E-ISSN: 2709-9385
P-ISSN: 2709-9377
JCRFS 2022; 3(2): 50-54

www.foodresearchjournal.com
Received: 21-05-2022
Accepted: 24-06-2022

Alimi J Praise
Nigerian Stored Products Research Institute, P.M.B. 5044, Onireke, Oyo State, Nigeria

Ahemen S Aondoaver
Akperan Orshi Polytechnic, P.M.B. 181, Gboko, Benue State, Nigeria

Alimi J Omolola
Department of Microbiology, P.M.B. 1, University of Ibadan, Oyo State, Nigeria

Yepshak N Bitrus
Department of Home and Rural Economics, Plateau State College of Agriculture Gerkawa, Nigeria

Oke O Alice
Nigerian Stored Products Research Institute, P.M.B. 5044, Onireke, Oyo State, Nigeria

Correspondence
Alimi J Praise
Nigerian Stored Products Research Institute, P.M.B. 5044, Onireke, Oyo State, Nigeria

Physical and sensory qualities of cookies produced with high quality cassava flours from low postharvest physiologically deteriorated cassava (*Manihot esculenta* Crantz)

Alimi J Praise, Ahemen S Aondoaver, Alimi J Omolola, Yepshak N Bitrus and Oke O Alice

Abstract
The physical and sensory quality of food determines its consumer acceptance. This study investigated the physical and sensory qualities of cookies made with high quality cassava flours (HQCFs) from low postharvest physiologically deteriorated (PPD) cassava. Wholesome four varieties of yellow-fleshed Low PPD cassava, one variety of high PPD cassava were processed into HQCFs. Six different cookies were prepared with wheat (control) flour, and HQCFs from IITA-TMS-IBA011368, IITA-TMS-IBA070593, IITA-TMS-IBA011412, IITA-TMS-IBA011371, and TMEB419 cassava. Cookies made were analyzed for physical and sensory properties. Data obtained were subjected to analysis of variance (ANOVA) using Statistical Package for Social Sciences (SPSS version 25.0) and significant means were separated applying Duncan Multiple Range Test. The cookies thickness, diameter, spread ratio and weight ranged from 1.09 to 2.19 cm, 4.46-6.00 cm, 2.04-4.66 and 11.00-15.50 g, respectively. Sensory scores for the cake appearance, aroma, mouth feel, sweetness, hardness, crunchiness and overall acceptability ranged from 2.55-3.55, 2.55-3.25, 2.55 - 2.95, 2.45-3.00, 3.00-3.40, 2.75-3.15 and 2.65-3.05, respectively. Cookies prepared with HQCFs from low PPD cassava were preferred to wheat cookies in terms of appearance, aroma, mouth feel, crunchiness and overall acceptability, with sample C-IBA011368 being the most preferred.

Keywords: Physical properties, cookies, sensory quality, physiological deterioration, crunchiness

1. Introduction

Sensory descriptive analysis of food products provides an understanding and control of the key attributes for consumer satisfaction and for market success [12]. Although sensory characteristics are subjective, they provide pertinent information important for overall understanding of food consumption, preference and acceptability. Consumer acceptance is crucial for the market success of new food products.

Screening of available clones of cassava (*Manihot esculenta*) for low PPD was considered a priority with the view to extending the postharvest life of cassava root from two days (48hrs) to 5 days (120hrs), enhancement of its nutritional value with pro-vitamin A or β-carotene that has propensity to prevent oxidation (anti-oxidative effect) and widening the functionality of its starch and flour [3]. Researchers had established that varietal differences affects quality characteristics like physical, functional and chemical properties of high quality cassava flour, indicating that flour quality and uses also differs [6, 15, 3].

Low postharvest physiologically deteriorated (PPD) cassava is a promising crop owing to its pasting (high gel strength, starch granule stability to heating, low peak time and tendency for retro gradation) characteristics and physical properties such as appealing yellow color that constitute appeal which could influence consumer preference when applied in baked food products such as cake, cookies, bread etc [2].

In Nigeria, crops such as cassava, cowpea etc. and their flour had been explored and prospected for use in replacing wheat flour up to 30% so as to reduce the over-dependence on wheat importation for use as food and industrial application [15, 4]. The use of cassava flour (CF) as partial substitute to wheat flour for baking purposes had received the support of the Federal Government of Nigeria, which mandated the flour mills to include up to 10% high quality cassava flour (HQCF) into wheat flour for baking purposes [4].

The incidence of celiac diseases has necessitated prospecting gluten-free flour such as high quality cassava flour for baking purposes. Celiac disease represents an autoimmune disease induced by gliadin and related prolamins present in gluten of wheat, barley and rye grains [16, 13]. High quality cassava flour from low postharvest physiologically deteriorated cassava is a gluten-free flour that could be beneficial for coeliac patients [7, 8]. One of the most popular food uses of cassava flour (CF) worldwide is in the manufacture of baked product such as bread but now prospected for cookies, cake etc [4].

Cookies have gained importance as a preferred way to use appropriate baking flour or composite flours simply because they are ready-to eat, provide a good source of energy, and are consumed widely throughout the world [5, 9]. Therefore, this study was conducted to investigate the physical properties and sensory qualities of cookies produced with HQCFs from low postharvest physiologically deteriorated (PPD) cassava.

2. Materials and Methods

2.1 Materials

The materials used for the study include HQCF from five (5) cassava varieties. The four (4) varieties screened for low postharvest physiological deterioration were: (IITA-TMS-IBA011368, IITA-TMS-IBA070593, IITA-TMS-IBA011412 and IITA-TMS-IBA011371) while one (1) variety of high PPD was (TMEB419). All the cassava varieties were obtained from International Institute of Tropical Agriculture (IITA), Ibadan while refined wheat flour was obtained from Nigerian Eagle Flour Mills, granulated sugar from Dangote Nigeria Plc., Lagos, other materials used include Fermipan baking yeast (DSM bakery ingredient, Dordrecht-Holland), Simas margarine (PT Intiboga Sejahtera, Jakarta, Indonesia), egg, nutmeg, vanilla essence and cinnamon were purchased in Aleshinloye market, Ibadan, Oyo State, Nigeria.

2.2 Preparation of high quality cassava flour (HQCF)

The high quality cassava flour was produced as described by [1] was used. Wholesome cassava roots obtained from the International Institute of Tropical Agriculture (IITA) were peeled using stainless steel knives and washed with clean water in a plastic bowl. The washed roots were then grated and pressed with screw jack press to dewater the mash. The dewatered mash was pulverized and subsequently dried with the aid of flash dryer at 120 °C for 8 min. The flash dried cassava mash was then milled into flour with the aid of cyclone hammer mill fitted with a screen of 250 µm aperture size. The sieved cassava flour was allowed to cool and packaged into high density polyethylene bag and subsequently sealed for further analysis.

2.3 Formulation and preparation of cookies

The recipe for the production of cookies is presented in Table 1. The method described by [11] was adopted with slight modification. The high quality cassava flours from low PPD cassava (HQCF), sugar, Simas margarine, baking powder, egg, nutmeg, vanilla essence and cinnamon were thoroughly dry mixed together at appropriate rate in a large bowl to achieve homogenous mixing. After mixing, the stiff dough was rolled tightly to 1cm thickness on a board and cut into round shape. Baking oven was preheated at 180 °C, cut dough was then baked at 190 °C for 10 mins in an electric oven (Macadams, UK, model: Convecta B) until fully baked. After baking, the cookies were allowed to cool for 1-2 min, packed and sealed for subsequent analyses.

2.4 Statistical analysis

Pertinent physical and sensory data obtained were subjected to analysis of variance (ANOVA) using Statistical Package for Social Sciences (SPSS version 25.0) and significant means were separated applying Duncan Multiple Range Test.

Table 1: Dough recipe and formulation for cookies

Recipe	Amount (g)
Cassava flours	200
Sugar	50
Margarine	100
Baking powder	5
Egg	90
Nutmeg	1.5
Water	54
Salt	2.0
Cinnamon	0.5
Vanilla essence	2

Source: [11]

3. Results and Discussion

3.1 Physical Properties of Cookies

The prepared cookies were significantly ($p<0.05$) different in terms of thickness which ranged from 1.09 to 2.19 cm (Table 2). The cookie prepared with wheat flour (C-WHEAT) had the highest thickness while cookie sample C-IBA070593 was least in thickness. This may not be unconnected with fact that the gluten which is the protein present in wheat has viscoelastic properties that entrap air during mixing and proofing, which consequently resulted to the rise in the thickness observed in cookie prepared with wheat flour when compared with cookies prepared with HQCF from low PPD cassava (gluten-free flours).

The prepared cookies were significantly ($p<0.05$) different in terms of diameter, the diameter of the cookies ranged from 4.46 to 6.00 cm. Cookie sample C-IBA011412 had the highest diameter while wheat cookie (C-WHEAT) had the lowest. It is pertinent to note that the cookies prepared with HQCF from all the five varieties of cassava investigated had higher diameter when compared with wheat (C-WHEAT). This is attributable to the oven spring characterized by rise in volume and height of cookie prepared with wheat flour during baking process resulting in compacted length with increased height of cookie.

The prepared cookies were significantly ($p<0.05$) different in terms spread ratio. The spread ratio of the formulated cookies followed the trend observed in the diameter of the cookies. The spread ratio ranged from 2.04 to 4.80 in cookie prepared with wheat (C-WHEAT) and C-IBA011412, respectively. The variation in spread factor was more influenced by thickness of cookies than their diameter. Similar results were reported by [14]. The spread ratio decreases with the increase of non-gluten flours which consequently would result into relative increase in water absorption when compared with wheat flour [10]. The quick binding of free water molecules by the hydrophilic sites of non-wheat flours or other ingredients can increase the viscosity of the batter thus resulting in cookies which spread less [14].

The weight of the cookies varied and ranged from 11.00 to 15.50 g. The highest cookie weight was recorded in cookie prepared with wheat flour (C-WHEAT) while the lowest weight was observed in cookie sample C-IBA011368. The highest weight observed in cookie prepared with wheat flour (control) could be attributed to the entrapped air in wheat dough during mixing and proofing process, which could also improve water absorption capacity of the dough [4]. The appearance of the cookies is presented in Figure 1.

3.2 Sensory Characteristics of Cookies

The sensory properties of the cookies made from HQCF from low postharvest physiologically deteriorated cassava are presented in Table 3. The appearance of the cookies prepared with the cassava flours varied significantly (p<0.05) from 2.55 to 3.55. The sensory score 3.55 for cookie sample C-WHEAT correspond to 'like moderately' while 2.55 for sample C-IBA011371 correspond to 'like very much'; Cookie samples C-IBA011368, C-IBA070593 and C-IBA011371 were not significantly different (p>0.05) in appearance. In terms of appearance, cookie prepared with wheat flour (C-WHEAT) exhibited an increase in thickness with corresponding compact shape, which could be attributed to the air entrapped into the gas cells in the gluten network structure of the dough via yeast fermentation resulting to rise in dough volume before and after baking as evident in the height of cookies prepared with wheat flour when compared with cookie prepared with gluten-free HQCF from low PPD cassava. The observed higher browning in cookies prepared with wheat in comparism with others could be attributed to pronounced browning reaction that results in the presence of sugar and addition of the heat to the batter (Fig 1).

Table 2: Physical properties of cookies prepared with low PPD cassava flours

Sample	Diameter (cm)	Thickness (cm)	Spread Ratio	Weight of cookies (g)
C-IBA011368	4.89^{b}±0.18	1.26^{c}±0.18	3.87^{b}±0.07	11.00^{a}±0.00
C-IBA070593	4.84^{b}±0.18	1.09^{a}±0.18	4.45^{d}±0.09	12.00^{b}±0.00
C-IBA011412	6.00^{c}±0.00	1.25^{c}±0.00	4.80^{e}±0.00	12.00^{b}±0.00
C-IBA011371	4.86^{b}±0.18	1.16^{b}±0.18	4.19^{c}±0.05	13.00^{c}±0.00
C-TMEB419	5.88^{c}±1.76	1.26^{c}±0.18	4.66^{de}±0.21	13.00^{c}±0.00
C-WHEAT	4.46^{a}±0.18	2.19^{d}±0.18	2.04^{a}±0.01	15.50^{d}±0.71

Results are expressed as mean + standard deviation of 3 replicate. Mean values followed by different superscript letter within a column are significantly different (p≤0.05)

C-IBA011368: Cookies made with HQCFs from IITA-TMS-IBA011368 cassava
C-IBA070593: Cookies made with HQCFs from IITA-TMS-IBA070593 cassava
C-IBA011412: Cookies made with HQCFs from IITA-TMS-IBA011412 cassava
C-IBA011371: Cookies made with HQCFs from IITA-TMS-IBA011371 cassava
C-TMEB419: Cookies made with HQCFs from TMEB 419 cassava
C-Wheat: Cookies made with refined wheat flour

Table 3: Sensory properties of cookies made with HQCF from low PPD cassava

Sample	Appearance	Aroma	Mouth feel	Sweetness	Hardness	Crunchiness	Ova ccp
C-IBA011368	2.80±0.70^{a}	2.25±0.97^{a}	2.65±0.99^{a}	2.85±1.31^{a}	3.35±0.99^{a}	2.75±0.97^{a}	2.65±0.81^{a}
C-IBA070593	2.55±0.61^{a}	2.65±1.04^{abc}	2.75±1.12^{a}	2.90±0.85^{a}	3.40±1.43^{a}	3.00±0.92^{a}	2.90±0.79^{a}
C-IBA011412	2.90±0.55^{ab}	3.15±0.93^{bc}	2.55±0.69^{a}	2.80±0.62^{a}	3.30±1.03^{a}	3.15±1.18^{a}	3.00±1.08^{a}
C-IBA011371	2.70±0.87^{a}	2.80±1.15^{abc}	2.70±1.08^{a}	2.80±1.36^{a}	3.40±1.05^{a}	2.85±1.18^{a}	2.95±1.15^{a}
C-TMEB419	3.10±1.12^{ab}	3.25±0.85^{c}	2.85±0.99^{a}	3.00±0.73^{a}	3.00±1.17^{a}	2.95±1.50^{a}	3.05±1.23^{a}
C-WHEAT	3.55±1.70^{b}	2.45±1.32^{ab}	2.95±1.47^{a}	2.45±1.15^{a}	3.35±1.46^{a}	2.90±1.17^{a}	3.00±1.75^{a}

Results are expressed as mean + standard deviation of 3 replicate. Mean values followed by different superscript letter within a column are significantly different (p≤0.05)

The samples were rated using a 9-point hedonic scale based on their degree of likeness, where 1= like extremely; 5= neither like nor dislike; 9= dislike extremely

Fig 1: Appearance of the cookies produced from varieties of low PPD cassava flours

C-IBA011412: Cookies made with HQCFs from IITA-TMS-IBA011412 cassava
C-IBA011371: Cookies made with HQCFs from IITA-TMS-IBA011371 cassava
C-IBA011368: Cookies made with HQCFs from IITA-TMS-IBA011368 cassava
C-IBA070596: Cookies made with HQCFs from IITA-TMS-IBA070593 cassava
C-TMEB419: Cookies made with HQCFs from TMEB 419 cassava
C-Wheat: Cookies made with refined wheat flour

Aroma of cookies prepared varied significantly from 2.25 to 3.25 in cookies C-IBA011368 and C-TMEB419, respectively. Sensory score 2.25 for cookie sample C-IBA011368 correspond to 'like very much' while the score 3.25 for sample C-TMEB419 correspond to 'like moderately'.

There was no significant (*p*>0.05) difference in mouth feel of cookies. The mouth feel score ranged from 2.55 - 2.95 in cookie sample C-IBA011412 and C-WHEAT, respectively. The sensory score 2.55 for cookie sample C-IBA011412 correspond to 'like very much' while 2.95 for sample C-WHEAT correspond to 'like very much'.

The sensory score for the sweetness of the cookies ranged from 2.45-3.00. Cookie samples C-WHEAT had sensory score 2.45 corresponding to 'like very much' while sample C-TMEB419 was rated least in terms of sweetness with 3.00 corresponding to 'like moderately'.

The hardness of the cookies prepared from the flours ranged from 3.00-3.40. Cookie C-TMEB 419 was the least hard while cookie samples C-IBA070593 and C-IBA070593 were rated hard. Generally, the observed relative hardness of the cookies prepared with the low PPD cassava flours when compared with the high PPD (TME419) could be attributed to the relatively high water absorption capacity and swelling power of the starch granules of low PPD cassava flours.

The crunchiness of the cookies varied between 2.75-3.15 in cookie samples C-IBA011368 and C-IBA011412 respectively. The sensory score 2.75 for cookie sample C-IBA011368 correspond to 'like very much' while the sensory score 3.15 for sample C-IBA011412 correspond to 'like moderately'.

The score for the overall acceptability of cookies ranged from 2.65-3.05. The sensory score 2.65 for cookie sample C-IBA011368 correspond to 'like very much' while 3.05 for sample C-TMEB419 correspond to 'like moderately'. The order of preference as measured by the overall acceptability for the cookies made from the low PPD cassava flours and wheat (control) as adjudged by the panelists revealed that cookie sample C-IBA011368 was the most preferred. The observed high (sensory rating) preference for cookies prepared with HQCF from yellow fleshed low PPD cassava could be attributed to the sensorial appeal of yellow color of the flours from which such cookies were produced. The pigment carotenoid present in the cassava varieties examined was responsible for the observed yellow color in the HQCF used in production of the cookies which could have been one of the factors that influenced the preference of the panelist as indicated by the relatively high sensory scores of appearance for cookies made with HQCF from low PPD.

Previous work conducted by Alimi *et al*. (2022) [2] reported that the sugar content of HQCF from low PPD cassava varieties IITA-TMS-IBA-011368, IITA-TMS-IBA-070593, IITA-TMS-IBA-011412 and IITA-TMS-IBA-011371 was significantly higher than HQCF produced from high PPD cassava TMEB 419 pointing to the fact that the amount of compounds responsible for the bitterness, such as tannins and cyanogens, was significantly lower in low PPD cassava when compared with high PPD cassava. This difference in genetic make-up of cassava varieties resulting to varying sugar content could possibly influence the taste (sweetness) of the cookies prepared with HQCF low PPD cassava and this could be adduced as a reason for the preference for cookies made with HQCF from low PPD cassava over cookies prepared with flour from high PPD cassava.

4. Conclusion

Cookies of acceptable physical properties and sensory qualities were produced with high quality cassava flours from selected varieties of low postharvest physiologically deteriorated cassava. The cookies prepared with HQCF from low PPD flours were preferred to cookies produced with wheat flour in terms of sensorial properties such as appearance, aroma, mouthfeel, crunchiness and overall acceptability. Sensory properties of the cookies established that cookie prepared with high quality cassava flour from IITA-TMS-IBA011368, IITA-TMS-IBA070593 and IITA-TMS-IBA011371 cassava varieties were preferred to cookie prepared from wheat flour. The most preferred cookie was the one prepared with HQCF from IITA-TMS-IBA011368 cassava. The use of high quality cassava flour produced from low PPD cassava root for confectionery and baked products could enhance the utilization of this crop in sub-Saharan African countries.

5. References

1. Ahemen SA, Alimi JP, Alimi JO, Iluebbey PO. Physical and Microstructural Properties of Composite Cassava-wheat Bread Produced from blend of wheat and low Postharvest Physiological Deterioration Cassava flours. American Journal of Food Science and Technology 2021b;9(4):142-148. Doi:10.12691/ajfst-9-4-5
2. Alimi JP, Ahemen SA, Alimi JO, Ngunoon TP, Yepshak NB. Comparative study on chemical and functional properties of flours produced from selected clones of low and high postharvest physiological deterioration cassava (*Manihot esculenta* Crantz). Journal of Current Research in Food Science. 2022;3(1):51-57. Doi: https://doi.org/10.22271/foodsci.2022.v3.i1a.60
3. Alimi JP, Ahemen SA, Ikeme AI, Iluebbey PO and Alimi JO. Physical, proximate and pasting properties of flours from selected clones of low postharvest physiological deterioration cassava. Research Journal of Chemical Sciences. 2021a;11(3):24-32. Available online at: www.isca.in, www.isca.me
4. Alimi JP, Shittu TA, Oyelakin MO, Olagbaju AR, Sanu FT, Alimi JO, *et al*. Effect of cowpea flour inclusion on the storage characteristics of composite wheat-cowpea bread. Journal of Agricultural and Crop Research. 2016;4(4):49-59. Retrievable Athttp://sciencewebpublishing.net/jacr/archive/2016/June/pdf/Alimi%20et%20al.pdf
5. Arshad MU, Anjum FM, Zahoor T. Nutritional assessment of cookies supplemented with defatted wheat germ. Food Chemistry. 2007;102:123-128. http://dx.doi.org/10.1016/j.foodchem.2006.04.040
6. Aryee FNA, Oduro I, Ellis WO, Afuakwa JJ. Physicochemical flour samples from the roots of 31 varieties of cassava. Food Control. 2006;2:916-922.
7. Biagi F, Andrealli A, Bianchi PI, Marchese A, Klersy C, Corazza GR. A gluten-free diet score to evaluate dietary compliance in patients with coeliac. British Journal of Nutrition. 2009;102:882-887.
8. Briani C, Samaroo D, Alaedini A. Celiac disease: From gluten to autoimmunity. Autoimmunity Reviews. 2008;7:644-650.

Doi:10.1016/j.autrev.2008.05.006
9. Chavan JK, Kadam SS. Nutritional enrichment of bakery products by supplementation with non-wheat flours. Critical Reviews in Food Science and Nutrition. 1993;33:189-226. http://dx.doi.org/10.1080/10408399309527620
10. Claughton SM, Peacce RJ. Protein enrichment o of sugar snap cookies with sunflower protein isolate. Journal of Food Science. 1989;54:354-356.
11. Gul K, Bala A, Singh Riar1 C. Functional and sensory properties of cookies prepared from wheat flour supplemented with cassava and water chestnut flours. Cogent Food and Agriculture. 2015;1:10-12.
12. Hough G. Sensory Shelf Life Estimation of Food Products. CRC Press, Taylor and Francis Group; Boca Raton, FL, USA; c2010.
13. Maki M Celiac. disease. In: Kleinman RE, Sanderson IR, Goulet O, Sherman PM, Mieli-Vergani G, Shneider B, editors. Walker's Pediatric Gastrointestinal Disease. 5th ed. Hamilton: BC Decker Inc; c2008. p. 319-27.
14. Mc Watters KH. Cookie baking properties of defatted peanut, soybean and field pea flour. Cereal Chemistry. 1978;55:853-863.
15. Shittu TA, Dixon A, Awonorin SO, Sanni LO, Maxiya-Dixon B. Bread from composite cassava-wheat flour II: effect of cassava genotype and nitrogen fertilizer on bread quality. Food Res. Int. 2008;41:569-578.
16. Troncone R, Auricchio S. Celiac disease. In: Wyllie R, Hymas JS, editors. Pediatric Gastrointestinal and Liver Disease. 3rd ed. Philadelphia: Saunders Elsevier; c2006. p. 517-27.