

## Production and Evaluation of Biscuits from Cocoyam (*Xanthosoma Sagittifolium Cv Okoriko*)-Wheat Composite Flour

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### ABSTRACT

Production and evaluation of biscuits from *Xanthosoma sagittifolium cv okoriko* was studied. The cocoyam (*Xanthosoma sagittifolium cv okoriko*) was processed into flour and the proximate composition of the flour sample was determined. Biscuits were produced from composite flours of cocoyam and wheat at the ratios - 100:0, 95: 5, 90:10, 85:15, 80: 20 respectively, using 100% wheat flour as control. Sensory evaluation was carried out on the biscuit samples. Physical analysis was carried out on the biscuit sample containing 100% cocoyam flour (AOK) and the control. The result of proximate composition of the flour sample indicated a protein content of 7.8%, ash content of 3.2%, fibre content of 0.5%, fat content of 4.5%, moisture content of 11.5% and carbohydrate content of 72.5%. Result of physical analysis of the biscuit samples showed that sample AOK had the highest value for spread ratio (4.48) while the control had (3.11) for spread ratio. The break strength of the biscuit samples ranged from 600- 700g with sample AOK having the highest break strength. The organoleptic properties of the biscuit samples showed that the control was significantly ( $p \leq 0.05$ ) different in colour, aroma and overall acceptability with a score of approximately 8.0 for each attribute. Sample DOKW (85% cocoyam flour and 15% wheat flour) was the most preferred in terms of texture with a score of approximately 8.0 while sample BOKW (95% cocoyam flour and 5% wheat flour) had the highest value (approximately 7.0) for overall acceptability excluding the control and was significantly ( $p \leq 0.05$ ) different from the control. This indicates that cocoyam (*Xanthosoma sagittifolium cv okoriko*) flour could be used in the production of quality biscuits and could also be used for substituting wheat flour up to 80% level in biscuit production without adversely affecting the sensory attributes of the product.

**Keywords:** biscuit, cocoyam flour, composite, evaluation, wheat flour

### INTRODUCTION

Biscuit is a chemically leavened baked product also known as cookies (Hanan, 2013). It is a term used for a diverse variety of baked (commonly flour- based) food products. Generally, the name biscuit is used in European countries and cookies in the USA (Sivasankar, 2002). Biscuits can be made from hard dough e.g. Crackers; hard sweet dough e.g. Rich tea; short or soft dough e.g. shortbread and shortcake. It is produced by mixing various ingredients like flour, fat, egg, sweeteners and water to form dough (Nwosu, 2013). Biscuits are ideal for nutrient availability, palatability, compactness and convenience. They differ from other baked foods like bread and cakes because they have low moisture content making them

comparatively free from microbial spoilage and increasing the shelf life and eating quality of the product (Hanan, 2013).

Flour used in making biscuits is made from soft wheat, a cereal which is cultivated in many parts of the world, but imported by countries with unfavourable climatic conditions for wheat cultivation. Hence, wheat consuming countries located in tropical regions, which mostly are developing nations, rely on countries located in temperate regions for wheat importation (Elijah, 2014). The dependence on the use of wheat flour is a major constraint in biscuit production. Huge sums of money are involved in wheat importation: in 2010 alone, Nigeria spent #635 billion (\$4.2 billion) on the importation of wheat (Momoh, 2011). It is therefore of economic

importance if wheat importation is reduced by substitution with other local sources of flour for baking (Oyeku et al., 2008). For example, Cocoyam, cassava, maize and other carbohydrate and protein rich flours commonly found in abundance in Nigeria.

Cocoyam (*Xanthosoma sagittifolium* and *Colocasia esculenta*) is an edible root crop grown in the tropics of which Nigeria is a major producer. It belongs to the family Araceae (Okpala et al., 2013). Cocoyam contributes significant portion of the carbohydrate content of the diet in many regions in developing countries and provide edible starchy storage corms or cormels (Okpala et al., 2013). Cocoyam has nutritional advantages over other root and tuber crops (Ojinnaka and Nnorom, 2015). It has more crude protein than other root and tuber crops and its starch is highly digestible because of the small size of the starch granules, its contents of calcium, phosphorus, vitamin A and B- vitamins are reasonable (Ojinnaka and Nnorom, 2015). All these are lost to nutrition because of low production and underutilization. Ammar et al. (2009) noted that edible aroid flours could be advantageous in the preparation of myriad products by the food development industry since it could be used in dehydrated soup formulation, baking goods, formulation of baby food, snacks and breakfast products. The flour from cocoyam has been used in baking of products as it has been reported that cocoyam has fine starch granule, which improves binding and reduces breakage of snack products (Huang, 2005). Recent studies show that cocoyam starch can be incorporated in the development of weaning food which is easily digestible and accessible to low income earners in developing countries (Ojinnaka et al., 2009).

The cocoyam (*Xanthosoma sagittifolium* cv okoriko) is one of the important root food crops especially among the low income earners in Nigeria. However, the utilization options of cocoyam are mainly limited to direct consumption as whole and boiled tuber or pounded into fufu and used as a soup thickener, thus making it an underutilized tuber and an insufficiently studied crop (Watanabe, 2002). The utilization and market options of cocoyam are very limited due to limited processing and utilization options. *Xanthosoma sagittifolium* cv okoriko is no longer in use and are uprooted by farmers and thrown away. They are currently found in abandoned farmlands and in disposal

dumps. Okoriko has large corms and is very prolific indicating that it will have high carbohydrate content and nutritive value needed for food. The major limiting factor in the utilization of *Xanthosoma sagittifolium* cv okoriko is the presence of oxalates which impart an acrid taste or cause irritation in the throat and mouth when foods prepared from it are eaten and interfere with bioavailability of calcium (Sefa-Dedeh and Agrir-Sackey, 2004), high rate of post-harvest losses and the lack of scientific attention (Mbofung et al., 2006). Other problems associated with processing and utilization of okoriko among others, include low storage and bulkiness. For greater utilization, *Xanthosoma sagittifolium* cv okoriko should be processed into dehydrated forms to maintain stability, for better storage and offer convenience and ease in preparation into other food forms (James et al., 2013), investigation should be made into forms that *Xanthosoma sagittifolium* cv okoriko corms and cormels should be converted to for ready utilization and acceptability and further exploration be made on the use of okoriko flour as a composite in specialty foods. The objectives of this study therefore are: to produce flour from *Xanthosoma sagittifolium* cv okoriko, to determine the proximate composition of the flour, to produce biscuits from *Xanthosoma sagittifolium* cv okoriko flour and varying percentage of wheat flour and to evaluate the quality characteristics of the products.

Over the years, the demand for pastry products in Nigeria has been on the increase and these are sold at every corner of the street as snacks. As the demands increase, there is tendency for the cost of wheat flour to increase and also the cost implication of importing wheat flour on the nation's foreign reserve. The use of *Xanthosoma sagittifolium* cv okoriko in baking will improve cocoyam competitiveness alongside other root and tuber crops, enhance its application in other food systems and improve marketing/economic potentials. Furthermore, the farmers are bound to grow more *Xanthosoma sagittifolium* cv okoriko as its utilization potentials are increased and this will in turn enhance their earnings and hence value addition for cocoyam in biscuit production.

### MATERIALS AND METHODS

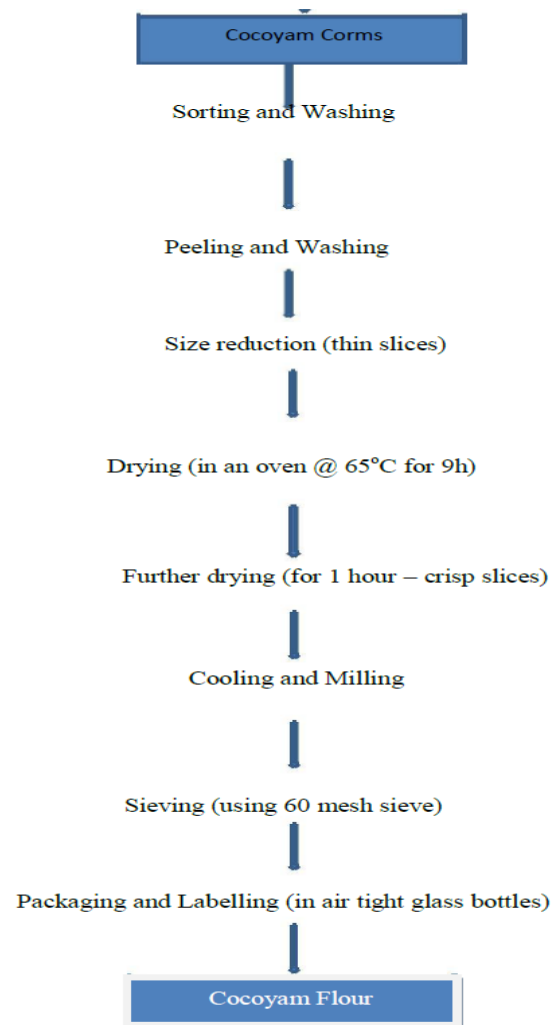
Cocoyam (*Xanthosoma sagittifolium* cv okoriko) used in the research work was purchased from a local market in Mbaise, Imo

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state. The cocoyam was purchased wholesome, that is, it was free from rot and had no physical damage. The milk powder, sugar, egg, salt, margarine, baking powder and wheat flour were purchased from Owerri main market, Imo state. Equipment, chemicals (reagents) and other facilities used in the research work were obtained from the laboratories of the Department of Food Science and Technology and Department of Biochemistry, Federal University of Technology, Owerri, Imo state.

### Production of Cocoyam Flour

The fresh corms of cocoyam (*Xanthosoma sagittifolium* cv okoriko) were washed, peeled, washed again and shredded into thin slices/size or thickness. The slices were sundried for 2h. After which the slices were spread thinly on drying trays and placed in the oven. It was then dried at a temperature of 65°C for 9h. The dried samples were removed from the oven, cooled and stored in a polyethylene bag. Before milling, the samples were put in the oven and dried at 65°C for one hour in order to make the slices crispy. Then, the samples were cooled and ground into flour using a disc attrition mill. The flour was sieved using a 60 mesh sieve. The cocoyam flour was stored in air tight bottles, labelled and kept in a cool dry place for further analysis. The flow diagram for the production of the flour is shown in fig.1. Pictures of *Xanthosoma sagittifolium* cv okoriko corms and dried slices are shown in plate 1 and 2.



**Figure1.** Flow chart for cocoyam (*Xanthosoma sagittifolium* cv okoriko) flour production.



**Plate1.** Cocoyam (*Xanthosoma sagittifolium* cv okoriko) corms and Plant.

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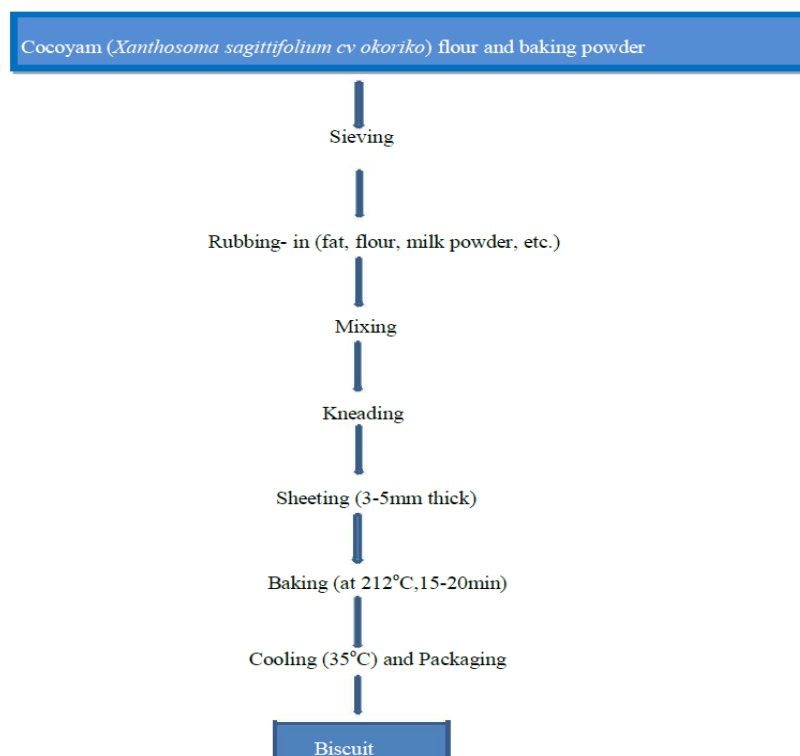
**Plate2.** Shredded and dried Cocoyam (*Xanthosoma sagittifolium cv okoriko*). Production of biscuit

The processed cocoyam (*Xanthosoma sagittifolium cv okoriko*) flour was used for biscuit production using standard recipes. Ingredients used are stated in Table 1.

**Table 1.** Ingredients for Biscuit making

Ingredient	Percentage	Proportions(g)
Flour	100	200
Fat	50	100
Sugar	60	120
Egg	25	50ml
Water	15	30ml
Salt	1.5	3
Baking powder	1.5	3
Vanilla powder	2.5	5
Milk powder	2.5	5

Source: (Ayo, 2016)



**Figure2.** Flow chart for Biscuit production.

A modified method used for the production of biscuit is based on that described by Ihekoronye (1998). The flour (200g) was sieved using a fine sieve (1mm aperture) alongside with baking



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powder (3g) to remove coarse particles and to get a uniform particle size. The rubbing-in-method was used for mixing of ingredients. Fat (100g), milk (5g), vanilla powder (5g) and salt (3g) were poured into a mixing bowl already containing flour and baking powder and mixed for 30sec. In a separate bowl egg (50ml), sugar (120g) and water (30ml) were mixed and added to the flour mixture and mixed to form dough. The dough was kneaded to develop it, rolled into a uniform thickness of about 3-5mm with the use of a rolling pin and board. Afterwards, was cut out using a biscuit cutter. The cut dough pieces were arranged on pre-oiled baking trays and baked in a preheated laboratory oven at a temperature of 212oC for 15-20min. After baking, the biscuits were brought out of the oven and allowed to cool. The biscuits were then packed in glass cookie jars for further analysis. The flow chart for the production of biscuits is shown in fig.2.

### Proximate Analysis

The proximate analysis of the flour sample was carried out using standard methods of Association of Official Analytical Chemists (A.O.A.C, 2000).

### Evaluation of Physical Properties of Biscuits

The quality characteristics of the biscuits were determined using the following methods:

### Cookie Spread/Spread Ratio Determination

The spread ratio of the biscuits was determined by measuring the length and height of two rows and columns, respectively of five well-formed biscuits. The spread ratio was calculated as diameter divided by height (Gomez et al., 1997). The determination of the spread ratio of biscuit is important because it aids in ascertaining the

binding properties of the flour and the texture of the biscuits (Agu and Okoli, 2014).

### Breaking Strength Determination

The breaking strength was determined by adapting Okaka and Isieh's (1990) method. Biscuit of known thickness (0.4cm) was placed centrally between two parallel metal bars (3cm apart). Weights were added on the biscuit until the biscuit snapped. The least weight that caused the breaking of the biscuit was regarded as the break strength of the biscuit.

### Sensory Evaluation

The biscuits' sensory qualities were assessed by a test panel of 20 judges. A 9-point hedonic scale quality analysis as described by Larmond (1997) was used with 1= dislike extremely, 5= neither like nor dislike, and 9= like extremely to evaluate the colour, taste, aroma, texture, crispiness and overall acceptability of the samples. The panelists were instructed to rinse their mouths with water after tasting every sample and not to make comments during evaluation to prevent influencing other panelists. They were also asked to comment freely on samples on the questionnaires given to them.

### Statistical Analysis

Data were obtained in triplicate and subjected to analysis of variance (ANOVA) and the treatment means separated using Fishers LSD (Least significant difference) test.

## RESULTS AND DISCUSSION

### Proximate Composition

The proximate composition of the cocoyam (*Xanthosoma sagittifolium* cv okoriko) flour is shown in Table 2.

**Table2.** Proximate composition of Cocoyam (*Xanthosoma sagittifolium* cv okoriko) Flour

Constituent	Content (%)
Moisture	11.5
Protein	7.8
Ash	3.2
Fibre	0.5
Fat	4.5
Carbohydrates	72.5
*Data are mean values of triplicate determination	

The protein content of the cocoyam flour was 7.8%. This protein content of 7.8% was within the range of protein content (7.4 – 8.9%) reported by Amandikwa (2012) for cocoyam (*Xanthosoma sagittifolium*) flour, though there

was no indication of the cultivar that was used in that work. The ash and fat contents of the cocoyam flour obtained from the work were 3.2% and 4.5% respectively. The fibre content of the flour was 0.5%. Owuamanam et al.

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(2010) reported a similar result where the fibre content of the cocoyam flour ranged from 0.20 - 0.99%, though the cultivars that were used were not stated. The moisture and carbohydrate contents of the cocoyam flour were 11.5% and 72.5% respectively. The low moisture value showed that the cocoyam (*Xanthosoma sagittifolium* cv okoriko) flour could have a long shelf life. The low moisture content of the flour

could promote food security and reduce post-harvest losses prevalent with cocoyam. The high carbohydrate content (72.5%) indicated that cocoyam could be a good source of energy.

### Physical properties of biscuit

The physical properties of the biscuit samples are presented in Table 3.

**Table 3.** Physical properties of Biscuit samples

Sample	Diameter (cm)	Height (cm)	Spread ratio	Break Strength (g)
AOK	13.45	3.00	4.48	700
Control	12.58	4.05	3.11	600

*\*Data are mean values of triplicate determination.*

The biscuit sample AOK which [produced from 100% cocoyam (*Xanthosoma sagittifolium* cv okoriko) flour] compared favourably to the control sample (produced from 100% standard wheat flour) with regards to spread ratio and breaking strength. The spread ratio of sample AOK was 4.48, and it was higher than that of the control sample which was 3.11. This could be due to disparity between the binding properties and protein content of the cocoyam flour and the wheat flour; which could have effect on the texture of the biscuits. It was observed that the control sample had a lower spread ratio and also a higher thickness. Okpala et al. (2013) observed the same trend in cookies produced from pigeon pea/sorghum/cocoyam composite flours. The low spread factor of the control sample showed that starch polymer molecules are highly bound with the granules and swelling is limited when heated. On cooling, the starch rapidly forms a rigid gel with capacity characteristics of large molecular aggregates (Abu et al., 2012). When a dough or batter becomes less viscous, it tends to spread more thereby increasing in diameter and consequently the spread factor and decreasing in thickness.

The break strength value of sample AOK was 700g while that of the control sample was 500g. This may be due to good quality of cocoyam (*Xanthosoma sagittifolium* cv okoriko) flour to form a strong network in the dough in a molten state at baking temperature. The high break strength of sample AOK indicates a decrease in the percentage of breakage and damages during post handling (loading, off-loading, transportation) of products. The physical properties of biscuit sample AOK showed that

*Xanthosoma sagittifolium* cv okoriko could be a good raw material for biscuit production.



**Plate 3.** Biscuits produced from 100% cocoyam (*Xanthosoma sagittifolium* cv okoriko) flour.

### Sensory properties of the biscuits

The Mean sensory scores of biscuits samples produced from varying percentage of cocoyam and wheat flour is shown in Table 4.

#### Colour

The colour of the control sample was significantly ( $p \leq 0.05$ ) different from all other biscuit samples (AOK, BOKW, COKW, DOKW, DOKW) with the highest mean score of approximately 8.0, that is "very much liked". Sample DOKW had the lowest mean score of 6.4.

#### Aroma

Aroma is another attribute that influences the acceptance of baked products. The control sample had the highest score of approximately 8.0 that is "very much liked", followed by sample BOKW with a score of approximately 7.0 that is "moderately liked". Samples AOK and DOKW were equally accepted. Sample EOKW had the lowest rating according to the

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panelist with the score 6.0 i.e. “slightly liked”. The control sample was significantly ( $p \leq 0.05$ ) different from all other biscuit samples in Table 4 (AOK, BOKW, COKW, DOKW, EOKW).

**Table 4.** Mean sensory scores of biscuits samples produced from varying percentage of cocoyam and wheat flour

Sample	Color	Taste	Aroma	Texture	Crispness	Overall Acceptability
AOK	6.75±1.41 <sup>b</sup>	5.15±2.32 <sup>c</sup>	6.15±1.46 <sup>b</sup>	5.40±2.64 <sup>b</sup>	5.50±2.59 <sup>b</sup>	5.45±2.33 <sup>c</sup>
BOKW	6.65±1.93 <sup>b</sup>	6.90±1.74 <sup>ab</sup>	6.70±0.92 <sup>b</sup>	6.15±1.79 <sup>b</sup>	6.15±2.06 <sup>b</sup>	6.65±1.76 <sup>b</sup>
COKW	6.55±1.93 <sup>b</sup>	6.00±2.15 <sup>bc</sup>	6.50±1.57 <sup>b</sup>	6.00±2.13 <sup>b</sup>	6.10±2.13 <sup>b</sup>	6.30±1.59 <sup>bc</sup>
DOKW	6.40±1.60 <sup>b</sup>	5.90±2.10 <sup>bc</sup>	6.30±1.46 <sup>b</sup>	7.75±1.52 <sup>a</sup>	5.50±1.99 <sup>b</sup>	6.00±1.92 <sup>bc</sup>
EOKW	6.55±2.04 <sup>b</sup>	6.25±2.45 <sup>bc</sup>	6.00±1.97 <sup>b</sup>	5.90±1.74 <sup>b</sup>	6.35±1.81 <sup>ab</sup>	6.60±1.96 <sup>bc</sup>
CONTROL	8.05±1.05 <sup>a</sup>	7.70±1.49 <sup>a</sup>	7.75±1.33 <sup>a</sup>	6.50±1.82 <sup>b</sup>	7.65±2.08 <sup>a</sup>	8.05±1.54 <sup>a</sup>
LSD	1.062	1.296	0.930	1.236	1.329	1.210

*a – c*–Means with different superscripts along the same column differ significantly at  $P < 0.05$ ; *LSD* - Least significant difference.

**KEY:** AOK– (100% cocoyam flour); BOKW – (95% cocoyam flour + 5% wheat flour); COKW – (90% cocoyam flour + 10% wheat flour); DOKW – (85% cocoyam + 15% wheat flour); EOKW – (80% cocoyam + 20% wheat flour); CONTROL – (100% wheat flour).

### Taste

The control sample had the highest taste score of approximately 8.0 which is “very much liked”. This was similar to sample BOKW which was moderately liked with a taste score of approximately 7.0. This result proves that both samples were equally accepted in terms of taste. However, the control sample and sample BOKW were significantly ( $p \leq 0.05$ ) different from the rest of the samples (AOK, COKW, DOKW, EOKW). Also there was equal acceptance in the taste of samples COKW, DOKW and EOKW, although they were not significantly different ( $p \leq 0.05$ ) in taste from sample AOK. From the results, it could be deduced that up to 80% of substitution with cocoyam flour could be accepted by the consumers (that is, “slightly liked” with score approximately 6.0).

### Texture

It was observed that the texture of biscuit sample DOKW with 85% cocoyam flour and 15% wheat flour had the highest score of approximately 8.0 and was “very much liked” in texture. Sample DOKW was significantly ( $p \leq 0.05$ ) different from the rest of the biscuit samples including the control which were moderately liked.

### Crispiness

Crispiness is a desirable quality of biscuits. It

was observed that the crispiness of the biscuit samples decreased with increase in the proportion of cocoyam flour. The control sample had the highest rating on crispiness with score approximately 8.0 while samples DOKW and AOK had the least rating on crispiness with score approximately 6.0. There was no significant ( $p \geq 0.05$ ) difference among samples AOK, BOKW, COKW and DOKW. The crispiness of all the biscuit samples was “slightly liked” with the exception of the control which was “very much liked”. The decrease in crispiness of the biscuit samples with increase in the proportion of cocoyam flour could be attributed to the lower gluten content in composite flour since gluten is responsible for the extensibility of the dough (Kent, 2000). Flour for biscuits should be more extensible but less springy as reported by (Kent, 2000) such that when masticated such biscuit will be crispy.

### Overall Acceptability

The quality of the biscuits (Aroma, colour, crispiness, texture and taste) indeed influence the overall acceptability of the biscuit. There was significant ( $p \leq 0.05$ ) difference between the control and other samples (AOK, BOKW, COKW, DOKW, EOKW) in the overall acceptability. The control sample had the highest score of approximately 8.0 (very much liked) and sample AOK had the lowest score of approximately 6.0 (slightly liked).

## CONCLUSION

Results from this work showed that cocoyam (*Xanthosoma sagittifolium* cv okoriko) flour could be used in the production of quality biscuits. Also, cocoyam flour could be used for substituting wheat flour up to 80% level in production of biscuits without adversely affecting the sensory attributes of the products. Biscuits made from higher levels of cocoyam flour substitutions had average mean scores ranging from approximately 6.0 – 7.0 for most of the attributes, they were fairly accepted by the judges. Besides the control sample, sample BOKW was the most accepted biscuit sample by the judges and had higher ratings in taste, aroma and overall acceptability with scores of approximately 7.0 for each attribute. The cocoyam flour also impacted a very good colour and nice aroma to the biscuits which aided in increasing the overall acceptability of the biscuits. The use of cocoyam (*Xanthosoma sagittifolium* cv okoriko) flour to produce convenience foods like biscuits will boost its production, utilization as well as the income of farmers and reduce the pressure on the use of wheat flour for biscuit production and help in utilization of cocoyam corms which is currently underutilized and disposed at refuse dumps.

## RECOMMENDATION

There should be more studies done to improve the texture and crispiness of the biscuits produced from *Xanthosoma sagittifolium* cv okoriko flour to enhance the acceptability of the products. Different types of biscuits and cakes which do not require hard texture and crispiness could be produced using the cocoyam flour. Weaning (baby) foods supplemented with protein isolates and concentrates could also be produced using cocoyam (*Xanthosoma sagittifolium* cv okoriko). The use of *Xanthosoma sagittifolium* cv okoriko in the formulation of breakfast food is also recommended.

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