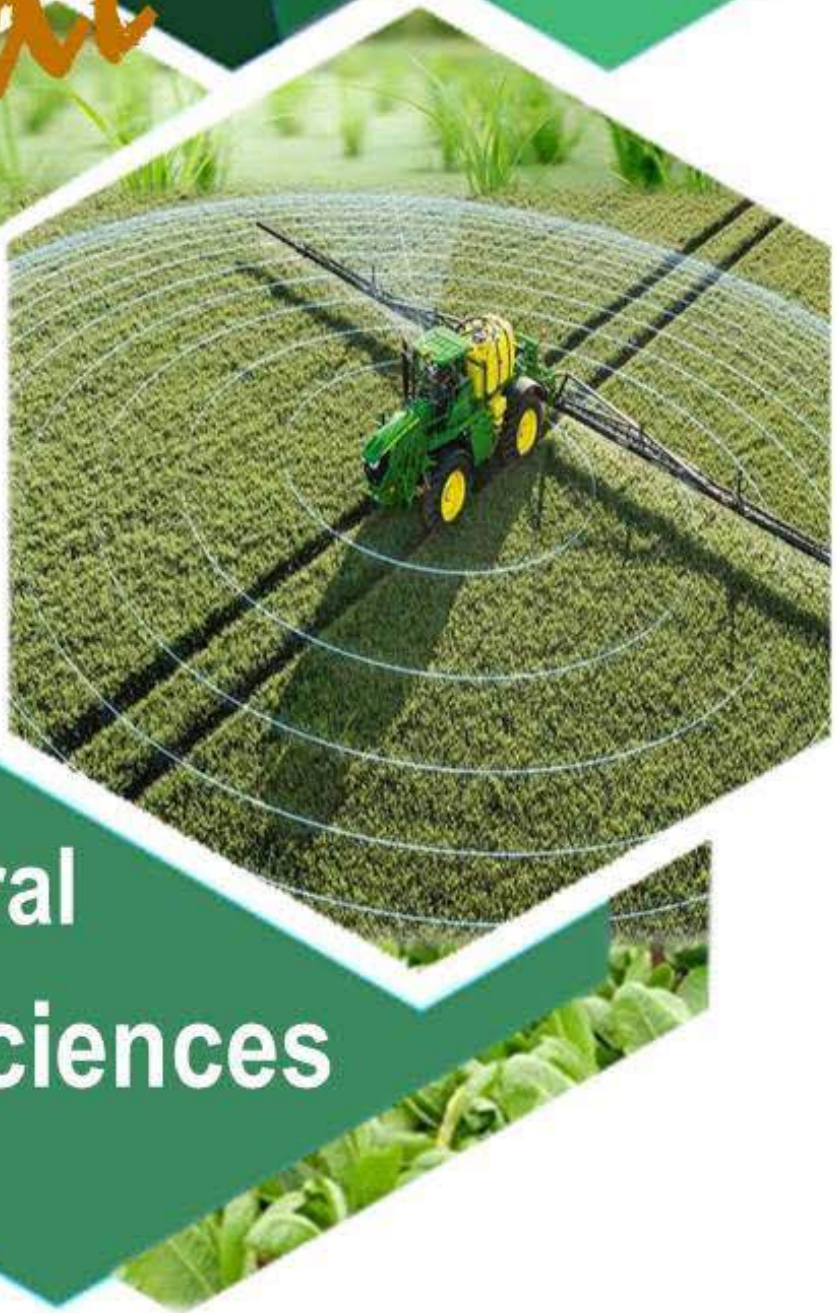
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The Effect of Cocoa Powder and Banana Flour on the Chemical and Sensory Properties of Whole Wheat Based Biscuits

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Abstract

Economically, the development of biscuits from composite flours is advantageous. The utilization of cocoa powder, banana flour and wheat flour in the production of composite biscuit aims at developing a functional food that is relatively cheap and available. This study focuses on the evaluation of biscuit produced from composite blends of cocoa powder, banana flour and whole wheat flour in the ratios 5:5:90, 10:10:80,15:15:70, 20:20:60, 25:25:50 and 0:0:100 (as the control) respectively. The biscuits samples were evaluated for their proximate composition, antioxidants and sensory properties using standard procedures. The proximate composition result revealed the biscuits were significantly different from one another and these are in the ranges of 11.09 to 25.10 %,14.33 to 26.67%, 2.13 to 4.87%, 1.73- 9.47%, 1.85 to 3.77% and 44.73 to 59.86% for protein content, fat, ash, moisture content, crude fibre and carbohydrate respectively. The antioxidants properties results ranged as follows: reducing power (1.05-3.54mg/g), total phenol (1.48-3.79mg/g), flavonoid (0.24-6.8mg/g), and total antioxidant. (2.9-9.91mg/g).

The sensory evaluation was also carried out for color, flavor, taste, crispiness and overall acceptability; the results were 5.10 -7.80, 4.20- 7.50, 2.90 – 7.50, 4.60– 7.40 and 4.50- 7.70 respectively. The values for the colour of the composite samples increased with increased inclusion of cocoa powder and banana flour. Hence, samples with smaller inclusions are darker than those with higher inclusion of cocoa powder and banana flour. Interestingly, sample containing 5% whole wheat flour and 10% each of cocoa powder and banana flour was the best in terms of nutritional and sensory qualities.

Keywords**:** Cocoa powder, anti-oxidative potentials, composite biscuits, nutritional quality

1.0 INTRODUCTION

Biscuits are convenient, cheap and ready-to-eat snack which are widely consumed by all age group in many countries (Adebowale *et.al.*, 2012). These type of snacks represent the largest category of snack foods in most parts of the world (Lorenz, 1983; Okaka and Isieh, 1990). Biscuits are mainly produced from 100% wheat flour in the past, but there is limited availability of wheat grains in Nigeria due to the unfavorable climatic condition for wheat cultivation and policies such as the ban on the importation. However, Nigeria has climatic conditions that are suitable for tropical crops such as roots, tubers and cereals. Therefore, consumption of biscuits require development of an adequate substitute for wheat. This is advantageous because it reduces the cost of importation by encouraging the use of indigenous crops such as cassava, yam,

maize and others that are partially substituted for wheat flour (Satin, 1988). The FAO reported that the utilization of composite flour in various food products would be advantageous economically if the importation of wheat could be reduced or even eliminated, and that demand for wheat based products could be met by the use of domestically grown products instead of wheat (Jisha *et al*., 2008).

Composite flour as defined by Milligan *et al*. (1981) is a mixture of flours, starches and other ingredients intended in totally or partially replacing wheat flour in bakery and pastry products. Shittu *et al.* (2007) was also agreement that composite flours were used either binary or ternary mixtures of flours from some other crops with or without wheat flour. In developing countries such as Malaysia, the use of composite flours had a few advantages in terms of: i) the saving of foreign currency; ii) promoting high-yielding, native plant species; iii) providing a better supply of protein for human nutrition; and iv) better overall utilization of domestic agriculture production (Berghofer, 2000; Bugusu *et al.*, 2001). Composite flour is considered advantageous in developing countries as it brings about a reduction in the importation of wheat flour and encourages the use of locally grown crops as flour (Hugo *et al.*, 2000; Hasmadi *et al*., 2014). The substitution of local raw materials for wheat flour is increasing due to the growing market for confectioneries (Noor Aziah and Komathi, 2009). Thus, numerous developing countries have encouraged the initiation of programmes to evaluate the feasibility of alternative locally available flours as a substitute for wheat flour (Abdelghafor *et al*., 2011).

Banana is one of the most consumed fruits in tropics and subtropics, and in terms of economical value it is the number five agricultural crop in world trade. The worldwide production of bananas in 2012 was 139.2 million tonnes (FAOSTAT, 2012). Besides, world banana exports are projected to reach almost 17.9 million tonnes in 2011.

Musa being one of the cheapest crops to produce and the cost of its production is less than most other staples. Besides being used solely as dessert, banana fruit may be processed into pulp-liquid fruit, canned slice, deep-fried chips, toffees, fruit bars, brandy and etc. (Kachru *et al.*, 1995; Morton, 1987). Bananas are highly perishable, with a significant proportion of the harvested crop being lost from the farm gate to the market place, owing to poor handling, storage and transportation of the fresh fruits. Non-harvesting losses may occur in peak production periods, when farmers do not harvest the whole of their production, because of saturated markets. All together, an estimate of 35% loss of the production of bananas was reported for developing countries (FAO, 1987).This is due to the fact that banana is a climacteric fruit and due to the habit of consuming ripe fruit, large quantities of this commodity are lost during its commercialization and post-harvest handling.

A new economic strategy is to process green bananas into dried flour and incorporate the flour into various innovative products so as to encourage consumption of banana and thus contributing to the health of humans (Ovando-Martinez *et al.*, 2009; Ramli *et al.*, 2010). Green banana flour contains up to 61.3-76.5 g/100 g starch on dry basis, a percentage comparable to that in the endosperm of corn grain and the pulp of white potato; apart from starch, Green banana Flour is high in total dietary fiber (6.28-15.54 g/100 g dry basis), which participates in the hypocholesterolaemic effect (Horigome *et al.*, 1992; Mota *et al.*, 2000; Zhang et al., 2005). This is a new economical strategy to increase utilisation of banana includes the production of banana flour when the fruit is unripe, and to incorporate the flour into various innovative products such as slowly digestible cookies (Aparicio-Saguilan *et al.*, 2007), high-fibre bread (Juarez-Garcia et al., 2006) and edible films, this in turn reduce losses and increase the income of farmer's producing banana and this ensures profitable farming in our country,

Cocoa in recent times has become the target of increased scientific research, due to its pro-health properties (Bogumiła and Jolanta , 2019). Fresh cocoa bean contains about 32–39% water, 30–32% fat, 10–15% protein, 5–6% polyphenols, 4–6% pentosans, 2–3% cellulose, 2–3% sucrose, 1–2% theobromine, 1% acids and less than 1% caffeine. Cocoa bean is also a rich source of mineral components (Bertazzo, *et al*., 2011; Kruszewski *et. al*., 2018). Three types of flavonoids dominant in cocoa beans are proanthocyanins (circa: 58%), catechins or flavan-3-ols (circa: 37%) and anthocyanins (circa: 4%) (Khan and Nicod, 2012; Khan *et al*., 2014).

The high polyphenol content of cocoa and its wide presence in many food products, makes it particularly interesting both from a nutritional point of view and health (Khan *et al*., 2014;

Ioannone *et al*., 2015; Da Silva Medeiros *et. al*., 2015; Cinquanta *et al*., 2016; Giacometti *et al*., 2016; Tsang *et al*., 2019). Polyphenols are not only antioxidant properties, but also affect sensory properties such as colour and taste (Kothe *et al*., 2013; Zyzelewicz *et al*., 2016;

Dabas, 2016; Giacometti *et al*., 2014). The aim of this study is to evaluate the effect of cocoa powder incorporation in banana wheat composite biscuit

2.0 MATERIALS AND METHODS

The banana fruit was purchased from Ologede market, Podo, Ibadan. While the other ingredients such as wheat, coco powder were purchased from Apete market, Ibadan.

2.1 Sample preparation

Banana fruits were peeled with a sharp knife and the peels were separated from the flesh using a blunt knife. The flesh of the fruits were then cut into smaller sizes and sundried for 2 days until they attained a constant weight. The peels were then ground with a blender (VTCL, Spark , made in India), and the powder sieved through a 500 μm diameter sieve. The powder was then stored in self-sealed paper bags and kept in a cool dry place until utilization.

2.2 Formulation of the biscuits

Six samples of the biscuits were formulated. The formulation of the biscuit produced from composite blends of cocoa powder, banana flour and whole wheat flour were in the ratios 5:5:90, 10:10:80,15:15:70, 20:20:60, 25:25:50 and 0:0:100 (as the control) respectively.

2.3 Sensory analysis

A consumer acceptance evaluation was performed with a panel of 25 untrained tasters, to whom biscuits were given in random order. Tasters were asked to evaluate different parameters, such as appearance, odor, taste, flavor, texture, overall liking, and purchase predisposition on a 9-point hedonic scale (1-extremely dislike, 9 -- extremely like)

2.4 Determination of antioxidant capacity

Sample extraction was done according to the method described by Bloor (2001).

Total phenolic content of the extracts were determined colorimetrically, using the Folin–Ciocalteu method as described by Singleton et al. (1999).

Total flavonoid content was determined based on the spectrophotometric method (Jia et al. 1999).

Antioxidant Capacity, Ferric Reducing/Antioxidant Power Assays were determined following the methods described by Katalinic *et al.* (2005).

2.5 Statistical analysis

The results of chemical, colour, antioxidant and sensory analyses were subjected to one-way analysis of variance (ANOVA) with Duncan's post hoc test at a 95% confidence level. Values obtained by the consumer acceptance test were analyzed by in SPSS software package, version 20.

3.0 RESULTS AND DISCUSSION

The sensory characteristics of biscuit samples are shown in Table 1. The color, flavor, taste, crispiness and overall acceptability ranged from 5.10 -7.80, 4.20- 7.50, 2.90 – 7.50, 4.60– 7.40 and 4.50- 7.70 respectively. The results obtained are significant different at 95% confidence level ($P<0.05$).The colour of the biscuit samples reduced with increased inclusion of the cocoa powder and banana flour, Sample WF had the highest acceptability followed by the sample with 5% inclusion of cocoa powder and banana flour. Similar finding was obtained by Adejumo *et al.*, (2020). However, sensory characteristics are of great importance in the consumers point of view (Ghadge *et al*., 2008), Higher expectation was therefore placed on the overall acceptability of the composite biscuits. The overall acceptability of samples CBWF5, CBWF10, CBWF25 and WF fell within the like region, while others did not. Among the composite biscuits

samples, panelists preferred the sample that its whole wheat flour was substituted with 5% cocoa powder and 10% banana flour.

Table 1: Sensory evaluation of cocoa powder- banana wheat composite biscuits

Samples	Colour	Flavour	Taste	Crispiness	Overall acceptability
CBWF5	6.30^{bc}	5.90^{ab}	6.80^{ab}	7.00^{a}	6.80^{ab}
CBWF10	5.20^{bc}	6.20^{a}	6.00^{b}	6.10^{ab}	6.30^{bc}
CBWF15	5.50^{bc}	4.20^{c}	2.90^{d}	5.10^{b}	4.50^{e}
CBWF20	5.10^{c}	4.50^{bc}	4.00^{cd}	4.60^{b}	4.70^{de}
CBWF25	6.60^{ab}	6.00^{ab}	4.60^{c}	6.10^{ab}	5.60^{cd}
WF	7.80^{a}	7.50^{a}	7.50^{a}	7.40^{a}	7.70^{a}

Mean values having different superscripts within a column are significantly different ($p<0.05$)

Table 2: Proximate composition of cocoa powder banana flour and wheat flour composite biscuits

Samples	Protein (%)	Ash (%)	Fat (%)	Moisture content (%)	Crude fibre(%)	Carbohydrate (%)
CBWF5	17.80^{c}	3.83^{b}	26.67^{a}	2.40^{c}	2.96^{b}	46.33^{cd}
CBWF10	18.04^{c}	4.87^{a}	24.16^{b}	2.67^{c}	2.43^{c}	47.83^{c}
CBWF15	21.60^{b}	4.80^{a}	20.00^{bc}	1.73^{c}	3.60^{a}	48.27^{c}
CBWF20	25.10^{a}	4.60^{a}	18.00^{bcd}	3.00^{b}	3.77^{a}	44.73^{d}
CBWF25	17.51^{c}	2.13^{c}	15.67^{cd}	9.47^{a}	2.92^{b}	52.30^{b}
WF	11.09^{d}	4.00^{a}	14.33^{d}	8.46^{a}	1.85^{d}	59.86^{a}

Mean values having different superscripts within a column are significantly different ($p<0.05$)

Table 3: CIELAB color values obtained for cocoa powder banana and wheat flour biscuit

Samples	L*	a*	b*
CBWF5	48.26^{c}	-3.83^{ab}	4.39^{b}
CBWF10	47.86^{c}	-3.17^{a}	3.26^{d}
CBWF15	54.65^{b}	-4.76^{c}	3.34^{d}
CBWF20	58.70^{a}	-4.87^{c}	3.89^{c}
CBWF25	53.92^{b}	-4.49^{bc}	3.40^{b}
WF	58.79^{a}	-4.25^{bc}	6.60^{a}

Mean values having different superscripts within a column are significantly different ($p<0.05$)

Table 4: Anti-oxidant values obtained for cocoa powder banana and wheat flour biscuit

Samples	Reducing power (%)	Total phenoic compounds (%)	Flavonoids (%)	Total Antioxidants (%)
CBWF5	1.11^{b}	2.60^{c}	3.61^{ab}	5.27^{a}
CBWF10	0.56^{b}	2.40^{d}	0.95^{b}	3.40^{a}
CBWF15	1.82^{b}	3.64^{b}	0.66^{b}	5.69^{a}
CBWF20	1.05^{b}	1.86^{e}	6.80^{a}	4.11^{a}
CBWF25	4.30^{a}	1.48^{f}	3.81^{ab}	2.92^{a}
WF	1.58^{b}	3.79^{a}	0.93^{b}	6.86^{a}

Mean values having different superscripts within a column are significantly different ($p<0.05$)

3.1 Proximate composition

The proximate composition of the biscuit samples showed that the differences in some of the parameters, and this could be attributed to effect of substituting wheat flour with both cocoa powder and banana flour. Similar result was reported by Usman *et al.*, (2015) who worked on the addition effect of maize bran and carrot puree on the wheat flour. The protein content of the biscuit sample ranges from 11.09 to 25.10 %, it was observed that there was increase in protein contents of the biscuits made from composite flours; this might be as a result of inclusion of cocoa powder, which contains higher protein content. Similar increase

in protein content of composite flour was observed by Bello *et al.,* (2017) who researched on the nutrient composition and sensory properties of biscuit from mushroom-wheat composite flours. The ash contents ranged from 2.13 to 4.87% with the sample CBWF10 having the highest ash content and sample CBWF25 having the lowest ash content. The higher ash contents observed in this study shows that the samples might be rich in minerals. This observation was in line with the report of Adejumo *et al.,* (2020) on composite biscuits. The fat contents of the biscuit varied from 14.33 to 26.67% with 100% wheat flour having the lowest fat content and sample CBWF5 having the highest.

Variation in the fat content might be as result of the introduction of cocoa powder which also contains high residual oil. A similar trend was reported by Bello *et al.,* (2017). All the samples exhibited significant differences ($p>0.05$) among each other. The moisture content of food gives their suitability to microbial spoilage (Olusanya, 2008). The moisture content of the biscuit sample ranged from 1.73- 9.47%, with sample CBWF25 having the highest moisture content and sample CBWF15 possessing the least. However, the moisture levels reported in this study were within the safe range (>10%), and might not support microbial spoilage (Sani *et al*., 2020).The crude fiber content of the biscuit ranged from 1.85 to 3.77% with sample CBWF20 having the highest value. This result shows that the crude fiber content of the composite biscuits were higher than the control sample. This might be as a result of the addition of both cocoa powder and banana flour to the wheat flour used in biscuits production. Adequate intake of dietary fiber will lower the level of serum cholesterol and may reduce the risk of developing hypertension, constipation, diabetes, colon cancer and coronary heart disease (Ishida *et al*., 2000). This claim is in accordance with the report given by Adejumo *et al.,* (2020).The carbohydrate content of the biscuit ranged from 44.73 to 59.86% with the whole wheat biscuit having the highest. This study revealed that the composite biscuits had moderately low carbohydrate contents. However, the amount of carbohydrate recommended for dietary allowance daily are 130g, 175g, and 210g for adults, pregnant and lactating mothers respectively (Duru Majesty *et al*., 2012). Values that are below the recommended limit might be suitable for infant. Moderate carbohydrate contents obtained in this study suggest that the samples might contribute significantly to the carbohydrate need of both infants and adults.

3.2 CIELAB colour analysis

The colour of the biscuit samples were determined using CIELAB colour space and this involves L* which signifies the lightness or darkness of the samples, a* for the redness or greeness and b* represents the yellowness or how bluer the samples are with respect to the control. The result obtained for L* ranged from 47.86 to 58.79, a*from -3.17 to -4.87 and b* from 3.26 to 6.60. There were significant differences in the colour of the biscuit samples. L* increased with increased addition of cocoa powder and banana flour a contrasting trend was reported by Olga Rojo-Poveda et al., (2020). Sample WF has the highest L*value indicating that WF has the lightest colour of all the samples followed by CBWF20 (20% cocoa powder, 20% banana flour and 60% wheat flour. while CBWF10 (10% cocoa powder,10% banana flour and 80% wheat flour has the darkest colour. the a* are of negative value , this means the biscuit samples are greener and increased with increased inclusion of cocoa powder and banana flour and b* values are positive indicating the samples\are yellowness. Sample WF is yellower than the other samples containing cocoa powder and banana flour. The yellowness of the samples decreased with increased addition of cocoa powder and banana flour.

3.3 Anti-oxidative Potentials

The reducing power of the cocoa powder-banana and wheat flour biscuit ranges between 0.56-4.30 with the CBWF25 having the highest value and CBWF10 was having the lowest value.

The total phenolic compounds of the cocoa powder-banana and wheat flour biscuit ranged between 1.48 – 3.79 with CBWF15 having the highest value but not higher than the WF.

The flavonoids of the cocoa powder-banana and wheat flour biscuit ranges between 0.56-4.30. Sample CBWF20 had the highest value followed by CBWF25.

4.0 CONCLUSION

This study has shown from the results obtained that nutrient dense biscuits can be produced by substituting wheat flour with 5% cocoa powder and 5% banana flour.

Biscuits produced from 90% wheat flour and 5% cocoa powder and 5% banana flour substitution was most acceptable to the panelist. Thus, consumption of cocoa powder, banana composite and wheat biscuits would increase protein and anti oxidant intake which help to prevent protein-energy malnutrition as well prevent diseases and increase the utilization of cocoa and banana in developing countries including Nigeria.

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