Production and Quality Evaluation of Cookies Using Cassava-Grey Speckled Palapye Cowpea Composite Flour

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Objective: The study aimed at production and quality evaluation of composite flours and cookies from cassava (*Maniholt esculenta*) -grey speckled palapye cowpea (*Vigna sinensis*).
Methods: Flour was respectively produced from cassava and palapye cowpea. The flours of cassava and palapye cowpea were mixed in the ratios of 100:0, 90:10, 80:20 and 70:30 respectively before being analyzed for antinutrient and functional properties. Cookies were produced from the flours and then evaluated for their respective nutrient and organoleptic attributes. Data was analysed using using spss version 21.0.
Results: The anti-nutrient concentration ranged from 0.83 to 1.25% (phytate), 0.07 to 0.19% (phenol), 0.12 to 0.17% (tannin), 0.09 to 0.21 Tiu/mg (trypsin inhibitor) and 0.28 to 0.88 mg/kg (hydrogen cyanide). The functional properties were found to be within 0.47 to 0.58 g/ml (bulk density), 1.62 to 2.04 g/g (capacity), 1.58% to 2.06 g/g (oil absorption capacity), 1.26 to 1.74 g/ml (swelling capacity) and 10.47 to 14.86% (foaming capacity). Proximate composition of the cookies samples showed 9.43 to 10.77% (moisture), 2.03 to 6.88% (protein), 1.03 to 1.91% (fat), 1.24 to 2.55% (ash), 3.22 to 4.26% (fibre) and 76.01 to 80.82% (carbohydrate). The sensory scores of the

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cookies ranged from 6.2 to 7.3 on the hedonic scale.
Conclusion: The cassava-grey speckled cowpea flour proved satisfactory in cookies production and could also serve well in formulations for other food products.

1. INTRODUCTION

Cassava (*Manihot esculenta)* is a major root crop and an important staple food for over 500 million people in the developing world [1]. It is a dicotyledonous perennial plant that grows up to 5 m (height) in the tropics. Among the root tubers, cassava has been considered the best choice in replacing wheat partially or completely due to its high flour yield and low cost of production. Cassava has been identified as the most important root crop in Nigeria in terms of food security, employment creation and income generation for many households [2]. Its major limitation is the presence of cyanogenic glycosides (linamarin and lotaustralin). However, several studies have shown that these cyanogenic glycosides are volatile and highly soluble in water and therefore easily eliminated by processing methods such as drying, soaking, and fermentation [3]. Ubbor *et al*. [4] later discovered that some cassava varieties are naturally low in these cyanogenic glycosides thus enhancing their utilization in several food formulations in the food industries especially in composite flour with cereals and legumes like the cowpeas [5]. Cowpea is one of the most important food grain legume crops in the semi-arid tropics covering Asia, Africa, southern Europe, and Central and South America, and it is widely grown as a multipurpose crop that is utilized not only for human food and medicine, but also for animal feed [6]. Proteins and extracts from various Vigna species have been reported to exhibit anti-mitogenic, antiviral, antifungal activities [7], and anticarcinogenic activity [8]. So it can offer both nutritional and health benefits if incorporated in weaning foods, bread, cookies, etc.

A cookie is a small, flat, sweet, baked good, usually containing flour, eggs, sugar and either butter or edible oil. It may contain other ingredients such as raisins, oats, chocolate chips or nuts. In most English speaking countries except for the US and Canada, crisp cookies are called biscuits. Some cookies may also be named by their shape, such as date squares or bars. Cookies are often served with beverages such as milk, coffee, tea, etc. The major raw material used in the production of cookies is wheat flour which is mainly imported to Nigeria because of unfavourable climatic conditions for its commercial growth. This importation places a considerable burden on the foreign exchange reserve of Nigeria's economy [9].

Despite this importation and its effects, Nigerians still remain large consumers of wheat products such as bread, cookies, noodles and other pastries. Some consumers of wheat based products suffer from celiac disease. Palapye cowpea on its own part is gradually going into extinct particularly within the Eastern part of Nigeria due to its extreme under-utilization and lack of nutritional information. Much is not known about its functional and pasting properties. Cassava is dense with carbohydrate and should be eaten along with other crops rich in essential amino acids to supplement the deficit in lysine, tryptophan, threonine, etc. The use of cassava-palapye composite flour would reduce the importation of wheat and increase Nigeria's foreign exchange. The incidence of celiac disease could be ameliorated if not completely eliminated. The cost of the products will be cheap and affordable to low income earners. Production of cookies with cassava-palapye composite flour will create variety in the market, improve the nutrient content of the cookies especially its protein and mineral values. The food products could therefore help in the fight against protein energy malnutrition. Successful formulation of the cookies in addition to other factors above will increase the demand for cassava and palapye, thereby encourage their cultivation. So this work is aimed at the quality evaluation of cookies produced from the blends of cassava-palapye composite flour.

2. MATERIALS AND METHODS

2.1 Materials' Collection and Preparation of Samples

The mature cassava tubers were obtained from a farm at Imo State Agricultural Development Program (IMOADP) in Owerri while the palapye cowpea seeds were obtained from a farm in

Ihemeje's Farm in Umuisiama, Obokwu Avu, Owerri West L.G.A, Imo State. The other ingredients for cookies production like fat, baking powder, sugar and salt were purchased at Relief Market, Owerri, Imo State. The cassava tubers were peeled, washed and grated with a cassava grater. The resulting mash was dewatered and sundried for two days after which it was milled with an attrition mill and sieved with a 40-mesh sieve into flour. The cassava flour was packaged in a cellophane bag and stored at room temperature until when needed for use. The palapye cowpea seeds were cleaned and soaked in water for 38 hours at 26°C, after which they were dehulled manually. The dehulled seeds were sun dried. During drying, the seeds were stirred at 40 minutes interval to ensure uniform drying. The dried seeds were milled, sieved with a 40 µm mesh sieve and packaged in airtight containers.
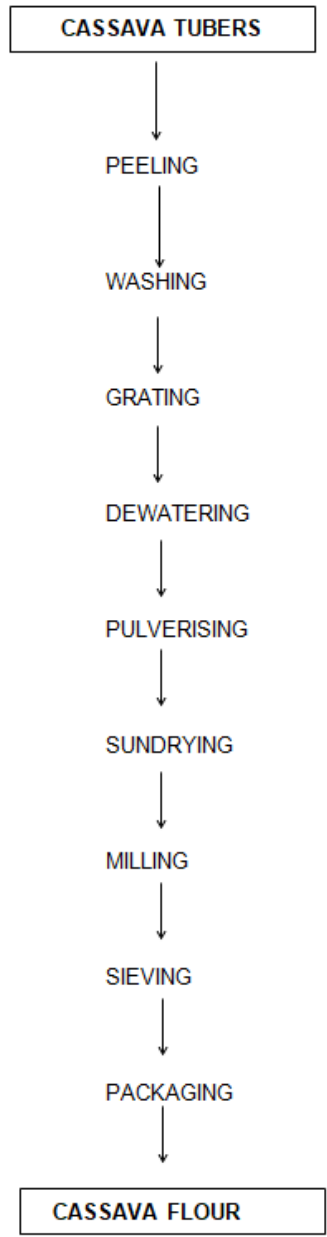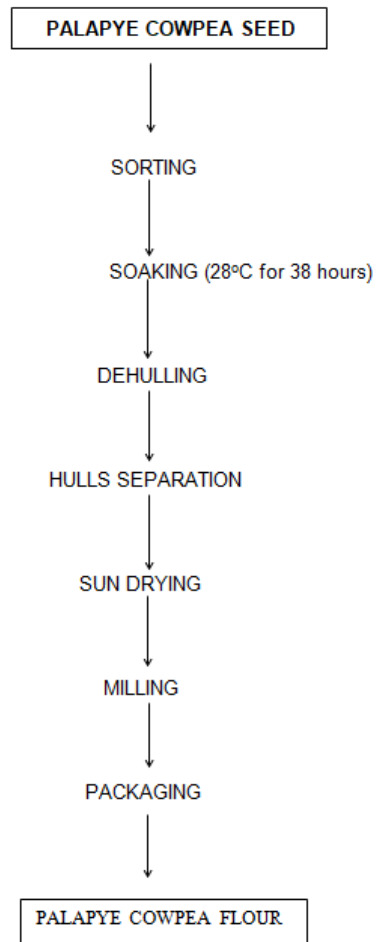
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Fig. 1. Production of cassava flour

Plate 1. Palapye – Cowpea

Fig. 2. Production of palapye cowpea flour

Table 1. Recipe for cookies produced using different ratios of cassava-cowpea composite flour

SAMPLES (CF:PCF)[**]	FAT (g)	SUGAR (g)	MILK (g)	SALT (g)	NUTMEG (g)	BAKING POWDER (g)	VANILLA FLAVOUR (g)
A (100:0)	40	25	15	1	0.3	1	0.5
B (90:10)	40	25	15	1	0.3	1	0.5
C (80:20)	40	25	15	1	0.3	1	0.5
D (75:25)	40	25	15	1	0.3	1	0.5
E (70:30)	40	25	15	1	0.3	1	0.5

[**]: CF = Cassava flour, PCF = Palapye cowpea flour
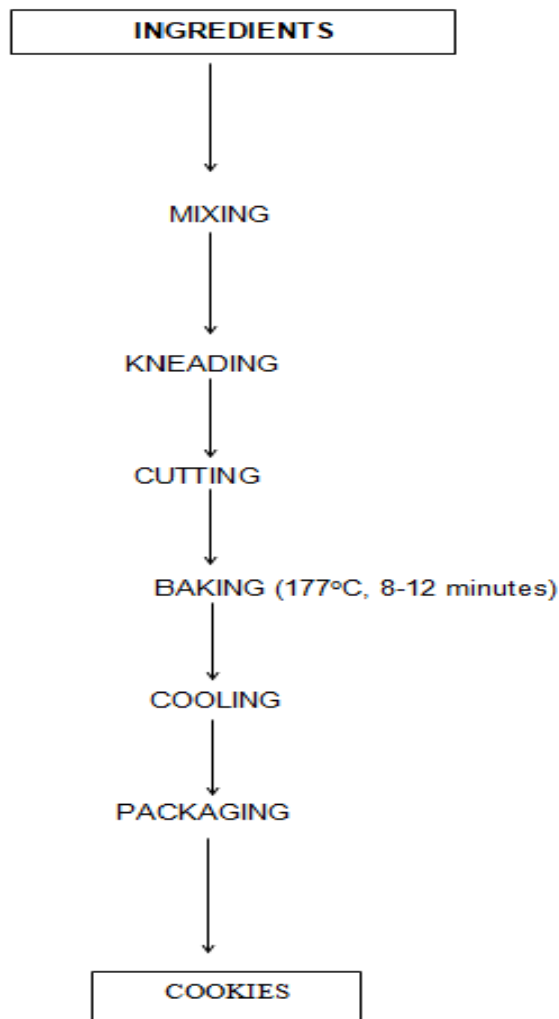
Fig. 3. Production of cookies

2.2 Analysis of Cookies Samples

Proximate composition of the cookies produced by using different ratio of cassava-cowpea composite flour was determined according to AOAC [10]. The carbohydrate content was determined by difference method (100 – moisture + protein + ash + fibre + fat) %. Bulk density, foaming capacity, swelling index and water absorption capacity of the flour blends were respectively evaluated as described by Onwuka [11]. Folin-ciocateam spectrophotometer and

Folin-Dennis spectrophotometer were respectively used in the determination of phenol and tannin concentration. Phytate, hydrogen cyanide and trypsin inhibitor were each evaluated according to Onwuka [11]. The weight and diameter of the baked cookies was determined by weighing and measured with a calibrated ruler respectively. The spread ratio was determined using the method described by Gomez et al. [12]. Sensory evaluation of cookies was carried out using randomly selected 30-man panelists. The panelists were instructed to assess the samples for aroma, appearance, taste, mouthfeel and overall acceptability using the hedonic scale which ranges from dislike extremely (1) to like extremely (9) as described by Iwe [13]. Data was subjected to descriptive statistics, one-way analysis of variance and significant means ($p < 0.05$) among the samples were separated using Duncan's multiple range test using statistical package for social sciences (SPSS) version 21.0 [14].

3. RESULTS AND DISCUSSION

The proximate composition of the cookies as presented in Table (2) shows that their moisture content ranged from 9.43% to 10.77%. The values are comparable with 10.10% - 11.32% moisture content obtained by Okpala and Ofoedu [15] on cookies produced from composite flours of palapye-cowpea and cassava flour blend fortified with brewer's spent grain flour. It's also consistent with the work of Okoye and Onyekwelu [16]. But Hawa et al. [17] and Mounika et al. [18] recorded lower moisture content values of 5.50% - 7.56% and 2.23% - 2.36% respectively. The moisture content of samples was reduced as the level of palapye-cowpea flour increased. Increase in moisture content has been reported to correlate with increase in fibre content [19].

Higher fat content (1.91%) was observed in sample E while sample A had the least fat content (1.03%). Fat content of the samples differed significantly ($p<0.05$) and was observed to increase on addition of palapye- cowpea flour. Higher fat content was reported in the works of Okoye and Onyekwelu [16], Hawa et al. [17] and Igbabul et al. [20]. Oil content influences mouthfeel and retention of flavor [21]. The ash content of the samples showed significant ($p<0.05$) increase from 1.24% in samples A to 2.55% in sample E. The values reported by Okpala and Ofoedu [15] and Atobatele and Afolabi [22] were slightly lower. The results indicate corresponding increase in ash content with increase in addition of palapye cowpea flour. A reverse trend of values was obtained for fibre. Incorporation of palapye led to significant ($p<0.05$) lower fibre content of the samples. The decrease in fibre agrees with the reports of earlier researches [16,23]. The sample produced from 100% cassava had the least protein content (2.03 %) while sample E which contains the highest incorporation of palapye cowpea had 6.88% protein. The samples differed significantly ($P<0.05$). Substitution of cassava flour with the palapye cowpea resulted in increased protein content of the cookies. This result corroborates with the assertions of previous studies that incorporation of legumes in foods enhances protein values [16,17,24]. The carbohydrate content of the cookies was within 76.01 (Sample E) to 80.67 % (Sample A). There was significant ($p<0.5$) difference among the samples. It was observed that the higher the level of incorporation of palapye-cowpea, the lower the carbohydrate content of the cookies. This may be as a result of low carbohydrate content of the palapye-cowpea in agreement with the work of Okoye and Obi [25] that discovered lower carbohydrate content of cookies produced from blends of cassava and palapye cow-pea.

Table 2. Proximate composition of the cookies produced by using different ratio of cassava-cowpea composite flour

Parameters	Sample A (100:0)[*]	Sample B (90:10)[*]	Sample C (80:20)[*]	Sample D (75:25)[*]	Sample E (70:30)[*]
Moisture	10.77[a]±0.03	10.22[b]±0.04	10.11[b]±0.03	9.87[bc]±0.01	9.43[a]±0.03
Protein	2.03[c]±0.10	2.34[c]±0.10	3.76[b]±0.11	4.38[b]±0.06	6.88[a]±0.05
Fat	1.03[c]±0.06	1.19[c]±0.02	1.37[bc]±0.04	1.56[b]±0.01	1.91[a]±0.02
Ash	1.24[c]±0.03	1.50[c]±0.10	1.56[bc]±0.26	1.95[b]±0.02	2.55[a]±0.02
Crude Fibre	4.26[a]±0.04	4.15[ab]±0.03	3.87[b]±0.04	3.62[c]±0.02	3.22[d]±0.02
Carbohydrate	80.67[a]±0.11	80.60[a]±0.23	79.33[b]±0.10	78.62[c]±0.26	76.01[d]±0.10

*Means are values of triplicate determinations. Mean values with different superscripts in the same row are significantly different (p<0.05). *(CF: PCF) CF=cassava flour PCF= Palapye Cowpea Flour*

Table 3. Antinutrient content of the different ratio of cassava-cowpea composite flour

Parameter	Sample A (100:10)*	Sample B (90:10)*	Sample C (80:20)*	Sample D (75:25)*	Samle E (70:30)*
Phytate (%)	0.9c±0.02	0.83c±0.03	0.98bc±0.03	1.14ab±0.02	1.25a±0.04
Phenol (%)	0.07b±0.01	0.08b±0.03	0.12a±0.01	0.14a±0.03	0.19a±0.04
Tanin (%)	0.07b±0.01	0.08b±0.03	0.14a±0.06	0.15a±0.03	.17a±0.09
Trypsin Inhibitor (TIU/mg)	0.09a±0.01	0.12cd±0.03	0.15bc±0.05	0.18ab±0.04	0.21a±0.21
HCN (mg/kg)	0.88a±0.06	0.88a±0.06	0.49bc±0.03	0.30c±0.02	0.28c±0.02

*Means are values of triplicate determinations. Mean values with different superscripts in the same row are significantly different (p<0.05). *(CF:PCF) CF=cassava flour PCF= palapye cowpea flour*

Table 4. Sensory evaluation of cookies produced by using different ratio of cassava-cowpea composite flour

Parameters	Sample A (100:0)*	Sample B (90:10)*	Sample C (80:20)*	Sample D (75:25)*	Sample E (70:30)*
Aroma	6.8a	6.7a	7.0a	6.6a	6.8a
Appearance	7.3a	7.2a	6.9a	6.9a	7.0a
Taste	6.4a	7.2a	6.5a	6.7a	6.9a
Mouth feel	6.3a	6.7a	6.8a	6.7a	6.9a
Overall Acceptability	7.1a	7.2a	6.8a	6.8a	7.3a

*Means are values of triplicate determinations. Mean values with different superscripts in the same row are significantly different (p<0.05). *(CF: PCF) CF=cassava flour PCF= palapye cowpea flour*

3.1 Antinutrient Content of the Different Ratio of Cassava-Cowpea Composite Flour

The anti-nutrient content of the composite flour blends was shown in Table (3). The antinutrients analyzed were phytate, phenol, tannin, trypsin inhibitor and hydrogen cyanide. The phytate content of the wheat-palapye-cowpea flour ranges from 0.83 - 1.25 % for samples A to E respectively. There was significant (p<0.05) increase in the phytate content of the flour samples as the level of substitution of cassava flour with palapye cowpea flour increased. This may be attributed to high phytate content of palapye-cowpea. The values obtained in this study were consistent with 0.064-1.35% reported by Bello et al. [26] on pigeon-pea, palapye-cowpea and cassava flour blends. Lower values (0.59-0.70%) were reported by Okpala and Okoli [27] on cocoyam, sorghum and cowpea flour blends. But, Bolarinwa et al. [28] recorded very high values compared to this work.

Phenol was observed to be highest in sample D (0.14%) but lowest in sample A (0.07%). Sample A (0.07%) and Sample B were significantly (P<0.05) different from Samples, C (0.12%), D (0.14%) and E (0.12%). Also, Samples C, D and E were significantly different from Samples A and

B. Phenol content of the samples fluctuated and therefore could not be attributed to incorporation of the palapye. The Tannin content of the flour blends was in the range of 0.12 to 0.16%. The highest tannin value was recorded in sample E while sample A recorded the least tannin value. Although the result of this study indicated that the tannin content of the blends increased steadily with increasing level of Palapye-cowpea flour but significant (p>0.05) difference was not observed among the flour samples. This might be due to high tannin content of palapye-cowpea. The researches carried out by Adeola et al. [29], Okpala and Okoli [27] and Olapade and Adeyemo [9] reported higher tannin contents. Tannins are phenolic compounds that precipitate protein and cause reduced protein digestibility [30]. However, there are reports that phenolic compounds and tannins possess antioxidant and antimicrobial activities [30] which may be of health benefits.

Trypsin inhibitor was higher in Sample D (0.18 TIU/mg) and lower in sample A (0.09TIU/mg). The samples differed significantly (p<0.05) and also fluctuated with addition of palapye flour. Adeola *et al.* [29] and Olapade and Adeyemo [9] reported significantly high trypsin inhibitor with values that ranged from (31.75-32.14 TIU/mg) and (2.50 - 4.17 TIU/mg) for cassava-cowpea

flour and Sorghum-pigeon-soybean flour respectively. The result obtained revealed that sample A (0.28 mg/kg) was lower in Hydrogen cyanide while sample E (0.88mg/kg) was higher. Significantly, the samples differed (p<0.05) among themselves. Hydrogen cyanide continuously increased on the increase in the ratio of the palapye-cowpea flours. The result of Okpala and Okoli [27] and Olapade and Adeyemo [9] showed significantly lower hydrogen cyanide with values that ranged from 0.16-0.24 mg/kg and 0.02 - 0.021 mg/kg respectively. But, Bello et al. [26] recorded relatively higher HCN (8.87-10.71 mg/kg) range for wheat-palapye-cowpea plantain flour blends.

3.2 Sensory Evaluation of the Cookies

The result of sensory evaluation of the samples is shown on Table (4). The attributes evaluated were taste, appearance, aroma, mouth-feel and over all acceptability. From the results, it was observed that the cookies did not differ significantly (p>0.05) in all the sensory attributes evaluated. Best taste as indicated by the panelist was from sample B (7.2). From the result, incorporation of palapye-cowpea increased the taste of the cookies. This present research was comparable with the work of Olapade and Adeymo [9] and Olapade et al. [31] on the cookies produced from cassava-cowpea flour blends. Scores of the appearance of the samples fell within 6.9 - 7.39. Sample A which is the control sample ranked highest with a mean score value of 7.39 but not significantly (p<0.05) different from other samples. The values recorded by Olapade and Adeyemo [9] on cookies produced from wheat-cowpea-cassava flour were consistent with those obtained in this research. There was no significant (p > 0.05) difference in the aroma of the samples. The values reported by Olapade and Adeyemo [9] were comparable with the scores obtained from this study but differ widely from 3.64 - 4.36 reported by Akubor et al. [32]. The panelists' scores revealed that increase in palapye-cowpea flour did not result in significant (p<0.05) difference in mouth feel of the cookie samples. Also from the results of the overall acceptability of the samples, there was no significant (p>0.05) difference among samples. Sample E with 70% cassava flour and 30% palapye-cowpea flour scored highest in the overall acceptability of the cookies. The overall rating of the cookies was fairly consistent with the values reported by Olapade et al. [31]. However, Akubor et al. [32]

reported lower values than those obtained from this study.

4. CONCLUSION

Incorporation of palapye-cowpea flour improved the protein, fat and ash contents of the samples while still maintaining their anti-nutritional contents within tolerable levels. The functional properties of the flour blends proved their potential suitability in food formulations. Organoleptic assessment of the cookies produced from the blends revealed high general acceptability. Therefore, cassava flour can be substituted with palapye-cowpea flour for cookies production without any negative impact on the sensory attributes and nutritional value. This flour blend is therefore a potential raw material to combat hunger and provide a healthy food to Nigeria and other developing countries.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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