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Quality Evaluation Biscuits Produced from Wheat and Pineapple Peel Flour

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ABSTRACT

Biscuits are consumed extensively all over the world as snack foods and on a large scale in developing countries where protein and caloric malnutrition are prevalent. There is increase in the advocacy on the consumption of functional foods by world nutrition bodies due to different health problems related to food consumption. This study therefore aimed at investigating the nutritional quality of pineapple peel flour (PPF) and wheat flour blends containing functional ingredients, such as high dietary fibre, proteins, minerals and vitamin. Dried pineapple peel was incorporated into wheat flour at different blend ratios (90:10, 80:20, 70:30, 60:40 and 50:50) and used to prepare biscuits, while buscuits prepared with flour without pineapple peel flour served as the control. The samples were subjected to chemical, functional, microbiological and mineral analyses using standard methods. There was an increase in oil and water absorption properties as the ratio of pineapple peel flour increased in the blends. Except for carbohydrate content which decreased with increase in pineapple peel flour, proximate composition increased on pineapple flour addition. Similarly, calcium, potassium, sodium, iron and copper contents increased in the biscuits. Sensory evaluation indicated that the mean scores for taste, colour, crispness, aroma and overall acceptability were generally high for all the cookies. However, biscuits made from 90:10 wheat-PPF flour had the highest mean scores for all parameters evaluated and were close to 100% wheat cookies. This indicates the feasibility of producing nutritious biscuits with desirable organoleptic qualities from wheat flour and PPF.

Key words: biscuits, dietary fibre, wheat flour, pineapple peel flour, nutritional quality, minerals

INTRODUCTION

In Nigeria, baked goods based on wheat flour alone, are popular food stuffs. These products are extensively consumed due to consistent availability of their raw materials through regular importation to Nigeria (Edema *et al*., 2005). Wheat flour, the major ingredient for production of these baked products such as biscuits, rich in carbohydrates that generate a high glycemic response after ingestion (Ade *et al*., 2012). Biscuits are popular cereal foods consumed by all age groups, especially pre-school and school age children. They are a form of confectionary product dried to low moisture content (Okoye and Okaka, 2009). They are ready-to-eat, convenient and inexpensive food snacks produced from unpalatable dough that is transformed into a light porous readily digestible and appetizing product through the application of heat. The principal ingredients are wheat flour, fat, sugar and egg, while other optional ingredients include milk, salt, flavouring agent, aerating agent and other food additives. They are a rich source of fat, protein and carbohydrate; hence they provide energy and are also a good source of minerals (Kure *et al.,* 1998).

Biscuits are consumed extensively all over the world as snack foods and on a large scale in developing countries, Nigeria inclusive, where protein and caloric malnutrition are prevalent (Chinma and Gernah, 2007). With the increased advocacy on the consumption of functional foods by world nutrition bodies due to different health problems related with food consumption such as celiac diseases, diabetes and coronary heart diseases, World Health Organization (WHO) recommended reduction in the overall consumption of sugars and foods that promote high glucose response (WHO/FAO, 2003). A current trend in nutrition is the consumption of low-carbohydrate diets, including slowly digestible food products, as well as an increased intake of functional foods. Food professionals/industries are therefore faced with the challenge of producing food products containing functional ingredients in order to meet the nutritional requirements of individuals with health challenges. This has prompted research into the production of biscuits from non-wheat flour blends containing functional ingredients such as high dietary fibre and resistant starch.

Wheat is the most popular energy grain for the production of confectionary products because of the unique properties of its protein (gluten) which combines strength and elasticity required to produce bread, cookies, cakes and pastries (Akhtar *et al.,* 2008). Pineapple (*Ananas comosus*) on the other hand, is one of the most important fruits in the world (Hongvaleerat, *et al*., 2008). During the production of pineapple juice or when the fruit is sliced and eaten, the peels and pulp are most time regarded as waste and on few occasions, put to other uses. Pineapple peels represent around 35% of the whole fruit mass and contains an appreciable amount of insoluble fibre-rich fraction (FRF). These fractions also contain notable proportions of lignin (Hebbar *et al*.,2008).

Dietary fibre is a group of food components which is resistant to hydrolysis by human digestive enzymes and necessary for promoting good health (Prakongpan *et al.,* 2006). It is known to enhance digestive process, stimulates bowel movements, lowers cholesterol, and exerts a positive influence on blood sugar levels (Higgins, 2004). The importance of dietary fibre in the prevention of diabetes mellitus, obesity, coronary heart diseases, colon cancer and diverticular diseases among others, has caused more awareness on the essence of consuming foods with high fibre content (Rehinan *et al.,*2004). On the other hand, resistant starch is one of the components that assist in preventing and managing prediabeties and type 2-diabeties (Jideani and Jideani, 2011).

In recent times, it has been reported that there are several diseases relating to inadequate consumption of high fibre diets (Sylvia *et al*., 2014). Many people seem to prefer taking fruit juices and less fibrous foods to whole fruits and vegetables (Slavin and Lloyd, 2012). Apart from the loss of the valuable dietary fibre contained in pineapple peel, another issue that justifies the development of fibre-rich products is waste management. Recovering fibre for edible uses increases the economic value of pineapple processing and decreases waste. The latter also lessens the pollution effect of pineapple processing. Therefore, there is the need to develop fibre-rich products (biscuits) containing valuable ingredients with high nutritional qualities to supplement the diet.

MATERIALS AND METHODS

Materials

The materials used for the study consists of pineapple peel, wheat flour, baking powder, margarine, granulated sugar, eggs, salt, water, mil. The equipment used are knife and oven. The pineapple peels were inspected and graded based on some quality parameters such as cleanliness and freedom from mechanical injury, pest damage and diseases. The graded pineapple peels were washed with alkaline solution to remove debris and dirt in order to reduce the number of microbes. The pineapple peels were then dried in an oven (Binder ED Series Gavity Convection Oven;1.9 Cu. Ft., 230VAC, EW-05012-14) at a temperature of about 50^{o}C until it reached a constant weight. The dried materials were milled into flour using plate mill and then sieved with 0.35 mm aperture to fine particle materials from the milled peels.

Methods

Flour blending and biscuits production

Biscuits were prepared using a modified method of Nishiber and Kawakishi (1990). Pineapple peel flour was mixed with wheat flour at various proportions of 90:10,80:20, 70:30, 60:40, 50:50 and 100:00 as control. The measurements were carefully weighed using Compact Analytical Balances according to the different blend ratios. The measured quantities of fat and granulated sugar were mixed well in a rubber bow to a creamy consistency. Wheat-pineapple flour blends, baking powder, milk and salt were mixed together as shown in Table 1. This was then added to the creamy mix mixer or mixture and kneaded until dough of plastic but not sticky consistency was obtained. Kneading continued for 5 min to obtain smooth, plastic dough. The batter was shaped using tomato tin (0.25×35mm) and baked in an air oven at 180°C for 8 min. They were allowed to cool on a rack after which they were packed in low-density polyethylene bag and kept in a plastic container.

Table 1: Recipe for Cookies Formulation

Ingredient	Ratios					
	100:00:00	90:10:00	80:20:00	70:30:00	60:40:00	50:50:00
Pineapple peel flour (g)	0	10	20	30	40	50
Wheat flour (g)	100	90	80	70	60	50
Salt (g)	1	1	1	1	1	1
Fat (g)	65	65	65	65	65	65
Sugar (g)	50	50	50	50	50	50
Baking powder (g)	1	1	1	1	1	1
Egg	1	1	1	1	1	1
Milk (ml)	5	5	5	5	5	5

Source: Nishiber and Kawakishi,1990

Functional properties analyses

Bulk density determination

Exactly 30 g of the flour sample was weighed into 100 ml gradual cylinder and the initial volume recorded. The cylinder was tapped repeatedly for 100 times to a constant volume and the final volume recorded. The bulk density was calculated as the mass of the sample divided by the volume at the end of tapping (Bankole *et al*., 2013).

Water absorption capacity

About 1g of the sample was suspended in 30 ml distilled water at 30°C in a centrifuge tube, stirred for 30 minutes intermittently and then centrifuged at 300 rpm for 10 minutes. The supernatant is decanted and measured using measuring cylinder. The weight of the gel formed was recorded (Adebowale *et al.*, 2005). The water absorption index (WAI) was calculated as gel weight per gram dry sample.

Water absorption index (WAI) × 100

Swelling capacity

Swelling capacity was determined by weighing 20 g of the sample into a cleaned, dried graduated cylinder. The cylinder was tapped 3times on the table and then 80 ml of distilled water was poured into the cylinder. The cylinder was allowed to stand for 1h after which the final volume of the sample was noted. The ratio of the final volume to initial volume gave the swelling capacity. The supernatant was descanted and the weight of the sample and the cylinder was obtained, and the ratio of the final weight to initial weight of the food sample gave the swelling capacity (Ijarotimi and Keshinro, 2012).

Least gelation

Gelation property was investigated using the modified method of Akubor and Chukwu, 1999. Appropriate sample suspension in 5 ml distilled water was obtained to give 2, 4, 6, 8, 10, 12 and 14% (w/v) suspensions. The test tube containing these suspensions were heated for 1hour in cooling water bath followed by rapid cooling under tap water. The test tubes were further cooled at 4°C for 2h, the least gelation concentration was determined as the concentration when the sample from the inverted test tube did not slip or fall.

Oil absorption capacity

Oil absorption capacity is an index of the amount of oil retained within a protein matrix under certain conditions. Exactly10 ml of oil of known specific gravity was added to 1 g of sample in a beaker. The suspension was stirred using magnetic stirrer for 3mins. The suspension obtained was thereafter centrifuged at 3500 rpm for 30min and the supernatant was measured into a 10 ml graduated cylinder. The density of oil was 0.931 g/ml. The oil absorbed by the starch was calculated as the difference between the initial volume of the oil and the volume of the supernatant (Adebowale *et al.*, 2005).

$QAC = D \times 100$; D = Density of oil (0.931g/ml)

Proximate composition

This was determined in terms of moisture content, protein, fat, ash content, crude fibre and carbohydrate content according to the standard methods of AOAC (2000).

Physical analysis of the biscuits

For the determination of diameter (width), thickness and spread factor, AACC (2000) methods were followed.

Determination of mineral element composition

The cookies samples were digested by the wet ashing method prior to mineral content determination using atomic absorption spectrophotometre for Ca, Mg, and Fe and Corning 400 flame photometer for K and Na (Abulude *et al.,* 2007). While the phosphorus content was determined colorimetrically with Jenway 6100 spectrophotometre using the method described by Nielson (2003).

Sensory evaluation

Twenty (20) semi trained panelists made up of males and females from the Department of Food Science and Technology, Federal University of Technology Akure, Ondo State, Nigeria were used. The panelists were educated on testing terminologies and requested to evaluate the various cookies samples for colour, crispiness, taste, texture, flavour and general acceptability using a 9-point Hedonic scale where 9 was equivalent to like extremely and 1 meant dislike extremely as described by Iwe (2010). The samples were presented in a well packaged material, coded with different random alphabets, served simultaneously to ease possibility of panelists evaluating the sample. Necessary precautions were taken to prevent bias of panelists. They were given a sachet of water to rinse their mouths after each stage of evaluation and by ensuring that the panelists were ignorant of the actual sample represented by a code. The sensory evaluation data were analysed using analysis of variance (ANOVA).

Microbiological examination of the Biscuits

The total viable count of produced cookies was determined using standard microbiological plating method as described by Giwa *et al*., (2012). Samples of biscuits from each treatment groups were milled to powdered and 1 g of the sample was measured and dissolved in 9 ml of sterile water and vortexed for homogenisation at 3000 rpm for 5 min. The supernatant was decanted and 1 ml of supernatant was diluted serially in 9 ml of sterile water till an appropriate dilution factor of 10 ^ 2. About 1 ml of dilutions 10^2 was plated aseptically on sterile prepared nutrient agar (NA) and

Eosin methylene blue (EMB) agar plates. Inoculated plates were incubated aerobically in a bacterial Incubator (DNP-9102, China). All media was prepared according to manufacturer's instruction and autoclaved at 121ºC, 15 mmHg pressure for 30 min.

RESULTS AND DISCUSSION

Plates 1- 3 shows the oven dried pineapple peel, pineapple flour and prepared cookies respectively.

Functional Properties of Flour Samples at Different Blend Ratio

Table 2 shows bulk density, swelling capacity, oil/ water absorption and least gelation of the flour samples of different blend ratios. Water absorption capacity (WAC) ranged from 0.83 – 1.60g/g. The low water absorption capacity of the flour samples revealed the keeping quality of the flour and may be used for food products which requires less less hydroscopic nature. The low water absorption capacity (WAC) could be as a result of compactness of the intermolecular structure which does not allow the intake of water. Sample with the same ratio of wheat and pineapple peel flour composite (WPC$_1$) had the highest water absorption capacity (1.60g/g) and sample contained only wheat flour (WFC) the lowest value of 0.83g/g. The lower values obtained may be due to the amount and nature of the hydrophilic constituents and to some extent on pH and nature of the protein (Gordon, 1993). The oil absorption capacity (OAC) ranged from 148.96 - 232.75g/g; sample WPC$_1$had the highest value while WFC had the lowest oil absorption capacity. However, samples WPC$_1$, WPC$_2$, WPC$_3$, WPC$_4$, and WPC$_5$ did not differ significantly. Bulk density ranged from 0.83-0.93g/ml; there were no significant differences among the samples. Swelling capacity ranged from 62.00-67.66; samples WPC4 and WPC5 did not differ significantly Least gelation ranged from 0.4-0.6 % and there were no significant differences between the flour samples.

Table 2: Functional properties of flour samples at different blend ratio

Samples	Bulk density (g/ml)	Swelling capacity (%)	Oil absorption (g/g)	Water absorption (g/g)	Least gelation (%)
WPC$_1$	0.84±0.01c	62.00±0.00^{c}	232.75±0.00^{a}	1.60±0.00^{a}	0.60±0.00^{a}
WPC$_2$	0.89±0.01^{b}	64.00±0.00^{b}	228.82±0.00^{b}	1.34±0.00^{b}	0.60±0.00^{a}
WPC$_3$	0.89±0.01^{b}	66.00±0.57^{a}	219.58±0.00^{c}	1.16±0.03^{c}	0.60±0.00^{a}
WPC$_4$	0.93±0.01^{a}	68.00±0.33^{a}	203.82±0.00^{d}	1.02±0.00^{d}	0.40±0.00^{a}
WPC$_5$	0.93±0.01^{a}	68.00±0.57^{a}	186.20±0.00^{e}	0.93±0.03^{e}	0.40±0.00^{a}
WFC	0.83±0.00^{c}	67.66±0.33^{a}	148.96±0.00^{f}	0.83±0.03^{f}	0.40±0.00^{a}

Data represent the mean ± standard error mean of triplicate readings. Values with the same uppercase superscript letter along the same column are not significantly different (P>0.05).

WPC$_1$: 50% Wheat flour and 50% Pineapple Peel Flour
WPC$_2$: 60% Wheat flour and 40% Pineapple Peel Flour
WPC$_3$: 70% Wheat flour and 30% Pineapple Peel Flour
WPC$_4$: 80% Wheat flour and 20% Pineapple Peel Flour
WPC$_5$: 90% Wheat flour and 10% Pineapple Peel Flour
WFC: 100% Wheat flour

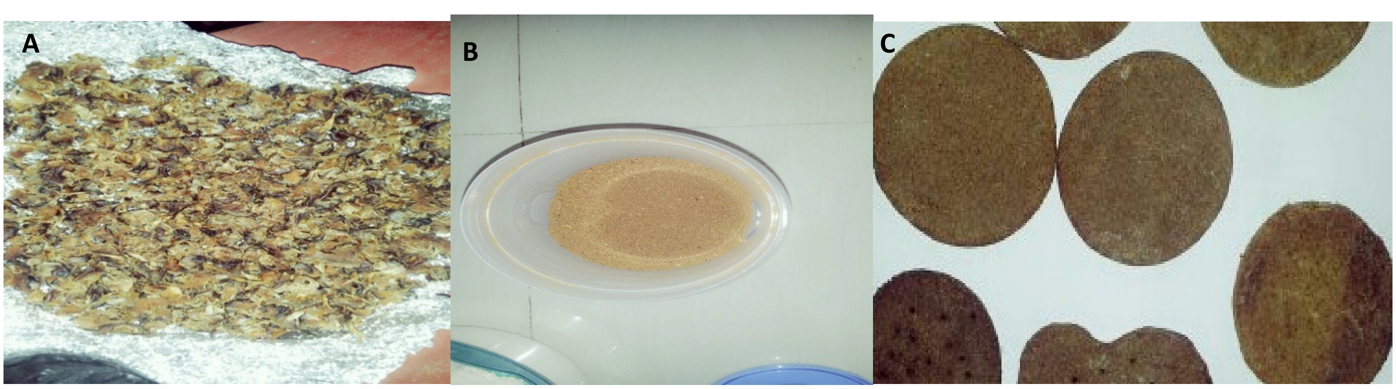

Plate 1: Oven dried pineapple peel (A), Pineapple peel flour (B) and The prepared cookies (C)

Proximate Composition of Biscuits Samples at Different Blend Ratio

The results of the proximate analysis of the cookies are presented in Table 3. The 100% wheat cookies contained 2.19 % protein, while samples $WPC_1$and WPC_2had the highest protein value of 2.45%. There is a gradual increase in crude protein with increase in the level of pineapple peel flour and this ranged from 2.19-2.45Kcal/kg with WFC having the lowest protein content. This may be due to the absence of pineapple peel flour in the sample, which has been reported to contain among all other nutrients, high protein (Slavin and Lloyd, 2012). The crude fat ranged from 1.04 to 1.37 % with WFC having the lowest crude fat content. This could be as a result of high nutrient content (protein and fat) in pineapple peel as reported by Slavin and Lloyd (2012). Crude fibre which ranged from 0.48 – 1.03% increased with increase in pineapple peel flour addition; WFC had the lowest value. This signifies that the pineapple peel flour is rich in fibre. The ash content ranged from 2.37 –2.76%. Increase in levels of pineapple peel flour resulted in decrease in carbohydrate content progressively from 93.92 % - 92.59%.

Physical Analysis of Biscuits at Different Blend Ratio

Table 4 shows the physical analysis of the biscuits. The spread ratio, diameter, weight and thickness did not differ significantly among samples. Spread ratio is an indication of ability of the cookies to rise, hence the lower the value the better the ability (Ahmad *et al*., 2016).

Mineral Element Composition of the Cookies

The mineral element composition of the cookies is shown in Table 5. Calcium was the most abundant element in all the samples, with highest values recorded in sample WPC_1 (50% pineapple peel flour substitution). The mineral content of the biscuits samples increased with pineapple peel flour substitution for all the minerals analyzed, except for zinc. High potassium and low sodium contents recorded by biscuits samples is advantageous and has been reported to protect against arterial hypertension (Wardlaw, 2004).

Table 3: Proximate composition of cookies samples at different blend ratio

Samples	Total ash (%)	Crude fat (%)	Crude protein (%)	Crude fibre (%)	Carbohydrate (%)
WPC_1	$2.76{\pm}0.05^a$	$1.18{\pm}0.00^d$	$2.45{\pm}0.00^a$	$1.03{\pm}0.00^a$	$92.59{\pm}18.33^b$
WPC_2	$2.67{\pm}0.00^b$	$1.09{\pm}0.01^e$	$2.45{\pm}0.00^b$	$0.99{\pm}0.00^b$	$92.80{\pm}0.01^a$
WPC_3	$2.59{\pm}0.01^c$	$1.30{\pm}0.00^b$	$2.36{\pm}0.00^c$	$0.86{\pm}0.00^c$	$92.91{\pm}0.00^a$
WPC_4	$2.57{\pm}0.05^c$	$1.37{\pm}0.00^a$	$2.33{\pm}0.00^d$	$0.79{\pm}0.00^d$	$92.95{\pm}0.01^a$
WPC_5	$2.51{\pm}0.01^c$	$1.22{\pm}0.01^c$	$2.27{\pm}0.00^e$	$0.70{\pm}0.01^e$	$93.31{\pm}0.00^a$
WFC	$2.37{\pm}0.00^d$	$1.04{\pm}0.00^f$	$2.19{\pm}0.01^f$	$0.48{\pm}0.00^f$	$93.92{\pm}0.00^a$

Data represent the mean ± standard error mean of triplicate readings. Values with the same uppercase superscript letter along the same column are not significantly different (P>0.05).

Key:

WPC_1: 50% Wheat flour and 50% Pineapple Peel Flour
WPC_2: 60% Wheat flour and 40% Pineapple Peel Flour
WPC_3: 70% Wheat flour and 30% Pineapple Peel Flour
WPC_4: 80% Wheat flour and 20% Pineapple Peel Flour
WPC_5: 90% Wheat flour and 10% Pineapple Peel Flour
WFC: 100% Wheat flour

Table 4: Physical analysis of the cookies at different blend ratio

Samples	Thickness (mm)	Diameter (mm)	Weight (mm)	Spread ratio
WPC_1	$19.20{\pm}0.20^a$	$71.00{\pm}0.00^c$	$34.06{\pm}0.79^a$	$3.70{\pm}0.13^a$
WPC_2	$19.33{\pm}0.33^a$	$71.66{\pm}0.16^a$	$34.11{\pm}0.21^a$	$3.71{\pm}0.22^a$
WPC_3	$19.33{\pm}0.33^a$	$71.66{\pm}0.16^a$	$34.96{\pm}0.02^a$	$3.71{\pm}0.17^a$
WPC_4	$19.33{\pm}0.33^a$	$71.66{\pm}0.16^a$	$34.60{\pm}0.66^a$	$3.71{\pm}0.42^a$
WPC_5	$19.46{\pm}0.66^a$	$71.66{\pm}0.16^a$	$34.98{\pm}0.37^a$	$3.68{\pm}0.39^b$
WFC	$19.16{\pm}0.57^a$	$71.33{\pm}0.33^b$	$34.93{\pm}0.29^a$	$3.72{\pm}0.24^a$

Data represent the mean ± standard error mean of triplicate readings. Values with the same uppercase superscript letter along the same column are not significantly different (P>0.05).

WPC_1: 50% Wheat flour and 50% Pineapple Peel Flour
WPC_2: 60% Wheat flour and 40% Pineapple Peel Flour
WPC_3: 70% Wheat flour and 30% Pineapple Peel Flour
WPC_4: 80% Wheat flour and 20% Pineapple Peel Flour
WPC_5: 90% Wheat flour and 10% Pineapple Peel Flour
WFC: 100% Wheat flour

Table 5: Mineral element Composition of the Biscuits

SAMPLES	Ca (mg/g)	Fe (mg/g)	Mg (mg/g)	K (mg/g)	Na (mg/g)	Zn (mg/g)	Cu (mg/g)	Mn (mg/g)	P (mg/g)
WPC_1	21.90 ± 0.00^a	0.30 ± 0.00^a	18.80 ± 0.01^d	18.30 ± 0.01^{ab}	1.70 ± 0.00^a	0.10 ± 0.00^a	0.10 ± 0.00	1.40 ± 0.01^{ab}	13.00 ± 0.00^a
WPC_2	21.40 ± 0.01^a	0.40 ± 0.00^a	19.66 ± 0.05^c	18.00 ± 0.00^{bc}	1.71 ± 0.00^a	0.10 ± 0.00^a	0.10 ± 0.00^b	1.70 ± 0.01^a	13.30 ± 0.01^a
WPC_3	21.50 ± 0.00^a	0.50 ± 0.00^a	19.50 ± 0.01^c	18.53 ± 0.26^a	1.70 ± 0.00^a	0.20 ± 0.00^a	0.20 ± 0.00^a	1.50 ± 0.01^a	13.20 ± 0.01^a
WPC_4	21.60 ± 0.01^a	0.40 ± 0.01^a	18.80 ± 0.00^d	18.10 ± 0.00^{bc}	1.40 ± 0.00^d	0.10 ± 0.00^a	0.10 ± 0.00^b	1.50 ± 0.01^a	12.60 ± 0.01^{ab}
WPC_5	21.30 ± 0.01^a	0.40 ± 0.00^a	19.90 ± 0.01^a	17.30 ± 0.00^d	1.50 ± 0.01^c	0.20 ± 0.00^a	0.20 ± 0.00^a	1.60 ± 0.01^a	12.80 ± 0.00^{ab}
WFC	21.70 ± 0.01^a	0.30 ± 0.00^c	19.41 ± 0.01^b	17.90 ± 0.01^c	1.60 ± 0.00^b	0.20 ± 0.00^a	0.20 ± 0.00^a	1.40 ± 0.01^{ab}	13.10 ± 0.01^a

Data represent the mean ± standard error mean of triplicate readings. Values with the same uppercase superscript letter along the same column are not significantly different (P>0.05).
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WPC_2: 60% Wheat flour and 40% Pineapple Peel Flour
WPC_3: 70% Wheat flour and 30% Pineapple Peel Flour
WPC_4: 80% Wheat flour and 20% Pineapple Peel Flour
WPC_5: 90% Wheat flour and 10% Pineapple Peel Flour
WFC: 100% Wheat flour

Microbial Quality of the Cookies

Table 6 shows microbial quality of the cookies. The total microbial load ranged from $7.0x10^2$ to $2x10^2$ cfu/g compare with the microbiological standards of fortified blended foods, total viable count TVC < 100,100 cfu/g. The result is still within acceptable value. These show that the cookies produced is acceptable and it reflects high hygiene standards adopted in the food preparation. Improper processing, handling and storage can allow the level to increase.

Table 6: Microbial Analysis of the cookies

SAMPLES	TPC×10²(CFU/g)
WPC_1	4.00 ± 0.00^b
WPC_2	3.00 ± 0.00^{ab}
WPC_3	5.00 ± 0.00^b
WPC_4	7.00 ± 0.00^a
WPC_5	2.00 ± 0.00^a
WFC	3.00 ± 0.00^{ab}

Data represent the mean ± standard error mean of triplicate readings. Values with the same uppercase superscript letter along the same column are not significantly different (P>0.05).
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WFC: 100% Wheat flour

Sensory Attributes of the Biscuits

Table 7 shows the mean score of the sensory evaluation. The taste of cookies ranged from 5.50 to 8.30. Biscuits from 100 % wheat scored highest (8.3), followed by cookies from 90:10 wheat-pineapple peel flour (7.2). There were significant (p<0.05) differences among the sample means for crispness. An increase in the substitution level of pineapple peel flour resulted in a decrease in crispness. Biscuits produced from whole wheat biscuits had the highest score of 8.5 for crispness while cookies from 50 % wheat flour and 50 % pineapple peel flour scored least (5.3). The scores for overall acceptability decreased with increase in the amount of the pineapple peel flour in the blend as indicated by most of the sensory properties. Aroma is another attribute that influences the acceptance of baked goods even before they are tasted. Substitution of wheat flour with pineapple peel flour at different levels significantly (p<0.05) affected the aroma; cookies produced from the control (WFC) scored the highest (8.0), while cookies with 50 % wheat flour and 50 % pineapple peel flour scored the least. The cookies were significantly (p<0.05) different in terms of colour. The change in colour observed could be as a result of heat applied during processing which causes browning reaction as a result of the sugar contained in the pineapple peel. The colour of 100% wheat flour cookies was most preferred by the panelists as compared to others.

CONCLUSION

The effect of proportion of blend on the quality of cookies made from pineapple peel flour and wheat flour had been examined. This research study indicates that biscuits produced from pineapple peel flour and wheat flour contain sufficient percentage of protein, fibre, and carbohydrate compared to cookies from 100% wheat flour. The pineapple peel flour gave smooth texture to cookies but brown colour was imparted and the colour gets darker as the levels of pineapple peel flour increases. The judicious use of pineapple peel flour in the diet in suitable proportions enhanced dietary quality. This research study indicates that biscuits produced from 90:10 wheat-PPF flour had the

Table 7: Sensory Attributes of the Biscuits

SAMPLES	Crispness	Colour	Aroma	Taste	Overall Acceptability
WPC_1	5.30±0.49^{de}	4.70±0.63^{c}	4.70±0.49^{d}	4.60±0.54^{d}	4.82±0.44^{d}
WPC_2	5.70±0.26^{d}	5.70±0.49^{bc}	5.80±0.41^{c}	5.5±0.37^{cd}	5.60±0.28^{cd}
WPC_3	6.40±0.22^{cd}	5.50±0.47^{c}	5.90±0.31^{bc}	5.70±0.30^{cd}	5.87±0.25^{c}
WPC_4	6.80±0.32^{bc}	5.80±0.32^{bc}	6.10±0.23^{bc}	6.10±0.50^{bc}	6.20±0.26^{c}
WPC_5	7.40±0.22^{b}	6.90±0.27^{b}	6.90±0.34^{b}	7.20±0.29^{ab}	7.10±0.19^{b}
WFC	8.50±0.22^{a}	8.40±0.22^{a}	8.00±0.25^{a}	8.30±0.21^{a}	8.30±0.16^{a}

Data represent the mean ± standard error mean of triplicate readings. Values with the same uppercase superscript letter along the same column are not significantly different (P>0.05).

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WPC_5: 90% Wheat flour and 10% Pineapple Peel Flour
WFC: 100% Wheat flour

highest mean scores for all parameters evaluated and therefore ranked as the best. Results show the potential of incorporating pineapple peel flour into baked products. This would be of economic importance in many developing countries such as Nigeria in promoting the utilization of pineapple peel and at large, enhance waste management generated from pineapple peel.

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