ml of oil for 30seconds using a warring whirl mixer. The sample was then allowed to stand for 30minutes at room temperature and then centrifuged at 5,000rpm for 30minutes. The volume of free oil (supernatant) was read directly from the graduated centrifuge tube. Absorption capacity is expressed as grams of oil absorbed (or retained) per gram sample.

Oil absorption capacity = Amount of oil absorbed total-free  $\times$  density oil

### 2.7.3. BULK DENSITY

The method of Onwuka, (2005) was adopted in the determination of bulk density. Bulk densities of samples were determined by weighing 25ml capacity graduated measuring cylinder, gently filling the cylinder with the sample and tapping the bottom of the cylinder on the laboratory bench several times until there is no further diminution of the sample level after filling the 25ml mark. The final volume is expressed as g/ml.

### 2.7.4. FOAM CAPACITY

The method of Onwuka, (2005) was adopted in the determination of foam capacity. From the powdered sample, 2.00g were weighed, blended with 100cm<sup>3</sup> of distilled water using blender for 5min. The mixture was then poured into a 100 cm<sup>3</sup> measuring cylinder and its volume was recorded after 30s. Foam capacity was expressed as percent increase in volume using the formula

Volume after whipping - volume before whipping Foam capacity =  $\times 100$  Volume before whipping and the suspension was whipped

## 2.8. SENSORY EVALUATION

The samples were presented as coded samples to 20 semi-trained panelists. The samples were randomly presented to the panelist. The panelists were given enough water to rinse their mouths in between each sample and were asked to indicate their observations using a 9-point hedonic scale for colour, taste, texture, flavor, sweetness, crunchiness, appearance and overall acceptability

## 2.9. STATISTICAL ANALYSIS

All data obtained from this study were subjected to analysis of variance (ANOVA), and means were separated using Duncan's multiple range test. SPSS software version 15 was used for all statistical analysis.

## 3. RESULTS AND DISCUSSION

### 3.1. PHYSICAL PROPERTIES

The physical properties of the cookies samples are shown in Table 3.1. Results showed that in all the parameters analyzed for physical properties, sample AOD having the maximum value while sample AOO (control) 100 % wheat flour having the minimum. Moreover, with the exception of thickness in which samples AOB and AOC were not significantly difference from each other, significant differences ( $p \leq 0.05$ ) existed in all the samples analyzed for physical properties. Dhankhar, (2003) reported spread ratio as significant properties of the cookies. The Maximum spread ratio values 7.52, 7.46 and 6.70 obtained for samples AOD, AOC and AOB, respectively compare to the value (6.15) obtained for 100 % wheat flour (control sample) cookies in spread ratio, indicate that the starch in wheat flour were highly hydrophobic in nature.

#### Physical Properties

Samples	Weight	Thickness	Diameter	Spread Ratio
AOO	4.12 <sup>d</sup> ± 0.01	0.67 <sup>c</sup> ± 0.01	4.80 <sup>d</sup> ± 0.01	6.15 <sup>d</sup> ± 0.01
AOB	4.76 <sup>c</sup> ± 0.01	0.69 <sup>b</sup> ± 0.01	4.84 <sup>c</sup> ± 0.01	6.70 <sup>c</sup> ± 0.01
AOC	5.22 <sup>b</sup> ± 0.01	0.70 <sup>b</sup> ± 0.01	4.86 <sup>b</sup> ± 0.01	7.46 <sup>b</sup> ± 0.01
AOD	5.49 <sup>a</sup> ± 0.01	0.73 <sup>a</sup> ± 0.01	4.88 <sup>a</sup> ± 0.01	7.52 <sup>a</sup> ± 0.01

AOO - 100% wheat flour (control)

AOB - 90 % sorghum flour, 5 % unripe plantain flour, 5 % water melon seed flour

AOC - 85 % sorghum flour, 10 % unripe plantain flour, 5 % water melon seed flour

AOD - 75 % sorghum flour, 15 % unripe plantain flour, 10 % water melon seed flour

### 3.2. PROXIMATE COMPOSITION OF COOKIES

The results obtained from the proximate composition of the cookies produced from sorghum, plantains and water melon seed composite flour is presented in Table 3.2. The protein content of the cookies significantly ranged from 12.73 % to 13.47 %. Cookies prepared at ratio 75 % sorghum flour, 15 % unripe plantain flour, 10 % water melon seed flour had the highest Protein content. The protein content of the cookies produced from the composite flour was higher than the protein content of the cookies produced from 100% wheat flour. The protein content of the cookies increases with increasing in the percentage substitution of unripe plantain and watermelon seed flour in the cookies dough blends. Significant difference ( $p < 0.05$ ) exists among the samples. The values (12.73% to 13.47%) obtained are higher than 1.14 - 3.69 % reported by Racheal and Margaret (2016) for quality characteristics of cookies produced from composite flours of unripe plantain, wheat and watermelon seed.

The fat content of cookies ranged from 15.07 % to 15.33 %. The blend AOD (75:15:10 % for sorghum, plantains and water melon seed flour; respectively) had the highest fat content while sample AOO (control) 100% wheat flour had the lowest. There was significant difference ( $p \leq 0.05$ ) in fat content among the blends. These values (15.07 % to 15.33 %) were higher than the findings of 12.96-15.21% reported by [Giwa and Ikujenlola \(2010\)](#) for biscuits

produced from composite flours of wheat and quality protein maize. Fat content of the cookies were within the standard value for soft dough biscuits. Fats are an integral part of cookies being the third largest component after flour and sugar. Cookies are in fact a rich source of fat and carbohydrates hence, are energy giving food (Kure *et al.*, 1998).

The crude fiber content of the cookies samples significantly ranged from 0.47 % to 0.81% with the least value observed in the cookies prepared from 100 % wheat flour. There was significant difference ( $p \leq 0.05$ ) in crude fiber content among the blends. Ash content ranged from 2.71% to 5.25 %. Cookies prepared at 100 % wheat flour had the highest ash content. The ash content (2.71 % to 5.25 %) of the cookies reported in this study was higher than the ash content (0.64 - 1.17%) of wheat-plantain-soy bread and plain wheat biscuits reported by Olaoye *et al.*, (2006)

Moisture content varied from 5.25 to 6.17%. Cookies produced from the blend of sorghum, plantains and water melon seed flour had the highest moisture content (6.17%) compare with the moisture content (5.25%) of the cookies produced from 100% wheat flour. There was significant difference ( $p \leq 0.05$ ) in moisture content among the blends. This result (5.76 to 6.17%) is lower with 9.37-10.03% reported for biscuits from maize-pigeon pea flour blends by Echendu *et al.* (2004). Cookies are generally low moisture foods. This moisture range would improve the shelf life and acceptability of the products.

The carbohydrates content of the cookies significantly ranges between 62.09 % to 62.56 %. The blend AOC had least carbohydrates content while AOB had the highest. Samples AOC and AOD were not significantly ( $p < 0.05$ ) different. This results (62.09 % to 63.56 %) was higher with 59.71 - 70.64% reported for cookies made from composite flours of unripe plantain, wheat and watermelon seed flour blends by Racheal and Margaret, (2016)

**Table 3.2:** Proximate composition of Cookies

Samples	Protein Content (%)	Fat Content (%)	Fibre Content (%)	Ash Content (%)	Moisture Content (%)	Carbohydrate Content (%)
A00	12.73 <sup>d</sup> ±0.01	15.07 <sup>a</sup> ±0.01	0.47 <sup>d</sup> ±0.01	5.25 <sup>a</sup> ±0.01	5.25 <sup>d</sup> ±0.01	63.56 <sup>a</sup> ±0.01
A0B	13.13 <sup>b</sup> ±0.01	15.21 <sup>c</sup> ±0.01	0.53 <sup>c</sup> ±0.01	2.71 <sup>d</sup> ±0.01	5.87 <sup>b</sup> ±0.01	62.56 <sup>b</sup> ±0.01
A0C	13.47 <sup>a</sup> ±0.01	15.16 <sup>a</sup> ±0.01	0.74 <sup>b</sup> ±0.01	2.84 <sup>b</sup> ±0.01	5.76 <sup>c</sup> ±0.01	62.09 <sup>c</sup> ±0.01
A0D	12.83 <sup>c</sup> ±0.01	15.33 <sup>b</sup> ±0.01	0.81 <sup>a</sup> ±0.01	2.77 <sup>c</sup> ±0.01	6.17 <sup>a</sup> ±0.01	62.10 <sup>c</sup> ±0.01

A00 - 100% wheat flour (control)

A0B - 90 % sorghum flour, 5 % unripe plantain flour, 5 % water melon seed flour

A0C - 85 % sorghum flour, 10 % unripe plantain flour, 5 % water melon seed flour

A0D - 75 % sorghum flour, 15 % unripe plantain flour, 10 % water melon seed flour

### 3.3. MINERAL COMPOSITION

The results of mineral composition of cookies samples are presented in Table 3.3. The value for zinc content (0.09 to 0.14 mg/100 g) and iron content (0.12 to 0.13 mg/100 g) of the composite cookies was higher than the value 0.08 and 0.11 mg/100 g, respectively obtained for the control (100%) wheat flour. There were no significant differences in all the mineral content of the samples. Calcium content varied from 0.11 to 0.13 mg/100 g. Sample A0C having the highest value. Phosphorous content of the samples increased significantly from 0.17 to 0.19 mg/100 g. The lowest values were recorded for samples A0B and A00 (control (100%) wheat flour).

**Table 3.3:** Mineral Composition of Cookies

Samples	Zinc mg/100 g	Iron mg/100 g	Calcium mg/100 g	Phosphorous mg/100 g
A00	.08 <sup>a</sup> ±0.01	.11 <sup>a</sup> ±0.01	.11 <sup>a</sup> ±0.01	.17 <sup>a</sup> ±0.01
A0B	.14 <sup>a</sup> ±0.01	.12 <sup>a</sup> ±0.01	.11 <sup>a</sup> ±0.01	.17 <sup>a</sup> ±0.01

AOC	.13 <sup>a</sup> ±0.01	.13 <sup>a</sup> ±0.01	.13 <sup>a</sup> ±0.01	.19 <sup>a</sup> ±0.01
AOD	.09 <sup>a</sup> ±0.01	.12 <sup>a</sup> ±0.01	.12 <sup>a</sup> ±0.01	.18 <sup>a</sup> ±0.01

A00 - 100% wheat flour (control)

A0B - 90 % sorghum flour, 5 % unripe plantain flour, 5 % water melon seed flour

A0C - 85 % sorghum flour, 10 % unripe plantain flour, 5 % water melon seed flour

A0D - 75 % sorghum flour, 15 % unripe plantain flour, 10 % water melon seed flour

### 3.4. FUNCTIONAL PROPERTIES OF COOKIES

The results of functional properties of cookies samples are presented in Table 3.4. With the exception of oil absorption capacity all other functional parameters analyzed for composite flour was higher than the corresponding values obtained for 100 % wheat flour, The solubility index of the composite flour ranges between 36.35 to 51.55%. Flour with 85:10:5 % had the highest solubility (51.55%) while 90:5:5 % flour had lowest solubility index (36.35%). There were no significant differences in all the functional properties of the samples.

The oil absorption capacity of 100% wheat flour (21.00) was highest than all the composite samples blends flour, while 90:5:5 % flour had lowest 13.50 %). Abu *et al.*, (2006) Oil absorption in starch relies predominantly on the physical entrapment of oil within the starch structure as starch does not possess nonpolar sites compared to those found in proteins.

The water absorption capacity of the blends ranges between 23.00 to 30.45%. Flour sample with A0B had the highest water absorption capacity (30.45). while 100% flour had the lowest water absorption capacity (15.00). The WAC is the ability of a product to associate with water under limiting conditions in order to improve its handling characteristics and dough making potentials (Singh *et al.*, 2001; Giami, 2004))

The swelling capacity of composite flour varied from 29.00 to 40.50 %. Sample A0C having the least swelling capacity (29.0%), while sample A0B having the highest (40.50%). Achinewhu *et al.*, (1998) reported that high swelling capacity has been reported as part of the criteria for a good quality product.

The bulk density of 100% wheat flour was highest than all the composite samples blends. The bulk density of the flour ranges between 21.50 - 26.50%. Flour sample with A0C had the highest (26.50%) while 80:15:5% had the lowest. Significant difference ( $p < 0.05$ ) exists among the samples. Values observed for the bulk density of the cookies in this study are higher to those reported (0.76 - 0.82) by Racheal and Margaret (2016) for cookies produced using unripe plantain, wheat and watermelon seed flour blends. Lewis, (1990) bulk density gives an indication of the relative volume of packaging material required and high bulk density is a good physical attribute when determining the mixing quality of a particulate matter.

**Table 3.4:** Functional Properties of Cookies

Samples	SI	OAC	WAC	SC	BD
A00	20.10 <sup>d</sup> ±0.01	21.00 <sup>a</sup> ±0.01	15.00 <sup>d</sup> ±0.01	29.75 <sup>c</sup> ±0.01	80.57 <sup>a</sup> ±0.01
A0B	36.35 <sup>c</sup> ±0.01	13.50 <sup>d</sup> ±0.01	30.45 <sup>a</sup> ±0.01	40.50 <sup>a</sup> ±0.01	23.50 <sup>c</sup> ±0.01
A0C	51.55 <sup>a</sup> ±0.01	15.50 <sup>c</sup> ±0.01	23.00 <sup>c</sup> ±0.01	29.00 <sup>d</sup> ±0.01	26.50 <sup>b</sup> ±0.01
A0D	51.45 <sup>b</sup> ±0.01	17.00 <sup>b</sup> ±0.01	29.00 <sup>b</sup> ±0.01	33.50 <sup>b</sup> ±0.01	21.50 <sup>d</sup> ±0.01

A00 - 100% wheat flour (control)

A0B - 90 % sorghum flour, 5 % unripe plantain flour, 5 % water melon seed flour

A0C - 85 % sorghum flour, 10 % unripe plantain flour, 5 % water melon seed flour

A0D - 75 % sorghum flour, 15 % unripe plantain flour, 10 % water melon seed flour

### 3.5. SENSORY PROPERTIES OF THE COOKIES

The result of sensory properties of cookies is presented in Table 3.5. The results of the sensory evaluation showed that 100% wheat cookies had the best attributes for, crispness, appearance and texture. The most preferred cookies with respect to the taste (8.85%) were the ones with inclusion of 90 % sorghum flour, 5 % unripe plantain flour and 5 % water melon seed flour. There was significant difference in taste and crispness of cookies produced. However, it was observed that there were no significant differences ( $p > 0.05$ ) in samples AOB and AOC in appearance and overall acceptability of the cookies. The overall Acceptability revealed that the cookies from 100 % wheat flour (control) was the most acceptable (7.95). This could be as a result of familiarity with 100 % wheat flour, followed by the cookies produced from the inclusion of 75 % sorghum flour, 15 % unripe plantain flour and 10 % water melon seed flour. while sample AOC (85 % sorghum flour, 10 % unripe plantain flour, 5 % water melon seed flour) having the least overall acceptability.

**Table 3.5:** Sensory Properties of the cookies

Samples	Appearance	Taste	Crispness	Texture	Overall Acceptability
A00	7.40 <sup>a</sup> ±0.10	7.55 <sup>b</sup> ±0.10	6.90 <sup>a</sup> ±0.10	8.55 <sup>a</sup> ±0.10	7.95 <sup>a</sup> ±0.10
AOB	5.90 <sup>b</sup> ±0.10	8.85 <sup>a</sup> ±0.10	5.95 <sup>b</sup> ±0.10	6.05 <sup>b</sup> ±0.10	7.65 <sup>b</sup> ±0.10
AOC	5.80 <sup>b</sup> ±0.10	5.50 <sup>c</sup> ±0.10	5.45 <sup>c</sup> ±0.10	5.65 <sup>c</sup> ±0.10	7.05 <sup>b</sup> ±0.10
AOD	5.00 <sup>c</sup> ±0.10	4.80 <sup>d</sup> ±0.10	5.05 <sup>d</sup> ±0.10	4.70 <sup>c</sup> ±0.10	7.30 <sup>c</sup> ±0.10

A00 - 100% wheat flour (control)

AOB - 90 % sorghum flour, 5 % unripe plantain flour, 5 % water melon seed flour

AOC - 85 % sorghum flour, 10 % unripe plantain flour, 5 % water melon seed flour

AOD - 75 % sorghum flour, 15 % unripe plantain flour, 10 % water melon seed flour

### 4. CONCLUSION

The study has shown that acceptable cookies can be formulated from composite of sorghum flour, unripe plantain flour, and water melon seed flour blends. The protein content of the cookies increased significantly with the increased in substitution level of sorghum, unripe plantain and water melon seed flour. In term of consumer acceptability cookies prepared from 75 % sorghum flour, 15 % unripe plantain flour, 10 % water melon seed flour were compare favorably with cookies made from 100 % wheat flour. Cookies made from composite flour have highest content of all the mineral than cookies made from 100 % wheat flour (control). Therefore, composite cookies from various substitution level of sorghum, unripe plantain and water melon seed flour were more nutritious than 100 % cookies produced from the wheat flour. More research should also be carried out on the ant nutrients properties of the various flour used in this study.

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### CONFLICT OF INTEREST

The author have declared that no competing interests exist.

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None.

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