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Evaluation of Cookies Produced from Malted Pigeon Pea (*Cajanus cajan*)

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Authors' contributions

This work was carried out in collaboration between both authors. Author AIA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author NNU managed the analyses of the study and managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

Background: Research efforts in Tropical countries are geared towards identification of non-wheat sources that could be used as an alternative to wheat flours, thus affecting saving in foreign exchange by limiting wheat importation and at the same time proffer solution to severe malnutrition caused by gluten intolerance of wheat.
Aim/Objectives: To evaluate the nutrient, physical and organoleptic properties of cookies made from malted pigeon pea.
Methodology: The sample were coded A, B, C, for 100% wheat, 70% malted pigeon pea/30% carrot and 70% raw pigeon pea/30% carrot flour respectively were used to produce cookies. The cookies produced were evaluated for chemical, physical and organoleptic properties using standard methods.
Results: The protein content of the cookies were 10.26%, 26.10% and 21.01% for A, B and C respectively. The fat was 2.46%, 2.52% and 3.21% for A, B and C respectively. The fibre content were 1.27% A, 2.68% B and 1.31% C. The energy content was 404.60Kcal A, 390.15Kcal B and 391.82Kcal C. The mineral was 47.75-62.61mg/100g Calcium, 1.32-1.91mg/100g Iron, 1.43-20.01mg/100g Zinc and 153.78-170.17mg/100g phosphorus. The vitamin contents were 2.45-4.28 mg/100 g thiamin, 0.04-1.53 mg/100 g ascorbic acid, 400-1900RE and 0.27-3.02 mg/100 g folic

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acid. The result of the physical properties shows that the cookies were 3cm in thickness, 6cm in length, 4cm in diameter and the weight varies from 14-20g. The spread ratio was between 1.10-2.40 and spread factor were between 3.34-5.17cm. The organoleptic scores showed that the texture, aroma and overall acceptability of sample A was rated higher compared to sample B and C. The colour of sample C was most preferable to the panelist.

Conclusion: The study revealed that acceptable cookies of nutrient dense can be produced from pigeon pea-carrot composite to improve the nutritional status of the consumers.

Keywords: Cookies; pigeon pea; organoleptic property; chemical properties.

1. INTRODUCTION

Cookies are convenient snacks that are consumed by all ages throughout the World. The high level of acceptability of this snacks could be as a result of packaging, easy availability, shelf-life, taste and they are probably cheap compared to other snacks. Cookies can also be referred to as soft biscuit. The three major ingredients are flour, sugar and margarine which compose the cookies dough and determine the nature of the end product.

Like every other snacks, cookies are produced from wheat flour, a cereal which is imported to Countries with the unfavourable climatic condition to grow it like Nigeria. Huge amount of money is spent on foreign exchange on the importation of wheat. It calls for an urgent need to provide substitute for wheat considering the high demand for snacks in this 21st Century.

Onwuka [1] opined that flour with better nutritional quality than wheat would be highly desirable as wheat substitute, especially in the developing countries where malnutrition is prevalent. The increased demand of functional foods has lead to the use of non wheat flour as an alternative to improve the nutritional quality of foods and enhance food security.

Pigeon Pea (*Cajanus cajan*) belongs to the order of *Fabaceae*. Pigeon pea originated from India and Asia where it travelled to African countries [2]. In Nigeria, it is grown extensively in the Norther part of the Country. It is called “Fio-Fio” in Anambra State, “Agbubu” in Enugu State and “Waken Kurawa” or “Otile” in some parts of the Northern States [2]. Pigeon pea contains 20-22% proteins, 12 % fat, 65% carbohydrate and 38% ash [3].

Legumes are better sources of protein compared to cereal and they complement each other in terms of amino acid profile [4]. The thrust of this work is to determine the physicochemical and organoleptic characteristics of cookies produced from malted and unmalted pigeon pea supplemented with carrot flour blend.

2. MATERIALS AND MATHODS

2.1 Procurement of Raw Materials

Two kilogram (2kg) pigeon pea (*Cajanus cajan*) seed, 1 kg of carrots and processed wheat flour were purchase from Ogbete Main Market Enugu, Nigeria.

2.2 Processing of Raw Materials

2.2.1 Production of malted pigeon pea flour

The method used was as described by Nwosu *et al.* [5]. The pigeon pea seeds were sorted to remove dirts and other extraneous materials. About 500g of the clean seeds were winnowed and thoroughly washed. These seeds were then steeped in water at 29^{0}C for 24 hours. Changing of water at 6hours interval was observed during steeping. The resultant steeped seeds were spread on jute bag and were covered with white cotton cloth to germinate for 72 hours. The sprouted seeds were oven dried at a temperature of 50 ^{0}C in order to terminate enzyme activities. The plumule was separated from the seed and the malted seeds were dried and milled into flour with an attrition mill.

2.2.2 Preparation of unmalted pigeon pea flour

Pigeon pea flour was prepared as described by Onwuka [6]. Pigeon pea seeds were sorted to remove foreign matters. The clean seeds were steeped in tap water for 12 hrs after which the seeds were washed and drained. The drained seeds were poured into water that was boiling at 100°C and cooked for 80 minutes. The cooked pigeon pea seeds were , spread on the trays and dried in a tray dryer (Model EU 850D, UK) at 60°C for 10 h with occasional stirring of the slices at intervals of 30 mins to ensure uniform drying, winnowed and ground into flour using attrition mill (Model Globe P44, China). The flour samples were passed through a 0.45mm mesh size sieve. It was then packaged inn an air tight polyethylene bag and stored in a plastic container with lid and the stored in a freezer until needed for analysis.

2.2.3 Preparation of carrot flour

The carrot flour was prepared according to the method of Aremu et al. [7]. One kilogramme of carrots were manually sorted to remove the dirt and other contaminants. The sorted carrots were cleaned with 2 litres of portable water and cut into smaller slices with kitchen knife. The carrot slices were placed into a stainless pot and blanched with 2.5 litres of portable water at 80°C for 10 mins on a hot plate. The blanched carrot slices were drained, spread on the trays and dried in a tray dryer (Model EU 850D, UK) at 60°C for 10 h with occasional stirring of the slices at intervals of 30 mins to ensure uniform drying. The dried slices were milled in a attrition mill and sieved through a 500 micron mesh-sieve. The flour produced was packaged in a lidded plastic container, labeled and kept in a freezer until further use.

2.2.4 Formulation of blends

Pigeon pea and carrot flour were mixed at the proportion of 70:30 for both malted and unmalted pigeon pea flour where 100% wheat flour served as control. An electric blender was used for mixing the samples at speed 6 for 3 minutes to achieve uniform mixing.

2.2.5 Proportion of ingredients

The proportion of ingredients used in cookies production were the method of Tyagi et al. [8].

Recipe
Flour 100g
Sugar 53g
Margarine 80g
Sodium bicarbonate 1.10g
Salt pinch
Unsweetened liquid milk 7.5ml
Egg 3 round ball
Vanilla flavor 2.5ml
Water 8 ml

2.2.6 Preparation of cookies

Creaming method of cookies production was used. The margarine and sugar were first creamed simultaneously until it became creamy and fluffy. Flour, sodium bicarbonate and all other dried ingredients were hand mixed in a bowl and transferred to the creamy fat and sugar. Egg, vanilla flavor and water were added to the mixture and thoroughly mixed with hand. The mixture was transferred into food processor (Home luck). The mixture was mixed thoroughly at medium speed for 5 minutes to obtain the dough. The dough was manually rolled out on a flat and smooth floured board into sheet of uniform thickness and cut with a rectangular cookies cutter. The cut dough was transferred into baking trays lined with grease and baked at 180°C for 20 minutes in a domestic oven (camara, Italy). The cookies were cooled at ambient temperature. Part of the cookies were used for sensory evaluation and the other part for chemical and physical analysis.

2.3 Analyses of Samples

2.3.1 Proximate analyses

The moisture contents of the composite cookies and cookies made from wheat flour blends were determined by drying the samples in a forced Genlab (Widnes, England) air oven at 105°C according to the guidelines of AOAC [8] methods. Crude protein (N x 6.25) was estimated through micro-Kjeldahl apparatus according to the protocol of AOAC [9]. Crude fat content of the flour samples was estimated using hexane as solvent in a soxlet system as described in AACC [10] methods. Total ash content was estimated by direct incineration of dried samples in a muffle furnace at 550oC after charring till greyish white residue according to the method of AACC [10]. Crude fibre content was determined by digesting the fat free samples in 1.25% H2SO4 followed by 1.25% NaOH using Labconco fibretech according to AACC (9) methods. Total carbohydrate was calculated by difference (total carbohydrate=100 - (moisture + crude protein + crude fat + crude fibre + ash) according to Ihekoronye and Ngoddy [4].

2.3.2 Mineral determination

The mineral contents, namely: Na, K, Ca, Mg, Cu, Mn, Hg and Pb contents were determined by the method described by Pearson [11] using a Pye Unicam SP9 Atomic Absorption Spectrophotometer (AAS) connected to an SP9 computer (Pye Unicam Ltd, York Street, Britain). Total phosphorus was determined by the spectrophotometric molybdovanadate [12].

Table 1. Sample coding

Sample	Processing method
A	100% wheat flour
B	70% Malted pigeon pea and 30% carrot flour
C	70 % unmalted pigeon pea 30% carrot flour

Vitamin determination: The vitamin content thiamin, vitamin C, Beta carotene and riboflavin were determined according to the protocol of AOAC [9].

2.4 Physical Properties

The AACC method 10-50D [10] was used to evaluate the width, thickness and spread ratio. The spread ratio of the samples were determined thus: three rows of well formed cookies were made and the height measured. The same were arranged horizontally, edge to edge and the sum diameter measured. The spread ratio was calculated as width/height of cookies. The break strength of the cookies was determined using Okaka and Isieh [13] method. Cookies of known thickness was placed between two parallel wooden bar (cm apart). Weight was added on the cookies until the cookies snapped. The least weight that caused breaking of the cookies was regarded as the break strength of the cookies. The weight of the cookies was determined by weighing five cookies from each sample using Mettler-Toledo Electric digital weighing balance with model number XP204 and 0.001 sensitive was used to determine the weight and the average weight recorded. The width was measured by taking two measurements from one cookies in 90° rotations. A total of five cookies were measured from each sample and the average value recorded. The thickness of the cookies was measured by taking three measurements with the use of Vernier caliper from one cookies sample and the mean values of the thickness of the five cookies taken and recorded. The spread factor was determined using the method of Ayo et al. [14]. The spread factor was calculated by dividing the weight of the cookies by its thickness W/T.

2.5 Sensory Evaluation

Twenty (20) semi trained panelist consisting of staff and students of the Department of Food Science and Technology, Enugu State University of Science and Technology, Enugu were constituted and used for the study. The sensory parameters were rated on the basis of 9- point hedonic scale ranging from 1 (dislike extremely) to 9 (like extremely). The cookies were prepared from both the control and the composites flour. Five pieces of each of the samples were placed on a plate and served to the panelist to evaluate for the attributes of colour, mouthfeel, texture and overall acceptability. Prior to the sensory test, the cookies were individually coded. Clean water was provided to the judges to rinse their month in-between testing of the c ookies to avoid residual effect [15]. Expectoration cups with lids were provided for the panelists who were not interested to swallow the samples.

2.6 Statistical Analysis

All the analysis conducted in this study was reported as mean ± standard deviation. One-way ANOVA was used to determine the statistical significance of the results. Duncan new multiple range test was applied to separate the mean [16].

3. RESULTS AND DISCUSSION

3.1 Proximate Composition

The proximate composition of the cookies is presented in Table 1. The moisture content of the cookies was A(7.49%/100 g), B(8.62%/100 g) and C(8.71%/100g). Sample A had the least moisture of 7.49% while sample C had the highest moisture content of 8.71%/100 g. The result is in line with the values reported by Echendu et al. [17] on biscuit produced from maize and pigeon pea flour blends. The low moisture content of food is commendable since high moisture content of food affect their shelf life and predispose them to microbial spoilage. Stahzadi et al. [18] recommend less than 13% moisture level for cookies. In contrast the moisture values (7.49-8.91%) of cookies obtained in this study is above the maximum level (6.0%) recommended by Nigerian Industrial Standard (NIS) requirement for biscuit [19]. The protein content of the cookies ranges from 9.22-17.39%/100g. The high protein content of sample B was expected since legume contain more protein content than cereal and also malting improves the protein content of food thereby activating the proteolytic enzymes that removed non-protein nitrogen to improve the protein quality. Protein is important in growth, building and maintenance of cell in the body. The fat content of the cookies were A (10.24%/100g), B (10.91%/100g) and C (10.54%/100g). The increase in content of all the cookies observed in this study could be as a result of margarine that was used for the preparation of the cookies. The result is in line with the observation of Chinma et al. [20] who observed the fat content of 11.25-18.40% in the biscuit produced from tiger nut and pigeon pea flour blends. The fibre content of the cookies ranged between 1.86-3.81%/100g with sample A having the least fibre and B having the highest fibre. The fibre value (1.86-3.81%) obtained in this study is below the maximum level (5.00%) recommended [21]. Fibre has been reported to reduce the onset of hemorrhoids, diabetes, high blood pressure and obesity. The carbohydrate content of the cookies ranged from 55.76-68.89%/100g. Sample A had the highest carbohydrate while sample B had the least carbohydrate. Carbohydrate is the source of fuel for the central nervous system and energy for working muscles. They also spare protein from being used as an energy source and enable fat metabolism. The energy content of cookies was A(404.60Kcal), B(390.15Kcal) and C(391.82Kcal). The energy content of food is the reflection of protein, carbohydrate and fat. The high energy content of these cookies is as a result of the margarine used for the preparation of the cookies which in turn increases the fat content of the cookies.

3.2 Minerals

The mineral composition of the cookies are presented in Table 3. The iron content of the cookies are A(1.56 mg/100 g), B (3.12 mg/100 g) and C (3.04 mg/100 g). The result of this study is in line with Chinma et al. [20] that recorded 3.14mg/100g iron on the biscuit made from tiger nut and pigeon pea flour blends. Iron is a component of myoglobin, a protein that provides oxygen to muscles and supports metabolism in humans [22]. The calcium content of the cookies ranged from 50.01-69.54 mg/100 g. Sample A had the least calcium while sample B had the highest calcium (69.54 mg/100 g). Calcium is important for proper bone development in infants and young children [23]. The zinc content of the cookies are A(0.86 mg/100 g), B (1.27 mg/100 g) and C (1.03 mg/100 g). Zinc support normal growth and development during pregnancy, adulthood and adolescent. It also stimulates the activities of vitamins, formation of red and white corpuscles, healthy functioning of the heart and normal growth [24]. The phosphorus content of the cookies ranged from 178.70-248.17 mg/100 g. Sample C which is the cookies made from unmalted pigeon pea and carrot flour blends had the highest phosphorus content of 248.17 mg/100 g. Phosphorus is an important nutrient that plays a significant role in the formation of Adenosine Triphosphate (ATP) in the body [25].

The vitamin content of the cookies is presented in Table 4. The thiamin content of the cookies ranged from 2.51-4.15 mg/100 g. Sample A had the least thiamin value of 2.51mg/100g. The result showed that the thiamin content of the cookies made from 70% unmalted pigeon pea and 30 % carrot flour had the highest thiamin value. Deficiency of thiamin causes beriberi which implied that consumption of thiamin will prevent the out break of beriberi. Riboflavin level in the cookies studied were A (3.45 mg/100 g), B(2.41 mg/100 g) and C (3.05 mg/100 g). Sample A which was the cookies made from 100% wheat flour had the highest riboflavin while sample B which was the cookies made from 70% malted pigeon pea and 30% carrot had the least riboflavin. Riboflavin helps in the metabolism of energy yielding nutrients (carbohydrate, protein and fat). The vitamin C content in the cookies ranged from 0.98-1.24 mg/100 g. The cookies made from 100% wheat flour had the highest vitamin C content of 1.24 mg/100 g. Vitamin C is important in the prevention of scurvy and it is an active antioxidant [26,27]. Beta-carotene content ranged between 2.24-3.68 mg/100 g. The cookies made from 70% unmalted pigeon pea and 30% carrot flour had the highest beta-carotene. Vitamin A help in the body's resistance to diseases, delay aging and enhances the normal vision of the eye [24].

The physical properties of the cookies are presented in Table 5. The break strength of the cookies varied between 2.20-3.34 kg. The break strength of cookies made from 100% wheat flour was significantly ($P \leq 0.05$) higher than the cookies prepared from the composite flour. The break strength is a mechanical property that is important in determining the perception of the cookies in the mouth and plays an important role in product acceptability. The reduction in break strength and thickness of the cookies may be related to the dilution effect the fibre has on the starchy-protein matrix of the cookies since pigeon pea flour contained high amount of crude fibre. This may disrupt the formation of a homogenous matrix and lead to a weakening in

Table 2. Proximate composition of cookies (%)

Sample	Moisture	Protein	Ash	Fibre	Fat	CHO	Energy(Kcal)
A	7.49^{b}±0.23	9.22^{c}±0.11	2.30^{c}± 0.02	1.86^{c}±0.04	10.24^{c}±0.87	68.89^{a}±0.75	404.60^{a}±0.43
B	8.62^{a}±0.41	17.39^{a}±0.05	3.51^{a}±0.06	3.81^{a} ±0.05	10.91^{a}±0.43	55.76^{c}±0.53	390.15^{b}±0.76
C	8.71^{a}±0.18	14.50^{b}±0.16	3.26^{b}±0.14	3.25^{b}±0.09	10.54^{b}±0.22	59.74^{b}±0.13	391.82^{b}±0.66

Values are mean of 3 replication, mean with different superscript letters along the same column are significantly different at P<0.05. Keys: A= Cookies made from 100% wheat flour. B= Cookies made from 70% malted pigeon pea flour and 30% carrot flour. C=Cookies made from 70% unmalted pigeon pea flour and 30% carrot flour.

Table 3. Mineral composition of cookies (mg/100g)

Sample	Iron	Calcium	Zinc	Phosphorus	Potassium
A	1.56^{a}±0.84	50.01^{c} ±0.58	0.86^{c}±0.05	178.70^{c}±0.24	124.79^{c}±0.34
B	3.12^{a}±0.26	69.54^{a} ±0.17	1.27^{a} ±0.02	223.19^{b}±0.45	129.83^{b}±0.96
C	3.04^{b}±0.02	63.22^{b}±0.15	1.03^{b}±0.03	248.17^{a} ±0.67	141.20^{a}±0.64

Values are mean of 3 replication, mean with different superscript letters along the same column are significantly different at P<0.05. Keys: A= Cookies made from 100% wheat flour. B= Cookies made from 70% malted pigeon pea flour and 30% carrot flour. C=Cookies made from 70% unmalted pigeon pea flour and 30% carrot flour

Table 4. Vitamin composition of cookies (mg/100 g)

Sample	Thiamin	Vitamin C	Beta carotene	Riboflavin
A	2.51^{c}±0.23	1.24^{a}±0.11	2.24^{c}±0.50	3.45^{a}±0.19
B	3.62^{b}±0.95	1.11^{b}±0.44	2.96^{b}±0.61	2.41^{c}±0.01
C	4.15^{a}±0.63	0.98^{c}±0.09	3.68^{a}± 0.14	3.05^{b}±0.07

Values are mean of 3 replication, mean with different superscript letters along the same column are significantly different at P<0.05. Keys: A= Cookies made from 100% wheat flour. B= Cookies made from 70% malted pigeon pea flour and 30% carrot flour. C=Cookies made from 70% unmalted pigeon pea flour and 30% carrot flour

Table 5. Physical properties of cookies

Sample	Width (cm)	Thickness (cm)	Weight (g)	Spread ratio	Break strength (kg)
A	$19.60^{c}\pm0.33$	$0.53^{a}\pm0.01$	$8.20^{b}\pm0.93$	$36.98^{b}\pm0.52$	$3.34^{a}\pm0.35$
B	$20.94^{b}\pm0.40$	$0.51^{a}\pm0.13$	$9.10^{a}\pm0.59$	$41.06^{a}\pm0.20$	$2.60^{b}\pm0.09$
C	$21.11^{a}\pm0.21$	$0.50^{a}\pm0.11$	$9.40^{a}\pm0.10$	$42.22^{a}\pm0.19$	$2.20^{c}\pm0.58$

Values are mean of 5 replication, mean with different superscript letters along the same column are significantly different at P<0.05. Keys: A= Cookies made from 100% wheat flour. B= Cookies made from 70% malted pigeon pea flour and 30% carrot flour. C=Cookies made from 70% unmalted pigeon pea flour and 30% carrot flour

Table 6. Sensory properties of cookies

Sample	Appearance	Texture	Flavour	Colour	Over all acceptability
A	$6.9^{a}\pm0.32$	$7.20^{a}\pm0.03$	$7.00^{a}\pm0.61$	$7.40^{a}\pm0.09$	$7.15^{a}\pm0.33$
B	$6.2^{b}\pm0.07$	$7.00^{b}\pm0.22$	$6.80^{b}\pm0.04$	$7.30^{b}\pm0.03$	$6.80^{b}\pm0.45$
C	$6.0^{c}\pm0.77$	$6.80^{c}\pm0.01$	$6.00^{c}\pm0.22$	$7.30^{b}\pm0.02$	$6.70^{c}\pm0.01$

Values are mean of 20 replication, mean with different superscript letters along the same column are significantly different at P<0.05. Keys: A= Cookies made from 100% wheat flour. B= Cookies made from 70% malted pigeon pea flour and 30% carrot flour. C=Cookies made from 70% unmalted pigeon pea flour and 30% carrot flour cookies structure. The width of the cookies are A(19.60cm), B(20.94cm) and C(21.11cm). The cookies made from 100% wheat flour had the least value for width 19.60 cm while the cookies made from 70% unmalted pigeon pea flour and 30% carrot flour had the highest width value of 21.11cm. The high value for the width of the composite flour could be as a result of low viscosity. The spread ratio of the cookies ranged from 36.98-42.22. The cookies prepared with 100% wheat flour was significantly (P≤0.05) lower than the cookies made from composite flour. Hosney and Rogers [28] noted that cookies with lower viscosity, spread at a faster rate. The result of this study is in line with Singh et al. [29] who observed that the spread ratio of cookies increased as non wheat protein increased. The high fat content of the cookies made from the composite flour could also cause the increase in the spread ratio. The width and spread ratio of the cookies made from composite flour were higher than the cookies made from wheat flour while the thickness and break strength were higher in wheat flour than the cookies made from composite flour. This observation is in line with the result of Chinma et al. [20] who carried out a studied on biscuit made from blends of tiger nut and pigeon pea flour. The weight of the cookies ranged from 8.20-9.40g. The cookies prepared from composite flour is significantly (P≤0.05) higher than the cookies prepared from 100% wheat flour. In contrast, Ayo et al. [14] observed a lower weight in cookies made from wheat flour than the cookies made from African walnut composite flour.

The sensory properties of the cookies was presented in Table 6. There was no significant different (P≤0.05) in texture and flavor of cookies made from the control and the composite flour. There was a significant different (P≤0.05) in over all acceptability, appearance and colour between the cookies made from control sample and the cookies made from composite flour. Sensory properties together with improvement of nutritional quality are the major attribute that lead to consumers over all acceptability of a developed recipe. The texture score is in agreement with the results of the break strength of the cookies. In terms of the cookies prepared with the composite flour, sample B was rated higher than sample C.

4. CONCLUSION

The study has revealed that acceptable cookies can be prepared using malted and unmalted pigeon pea and carrot flour blends. The width and spread ratio of the composite cookies were higher than the wheat cookies while thickness and break strength were lower in the composite cookies compared to wheat cookies. The use of pigeon pea and carrot flour in cookies preparation resulted in significant improvement in the nutrient content of the composite cookies. The composite cookies had acceptable organoleptic properties in which the over all acceptability was 6.80 and 6.70 for cookies made from 70% malted pigeon pea and 30% carrot flour blend and 70% unmalted pigeon pea and 30% carrot flour blend respectively which is like slightly using the hedonic scale.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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