Journal of
Food Chemistry & Nanotechnology

https://doi.org/10.17756/jfcn.2020-085

Research Article

Open Access

Chemical, Physical and Sensory Properties of Pawpaw Fortified Pan Bread

I.F Bolarinwa[1*], T.E Aruna[2], J.A Adejuyitan[1], G.A Adeyemo[3] and O.D Alabi[3]

[1]*Department of Food Science, Ladoke Akintola University of Technology (LAUTECH), P.M.B.4000, Ogbomoso, Nigeria*
[2]*Department of Food Science and Technology, Kwara State University, Kwara State, Nigeria*
[3]*Nutrition and Dietetics Department, Ladoke Akintola University of Technology (LAUTECH), P.M.B.4000, Ogbomoso, Nigeria*

[*]Correspondence to:
I.F Bolarinwa
Department of Food Science
LadokeAkintola University of Technology
P.M.B.4000, Ogbomoso, Nigeria
E-mail: ifbolarinwa@lautech.edu.ng

Received: January 13, 2020
Accepted: April 07, 2020
Published: April 09, 2020

Citation: Bolarinwa IF, Aruna TE, AdejuyitanJA, AdeyemoGA, AlabiOD. 2020. Chemical, Physical and Sensory Properties of Pawpaw Fortified Pan Bread. *J Food ChemNanotechnol* 6(2): 65-71.

Published by United Scientific Group

Abstract

Micronutrient deficiency is a major health problem among children and pregnant women in developing countries. Vitamin A deficiency can be prevented by fortifying staple food with pro-vitamin A rich plant such as pawpaw. This study evaluated the quality attributes of pawpaw fortified bread. Matured ripe pawpaw fruits were harvested, washed, peeled and blended to produce puree. Six different blends of various proportions (100:0, 90:10, 80:20, 70:30, 60:40, 50:50) of wheat and pawpaw were produced and used to prepare pawpaw-bread samples. The bread samples were analysed for chemical composition, mineral contents, physical properties and sensory attributes, using standard methods. Vitamin A content of the pawpaw-bread significantly increased from 13.04 µg/g to 46.40 µg/100 g. Supplementation of wheat flour with pawpaw puree also led to increase in calcium (52.66 – 87.54 mg/100 g), iron (0.94 – 1.71 mg/100 g), phosphorus (84.49 – 129.95 mg/100 g) and potassium (165.86 – 181.32 mg/100 g) contents of the pawpaw bread. Texture profile (hardness, cohesiveness, chewiness and springiness) of the pawpaw fortified bread samples were significantly lower than that of the 100% wheat bread. Sensory results showed that bread fortified with 20% pawpaw puree was rated similar to 100% wheat bread in terms of colour, taste, texture and flavour. In conclusion, acceptable pawpaw fortified bread samples with higher micronutrients contents than conventional bread was produced in this study.

Keywords

Vitamin A, Chemical composition, Pawpaw, Bread, Texture profile

Introduction

Bread belongs to the class of ready to eat food made by mixing wheat flour with water and yeast, kneading and baking in an oven [1]. It is a staple food consumed by both old and young in most regions of the world. It is consumed in large quantity in the world in different types and forms depending upon cultural habits. Bread is an ideal functional product in developing countries, since it is an important part of their daily diet.

Pawpaw fruit *(Carica papaya)* belongs to *caricaceae* family. It is one of the cheapest, economically important fruit trees grown and consumed for its nutritional content, even though it is often found growing wild in tropical regions. It is usually consumed fresh in slices, in chunks as dessert or could be processed and used in a variety of products such as jams and fruit juice. Pawpaw is a good source of β-carotene [2] and also contains high amount of vitamin C and minerals such as potassium, magnesium, iron and sodium [3]. The amount of these nutrients is greater than or the same as those found in bananas, apples or oranges [4]. Pawpaw fruit can be used as carbohydrate-based fat replacer [5] and as natural source of fruit flavour in baked products [6]. Pawpaw puree can also be used in thermally processed food like jams, jellies, ice cream, and other beverage products such as nectars and non-fermented beverage [7].

Micronutrient deficiency is one of the major health challenges affecting the vulnerable groups (mainly children and pregnant women) in developing world. This is due to high cost of most of animal foods which are major sources of these nutrients. However, these micronutrients are very vital to healthy living of man, and their deficiency can lead to acute or chronic diseases. For instance, xerophthalmia, an abnormal dryness of the eyeball characterized by conjunctivitis occurs due to Vitamin A Deficiency (VAD). Vitamin A deficiency is a leading cause of high morbidity and mortality among preschool children, pregnant women and lactating mothers in developing countries [8]. According to UN/SCN [9], prevalence of VAD in Nigeria is 28.1% in preschool children and 4.7% for nursing mothers. Similarly, Maziya-Dixon et al. [10] also reported 29.5% prevalence of VAD in Nigerian children that are less than five years of age. Thus, vitamin A is an essential vitamin in human diet that is vital for sight brightness and proper vision, as well as other metabolic functions in the body. Dietary diversification and fortification of staple food could reduce or solve micronutrients deficiency problems in developing countries.

Food fortification or enrichment is a process in which food product is modified with the nutrients which are not originally present in the food product or originally presents in the food product but lost or reduced during food processing. It is a practice of deliberately increasing essential micronutrients, vitamins, proteins and minerals in a food product irrespective of whether the nutrient was originally present in food before processing or not, with the aim of improving the nutritional quality of food supply and to solve particular nutrient deficiency prevailing among a populace. Food fortification has the ability to provide rapid solution to address low micronutrients intakes of a population through their traditional dietary patterns [11]. Fortification of wheat flour with pawpaw puree for bread making can serve as a practical and sustainable approach to increase pawpaw utilization and also improve micronutrients contents of bread. The use of pawpaw puree as fat replacer in cake making has been reported [12]. The objective of this study was to determine the chemical, physical and sensory properties of wheat bread fortified with pawpaw puree.

Materials and Methods

Materials

Matured pawpaw fruits were harvested at Ladoke Akintola University of Technology (LAUTECH) teaching and research farm. Wheat flour, margarine, baker's yeast and sugar were purchased from a local market in South-West Nigeria. All experiments were performed at food processing and food chemistry laboratory, LAUTECH, Oyo state, Nigeria.

Methods

Preparation of pawpaw puree

Ripe pawpaw fruits were washed and peeled. The seeds were removed and pawpaw flesh was uniformly sliced and blended using a blender set at speed 2 to obtain a smooth puree.

Production of pawpaw fortified bread

Pawpaw puree was mixed with various proportions of wheat flour to produce wheat-pawpaw puree blend as presented in table 1. The wheat-pawpaw puree blends (500 g) were mixed with sugar (100 g), salt (2 g), yeast (6 g), and butter (40 g) and kneaded to form a dough. The dough was scaled, moulded and placed in greased baking pans and allowed to proof for 55 min at 30 °C in a proofing cabinet at a relative humidity of 40%. The proofed dough was baked in an electric oven (230 °C; 20 min) and cooled at ambient temperature for 40 min.

Table 1: Pawpaw puree-wheat flour blend formulation.

Sample	A	B	C	D	E	F
Wheat flour (%)	100	90	80	70	60	50
Pawpaw puree (%)	0	10	20	30	40	50

Chemical analyses

Determination of proximate composition

The proximate composition (protein, crude fat, ash, crude fibre) of the pawpaw fortified bread was determined according to AOAC [13]. Prior to analysis, three slices from each bread sample were frozen, dried in an oven and ground into a coarse powder before analysis [14]. Carbohydrate contents of the bread samples were determined by difference. Energy contents of the bread samples were calculated by multiplying the protein, carbohydrate and fat contents of each bread sample by factors of 4, 4 and 9, respectively.

Determination of mineral content

The mineral contents (Fe, Ca, K, P) of the bread samples were determined using atomic absorption spectrometer. The ash obtained after the determination of ash content was first dissolved in 5ml concentrated hydrochloric acid (11.8M) and filtered into a 50 ml volumetric flask. The solution was made up to the 50 ml mark with more distilled water and transferred into a plastic sample bottle with a lid. The concentrations of minerals of iron, calcium, potassium, and phosphorus in the bread samples were measured by atomic absorption spectrophotometer following flame atomization using air acetylene flame and single element hollow cathode lamp.

Determination of vitamin A content

Vitamin A contents of the bread samples were determined using the procedure described by Singh *et al.* [15]. The bread sample (5 g) was ground and placed in 10 ml acetone. Few crystals of anhydrous sodium sulphate were added and the mixture was allowed to settle. The supernatant was then decanted into a beaker and transferred to a separator funnel. Petroleum ether (10 ml) was added to the supernatant, mixed thoroughly and allowed to separate into two layers. The lower layer was discarded and the upper layer was collected in a 100 ml volumetric flask, and the volume was made up to 100 ml with petroleum ether. The optical density (OD) of the solution was then determined at 452 nm, using petroleum ether as blank.

Calculations:

$$\text{B-carotene} = \frac{\text{OD13.910000100}}{\text{Weight of sample5601000}}$$

Where OD = Optical density of the solution at 452 nm

$$\text{Vitamin A} = \frac{\beta\text{-carotene } (\mu g/100)}{0.6}$$

Specific volume

Loaf volume and specific volume were determined by the method described by Hanis-Syazwani et al. [16]. Loaf volume of the bread samples were measured by using the rape seed displacement method. Specific volume was estimated by dividing the loaf volume of each bread by the weight of the bread and expressed as cm^3/g.

Bread quality assessment

Colour analysis

Crust colour analysis of the bread samples was done by using Hunter Lab colorimeter (model SM-3001476 micro sensors, New York). The instrument was calibrated with user supplied black plate calibration standard used for zero setting and white calibration plates for white calibration settings. Sample measurements were taken at three different points and readings were displayed as L*, a* and b* colour parameters according to CIELAB system of colour measurement. The value of a* ranged from -100 (redness) to +100 (greenness), b* values ranged from -100 (blueness) to +100 (yellowness) while L* value which indicates lightness, ranged from 0 (black) to 100 (white).

Texture profile analysis

Texture analyser (TA HD Plus, stable micro Systems, Godalming, Surrey, UK) was used to measure the hardness, cohesiveness, chewiness and springiness of the bread samples according to AACC [17] procedure.

Sensory evaluation

The bread samples were coded and served to thirty (30) randomly selected semi trained panellists. The panellists were asked to score the bread samples for colour, taste, after-taste, texture, flavour, mouth feel and overall acceptability, using a nine (9) point's hedonic scale, where 1 to 9 represents dislike extremely and like extremely, respectively. Bread produced from 100% wheat flour (conventional bread) was used as control.

Statistical analyses

All experiments were repeated three times and data obtained were subjected to analysis of variance (ANOVA). Means was tested for significance difference by Duncan's Multiple Range Test. Significance difference was accepted at $p < 0.05$.

Results and Discussion

Proximate composition of pawpaw fortified bread

Table 2 shows the proximate composition of the pawpaw fortified bread samples. There was no significant difference ($p>0.05$) in the protein content of the unfortified (11.18%) and the fortified bread sample (11.20 – 11.41%). Fortification of wheat bread with pawpaw puree did not have any effect on the protein content of the bread samples. This could be due to low protein content (0.47%) in pawpaw fruit [18].

Ash is a non-organic compound which represent the mineral content of food, and aids in the metabolism of other compounds. The ash content of the pawpaw-bread increased from 1.33% to 2.86% with increase in percentage of pawpaw puree fortification. Sample F (50% wheat flour, 50% pawpaw puree) had the highest value of ash content (2.86), while sample A (100% wheat flour) had the least ash content (1.33%). This could be due to high mineral contents of pawpaw fruit [19].

The crude fibre contents of the pawpaw bread samples increased from 0.85% to 1.38%. Sample F (50% wheat flour, 50% pawpaw puree) had the highest value of crude fibre (1.38%) while the control sample (100% wheat flour) had the least value (0.80%). [20] also reported higher fibre values (2.01%–3.45%) for pawpaw-enriched cookies. The increment in the crude fibre contents of the bread samples could be due to high fibre content (7.6%) in pawpaw fruit [21]. Slight increment in crude fat content (2.25 – 3.60%) of the pawpaw-bread samples were recorded. This indicates that addition of pawpaw to wheat flour for bread making did not have significant effect on the fat content of the bread sample. This result is expected because pawpaw fruit is low in fat (0.26%) [18]. The moisture content of the bread samples ranges from 21.37% to 26.55% (Table 2). These results showed that the moisture content of the pawpaw-bread increases as the proportion of pawpaw puree increases in the flour blend. This could be due to high moisture content in ripe pawpaw fruit used in the flour blends. Carbohydrate content of the fortified pawpaw bread decreases from 63.09% to 52.80%. Decrease in carbohydrate content was as a result of increasing level of pawpaw puree in the samples. The result showed that the higher the percentage fortification of pawpaw puree in the flour blend, the lower the carbohydrate content. This indicates that the carbohydrate content of pawpaw fruits are low. This finding is in agreement with previous study by Yusufu and Akhigbe [20] who reported decreased in carbohydrate content (73.85% - 67.15%) of pawpaw-based cookies. The energy value of the bread samples decreases (317.06 – 289.24 kcal/100 g) as the proportion of pawpaw puree increases in the bread sample. This could be due to low carbohydrate contents (10.82%) of pawpaw fruit [18]. On the other hand, the energy value of the pawpaw bread samples was higher than that of conventional white bread (244 kcal/100 g) [18].

Table 2: Proximate Composition of pawpaw fortified bread.

Code	Crude Protein (%)	Ash (%)	Crude fibre (%)	Crude fat (%)	Moisture Content (%)	Carbo-hydrate (%)	Energy value (kcal/ 100 g)
A	11.18 ± 0.04[a]	1.33 ± 0.01[a]	0.80 ± 0.02[a]	2.22 ± 0.06[a]	21.37 ± 0.01[a]	63.09 ± 0.09[d]	317.06
B	11.20 ± 0.01[a]	1.43 ± 0.01[b]	0.85 ± 0.04[a]	2.25 ± 0.01[a]	22.11 ± 0.02[b]	62.16 ± 0.08[d]	313.69
C	11.23 ± 0.01[a]	2.16 ± 0.01[d]	1.29 ± 0.01[b]	3.19 ± 0.02[c]	24.11 ± 0.02[c]	58.02 ± 0.04[c]	305.71
D	11.30 ± 0.04[a]	1.94 ± 0.02[c]	1.27 ± 0.01[b]	2.81 ± 0.01[b]	22.78 ± 0.03[b]	59.90 ± 0.10[c]	310.09
E	11.37 ± 0.04[a]	2.70 ± 0.00[e]	1.34 ± 0.01[c]	3.41 ± 0.01[d]	25.23 ± 0.02[c]	55.95 ± 0.07[b]	299.97
F	11.41 ± 0.04[a]	2.86 ± 0.06[e]	1.38 ± 0.01[c]	3.60 ± 0.02[d]	26.55 ± 0.04[d]	52.80 ± 0.04[a]	289.24

Mean values along the same column with different superscripts are significantly different ($p<0.05$). A = 100% wheat flour; B = 90% wheat flour + 10% pawpaw puree; C = 80% wheat flour + 20% pawpaw puree; D = 70% wheat flour + 30% pawpaw puree; E = 60% wheat flour + 40% pawpaw puree; F=50% wheat flour + 50% pawpaw puree.

In general, the nutrient contents of the pawpaw fortified bread samples produced in this study is higher than the nutritional recommendation for white bread by United State Department of Agriculture (USDA). According to USDA, white bread must contain 6.67% protein, 4.4% fat, 42% carbohydrate and 2.2% fibre [18]. This indicates that consumption of the pawpaw bread will increase the nutrient intake of the people and may reduce malnutrition in developing countries.

Mineral composition of pawpaw fortified bread

Generally, the mineral contents of the bread samples increased as the proportion of pawpaw increased in the bread samples (Table 3). Calcium is an important constituent of bone and teeth, and it is actively involved in the regulation of nerve and muscle functions [22]. The calcium content of pawpaw-bread ranged from 52.66 to 87.54 mg/100g with sample A (100% wheat flour) having the least calcium content while sample F (50% pawpaw fortified bread) had the highest value. Adebayo-Oyetoro *et al.* [23] also reported higher calcium contents (21.00 - 24.20 mg/100g) for pawpaw fortified milk. The potassium content of the pawpaw bread increased as the proportion of pawpaw puree increases from 0% to 50% in the bread samples. These findings are in agreement with the report of Bolarinwa *et al.* [24] who reported increased in potassium content (272.5 – 327 mg/100 g) of moringa fortified bread as moringa concentration increased in the blends. Phosphorus content of the pawpaw-bread increased from 86.49 to 129.95 mg/100 g. Similarly, the iron content of the pawpaw bread samples was also significantly higher than that of the 100% wheat bread (Table 3). Iron is an essential mineral required in the diet of pregnant women, nursing mothers, infant, convoluting patients and elderly people. It is also important for the prevention of anaemia [25].

Table 3: Mineral composition of pawpaw fortified bread.

Sample code	Calcium (mg/100g)	Potassium (mg/100g)	Phosphorous (mg/100g)	Iron (mg/100g)
A	52.66 ± 0.028[a]	165.86 ± 0.03[a]	84.49 ± 0.014[a]	0.88 ± 0.02[a]
B	60.37 ± 0.14[b]	167.10 ± 0.03[b]	89.91 ± 0.014[b]	0.94 ± 0.03[a]
C	64.21 ± 0.02[c]	168.38 ± 0.03[b]	92.14 ± 0.02[c]	1.32 ± 0.00[b]
D	68.34 ± 0.03[d]	170.20 ± 0.01[c]	105.54 ± 0.05[d]	1.54 ± 0.03[c]
E	70.90 ± 0.03[e]	175.28 ± 0.53[d]	111.50 ± 0.03[e]	1.61 ± 0.01[c]
F	87.54 ± 0.02[f]	181.32 ± 0.03[f]	129.95 ± 0.19[f]	1.71 ± 0.01[c]

Mean values along the same column with different superscripts are significantly different ($p<0.05$). Sample code is as presented in table 2.

Vitamin A contents of pawpaw fortified breade

Vitamin A content of the fortified bread sample increased from 13.04 µg/100 g to 46.40 µg/100g (Figure 1). Bread sample fortified with 50% pawpaw had the highest vitamin A content (46.40 µg /100g). This could be due to high concentration of β-carotene (180 - 644 µg/100g) [26-27] and vitamin A (47 µg/100 g) in pawpaw fruit (USDA, 2019) [19]. Although, white bread does not generally contain vitamin A, however majority of white bread in developing countries including Nigeria contain vitamin A due to fortification of wheat flour with synthetic vitamin A, as a measure of reducing the vitamin deficiency among vulnerable group in the country. Despite this measure by government, VAD is still a problem in developing countries such as Nigeria. Pawpaw fortified bread will complement vitamin A intake of children and pregnant women and possibly help to reduce VAD problem in the country.

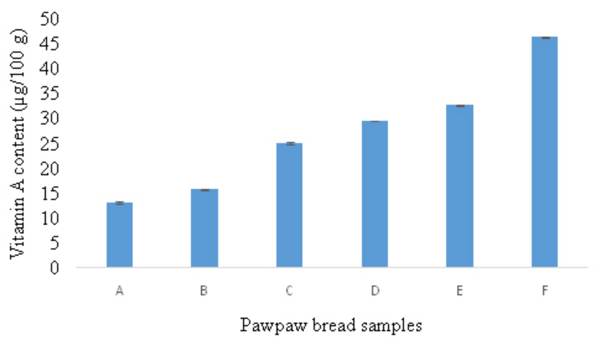

Figure 1: Vitamin A contents of pawpaw fortified bread. Sample code is as presented in table 2.

Specific volume of pawpaw fortified bread

The specific volume of the bread samples decreases with increased in the proportion of pawpaw puree in the bread samples (Figure 2). This could be due to the dilution effects of pawpaw puree on gluten network of wheat flour. Generally, gluten fraction of wheat flour is responsible for the elasticity of wheat flour dough by causing it to extend, and enable it to trap carbon dioxide generated by yeast during fermentation. This is responsible for bread leaving and increased volume of bread. Addition of pawpaw puree to wheat flour during pawpaw fortified bread dough making impaired gas production and retention during fermentation, thus leading to decrease in the volume of the fortified bread samples. Previous study also reported decrease in loaf volume of bread due to dilution of gluten network by supplementation of wheat flour with fibre [28].

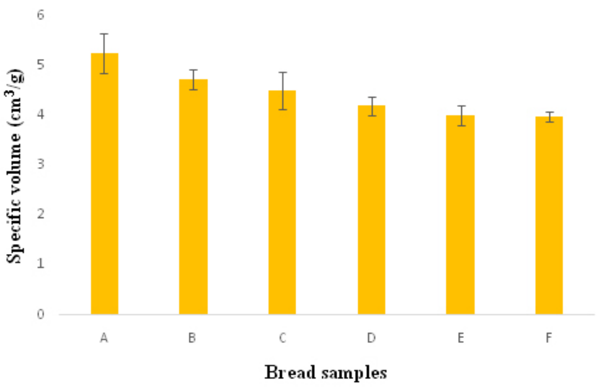

Figure 2: Specific volume of pawpaw fortified bread. Sample code is as presented in table 2.

Colour measurement of pawpaw fortified bread

Bread color is an important quality attribute of bread that determines consumer's acceptability. Golden brown color of bread is mainly due to Maillard reaction which occurs as a result of interaction between wheat flour protein and sugar used in the bread formulation, and also as a result of starch dextrinization and caramelization induced by high baking temperature [29]. The colors of the pawpaw bread samples are presented in table 4. The results obtained showed that fortification of bread with pawpaw puree significantly affected the color of the bread samples. This could be due to the yellow color of pawpaw fruit used as fortificant, which is responsible for increased in lightness (L*) with corresponding increase in yellowness (b*) values in the pawpaw bread samples as the proportion of pawpaw puree increases in the bread. Indeed, the bread sample containing 50% pawpaw puree (sample F) was yellow in appearance instead of having the golden brown color of conventional bread. There were significant differences in the redness (a*) value of all the bread samples. This could be due to the improvement in the redness due to high baking temperature [30]. In addition, the color intensity (EΔ) of the bread samples increases with increase in pawpaw fortification level in the bread samples.

Table 4: Colour measurement values of pawpaw fortified bread.

Sample code	L*	a*	b*	EΔ
A	42.76 ± 0.62^{a}	4.21 ± 0.78^{a}	14.18 ± 0.12^{a}	26.94 ± 0.30^{a}
B	55.60 ± 0.54^{b}	6.16 ± 0.15^{b}	18.37 ± 0.39^{b}	28.64 ± 0.45^{b}
C	59.14 ± 0.74^{c}	6.89 ± 0.10^{b}	19.23 ± 0.54^{b}	30.37 ± 0.56^{c}
D	62.48 ± 0.40^{d}	7.77 ± 0.35^{c}	20.29 ± 0.47^{bc}	33.39 ± 0.35^{c}
E	68.84 ± 1.03^{e}	8.12 ± 0.54^{c}	21.54 ± 0.60^{c}	34.84 ± 0.17^{c}
F	75.38 ± 1.36^{f}	9.88 ± 0.35^{d}	25.40 ± 0.76^{d}	36.63 ± 1.54^{d}

Mean values along the same column with different superscript are significantly different ($p < 0.05$). L* - Lightness; a* - redness; b* - yellowness; EΔ - colour intensity. Sample code is as described in table 2.

Texture profile of pawpaw fortified bread

Consumers' acceptance of bread is strongly based on the texture of the Bread. The textural properties of pawpaw fortified bread samples are presented in Table 5. Generally, the textural properties of the pawpaw breads were affected by increasing proportion of pawpaw puree in the bread dough except for cohesiveness, which shows no significant differences ($p>0.05$) in all the samples. The hardness of the bread samples increases significantly ($p<0.05$) as the proportion of pawpaw puree increases in the bread. This could be due to high dietary fibre contents (14.1 – 17%) of pawpaw fruit [19].

The chewiness of the pawpaw bread is significantly lower than that of the 100% wheat bread. Lower chewiness values recorded for the pawpaw bread samples indicate better eating quality and the likelihood that the fortified bread samples will be more acceptable to elderly people and small children who may not have the strength to chew for long period.

Table 5: Texture profile of pawpaw fortified bread.

Sample code	Hardness (g)	Cohesiveness	Chewiness (mm)	Springiness (mm)
A	429.60 ± 0.69^{a}	0.52 ± 0.01^{a}	374.08 ± 2.04^{e}	0.94 ± 0.94^{e}
B	432.10 ± 0.35^{b}	0.53 ± 0.01^{a}	350.26 ± 0.76^{d}	0.86 ± 0.86^{d}
C	440.93 ± 0.30^{c}	0.53 ± 0.01^{a}	353.17 ± 0.78^{d}	0.79 ± 0.80^{c}
D	442.55 ± 0.86^{c}	0.53 ± 0.01^{a}	326.68 ± 1.46^{c}	0.72 ± 0.72^{b}
E	457.51 ± 0.16^{d}	0.52 ± 0.00^{a}	314.86 ± 0.76^{b}	0.71 ± 0.83^{b}
F	473.43 ± 0.72^{d}	0.55 ± 0.01^{a}	309.96 ± 4.23^{a}	0.65 ± 0.85^{a}

Mean values along the same column with different superscript are significantly different ($p < 0.05$). Sample code is as described in table 2.

Springiness is a measure of the elastic property of bread. The springiness of all the samples was significantly different ($p < 0.05$). Higher springiness value (0.94 mm) recorded for the control bread sample (100% wheat bread) is an indication that the bread will maintain its shape after pressing. However, lower springiness values (0.65 – 0.86) recorded for the pawpaw fortified bread showed that the bread will flatten after pressing. This is probably due to dilution of gluten network and hence, reduced carbon dioxide produced during fermentation, which is responsible for softness and springiness of bread.

Sensory evaluation of pawpaw fortified bread

There were no significant differences ($p > 0.05$) in the taste and after taste of all the bread samples (Table 6). However, the control (100% wheat bread) was significantly different ($p < 0.05$) from the pawpaw bread samples in terms of colour, texture, flavour and overall acceptance. On the other hand, bread samples fortified with 10% and 20% pawpaw puree (sample B and C) were rated similar to the control bread sample in terms of overall acceptance. This could be because sample B and C contains low amount of pawpaw puree and thus has similar sensory attributes with the control bread. Moreover, sample F taste better and was rated higher (7.15) than the control bread (7.03) due to the effect of pawpaw puree on the sweetness of the bread. In terms of colour, sample F had the lowest rating (5.42) while sample A (100% wheat bread) had the highest sensory score (7.41) for colour. This could be due to yellowness (instead of the conventional golden-brown colour of bread) of the bread sample as the pawpaw puree increased in the bread formulation. In addition, the flavour of all the fortified bread sample was distinctively different from that of the control bread, due to the flavour of pawpaw puree in the bread. This characteristic flavour could be responsible for lower rating of the pawpaw bread.

Table 6: Sensory evaluation score test of pawpaw fortified bread.

Sample	Colour	Taste	After taste	Texture	Mouth feel	Flavour	Overall Accept-ability
A	7.41^c	7.03^a	6.84^a	7.86^b	7.09^b	7.12^b	7.61^b
B	7.12^c	7.09^a	6.77^a	7.71^b	6.57^{ab}	6.67^b	7.21^b
C	7.09^c	7.01^a	6.90^a	7.67^b	6.88^{ab}	6.50^b	7.08^b
D	6.05^b	6.53^a	5.69^a	6.65^a	6.26^a	6.45^a	6.42^a
E	5.94^a	6.79^a	6.26^a	6.50^a	6.16^a	6.11^a	6.40^a
F	5.42^a	7.15^a	6.30^a	6.27	6.33^a	6.25^a	6.40^a

Mean values along the same column with different superscript are significantly different ($p < 0.05$). Sample code is as described in table 2.

Conclusion

Pan bread was successfully fortified with pawpaw puree. Addition of pawpaw puree to the bread samples slightly increased the nutritional values of the fortified breads compared to the 100% wheat bread. However, for the fortified bread samples to meet the nutrient requirements of consumers, the processing conditions and raw material formulation should be optimised to meet micronutrients needs of the target groups. The textural properties of the fortified breads were negatively affected by increased proportion of pawpaw puree in the formulation. Bread sample fortified with 20% pawpaw puree was the most acceptable sample to the sensory panellists.

Conflict of Interest

Authors declared no conflict of interest.

References

1. Adeleke RO, Odedeji JO. 2010. Acceptability studies of bread fortified with tilapia fish flour. *Pak J Nutr* 9 (6): 531-534. https://doi:10.3923/pin.2010.531.534
2. Ncube TN, Greiner T, Malaba LC, Gebre-Medhin M. 2001. Supplementing lactating women with pureed papaya and grated carrots improved vitamin A status in a placebo-controlled trial. *J Nutr* 131(5): 1497-1502. https://doi.org/10.1093/jn/131.5.1497
3. Oloyede OI. 2005. Chemical profile of unripe pulp of *Carica papaya*. *Pak J Nutr* 4(6): 379-381. https://doi.org/10.3923/pin.2995.379.381
4. Jones SC, Layne DR. 2009. Pawpaw description and nutritional information, Kentucky state university cooperation extension program. Pawpaw research project, community research service, Atwood research facility Frankfort, KY, pp. 40601-2355.
5. Duffrin MW, Holben DH, Bremner MJ. 2001. Consumer acceptance of pawpaw (*Asimina Triloba*) fruit puree as a fat-reducing agent in muffins, compared to muffins made with applesauce and fat. *Fam Consum Sci Res J* 29: 281-287. https://doi.org/10.1177/1077727X01293005
6. McGrath MJ, Karahadian C. 1994. Evaluation of headspace volatiles and sensory characteristics of ripe pawpaws (*Asimina triloba*) from selected cultivars. *Food Chem* 51(3): 255-262. https://doi.org/10.1016/0308-8146(94)90024-8
7. Matsuura FCAU, Folegatti MIDS, Cardoso RL, Ferreira DC. 2004. Sensory acceptance of mixed nectar of papaya, passion fruit and acerola. *Sci Agric (Piracicaba Braz)* 61: 604-608. http://doi.org/10.1590/S0103-90162004000600007
8. Uchendu FN, Atinmo T, Oyewole O. 2012. Stability of vitamin A in selected Nigerian bread made from commercial fortified wheat flour. *Int J Appl Sci Technol* 2(3): 93-98.
9. UN/SCN. 2004. 5th Report on the world nutrition. Nutrition for the improved development outcome. pp: 101-103.
10. Maziya-Dixion BB, Akinyele IO, Sanusi RA, Oguntona TE, Nokoe SK, et al. 2006. Vitamin A deficiency is prevalent in children less than 5 years of age in Nigeria. *The Journal of Nutrition* 136: 2255-2261. https://doi.org/10.1093/jn/136.8.2255
11. Serrem C, Kock H, Taylor J. 2011. Nutritional quality, sensory quality and consumer acceptability of sorghum and bread wheat biscuits fortified with defatted soya flour. *Int J Food Sci Technol* 46(1): 74-83. https://doi.org/10.1111/j.1365-2621.2010.02451.x
12. Akubor PI, Eze EC, Popoola CA 2017. Effect of substituting fat with pawpaw puree on the qualities of cake in storage. FUW J Agric Life Sci 1(1): 1-7.
13. AOAC. 2005. Official methods of analysis of AOAC International, 18th edition, Maryland, USA.
14. Malomo SA, Eleyinmi AF, Fashakin JB. 2011. Chemical composition, rheological properties and bread making potentials of composite flours from breadfruit, breadnut and wheat. *African Journal of Food Science* 5(7): 400-410.
15. Singh E, Kalyani B, Reddy BS, Kalyani PU, Devi H, et al. 2015. Study on dehydration of papaya slices using osmotic dehydration mediated hot air oven drying. *IOSR Journal of Environmental Science, Toxicology and Food Technology* 9(11): 72-95. https://doi.org/10.9790/2402-091127295
16. Hanis-Syazwani M, Bolarinwa IF, Lasekan O, Muhammad K. 2018. Influence of starter culture on the physicochemical properties of rice bran sourdough and physical quality of sourdough bread. *Food Res* 2(4): 340-349. https://doi.org/10.26656/fr.2017.2(4).045
17. AACC. 2004. Approved Methods of the AACC. Methods 10-05, 74-09. American Association of Cereal Chemists, St. Paul, MN, USA.
18. USDA. 2019. USDA Food and Nutrient Database for Dietary Studies. [Accessed on the April 07, 2020].
19. Saxholt E, Christensen AT, MØller A, Hartkopp HB, Hess YK, et al. 2008. Danish food composition databank.
20. Yusufu MI, Akhigbe AO. 2014. The production of pawpaw enriched cookies: functional, physico-chemical and sensory characteristics. *Asian Journal of Agriculture and Food Sciences* 2(2): 100-106.
21. Maisarah AM, Asmah R, Fauziah O. 2014. Proximate analysis, antioxidant and anti-proliferative activities of different part of *Carica papaya*. *J Nutr Food Sci* 4(2): 1-7. https://doi:10.4172/2155-9600.1000267
22. Soetan KO, Olaiya CO, Oyewole OE. 2010. The importance of mineral elements for humans, domestic animals and plants: a review. *African Journal of Food Science* 4(5): 200-222.

23. Adebayo-Oyetoro AO, Ogundipe OO, Adeyemo IG, Ogundipe FO, Bamdele FA, et al. 2016. Chemical, sensory and shelf life study of pawpaw juice-milk blends. *J Cogent Food Agric* 2(1): 1-9. https://doi.org/10.1080/23311932.2016.1271276
24. Bolarinwa IF, Tawakalitu EA, Akeem OR. 2017. Nutritive value and acceptability of bread fortified with moringa seed powder. *J Saudi Soc Agric Sci* 18(2): 195-200. https://doi.org/10.1016/j.jssas.2017.05.002
25. Oluyemi EA, Akinlua AA, Adenuga AA, Adebayo MB. 2005. Mineral contents of some commonly consumed Nigeria Foods. *Eur J Sci Res* 6(2): 11-15.
26. Chandrika UG, Errol RJ, Nalinie W, Narada DW. 2003. Carotenoids in yellow-and red- fleshed papaya (*Carica papaya* L.). *J Sci Food Agric* 83(12): 1279-1282. https://doi.org/10.1002/jsfa.1533
27. Wall MM. 2006. Ascorbic acid, vitamin a and mineral composition of banana (*Musa* sp.) and papaya (*Carica papaya*) cultivars grown in Hawaii. *J Food Compos Anal* 19(5): 434-445. https://doi.org/10.1016/j.jfca.2006.01.002
28. Elleuch M, Bedigan D, Roiseux O, Besbes S, Blecker C, et al. 2011. Dietary fibre and fibre-rich by-products of food processing: Characterisation, technological functionality and commercial applications: A review. *Food Chem* 12(2): 411-421. https://doi.org/10.1016/j.foodchem.2010.06.077
29. Bolarinwa IF, Lim PT, Muhammad K. 2019. Quality of gluten-free cookies from germinated brown rice flour. *Food Res* 3(3): 199-207. https://doi.org/10.26656/fr.2017.3(3).228
30. Cheng YF, Bhat R. 2016. Functional, physicochemical and sensory properties of novel cookies produced by utilizing underutilized jering (*Pithecellobium jiringa* Jack.) legume flour. *Food Biosci* 14: 54-61. https://doi.org/10.1016/j.fbio.2016.03.002