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QUALITY AND SENSORY EVALUATION OF COOKIES PRODUCED FROM CORN FLOUR (Zea mays)AND PIGEON PEA FLOUR (Cajanus cajan)

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ABSTRACT

The effect of sprouting and fermentation of corn mixed with pigeon pea to produce cookies was studied. A portion of the corn was sprouted and, another portion was fermented while the other portion was left unprocessed. These processed products and pigeon pea were then milled into flour. The three samples of corn were mixed with pigeon pea flour at ratio 80:20 and 60:40, respectively to produce cookies. The cookies produced were evaluated for proximate composition, mineral composition and sensory properties. The proximate composition revealed that cookies produced from 80% fermented corn mixed with 20% pigeon pea (F1) and 60%fermented corn mixed with 40% pigeon pea (F2) were high in protein (F1: 15.25% and F2: 19.40%)and fibre (F1: 7.40% and F2: 8.17%) followed by the sprouted corn sample. Cookies from the raw sample (60:40 and 80:20) were high in fat followed by cookies from the fermented corn samples (60:40 and 80:20). The mineral composition revealed that cookies from raw corn flour mixed with pigeon pea flour (80:20) was high in sodium, phosphorous and selenium (60.20, 408.09, 0.07 ppm) while fermented corn flour mixed with pigeon pea flour (60:40) sample was high in calcium, potassium, iron, manganese and zinc (213.43, 956.53, 1.31, 0.70 and 1.23 ppm). The sensory properties of the cookies were not significantly (p? 0.05) altered after production. Cookies produced from fermented corn mixed with pigeon pea showed more nutritional importance compared to the cookies from the sprouted corn and the raw corn.

Keywords: Sprouting, Fermentation, Corn, Pigeon pea, Cookies, Proximate, Mineral, Sensory evaluation

INTRODUCTION

Cookies, a form of confectionary product dried to low moisture content, are snack food by children and adult alike and are consumed all over the world (Okaka, 2009), and soften when compared to biscuits. The consumption of cookies and other western styled bakery products such as bread and cakes prepared from wheat flour has become very popular in Nigeria, especially, among children (Ayo and Nkama, 2003). Cookies had been suggested to be better than bread because of its ready to eat nature, wide consumption by different categories of people and relatively long shelf-life (Kiin-Kadari and Giami, 2015). Protein-richcookies are attractive in countries where protein energy malnutrition is prevalent (Chinma and Gernah, 2007), and also in areas such as child feeding programmes, low income and disaster relief operations (Kiin-Kadari and Giami, 2015). The enrichment or fortification of cookies and other bakery products with other protein sources such as oilseeds and legumes has received considerable attention. This is because oil seed and legume proteins are high in lysine, an essential limiting amino acid in most cereals (Ihekoronye and Ngoddy, 1985). Corn grain consist of the outer hull or bran which contains a lot of fibre, embryo (germ) rich in oil and the endosperm rich in starch. Pigeon pea belongs to the lesser known and under-utilized legume in Nigeria. Cookies with high sensory ratings have been produced from blends of wheat/soybean (McWalters*et al*.,2003), wheat and full fat soya (Ndiefe*et al*., 2014). Several studies have reported the use of wheat-based composite flour in cookies production (Kamaljit*et al.,* 2010); Onoja*et al*., 2010;Ajankau*et al.,* 2011). All these efforts were aimed at improving the nutritional content of the cookies and also to enhance crop utilization. Recently, attempts had been made to produce cookies from non-wheat based composite flours with high nutritional and sensory properties from unripe plantain and defatted sesame flour blends (Chinma et al., 2012), cassava groundnut–corn starch blends (Agriga and Iwe, 2009) and pigeon pea, cocoyam and sorghum flourblends (Okpala and Okoli, 2001). A current trend in nutrition is the consumption of functional foods (foods that not only supply basic nutrients but also help to prevent disease) advocated by world nutrition bodies due to different health problem related with wheat consumption such as celiac disease (life-long intolerance to wheat gluten,

characterized by inflamination of the proximal small intestine), diabetes and coronary heat diseases (WHO/FAO, 2003). This situation has created the need for the consumption of low-carbohydrate diets, slowly digested starchy foods as well as an increased intake of functional foods (Hurs and Martin, 2005).

The objective of this study is therefore, to produce cookies from processed corn flour blends with pigeon pea flour in order to improve the nutritional quality of the cookies and increase the utilization of pigeon pea by studying the effect of processing on the nutritional composition and sensory properties of the cookies produced.

MATERIALS AND METHODS

The corn (*Zeamays*), pigeon pea (*Cajanuscajan*) seeds and other materials used were purchased from a local market in Ado-Ekiti, Ekiti State, Nigeria.

Preparation of corn flour and pigeon pea flour

The corn was cleaned by removal of the dirt and the unwanted materials while being divided into three (3) portions. The first portion was processed into raw corn flour by washing with water, dried at 60°C for 5 h in hot air oven (Model DHG 9030A Hinotek, China). The dried samples were milled and sieved into flour using 0.25mm sieves. The second portion was processed into sprouted corn flour using the method described by Omowaye-Taiwo et al., (2014) with little modification. The corn was soaked for 5 h in water, drained, and spread inside tray, it was sprayed with water every morning until there was an evidence of sprouting. The sprouted corn was taken to the oven and dried at 60°C for 48 h. The dried sample was milled and sieved into flour using 0.25mm sieves. The third portion was processed into fermented corn flour using the method described by Omowaye-Taiwo et al., (2014). The corn was soaked in water for three day, the water was drained, washed with clean water and transferred into the hot air oven and dried at 60°C for 48 h. The dried sample was milled and sieved into flour using 0.25mm sieves.

The methods of Kiin-Kabiri and Giami (2015) were used for the production of pigeon pea flour. Pigeon pea seeds were sorted and soaked for 24h in water and dehulled manually. The seeds were further boiled for 10 min (1:4 beans to water ratio), in a stainless steel pot, drained and dried at 60°Cin an air circulating oven (Model DHG 9030A Hinotek, China) for 48 h. The dried samples were milled and sieved into flour using 0.25mm sieves.

Table 1: Recipe for the production of corn and pigeon pea cookies (g)

Ingredient	R1	R2	F1	F2	S1	S2
Corn flour	160	120	160	120	160	120
Pigeon pea flour	40	80	40	80	40	80
Sugar	75	75	75	75	75	75
Margarine	125	125	125	125	125	125
Powdered Milk	105	105	105	105	105	105
Baking powder	5	5	5	5	5	5
Egg (whole)	1	1	1	1	1	1

Key:
R1= 80% Raw corn flour and 20% Pigeon pea flour
R2= 60% Raw corn flour and 40% Pigeon pea flour
F1= 80% Fermented corn flour and 20% Pigeon pea flour
F2= 60% Fermented corn flour and 40% Pigeon pea flour
S1= 80% Sprouted corn flour and 20% Pigeon pea flour
S2= 60% Sprouted corn flour and 40% Pigeon pea flour

Production of Cookies

The method described by Arisa*et al.*, (2013) was used in the production of corn with pigeon pea cookies. Sugar (75g) was added to 125g of margarine in a mixer (Bear Varimixer, Wodschow & Co, Denmark, Glostrup-Copenhagen) and mixed at medium speed until fluffy. Whole egg and milk powder were added while mixing and then mixing continued for about 3 min. Sifted corn and pigeon pea flour and baking powder were slowly added to the mixture and mixed carefully to form dough. It was then rolled on a flat rolling board sprinkled with flour to a uniform thickness of about 0.4cm, circular cookies of 5.8 – 6.0cm diameter were cut, placed in oiled baking trays and baked in the oven at 160°C for 15 min. it was removed from the oven (Model DHG 9030A Hinotek, China) after baking, cooled and wrapped in high density polyethene and sealed.

Determination of proximate analysis of raw, sprouted and fermented corn and pigeon pea cookies

The cookies produced from raw, sprouted and fermented corn and pigeon pea flours were analyzed for moisture, protein, fat, crude fiber and ash content according to the methods described in AOAC (2012) while the total carbohydrate was calculated by differences.

Determination of mineral composition

Sodium and Potassium were determined using a flame photometer as described by AOAC (2012). Phosphorus was determined using phosphovanade-molybdate (yellow) method (AOAC, 2012). Calcium, iron, selenium, copper, manganese and zinc of the cookies samples were determined using an automated atomic absorption spectrophotometer (Perkin-Elmer, Model 2380). The samples and standard solutions were prepared according to the procedures of the AOAC (2012).

Evaluation of sensory properties of raw, sprouted and fermented corn and pigeon pea cookies

Sensory evaluation of raw, sprouted and fermented corn and pigeon pea cookies were carried out after baking using the methoddescribed by Giami and Barber (2004) for fluted pumpkin cookies. The sensory attribute included were; colour, flavour, taste, crispness and general acceptability were evaluated using a 9 – pointhedonic scale with 1 representing the least score (dislike extremely) and 9, the highest score(like extremely) as described by Iwe (2010).

Statistical Analysis

The data obtained were analysed using the analysis of variance (ANOVA) and means were separated using the Duncan multiple range test at the level of $P \leq 0.05$(Kiin-Kadari and Giami, 2015).

Table 2: Proximate analysis of raw, sprouted and fermented corn and pigeon pea cookies (%)

Sample	Moisture	Ash	Protein	Fat	Fibre	CHO
R1	8.20±0.01^{d}	1.12±0.01^{e}	9.48±0.03^{e}	10.13±0.58^{a}	4.12±0.07^{e}	66.66±0.06^{a}
R2	7.57±0.12^{e}	1.82±0.01^{b}	9.79±0.38^{e}	11.49±0.02^{e}	3.19±0.09^{f}	66.14±0.11^{a}
F1	8.31±0.15^{d}	1.39±0.01^{d}	15.25±0.09^{b}	8.26±0.06^{c}	7.40±0.01^{b}	59.39±0.10^{d}
F2	9.00±0.02^{c}	1.11±0.01^{e}	19.40±0.02^{a}	9.40±0.11^{b}	8.17±0.04^{a}	52.92±0.11^{e}
S1	9.57±0.83^{b}	2.05±0.01^{a}	10.62±0.04^{d}	6.05±0.06^{f}	6.51±0.02^{c}	65.20±0.13^{b}
S2	10.29±0.25^{a}	1.67±0.01^{c}	13.68±0.01^{c}	7.77±0.12^{d}	4.86±0.04^{d}	61.73±0.20^{c}

Means in the same column with the same superscript are not significantly different (P > 0.05).

Key:

R1= 80% Raw corn flour and 20% Pigeon pea flour
R2= 60% Raw corn flour and 40% Pigeon pea flour
F1= 80% Fermented corn flour and 20% Pigeon pea flour
F2= 60% Fermented corn flour and 40% Pigeon pea flour
S1= 80% Sprouted corn flour and 20% Pigeon pea flour
S2= 60% Sprouted corn flour and 40% Pigeon pea flour

Table 3: Mineral composition of raw, sprouted and fermented corn and pigeon pea cookies (ppm)

Sample	Na	Ca	K	P	Fe	Se	Cu	Mn	Zn
R1	60.20 ±2.13^{a}	127.87 ±1.02^{e}	642.83 ±3.07^{e}	408.09 ±0.90^{a}	0.35 ±0.01^{e}	0.07 ±0.01^{a}	0.14 ±0.01^{c}	0.46 ±0.01^{d}	0.32 ±0.01^{e}
R2	33.30 ±0.44^{c}	120.07 ±0.81^{e}	584.57 ±3.49^{f}	235.53 ±6.22^{f}	0.29 ±0.01^{f}	0.06 ±0.01^{b}	0.12 ±0.01^{d}	0.40 ±0.07^{e}	0.50 ±0.01^{d}
F1	45.27 ±0.41^{b}	189.33 ±2.23^{b}	928.67 ±3.71^{b}	274.78 ±0.79^{d}	1.21 ±0.01^{b}	0.03 ±0.01^{f}	0.15 ±0.01^{c}	0.62 ±0.01^{b}	0.75 ±0.01^{b}
F2	46.77 ±0.42^{b}	213.43 ±3.36^{a}	956.53 ±8.44^{a}	303.17 ±0.42^{c}	1.31 ±0.01^{a}	0.05 ±0.01^{d}	0.20 ±0.02^{a}	0.70 ±0.06^{a}	1.23 ±0.09^{a}
S1	29.20 ±0.36^{d}	185.40 ±2.26^{b}	854.23 ±1.22^{d}	316.31 ±3.06^{b}	1.13 ±0.01^{c}	0.01 ±0.01^{c}	0.21 ±0.01^{a}	0.52 ±0.01^{c}	0.52 ±0.01^{d}
S2	33.70 ±0.87^{c}	141.17 ±3.12^{c}	916.20 ±0.98^{c}	264.26 ±1.19^{e}	0.63 ±0.01^{d}	0.03 ±0.01^{e}	0.17 ±0.01^{b}	0.40 ±0.01^{e}	0.64 ±0.01^{c}

Means in the same column with the same superscript are not significantly different (P > 0.05)
Key:
R1= 80% Raw maize powder + 20% Pigeon pea flour
R2= 60% Raw maize powder + 40% Pigeon pea flour
F1= 80% Fermented maize powder + 20% Pigeon pea flour
F2= 60% Fermented maize powder + 40% Pigeon pea flour
S1= 80% Sprouted maize powder + 20% Pigeon pea flour
S2= 60% Sprouted maize powder + 40% Pigeon pea flour

Table 4: Sensory evaluation of raw, sprouted and fermented corn and pigeon pea cookies

Sample	Colour	Flavour	Taste	Crispness	Overall Acceptability
R1	6.80±1.14^{a}	5.40±1.17^{a}	6.50±1.18^{a}	6.80±1.32^{a}	6.30±1.16^{a}
R2	5.80±0.92^{ab}	5.80±1.75^{a}	6.00±1.50^{ab}	5.60±1.43^{a}	6.20±1.48^{a}
F1	6.60±0.97^{a}	5.60±1.35^{a}	4.90±1.37^{b}	5.60±1.58^{a}	6.10±0.99^{a}
F2	6.30±1.70^{a}	5.20±1.35^{a}	5.40±1.78^{ab}	6.60±1.88^{a}	5.50±1.78^{a}
S1	6.20±1.32^{a}	5.10±1.60^{a}	6.00±1.15^{ab}	7.00±1.05^{a}	6.00±0.82^{a}
S2	4.90±1.60^{b}	4.80±1.80^{a}	5.30±1.16^{ab}	6.00±1.70^{a}	5.70±1.57^{a}

Means in the same column with the same superscript are not significantly different (P > 0.05)
Key:
R1= 80% Raw maize powder + 20% Pigeon pea flour
R2= 60% Raw maize powder + 40% Pigeon pea flour
F1= 80% Fermented maize powder + 20% Pigeon pea flour
F2= 60% Fermented maize powder + 40% Pigeon pea flour
S1= 80% Sprouted maize powder + 20% Pigeon pea flour
S2= 60% Sprouted maize powder + 40% Pigeon pea flour

RESULTS AND DISCUSSION

The proximate composition of cookies made from raw, sprouted and fermented corn flour and pigeon pea flour blends are shown in Table 2. The moisture content of all the cookies sample was significantly different from each other ($p<0.05$) with the sprouted corn flour mixed with pigeon pea (80:20 and 60:40%) having the highest value (9.57 and 10.29), followed by the cookies from the fermented corn flour (9.00 and 8.31%) while the cookies from raw corn flour had the least moisture content (7.57 and 8.20%). The moisture content of the cookies was similar to the value(9.86%) reported by Okoye et al., (2008). The value for protein and crude fibre contents were significantly different ($p<0.05$). The cookies produced from 80% fermented corn mixed with 20% pigeon pea (F1) and 60% fermented corn mixed with 40% pigeon pea (F2) were high in protein (F1: 15.25% and F2: 19.40%)and crude fibre (F1: 7.40% and F2: 8.17%) followed by the sprouted corn flour mixed with pigeon pea (S1:10.62% and S2:13.68%) while the raw corn flour blends with pigeon pea flour had the least value (R1: 9.48% and R2: 9.79%). As expected, the high value of protein recorded for sample F2 (19.40%) may be attributed to the high percentage of pigeon pea (40%) present. The result showed that pigeon pea improves the crude protein of cookies produced from corn flour. This is in agreement with past work (Kiin-Kadari and Giami, 2015), that reported an improved protein content through addition of Bambara nut protein concentrate to plantain flour in the production of composite cookies. It has been discovered that most leguminious plants like pigeon pea are rich in protein with good arrays of amino acids and minerals (Fagbemi et al., 2004). The values obtained for crude fibre compared favourably with the cookies produced from the 50% soy flour supplemented with wheat flour as reported by Ndife et al., (2014). However, the ash content of the samples were significantly ($p<0.05$) low. Cookies produced from 80% sprouted corn flour and 20% pigeon pea flour had highest value while the lowest value was found in cookies produced from 60% fermented corn flour and 40% pigeon pea flour. The values obtained for the cookies were comparable to the result (1.20-2.80%) obtained by Kiin-Kadari and Giami (2015) for cookies produced from plantain flour enriched with Bambara groundnut protein concentrate, while the values were low when compared with the cookies produced from 50% soy flour supplemented with wheat flour as reported by Ndife et al., (2014). Cookies of80% raw

corn flour mixed with 20% pigeon pea flour had highest carbohydrate (66.66%)while cookies produced from 60% fermented flour mixed with 40% pigeon pea had the least value (52.92%). The mineral composition of the cookies produced from raw, fermented and sprouted corn flour blends with pigeon pea flour was showed in Table 3. The cookies produced from 80% raw corn flour and 20% pigeon pea flour was high in sodium, phosphorus and selenium while cookies produced from the 60% fermented corn flour and 40% pigeon pea was high in calcium, potassium, iron, copper, manganese and zinc. This value of calcium is adequate for bone and teeth development (Oladele, 2007). Potassium is required to maintain osmotic balance of the body fluids, the pH of the body, regulate muscle and nerve irritability, control glucose absorption and enhance normal retention of protein during growth (Omoba*et al.,* 2013).

The sensory evaluation of cookies produced from raw, fermented and sprouted corn flour blends with pigeon pea flour were shown in Table 4.All the cookies produced from raw, fermented and sprouted corn flour blends with pigeon pea flour were acceptable with reference to flavour, crispiness and overall acceptability, which showed no significant difference ($p>0.05$).Flavour is the main criterion that makes the product to be liked or disliked. Colour is very important parameter in judging baked biscuits properly, it does not only reflect the suitability of raw material used for the production but also provides information about the formation and quality of the product. The colour of cookies produced were not significantly different ($p>0.05$) from each other except cookies produced from 60% spouted corn flour and 40% pigeon pea flour which was significantly different ($p>0.05$) from other blends. This may be due to extent of heat transfer within the cookies during baking, which influence caramelization and millard reactions that are responsible for development of colour in baked foods(Kiin-Kadari and Giami, 2015). There was no significant difference ($p<0.05$) in the taste of the cookies, which showed that spouting and fermentation does not affect the taste of the cookies.

CONCLUSION

Fermentation of corn and the addition of pigeon pea flour for the production of cookies had better nutritional quality than the cookies produced from raw and sprouted corn flour mixed with pigeon pea flour. The sensory score showed that all the cookies produced from raw, fermented and sprouted corn flour mixed with pigeon pea flour at different ratios enjoyed consumer acceptability. Thus, the use of composite flours will reduce the pressure on wheat flour importation and help to improve the utilization of corn and pigeon pea and by preventing their post-harvest losses.

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