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Production and Quality Evaluation of Cookies from Blends of Millet-Pigeon Pea Composite Flour and Cassava Cortex

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ABSTRACT

Millet Flour (MF) and Pigeon Pea Flour (PPF) were produced and blended in the ratio of 65:35 to obtain Millet-Pigeon Pea Flour blend (MPF). Wheat Flour (WF) and MPF were used in ratios of 100:0, 90:10, 80:20, 70:30 and 60:40 to produce cookies which were subjected to sensory evaluation, to isolate the best ratio (80:20). Following this preliminary study, cookies were produced from a combination of Cassava Cortex Flour (CCF), Millet-Pigeon Pea Flour (MPF) and Wheat Flour (WF). CCF was used to substitute different levels of WF in the 80:20 (MF: MPF) blend, to give ratios of WF: MPF: CCF as 100:0:0, 80:20:0, 75:20:5, 70:20:10, 65:20:15 and 60:20:20. The composites were used with other ingredients to produce cookies that were subjected to proximate, energy, anti-nutrient, microbial and sensory analyses. Their moisture contents ranged from 7.00-8.40, ash 1.05-1.75%, crude fibre 1.25-1.70%, protein 6.25-7.44%, fat 16.40-17.20% and digestible carbohydrate 64.70-66.86%. The ranges of anti-nutrients in the cookies were; 0.09-0.22% tannin, 0.63-1.13% phytate, 0.09-0.15 Hu/mg haemaglutinin and 0.55-1.45% hydrogen cyanide. Sensory evaluation revealed that the cookies had high attributes ratings compared to cookies with 100% wheat flour. The bacteria and mould counts ranged from 0.2×10-0.8×10^2 CFU g^{-1}.

Key words: Cookies production, proximate, energy, anti-nutrients, microbial load, sensory attributes

INTRODUCTION

Cassava cortex is the inner whitish layer of cassava peel generated through manual or mechanized peeling of cassava tubers at domestic or industrial level- which is obtained by scrapping off the outer brown peel. The peel which is considered as waste, constitute 20-35% of the total weight of cassava tuber (Ekundayo, 1980). It poses a disposal problem especially during industrial processing of cassava tubers into products like cassava flour, "garri" and others. The usual disposal practice has been to dump compost or feed to animals. Cassava peels however, contain toxic levels of cyanogenic glucosides and usually have higher concentration of cyanogenic glucoside than the parenchyma (pulp) (Tweyongyere and Katongole, 2002). This makes the peel unsuitable for animal and human consumption (Oboh and Akindahunsi, 2003) and often results in fatalities to animals depending on the quantity consumed and concentration of cyanogenic glycosides present. However, the peels contain more linamarase than the pulp, which hydrolyses the glucosides when the peel is grated or milled thereby liberating gaseous hydrogen cyanide (HCN) that are dissipated into air (Bokanga, 1990). Suitable processing of cassava cortex such as soaking in water, grating and drying (Onyekwere *et al*., 1989), can however reduce the cyanide in the cortex to safe level (less than 50 mg of HCN/kg of pulp (Grace, 1971). According to Obadina *et al*. (2006), cassava peels were found to contain 42.6% carbohydrate, 1.6% protein, 12.1% ether extract, 5.0% total ash and 22.5% crude fibre. These peels constitute an important potential resource if properly harnessed (Obadina *et al*., 2006), by processing into flour for production of fiber enriched snack food products after appropriate processing. Higher fibre diets are associated with fewer digestive complaints, better blood-sugar control, lower blood-cholesterol levels and reduced rates of colon cancer, heart and kidney diseases (SNAC., 2005). However, little research effort has been directed to the possibility of processing the peels into snack food products for human consumption.

The snack food industry is growing globally with rapid introduction of new products formulated with the intent of meeting specific health or organoleptic need of consumers. These products are increasingly becoming available every year especially in developed countries. However, they are also exported to developing countries, where snacks are relied upon to meet the physiological needs of the populace particularly children (Thakur and Saxena, 2000). An increasing proportion of the household food budget in Nigeria is spent on snack food items, in which convenience and quality are perceived as most important (Lasekan and Akintola, 2002). Most of the snacks are cereal-based and poor sources of protein (Brink and Belay, 2006). Snacks such as doughnuts, pies, cookies among others which are usually produced from wheat flour have low nutritional values (Lasekan and Akintola, 2002). Choosing healthy snack foods is just as important at snack time as it is at meal time; therefore it is possible to improve the nutritional quality of cereal proteins by combination with leguminous plant protein sources (Akpapunam and Daribe, 1994), such as pigeon pea, cowpea and soybeans amongst others. Pigeon pea (Cajanus cajan), a leguminous plant which is nutritionally important is considered one of the industrially under-utilized crops with great potentials for becoming an industrial food raw material. It contains high levels of protein and important amino acids like lysine and tryptophan. Its combination with cereals such as millet will yield a well-balanced human food (Duke, 1981). Millet (*Pennisetum americanum*), which is also underutilized in Nigeria and has good nutritional quality (Eneche, 1999) could be a good replacement source for portions of wheat flour in snacks production.

The objectives of this study were to produce baked snacks (cookies) from combination of a recyclable waste product (cassava cortex), wheat and millet-pigeon pea flours and evaluate their chemical and sensory properties.

MATERIALS AND METHODS

Raw pigeon pea (Cajanus cajan), millet (*Eleusine coracana*), wheat flour and ingredients such as sugar, baking fat, flavour among others were purchased from Ogige market Nsukka, Enugu State, Nigeria. Fresh cassava (Manihort esculanta) peels were collected from cassava processors in Nsukka town.

Preparation of raw materials: The raw materials were processed into flour as discussed below:

Millet flour: Millet was processed into flour according to method of Jideani (2005). Two kilograms of the grains were cleaned by sorting and winnowing. The cleaned grains were dehulled using traditional method. Hulls were removed by winnowing and the weight of the dehulled grains noted. The dehulled grains were washed and dried at 50°C for 24 h in an oven (Fulton, Model NYC-101 oven). The grains were reduced to powder using a hammer mill (De-Demark Super) and sieved through 4.25 μm sieve.

Table 1: Composite flour blends prepared from wheat flour, millet-pigeon pea flour and cassava cortex flour

Samples	Wheat flour (%)	Millet-pigeon pea flour blend (%)	Cassava cortex flour (%)
A	100	0	0
B	80	20	0
C	75	20	5
D	70	20	10
E	65	20	15

A: Cookies made from 100% wheat flour, B: Cookies made from 80% WF + 20% millet-pigeon pea flour, C: Cookies made from 75% WF + 20% MPF+ 5% cassava cortex, D: Cookies made from 70% WF + 20% MPF + 10% CCF, E: Cookies made from 65% WF + 20% MPF +15% CCF, F: Cookies made from 60% WF + 20% MPF + 20% CCF, WF: Wheat flour, MPF: Millet-pigeon pea flour, CCF: Cassava cortex flour

Pigeon pea flour: Pigeon pea was processed into flour according to the method described by Enwere (1998). Two kilograms of the grains were cleaned to remove stones, dirts and chaff; washed dried and milled into flour as described for millet.

Preparation of cassava cortex flour: The outer layer of fresh cassava peels were scraped off with knife and the inner peels (cortex) retained and washed thoroughly in clean water. The cortex was soaked in water for 72 h. During soaking, the water was changed every 24 h. Afterwards the soaked cortices were dried in an oven (Fulton, Model NYC-101 oven) at 50°C for 24 h and milled into flour.

Formulation of composite flour blends: Wheat flour portions were substituted with cassava cortex flour at different levels. Each level was blended with 20% of millet-pigeon pea flour blends (65:35). The flour was thoroughly mixed to obtain a homogenous blend. Samples were stored at ambient temperature (28±2°C) in air tight plastic containers until required. Table 1 shows the proportion of the composite flour blends.

Production of cookies: The cookies were prepared using the method described by Eneche (1999) with slight modifications. The flour (500 g), sugar (150 g), baking fat (190 g) and salt (5 g) were mixed together manually for 5 min to get a creamy dough. The baking powder (2.5 g) and vanilla (5 g) were then added. The measured amount of water (125 mL) was gradually added using continuous mixing until good textured, slightly firm dough was obtained. The dough was kneaded on a clean flat surface for 4 min. It was manually rolled into sheets and cut into shapes using the stamp cutting method. The cut dough pieces were transferred into fluid fat greased pans and baked at 180°C for 20 min, cooled and packaged for analysis.

Sensory evaluation: A semi-trained thirty member panel was used for the organoleptic evaluation of the cookies. The panelists, made up of Staff and students of the Department of Food Science and Technology, University of Nigeria, Nsukka, were familiar with quality attributes of cookies. The samples were coded and presented in identical containers. Questionnaire for entering scores and portable water for mouth-rinsing between each tasting was made available to the panelists. The cookies samples were evaluated using a 7-point category scale (1 = extremely dislike to 7 = extremely like). Each of the samples was rated for colour, flavour, taste, texture and overall acceptability

Proximate analysis and calorific content determination: Moisture, crude protein, fat, fibre and ash contents were determined using the method of AOAC (2010). Carbohydrate was determined by difference as described Pearson (1976). The values obtained for protein, fat and carbohydrate were used to calculate the calorific content value of the samples as expressed below Pearson (1976): Calorific value (kcal/100 g) = P×4.0+F×9.0+C×3.75. Where; Protein content (%) = P, Fat content (%) = F, Carbohydrate content (%) = C.

Determination of anti-nutrients: Tannin content was determined by the Folin-Dennis colorimetric method described by Kirk and Sawyer (1998). Haemagglutinins was determined by the spectrophotometric method of AOAC (2010). Phytate content was determined using spectrophotometric method as described by Pearson (1976). The hydrocyanic acid content of the samples was determined by the alkaline picrate colorimetric method of Bradbury *et al.* (1999).

Microbial analysis Pour plate method as described by Harrigan and McCance (1976) was used to determine the mould, coliform and total viable counts.

Statistical analysis: Data were subjected to Analysis of Variance (ANOVA) using Statistical Package for Social Sciences (SPSS) version 17.0. Duncan's New Multiple Range Test (DNMRT) was used to compare the treatment means. Statistical significance was accepted at $p \leq 0.05$.

RESULTS AND DISCUSSION

Selected anti-nutrients in the flour samples: The data in Table 2 shows some anti-nutrients in the flour samples. Significant ($p<0.05$) differences were observed in the entire antinutrients determined. Fermentation and drying processes reduced the antinutrient levels of the flour to safe levels. Hydrogen cyanide levels ranged from 0.45% in cassava cortex flour to 1.90% in pigeon pea flour. Seventy two (72) h soaking in water was found to reduce the hydrogen cyanide level of cassava cortex to 0.45%. Liberated cyanide will usually dissolve in water when fermentation is effected by prolonged soaking (Casadei, 1988). According to Rosling (1987) the toxic level of cyanide is an intake above 20 mg per 100 g. Hydrogen cyanide level of millet flour (0.50%) and pigeon pea flour (1.90%) observed in this study were lower than the value (9.85%) obtained by Anuonye *et al.* (2012) for pigeon pea and unripe plantain blend.

Tannin levels ranged from 0.11% in cassava cortex flour to 0.44% in pigeon pea flour. These levels were found to be lower than 0.98% reported by Anuonye *et al.* (2012) for pigeon pea and unripe plantain blend. Phytate levels ranged from 0.5% in millet flour to 1.13% in pigeon pea flour, while haemagglutinins levels ranged from 0.04 Hu/mg in cassava cortex flour to 0.45 Hu/mg in pigeon pea flour. Bushway *et al.* (1984) reported that the maximum tolerable dose of phytate in the body is from 250-500 mg/100 g. Therefore phytate levels of flour observed in this study may be considered safe. The disparity in the anti-nutrient contents of flour processed from millet, pigeon pea and cassava cortex is expected since the raw materials are completely different.

Table 2: Anti-nutrient composition of flour from millet, pigeon pea and cassava cortex

Antinutrients	MF	PPF	CCF
Tannin (%)	0.25 ± 0.01^{b}	0.44 ± 0.14^{a}	0.11 ± 0.04^{c}
Phyate (%)	0.50 ± 0.01^{b}	1.13 ± 0.03^{a}	1.00 ± 0.11^{a}
Hemagglutinin (Hu/mg)	0.06 ± 0.03^{b}	0.45 ± 0.04^{a}	0.04 ± 0.02^{b}
HCN (%)	0.50 ± 0.03^{b}	1.90 ± 0.01^{a}	0.45 ± 0.01^{b}

Values are Means ±S.D of duplicate determinations, samples with different superscript within the same column were significantly ($p<0.05$) different, MF: Millet flour, PPF: Pigeon pea flour, CCF: Cassava cortex flour

Table 3: Proximate composition of cookies from wheat, cassava cortex and millet-pigeon pea flour blends

Samples	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude fibre (%)	Carbohydrate (%)
A	7.00±0.04[c]	7.44±0.06[a]	16.40±0.01[b]	1.05±0.01[b]	1.25±0.03[c]	66.86±0.16[a]
B	7.05±0.07[c]	7.01±0.01[a]	17.10±0.03[a]	1.70±0.03[a]	1.30±0.17[c]	65.84±0.00[b]
C	7.30±0.28[c]	6.57±0.10[a]	17.13±0.04[a]	1.70±0.04[a]	1.35±0.01[bc]	65.95±0.21[b]
D	7.70±0.03[b]	6.57±0.04[a]	17.15±0.04[a]	1.75±0.01[a]	1.50±0.03[b]	65.33±0.07[c]
E	7.75±0.01[b]	6.32±0.98[a]	17.20±0.06[a]	1.75±0.03[a]	1.53±0.03[b]	65.45±0.06[c]
F	8.40±0.14[a]	6.25±0.88[a]	17.20±0.07[a]	1.75±0.01[a]	1.70±0.06[a]	64.70±0.10[d]

Values are Mean±SD of duplicate determination, samples with different superscripts in the same column were significantly different (p<0.05), A: Cookies made from 100% wheat flour, B: Cookies made from 80% WF + 20% millet-pigeon pea flour, C: Cookies made from 75% WF + 20% MPF+ 5% cassava cortex, D: Cookies made from 70% WF + 20% MPF + 10% CCF, E: Cookies made from 65% WF + 20% MPF +15% CCF, F: Cookies made from 60% WF + 20% MPF + 20% CCF, WF: Wheat flour, MPF: Millet-pigeon pea flour, CCF: Cassava cortex flour

Effect of cassava cortex incorporation on proximate composition of cookies made from wheat and millet-pigeon pea flour blends: The proximate composition of the cookies is shown in Table 3. There were significant ($p<0.05$) differences in all the measured parameters except protein.

The moisture content ranged from 7.00-8.40% with the highest value observed in the sample which had 20% cassava cortex flour. This could be as a result of the high water absorption capacity of CCF; so that at higher level of incorporation (20%), the product would invariably contain more moisture. This result compared well 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 protein contents which ranged from 6.25-7.44% were not significantly ($p>0.05$) different from each other. The lowest value was expectedly observed in sample F which had the highest incorporation of cassava cortex flour (20%). There was generally a gradual decrease in the protein values of the cookies as cassava cortex flour incorporation increased. This may be as a result of dilution effect. These results compared favourably with 7.2% protein value reported for biscuit made from 100% millet (Eneche, 1999). Earlier work by Oke (1978) and Tewe (1987) showed that because of low protein content of cassava peels, cassava peel-based diets must be supplemented with rich protein sources in order to improve their palatability and nutrient density. These protein values observed for the formulated cookies were however higher than the 5.1% reported by Pearson (1976).

The fat contents of the cookies were observed to be generally high. They ranged from 16.40-17.20% and only the control sample was significantly ($p<0.05$) different from all the other samples. This could be as a result of the presence of millet and pigeon pea flour blends in the other samples, since the same amount of fat was used for all the recipes. These values were in agreement with the findings of Okpala (2010) who reported 16.31-21.33% for cookies made from jackfruit pulp and wheat flour blends, as well as 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 (Manley, 2000). Cookies are in fact a rich source of fat and carbohydrates hence, are energy giving food (Kure *et al*., 1998).

The ash content of the cookies showed significant ($p<0.05$) difference between the control and other samples with values ranging from 1.05-1.75%. The control sample had the lowest value. The increase in ash content in all the other samples could be attributed to the inclusion of cassava cortex, millet and pigeon pea flour in the recipe. Comparable values of 1.5-2.0% were also observed by Eneche (1999).

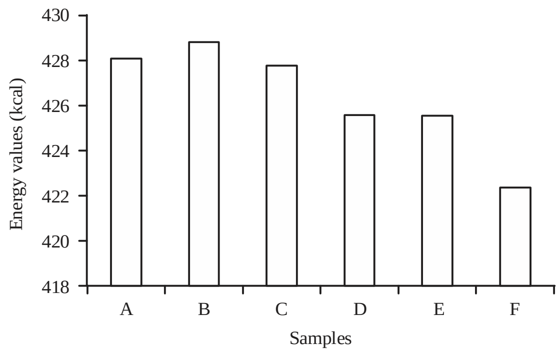

Fig. 1: Energy values of cookies, A: Cookies made from 100% wheat flour, B: Cookies made from 80% WF + 20% millet-pigeon pea flour, C: Cookies made from 75% WF + 20% MPF+ 5% cassava cortex, D: Cookies made from 70% WF + 20% MPF + 10% CCF, E: Cookies made from 65% WF + 20% MPF +15% CCF and F: Cookies made from 60% WF + 20% MPF + 20% CCF, WF: Wheat flour, MPF: Millet-pigeon pea flour, CCF: Cassava cortex flour

The fibre contents of the cookies were lower than expected, considering the high crude fibre content of cassava cortex flour. The values ranged from 1.25-1.70% and they increased as the level of cassava cortex flour incorporation increased. There were significant differences ($p<0.05$) among the samples. Similar ranges 0.57-2.17% and 1.26-1.40% were obtained by Echendu *et al.* (2004) and Giwa and Ikujenlola (2010), respectively. However lower values of 0.0-0.1% were obtained by Eneche (1999).

The carbohydrate content of the formulated cookies were found to be generally high and ranged from 64.70-66.86%. These values compared favourably with 61.0-66.5% and 68.29-74.34% ranges from previous works by Eneche (1999) and Magda *et al.* (2008), respectively.

Energy values of cookies: The data in Fig. 1 shows the energy values of the cookies which ranged from 422.43-428.84 kcal. The values increased from 428.09 kcal for the control to 428.84 kcal for B. This slight increase could be a function of the replacement of portions of wheat flour (20%) with MPF. The energy values decreased with 5, 10, 15 and 20% CCF incorporation. High fibre foods tend to be low in energy. Protein, fat and carbohydrate values contributed to the calorie content of the cookies. Cookies are energy-giving foods which are consumed by both young and old, especially in-between meals. Consumption of 15-20 pieces of the cookies can provide adequate energy per day based on recommended dietary allowances for children (7.6 MJ) and for adults (10.8 MJ) (Okaka *et al.*, 1992).

Anti-nutrient composition of cookies and from wheat, cassava cortex and millet pigeon pea flour blends: The anti-nutrient content of each cookie samples shown in Table 4. The tannin content of the cookies ranged from 0.09-0.22% with the lowest values observed in the control samples. Significant ($p<0.05$) differences existed between the samples. Baking reduced the tannin level by 79.55%. Tannins form insoluble complexes with proteins thereby decreasing its digestibility (Uzoechina, 2007). Tannin level decreased with increase in cassava cortex flour. The phytate content for cookies samples ranged from 0.63-1.13%. These values were quite lower than the lethal dose for phytate (250-500 mg/100 g) reported by Bushway *et al.* (1984). The values obtained agreed reasonably well with phytate levels of 0.56-0.70 mg/100 g reported by Okpala and Okoli (2011). It

Table 4: Antinutrient composition of cookies from wheat, cassava cortex and millet-pigeon pea flour blends

Cookies	Tannin (%)	Phytate (%)	Hemagglutinin (Hu/mg)	Hydrogen cyanide
A	0.09±0.001^{e}	1.00±0.14^{a}	0.14±0.01^{a}	0.55±0.01^{d}
B	0.17±0.004^{b}	1.00±0.14^{a}	0.09±0.01^{b}	1.45±0.28^{a}
C	0.17±0.006^{b}	0.63±0.01^{b}	0.14±0.01^{a}	1.20±0.01^{b}
D	0.14±0.003^{c}	1.00±0.28^{a}	0.15±0.01^{a}	0.80±0.28^{c}
E	0.10±0.004^{d}	1.13±0.01^{a}	0.11±2.8^{ab}	0.75±0.01^{c}
F	0.22±0.003^{a}	0.63±0.01^{b}	0.09±0.01^{b}	0.80±0.01^{c}

Values are Mean±SD of duplicate determination, samples with different superscripts on the same column are significantly different ($p<0.05$), A: cookies made from 100% wheat flour, B: Cookies made from 80% WF + 20% millet-pigeon pea flour, C: Cookies made from 75% WF + 20% MPF+ 5% cassava cortex, D: Cookies made from 70% WF + 20% MPF + 10% CCF, E: Cookies made from 65% WF + 20% MPF +15% CCF, F: Cookies made from 60% WF + 20% MPF + 20% CCF, WF: Wheat flour, MPF: Millet-pigeon pea flour, CCF: Cassava cortex flour

Table 5: Sensory evaluation scores for cookies made from wheat, cassava cortex and millet-pigeon pea flour blends

Samples	Appearance	Flavor	Taste	Texture	Overall acceptability
A	6.70±0.45^{a}	6.43±0.68^{a}	6.73±0.45^{a}	6.50±0.51^{a}	6.70±0.47^{a}
B	6.20±0.80^{b}	5.83±1.02^{b}	6.13±0.94^{b}	6.17±0.80^{ab}	6.13±0.86^{b}
C	5.50±1.01	5.70±0.70^{bc}	5.80±0.48^{bc}	5.90±0.89^{bc}	5.70±0.60^{c}
D	5.53^{c}±1.01^{c}	5.53±0.73^{bc}	5.70±0.70^{cd}	5.83±0.87^{bc}	5.83±0.65^{bc}
E	5.33±0.92^{c}	5.37±1.03^{bc}	5.37±0.77^{d}	6.10±0.71^{ab}	5.33±0.66^{d}
F	5.27±1.17^{c}	5.27±0.94^{c}	4.70±0.88^{e}	5.57±1.10^{c}	4.83±0.83^{e}

Values are Mean±SD of scores of 30 panelists samples with different superscript on the same column are significantly different ($p<0.05$), A: Cookies made from 100% wheat flour, B: Cookies made from 80% WF + 20% millet-pigeon pea flour, C: Cookies made from 75% WF + 20% MPF+ 5% cassava cortex, D: Cookies made from 70% WF + 20% MPF + 10% CCF, E: Cookies made from 65% WF + 20% MPF +15% CCF, F: Cookies made from 60% WF + 20% MPF + 20% CCF, WF: Wheat flour, MPF: Millet-pigeon pea flour, CCF: Cassava cortex flour

is expected that phytate lowering should enhance the bioavailability of minerals such as iron in the cookies and extruded snacks as phytic acid makes such minerals unavailable (Anuonye *et al*., 2012). Hemagglutinin values for cookies ranged from 0.09 -0.15 HU/mg. Hydrogen cyanide content values ranged from 0.55-1.45% for cookies. The residual hydrogen cyanide values were found to be far lower than 10-20 ppm detected in finished garri (Onyekwere *et al*., 1983). Baking reduced the anti-nutrient contents of the formulated samples, since these values are lower than the anti-nutrient values of the flour used for the product formulations. These values obtained agreed reasonably with those reported by Okpala and Okoli (2011).

Sensory profile of the cookies: The sensory scores of the cookies made from cassava cortex flour, wheat flour and millet-pigeon pea flour blend are shown in Table 5. The result shows that all the samples had very high sensory ratings in all the attributes considered such as appearance, flavor, taste, texture and overall acceptability. The control sample (A) made with 100% wheat flour had significantly ($p<0.05$) higher ratings than all the other samples in all the attributes evaluated except texture. This may probably be due to familiarity of assessors with cookies made from wheat flour. There were no significant ($p>0.05$) differences in texture of samples A (100% WF), B (80% WF + 20% MPF) and E (65% WF + 20% MPF +15% CCF) as well as between samples B (80% WF + 20%MPF), C (75% WF + 20% MPF+ 5% CCF), D (70% WF + 20% MPF + 10% CCF) and E (65% WF + 20% MPF +15% CCF). This shows that cassava cortex inclusion up to 15% did not affect the texture of the cookies. It may also be linked to moisture and fibre contents of the cookies that were highest in samples E and F (60% WF + 20% MPF + 20% CCF). There was also no significant ($p>0.05$) difference between samples B and C and between samples C, D and E in terms of taste. Implying that the taste of cookies deteriorated, with increasing addition of cassava cortex. In terms of overall acceptability, there was no significant difference ($p>0.05$) between samples B and D and between samples C and D.

Table 6: Microbial counts of cookies made from wheat, cassava cortex and millet-pigeon pea flour blends

Samples	Bacteria count (CFU g^{-1})	Mould count (CFU g^{-1})	Coliform count (CFU g^{-1})
A	0.2×10	0.25×10	NG
B	0.8×10^{2}	0.8×10^{2}	NG
C	0.2×10	NG	NG
D	NG	0.8×10^{2}	NG
E	0.3×10	0.2×10^{2}	NG
F	NG	0.2×10^{2}	NG

A: Cookies made from 100% wheat flour, B: Cookies made from 80% WF + 20% millet-pigeon pea flour, C: Cookies made from 75% WF + 20% MPF+ 5% cassava cortex , D: Cookies made from 70% WF + 20% MPF + 10% CCF, E: Cookies made from 65% WF + 20% MPF +15% CCF, F: Cookies made from 60% WF + 20% MPF + 20% CCF, NG: No growth, WF: Wheat flour, MPF: Millet-pigeon pea flour, CCF: Cassava cortex flour

The degree of likeness in almost all the attributes decreased as the level of substitution with cassava cortex flour increased. The high mean scores observed for appearance, flavor, taste, texture and overall acceptability indicated that all the biscuits were of good quality. However, sample F appeared to be the least preferred considering its mean scores for taste (4.70) and overall acceptability (4.83). This may be attributed to the higher level of cassava cortex flour (20%) in this sample which conferred fibrous and hard texture to the sample.

Microbial profile of the cookies: The microbial count of the cookies is shown in Table 6. The bacteria and mould counts both ranged from 0.2×10-0.8×10^{2} CFU g^{-1}. The samples had very low levels of bacteria and mould growth, while coliform was not detected. The presence of microorganisms in these samples may be attributed to the fact that the microbial analysis was not carried out on the zero day. There may have been contamination in the cause of keeping as the samples were kept for some days before the microbial analysis. However these counts were within acceptable limits (Fawole and Oso, 1988).

CONCLUSION

The study has shown that acceptable cookies can be formulated from composite of wheat flour, cassava cortex flour, millet and pigeon pea flour blends. These cookies were found to be good nutritional products. Cassava cortex flour inclusion did not have any negative effect on the products but rather it improved fibre content of the products. However higher levels of incorporation above 10% may not produced good nutritional products. The ash content was also improved probably because of the presence of pigeon pea in the products. This suggests high mineral contents in the products.

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