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CHEMICAL AND SENSORY PROPERTIES OF COOKIES PRODUCED FROM BLENDS OF WHEAT, CORN AND TOASTED PIGEON PEA FLOUR

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ABSTRACT

This study was carried out on the quality evaluation of cookies produced from blends of wheat, corn and toasted pigeon pea. Composite samples were prepared from inclusion of wheat, corn flour and toasted pigeon pea flour with AAA= 100% wheat flour, BBB=90% wheat flour, 5% corn flour and 5% toasted pigeon pea flour, CCC= 80%wheat flour, 10% corn flour and 10% toasted pigeon pea flour, DDD=70% wheat flour, 15% corn flour, 15% toasted pigeon pea flour. The proximate and mineral of the samples were evaluated using standard methods. Sensory qualities of the product was also evaluated using a 20 man panelist. Result for the product showed moisture content value ranged from 5.00 to 6.20%, ash content ranged from 1.13 to 1.48%, crude fibre 0.91 to 1.22%, fat 18.45 to 20.43%, 11.99 to 21.98% for protein and 51.93 to 62.38% for carbohydrates. Values ranging from 186.20 to 245.60 mg/100g, 88.25 to 160.50mg/100g, 10.20 to 23.60mg/100g and 4.25 to 6.50mg/100g were obtained for minerals, calcium, magnesium, iron and zinc respectively. Anti-nutrients showed a range of 5.06 to 8.86µ/L, 2.42 to 4.76µ/L, 12.78 to 23.03µ/L, and 3.08 to 3.17µ/L were obtained for phytate, tannin, oxalate and hydrogen cyanide respectively. The sensory evaluation score for taste, crunchiness, flavour, appearance and overall acceptability ranged from 7.73 to 8.20, 7.60 to 8.13, 7.73 to 8.20, 7.67 to 8.00 and 8.27 to 8.60 respectively. Values shows, proximate and mineral content increases as the inclusion level of pigeon pea and corn flour increases, however values of anti-nutrients reduced as inclusion decreases. It is therefore recommended that sample DDD (70% wheat flour, 15% corn flour and 15% toasted pigeon pea flour) be used in making cookies.

Keyword: *Quality, Cookies, Wheat, Nutrient, Acceptability.*

INTRODUCTION

Cookies are a popular and versatile snack in the confectionary industry worldwide due to their high affordable prices, different taste/flavour, ease of use and longer shelf life among other processed foods (Hruskova and Svec, 2015). Cookies are the second most consumed confectionary products closely followed by bread all over the world (Wang and li, 2014). Cookies are the high-end variant of biscuits which have become an organized industrial commodity in the various country's market (Pratima and Yadave, 2000). They are a small, flat-baked food product with crispy and fluffy textures with extra sugar of cereals used in the dressing. Cookies are made using a wide variety of styles with an array of ingredients (Chappalwar *et al.,* 2013), They are widely cherished and accepted in so many countries by all age brackets and consumer profiles, and thus providing a valuable tool for dietary substitution (Arshad *et al,* 2007). Cookies are reported to be a concentrated food due to the high content of carbohydrates, fats and low moisture (Pratima and Yadave, 2000). Nutritionally, their values can be improved by the addition a certain class of ingredients. Thereby making cookies a tremendous medium to successfully deliver special nutrients to consumers. Another significant way to design cookies is with the aim of improving the nutritional status and the maintenance of the product's sensory characteristics as the acceptability of the consumer always remains the primary factor in determining the successful implementation to a newly developed product (Skrbic and Cvejanov, 2011). As most consumers are becoming more concerned about their health, the demand for functional foods has risen. This have increased the demand for food processing to meet up with the nutritional requirements of individuals with special dietary heeds, as this have posed a major challenge for the food researchers to develop confectionary products containing functional ingredients. The concept of composite flour technology was initiated by the Food and Health Organization (FAO) in 1964 to promotes the use of locally grown crops other than wheat in the upgrade of both the nutritional, functional and organoleptic quality of flour used in the production of cookies (Jisha *etal.,* 2008). Maize grain is free of gluten with a unique-profiles of bioactive compounds and nutrients. It's proximate contains is about 62% carbohydrate, 4% ether extract, and 8.7% protein. Corn is an important source of micronutrients, dietary fiber and various phytochemical such as carotenoids phenolics, phytate, phytosterols, flavonoids and anthocyanins (Hassan *et al.,* 2019). The consumption of products from whole grain has been linked to the lowering risk of cardiovascular disease, type-2 diabetes, obesity, cancer etc. (Siyuan *et al.,* 2018). According to Shah *et al.* (2016), the resistant starch from corn is known for prevention against cecal cancer, atherosclerosis, and obesity-related complications.

Pigeon pea *(Cajanus cajan}* has been used as a novel ingredient in restructured baking products (Ihekoronye and Ngoddy, 1985). It is also used as a substitute for wheat flour to improve the nutritional value of cookies (Arshad *et al,* 2007) and crackers (Etonihu *et al.,* 2009). The composite flour made by blending pigeon pea and wheat flour had a low glycemic index, which causes a reduced peak in postprandial glucose in diabetic patients after 30 min of consumption (Ghadge *et al.,* 2018). Pigeon pea, is a potential food ingredient. It has been previously shown that pigeon pea flour substitution on the starch and protein has a high the effect on the digestibility of whole wheat flour. Pigeon pea is consumed in various forms and supplies about 22% of the protein needs thereby contributing to a nutritionally balanced human food (Jambunathan and Sigh, 2021). This study was carried out to evaluate the nutritional quality of cookies produced from blends of Wheat, Maize and toasted Pigeon pea flour.

MATERIALS AND METHODS

Sources of Samples and Collection

2kg of wheat *(Triticum aestivum* flour), maize *(Zea mays}* and pigeon pea *(Cajanus cajan)* with other ingredients used in this study was obtained from Anyigba market. These samples was bought and other ingredient collected and placed in separate airtight container then taken to the Laboratory for Production of the cookies.

Sample Preparation

Preparation of corn flour

Edible samples of corn flour was prepared in accordance with the method described by Okoye *et a!.,* (2008) as shown in fig 1. During preparation, 1kg of com flour was prepared by individually sorting the grains (free of sand and other debris), drying, milling sieving and the bagging the flour in an air tight container for use in the cookie preparation.

Maize

Sorting

↓

Drying

↓

Milling

↓

Sieving

↓

Packaging

↓

Corn Flour

Fig 1. Flow Chart for corn flour Processing (Okoye *et al.,* 2008)

Preparation of Pigeon Pea Flour

The pigeon pea flour was produced in accordance with the method described by Echendu *et al.* (2014). Pigeon pea was sorted to remove bad seeds and extraneous materials like stones, stalks, dirt etc. One kilogram of pigeon pea was toasted and dehulled. The dehulled pigeon pea was grinded using an attrition mill, the sieved with a Muslim cloth. The filtrate was kept in an airtight container for cookie production.

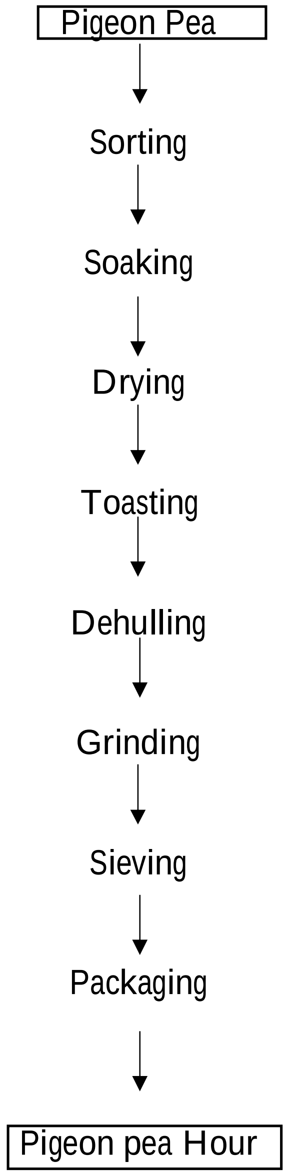

Fig. 3.1. Flow chart for the preparation of pigeon pea flour (Echendu *et al.*, 2014)

Table 1. Sample Formulation for Wheat/Corn and Toasted Pigeon Pea Flour Cookies

Sample code	Wheat flour %	Corn Flour %	Pigeon Pea Flour %
AAA	100.00	0.00	00.
BBB	90.00	5.00	5.00
ccc	80.00	10.00	10.00
ODD	70.00	15.00	15.00

AAA=100% wheat flour. BBB= 90% wheat flour, 5% corn flour and 5% pigeon pea flour, CCC= 80% wheat flour, 10% corn flour and 10% pigeon pea flour. DDD= 70% wheat flour, 15% corn flour and 15% pigeon pea flour

Ingredient for Preparation of cookies

500g flour blend
200g butter
1 Spoon of milk (moderate)
100cl water
1 tea spoon of baking powder
150g sugar
4 eggs
Pinch of salt

Procedure for Cookies Preparation

The cookies was prepared in accordance with method described by (Gopalan *et al,* 2004). 150g of weight of sugar was mixed with 200g butter until fluffy in a mixer at medium speed. Refined wheat flour for control sample and composite flour blends for experimental samples (wheat + maize + toasted pigeon pea flour) along with one (1) tea spoon baking powder and eggs (beaten to make a fluffy structure) were then slowly added and mixed until a uniform smooth dough was obtained. The dough was uniformly spread over the board to a thickness of about 2 cm using a rolling pin. Circular cookies of about 4 cm in diameter was cut using a cookies mould. The Cookies were placed on a baking mesh and baked at 200°C for 10-15 minutes in oven. The baked cookies was cooled to room temperature and stored in sealed polyethylene sachets of appropriate thickness and permeability.

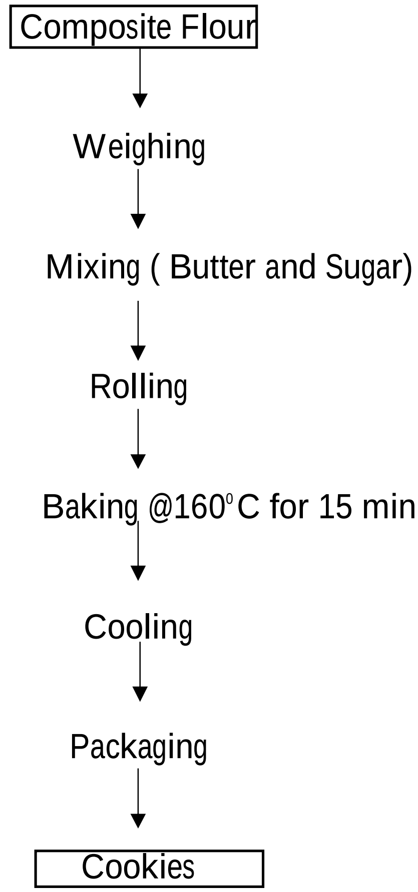

Fig. 3.1. Flow chart for the preparation of cookies from blends of wheat, corn and Toasted pigeon pea (Gopalan *et al,* 2004).

Analysis of Sample

Proximate Determination

All Proximate analysis parameters were determined according to the methods described by AOAC (2000)

Mineral Determination

The analyses of Ca, Mg, Zn, and Fe was conducted by flame atomic absorption spectroscopy (FAAS) using an Analyst 800 atomic absorption spectrometer (Perkin Elmer, USA) equipped with an AS 800 auto-sampler (Perkin Elmer, USA).

Determination of Antinutritional Factors

Determination of phytate

The method of Wheeler and Ferrei (1971) was employed for phytate determination. Two grammes (2.0 g) of each sample (finely ground) was dissolved in 100 mL of 2% HCI (v/v) for 3 h and filtered. The filtrate (25 mL) was placed in a 100 mL conical flask and 5 mL of 0.03% NH_4SCN solution was added as indicator, 50 mL of distilled water was added. This was titrated with ferric chloride solution which contained 0.005 rng of Fe^{3+} per mL of $FeCl_3$ used, the equivalent was obtained and from this, the phytate content in mg/100 g was calculated.

Iron equivalent = titre value x 1.95 x 1.19 = Phytic mg/g
Phytic acid = titre value x 1.95 x 1.19 x 3.5 mg/phytic acid

$$\%\ \text{Phytic Acid} = \frac{V \times 8.24}{1000} \times \frac{1000}{\text{Weight of Sample}} \quad \text{......................Enq 1}$$

where V = titre (mL)

Determination of Tannin

The tannin content was determined by modified procedure of Markkar and Goodchild (1996). Finely ground sample (0.2 g) was weighed with a 50 mL sample bottle, about 10 mL of 70 % aqueous acetone was added and covered properly. The bottles was put in an ice bath shaker and shaken continuously for 2 h at 30 ° C. Each solution was then centrifuged at 3000 g and the supernatant stored in ice, 0.2 mL of each supernatant was pipetted into test tubes and 0.8 mL of distilled water was added. Standard tannic acid solution was prepared from a 0.5 mg/mL stock solution and the solution was made up to 1 mL with distilled water. Folin ciocalteau reagent (0.5 mL) (colour developer) was added to both the sample and standard, followed by 2.5 mL of 20 % Na_2CO_3 solution. The solutions was then incubated for 40 min at room temperature after which their absorbance was read at 725 nm against a reagent blank. The concentration of the sample was obtained from a standard tannic acid curve.

Determination of Oxalate

The method described by Day and Underwood (1986) was used. One (1) gram of each sample was weighed into 100 mL conical flask, 75 mL of 3 M H_2S0_4 was added and the solution was carefully stirred intermittently with a magnetic stirrer for about 1 h and then filtered through Whatman No 1 filter paper. Exactly 25 mL of the filtrate was collected and titrated hot (80 - 90 °C) against 0.1 M KMnO4 solution to the point when a faint pink colour appeared and persisted for at least 30 s.

Oxalate (mg/g) = V_T x 0.9004
Where, V_T = Titre volume (mL)

Determination of Cyanide

The method described by Day and Underwood (1986) was used. One (1) gram of each sample was weighed into 100 mL conical flask, 75 mL of 3 M H_2SO_4 was added and the solution was carefully stirred intermittently with a magnetic stirrer for about 1 h and then filtered through Whatman No 1 filter paper. Exactly 25 mL of the filtrate was collected and titrated hot (80 - 90 °C) against 0.1 M $KMnO_4$ solution to the point when a faint pink colour appeared and persisted for at least 30 s.

cyanide (mg/g) = V_T x 0.9004

Where, V_T = Titre volume (mL)

Sensory Evaluation

This was determined using a 7-point hedonic scale of preference from 1 (dislike extremely) to 7 (like extremely). This was done by a 15 trained panel from the department of Food Science and Technology Kogi State University Anyigba, with ability to differentiate food sensory properties as described by (Iwe, 2002).

Statistical Analysis

All data obtained was subjected to a one-way Analysis of Variance (ANOVA). Differences between means was separated using Fisher's Least Significant Difference (LSD) by the use of Statistical Package for Social Science (SPSS) version 20 computer software.

RESULTS AND DISCUSSION

Table 4.1 shows the results of the proximate composition of the cookies sample prepared from blends of wheat, corn and toasted pigeon pea flour.

The average moisture content of the cookies produced from the various flour blend ranged from 5.00 - 6.20%, implying that more moisture is present in the CCC flour (80% wheat flour, 10% corn flour and 10% toasted pigeon pea flour) than the rest flour blends. The higher the moisture content of the cookies sample the lower the shelf life (Tajkarimi *et al.,* 2011). The lower moisture content of the AAA (100% wheat flour) implies a low level of deterioration of the cookies produced, indicating longer shelf life. The ash values ranged from 1.13 to 1.48%. a steady significant (P<.0.05) increase in value was obtained in cookies produced from sample AAA (100% wheat) to sample DD (70% wheat flour, 15% corn flour and 15% pigeon pea flour). This implies an increasing trend of inorganic matter percentage with decrease in the wheat flour inclusion thereby decreasing the absorbable organic content available per cookies consumed. Tendall *et al.* (2015) reported that high ash implies higher mineral content which will translate into better utilization of protein and other biochemical processes upon digestion of the cookies with lower wheat flour. The average fibre content values steadily increased from 0.91 obtained from the 100% wheat flour to 1.22% obtained in the wheat flour, 15% corn flour and 15% pigeon pea flour. The significant ($P<0.05$) higher value obtained for the sample DDD cookies, implies improvement in gut feel for consumers.

However, crude fibre value range in this experiment is similar to findings of (Roth *et al.,* 2016) for frost cake. Fat value ranged from 18.45% - 20.43%. The steady significant ($p<0.05$) increase in fat value obtained with decrease in wheat flour inclusion could result from the higher oil content of pigeon pea and other ingredients added such as butter. The average protein content of the cookies produced from the various flour blends steadily increased from 11.99 obtained from the 100% wheat flour to 21.98% obtained from the 70% wheat flour, 15% corn flour and 15% pigeon pea flour. Values obtained is higher than the range of values of 7.93% -18.29% reported by Olaoye *et al.* (2016) for bread produced from composite wheat flour, plantain and soybean blends. Protein content value steadily increased with decrease in the inclusion content of wheat flour. This implies more protein nourishment with healthy growth, tissue development and repair with consumption of cookies with 70% wheat flour, 15% corn flour and 15% pigeon pea flour. Average carbohydrate value ranged from 48.87 - 62.38%. High carbohydrate content in the 100% wheat flour implies high presence of glucose which could be converted into high metabolizable energy derived from the consumption of the cookies thereby improving the energy content of the cookies. With increasing inclusion of the pigeon pea and corn, a decreasing trends in carbohydrate content was obtained (Amaefule and Ironkwe, 2007). This therefore implies that cookies sample of AAA tends to have significantly higher carbohydrate content.

Table 4.1: Proximate properties of cookies produced from blends of wheat, corn and toasted pigeon pea flour

SAMPLE	PROTEIN%	MOISTURE%	ASH%	FAT%	CRUDE FIBRE%	CARBONHYDRATE%
AAA	5.17^{b}±0.04	1.13^{c}±0.04	18.45^{d}±0.07	0.91^{c}±0.01	11.99^{d} ±0.00	62.38^{a}±0.05
BBB	5.00^{b}±0.00	1.20^{c}±0.00	18.80^{c}±0.00	1.09^{b}±0.01	18.77^{c} ±0.06	55.15^{c}±0.06
CCC	6.20^{a}±0.14	1.38^{b}±0.04	19.15^{b}±0.07	1.17^{a}±0.01	20.17^{b} ±0.06	51.93^{c}±0.18
DDD	6.02^{a}±0.03	1.48^{a}±.04	20.43^{a}±0.04	1.22^{a}±0.03	21.98^{a} ±0.04	48.87^{d}±0.17

Values are mean with ± standard deviation of duplicate determination. Means with different superscript in the same column are significantly different (p<0.05)

Keys
AAA= 100% wheat flour
BBB= 90% wheat flour, 5% corn flour and 5% pigeon pea flour,
CCC= 80% wheat flour, 10% corn flour and 10% pigeon pea flour.
DDD= 70% wheat flour, 15% corn flour and 15% pigeon pea flour

Table 4.2 shows the results of the mineral component of the cookies sample prepared from blends of wheat, corn and toasted pigeon pea flour.
The average calcium content value for the various flour blend cookies ranged from 186.20 from the 100% wheat flour cookies (AAA) to 245.60mg/100g for sample DDD 70% wheat flour, 15% corn flour and 15% pigeon pea flour blend. Jideani *et al.* (2018) reported that significantly improved (p<0.05) calcium level implies better transport of protein, soft tissue formation, bone and teeth formation and development. The progressive increase of calcium with decrease in wheat flour could be an indicator that less calcium is present in wheat as compared to maize and pigeon pea.
Magnesium followed similar trend with higher value obtained for sample DDD 70% wheat flour, 15% corn flour and 15% pigeon pea flour blend and lower value for sample AAA. Value ranged from 88.25 to 160.50mg/100g. Same trend was noticed for iron and zinc components. Iron value ranged from 10.20 to 23.60mg/100g. This implies higher iron present in the cookies

in sample DDD has more potential for blood building with increase in the inclusion of pigeon pea and maize in the cookies as iron is a precursor for hemoglobin production (Revanappa and Salimath, 2010). Zinc value ranged from 4.25 to 6.50mg/100g. Sample AAA had lower zinc value while sample DDD had the higher values.

Table 4.2 show the results of the mineral component of the cookies sample prepared from blends of wheat, corn and toasted pigeon pea flour.

Sample	Calcium (mg/100g)	Magnesium (mg/100g)	Iron (mg/100g)	Zinc
AAA	186.20^{d}±0.14	88.25^{d}-H).35	10.20^{d}±0.00	4.25^{C}± [illegible]
BBB	206.00^{C}±0.00	113.60^{C}±0.14	11.80^{c}±0.00	5.25^{b}±0.21
CCC	228.45^{b}±0.07	139,15^{b}±0.07	12.20^{b}±0.14	6.05^{a}±0.07
DDD	245.60^{a}±0.28	160.50^{a}±0.28	23.60^{a}±0.14	6.50^{a}±0.28

Values are means with ± standard deviation of duplicate determination, means with different superscript in the same column are significantly different ($p<0.05$)

Key

AAA=100% wheat Hour.
BBB= 90% wheat flour, 5% corn flour and 5% pigeon pea flour,
CCC= 80% wheat flour, 10% corn flour and 10% pigeon pea flour.
DDD= 70% wheat flour, 15% corn flour and 15% pigeon pea flour

Table 4.3 shows the result of phytochemical properties of the cookies sample prepared from of wheat, corn and toasted pigeon pea flour.

The average phytate content value for the various flour blend cookies ranged from 5.06µ/L for the 100% wheat flour cookies (AAA) to 9.89bµ/L for BBB 90% wheat flour, 5% corn flour and 5% pigeon pea flour. Phytic acid hinders the activity of enzyme, which are necessary for protein degradation in the small intestine and stomach (kies *et al*. 2006). The tannin values were highest in sample BBB 90% wheat flour, 5% corn flour and 5% pigeon pea flour with values of 4.76µ/L. lower values were obtained in sample DDD 70% wheat flour, 15% corn flour and 15% pigeon pea flour blends 2.42μ/L. Tannins usually affect protein digestibility and lead to reduction of essential amino acids by forming reversible and irreversible tannin-protein complexes between the hydroxyl groups of proteins (Raes *et al.,* 2014). Oxalate values however steadily increased for sample AAA 100% wheat flour having a value of 12.78μ/L and sample DDD 70% wheat flour, 15% corn flour and 15% pigeon pea flour cookies having a value of 23.03μ/L.

Oxalate have a property of being able to interact with the cholesterol group of erythrocyte membranes, which leads to hemolysis (fleck *et al.* 2019). This also implies higher inhibitory activities of digestive enzymes such as amylase. Glucosidase, trypsin, chymotrypsin and lipase, which can cause indigestion related health disorders (Ercan and El, 2016; Lee *et al.,* 2015). Hydrogen cyanide was highest in sample DDD 70% wheat flour, 15% corn flour and 15% pigeon pea flour and then lowest in sample BBB, values ranged from 3.08 to 3.17μ/L.

Table 4.3 Phytochemical properties of the cookies sample prepared from blends of wheat, corn and toasted pigeon pea flour

Sample	Phytate (μ/L)	Tannin (μ/L)	Oxalate (μ/L)	Hydrogen cyanide (μ/L)
AAA	$8.86^{b}\pm0.05$	$3.01^{c}\pm0.08$	$12.78^{d}\pm0.07$	$3.13^{a}\pm0.01$
BBB	$9.89^{a}\pm0.20$	$4.76^{a}\pm0.04$	$17.16^{c}\pm0.21$	$3.08^{c}\pm0.01$
CCC	$5.53^{c}\pm0.01$	$3.66^{b}\pm0.08$	$21.22^{b}\pm0.07$	$3.12^{b}\pm0.03$
DDD	$5.06^{d}\pm0.05$	$2.42^{d}\pm0.00$	$23.03^{a}\pm0.07$	$3.17^{b}\pm0.00$

Values are means with ± standard deviation of duplicate determination, means with different superscript in the same column are significantly different ($p<0.05$)
Key
AAA=100% wheat flour.
BBB= 90% wheat flour, 5% corn flour and 5% pigeon pea flour,
CCC= 80% wheat flour, 10% corn flour and 10% pigeon pea flour.
DDD= 70% wheat flour, 15% corn flour and 15% pigeon pea flour

Table 4.4 shows the result of the sensory evaluation of cookies made from wheat, corn and toasted pigeon pea flour blends.

Due to the biological variation in man, what people perceive as appropriate sensory properties could vary from one person to another. However, the overall average gives a description of what the overall acceptability of the product is. Significant higher taste score value ($p<0.05$) was recorded for sample DDD (70% wheat flour, 15% corn flour and 15% pigeon pea flour) with a value of 8.20. While sample AAA had the least taste score value ($p<0.05$). High taste score value for sample DDD could be attributed to the corn which have been reported to have high simple sugar (Hassan *et al.,* 2019). This could result from the increase in the soluble carbohydrate (simple sugar) of the cookies with increasing inclusion levels of maize and pigeon pea (Jideani *et al,,* 2018). Crunchiness score ranged from 7.60 obtained for sample CCC 80% wheat flour, 10% corn flour and 10% pigeon pea flour. Highest crunchiness was obtained for sample BBB 90% wheat flour, 5% corn flour and 5% pigeon pea flour with crunchiness value of 8.13. This implies that high starchy content aided in the binding of the cookies particles making it crunchy and crispy (Lasekan *et al,* 2011).

Score value for flavour however was highest in the sample DDD 70% wheat flour, 15% corn flour and 15% pigeon pea flour with score value of 8.20. While sample BBB had the least value of 7.73 (90% wheat flour, 5% corn flour and 5% pigeon pea flour). The high flavour obtained in the DDD could be a result of the pigeon pea fat content. This could be occasioned by the high oil/fat content of the cookies which could translate into better aroma when heated as compared to the wheat flour. Appearance score value ranged from 7.67 for sample DDD 70% wheat flour, 15% corn flour, and 15% pigeon pea flour to 8.00 for sample AAA 100% wheat and CCC 80% wheat flour, 10% corn flour, and 10% pigeon flour. Sample AAA and CCC had a highest appearance score value and acceptability while sample DDD had the least appearance score value and this may be due to higher pigeon pea flour content. Overall acceptability had no significant ($p>0.05$) variation. Sample DDD had the highest score with value of 8.60. This implies that generally the consumers prefers cookies with lower wheat content as it is more preferred in terms of taste, crunchiness, flavour and overall acceptability.

Table 4.4 shows Sensory properties of cookies made from wheat, corn and toasted pigeon pea flour blends

Sample	Taste	Crunchiness	Flavour	Appearance	Overall Acceptability
AAA	7.73^{b} ± 0.99	8.00^{a}±0.85	7.93^{b}±1.03	$8,00^{a}$ ± 0.76	8.46^{a}± 0.83
BBB	7.87^{b} ±1.28	8.13^{a}±0.74	7.73^{b}±0.79	7.93^{b}±1.09	8.40^{a}± 0.98
CCC	8.06^{a} ± 0.09	7.60^{b}±1.29	8.00^{a}±0.79	8.00^{a}±0.06	8.27^{a}±1.09
DDD	8.20^{a} ± 1.01	7.87^{b}±1.36	8.20^{a}±0.94	7.67^{b} ± 1.59	8.60^{a}± 0.96

Values are means with ± standard deviation of duplicate determination, means with different superscript in the same column are significantly different ($p<0.05$). Where n=20

Key
AAA=100% wheat flour.
BBB= 90% wheat flour, 5% corn flour and 5% pigeon pea flour,
CCC= 80% wheat flour, 10% corn flour and 10% pigeon pea flour.
DDD=70% wheat flour, 15% corn flour and 15% pigeon pea flour

CONCLUSION

Based on the result obtained in this study, it can be concluded that there was significant increase in nutritional content of the produced cookies. There was a steady increase in the proximate content value of protein, fat, fibre and ash as the inclusion levels of pigeon pea and corn flour increased. However, similarly, mineral content values of magnesium, calcium zinc and iron significantly increased with increase in the inclusion of the corn and pigeon pea. Implying improved mineral functionality with increased inclusion of the composite in the cookies. Sample DDD containing the highest inclusion level of corn flour and pigeon pea had the least value for phytate and tannin, however, oxalate value was highest in the DDD sample. Taste, crunchiness, flavour and overall acceptability in the sensory evaluation score was significantly higher in the DDD sample.

RECOMMENDATION

Based on the result obtained in this study, it is therefore recommended that:

Cookies can be made from composite flour containing 70% wheat flour, 15% corn flour and 15% toasted pigeon pea flour as it improves the nutritive and sensory values of the product.

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