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Alozie EN
Department of Home Science Hospitality Management and Tourism, Michael Okpara University of Agriculture, Umudike, Umuahia, Abia State, Nigeria

Okoronkwo KA
Department of Food Science and Technology, Abia State University, Uturu, Nigeria

Correspondence
Alozie EN
Department of Home Science Hospitality Management and Tourism, Michael Okpara University of Agriculture, Umudike, Umuahia, Abia State, Nigeria

Production of doughnut using pigeon pea (*Cajanus cajan*) blend with wheat flour

Alozie EN and Okoronkwo KA

Abstract
This study examined the potentials of Pigeon pea (*Cajanus Cajan*) blended with wheat flour in production of doughnut. The proximate, vitamin, organoleptic properties and functional properties of the doughnut was assayed. The nutritional and health benefits of pigeon pea were verified while the sensory evaluation was conducted using 20 panelists and the result showed that there is significant variation ($p<0.05$) in taste, flavour, texture, appearance and general acceptability of the doughnut. Also, the result indicated that there is high acceptability of the doughnut. Consequently, this blend (50:50) have greater promise for increased use of under-utilized food crops like pigeon pea and subsequent elimination of wheat importation in Nigeria.

Keywords: doughnut, pigeon pea (*Cajanus cajan*), wheat flour

Introduction
It is believed that snack products of which doughnut is one of them have been associated with 'empty calorie or "junk", it therefore becomes a worthy research to investigate the addition of pigeon pea to the product so as to improve the nutritional value of doughnuts. The physical and psychological consequences of protein energy malnutrition has been referred to as the most serious problem in Nigeria, while many consumers today are challenged to find wide solution of these food variety to be available at all times (Nam, 1997). However, this problem has been proved to be solved by the use of locally available raw materials such as cereals and legume products to improve the nutritive value in the diet. Therefore, pigeon pea and wheat flour blend in right proportions is a balanced diet with amino acids as well as improved nutrient and energy intake.

Materials and Methods
Sample Collection
The food items used for this study were pigeon peas and wheat flour purchased from Ogbete market, Enugu State. Industrial sugar, margarine, nutmeg, salt, vegetable oil, powdered milk and yeast were purchased from Ubani market, Umuahia, Nigeria.

Area of Study
Home Science/Hospitality Management and Tourism laboratory in the College of Applied Food Science and Tourism (CAFST), Michael Okpara University of Agriculture, Umudike, Abia State was used.

Population of Study
The population of this study was fourteen lecturers from different departments in CAFST and forty final year students of Home Science department. This amounted to 54 personnel.

Sample and Sample Techniques
Twenty (20) panelist formed the sample size of the study. They were chosen using random sampling techniques.

Instrument for Data Collection
A nine point hedonic liked scale questionnaire was used to determine the organoleptic

properties of the samples.

9 - like extremely
8 - like very much
7 - like moderately
6 - like slightly
5 - Neither like nor dislike
4 - Dislike slightly
3 - Dislike moderately
2 - Dislike very much
1 - Dislike extremely

Sample Fomulation

Six samples of doughnuts were produced for sensory evaluation. The first sample coded (A) was 90% pigeon pea flour and 10% wheat flour doughnut, the second sample coded (B) was 80% pigeon pea and 20% wheat flour doughnut, the third sample coded (C) was 70% pigeon pea and 30% wheat flour doughnut, the forth sample coded (D) was 60% pigeon pea and 40% wheat flour doughnut, the fifth sample coded (E) was 50% pigeon pea and 50% wheat flour doughnut and the sixth sample coded (F) was 100% wheat flour doughnut and it served as the control.

Formulation of Composites

Pigeon pea flour (PPF) and wheat flour (WF) was blended in the ratio of 50:50.

Doughnuts was produced from graded levels (10, 20, 30, 40 and 50%) of composite flour (PWF) and used further for production of doughnut.

Composite flour blends prepared from pigeon pea flour and wheat flour

Wheat Flour (WF) (%)	Pigeon Pea Flour (PW) (%)
10	90
20	80
30	70
40	60
50	50
100	0

Development of Products

Six different samples were developed from the flour blend.

Production of Doughnut/Ingredients:

500g of plain flour blends
2.5 tablespoons of instant dry yeast
5 table spoons of warm water
25g of melted Butter
1 large egg
180ml warm milk
50g sugar
1 tea spoon of salt

Preparation of Doughnut

In a small bowl, yeast, 3 tablespoonful of flour, 5 table's poonfuls of warm water were added and mixed together. They were covered and left in a warm place to rise, double and begin to form small bubbles. Product was set aside into another large bowl and the remaining flour, sugar and salt were added and mixed very well.

At this point the egg, warm milk, melted butter and the yeast batter (starter) were introduced and mixed thoroughly for about 10 minutes. The sticky dough was folded into a rough ball and placed in greased bowl. It was covered with a clean napkin/nylon, tilted to one side and left for about 1 hour until the dough doubles in size.

When the dough has risen, it was placed on a floured table; flattened with the palm and a little flour was rubbed on the sticky flattened dough. Using a biscuit cutter, the flattened dough was cut into doughnut rounds. A syringe (without the needle) was used to fill the doughnuts with jam. The doughnuts was left to rise for another 20 minutes before frying, to get a very large sized doughnut. Heat was applied to the oil until very hot to about 180^0. Oil test was performed by dropping a little of the dough in the oil, to see how fast it will fry. Finally, the doughnut was rolled in sugar or any glaze of choice.

Determination of Moisture Content

The moisture content of the sample was determined by the gravimetric method as described by Bradley (2003).

$$\text{\% moisture} = \frac{W2 - W1}{W2 - W3} X \frac{100}{1}$$

Where:
W1 = weight of empty moisture can
W2 = weight of moisture can + sample before drying
W3 = weight of moisture can + sample after drying to constant weight.

Determination of Crude Protein

The protein content of the sample was determined by the Kjedahl method as describe by Slang (2003).

The nitrogen and protein content was calculated thus:

$$\% \ N_2 = \frac{100}{W} X \frac{14}{1000}$$

Where:
W = weight of sample analyzed = 0.5g
N = Normality of titrate (H_2S0_4) = 0.02N

Determination of Crude Fiber

This was determined by the Weende method described by Bemicar (2003)

$$\text{\% Crude fiber} = \frac{W2 - W3}{W_1} X \frac{100}{1}$$

Where:
W1 = weight of sample
W2 = weight of crucible + sample after drying
W3 = weight of crucible + sample ash (after ashing).

Determination of Carbohydrates

The carbohydrate content of the test sample was determined by estimation using the arithmetic difference method described by Bemiller 2003.

The carbohydrate was calculated and expressed as the nitrogen free extract (NFE) as shown below:

% CHO (Nitrogen free extract) = 100-% (a + b + c + d)

Where:
A = protein
B = fat
C = ash
D = fiber

Determination of Minerals

The mineral content of the sample was determined by the dry ash acid extraction method described by Udo and Ogunwale (1986).

Determination of Calorific Content

The value obtained for protein, fat and carbohydrate was used to calculate the calorific content value of the sample as expressed below:

Protein content (%) = P Fat content (%) = F Carbohydrate content (%) = C Calorific value (Kcal /100g) P x 4.0 + F x 9.0 + C x 3.75

3.9.9.1 Fat content Determination

The continuous solvent extraction method using soxhlet extractor described by Min and Buff (2003) was adopted.

The fat content was determined by weight difference of each sample and expressed as a percentage of each weight of sample as shown below

$$\% \text{ Fat} = \frac{W2 - W3}{W2 - W1} \times \frac{100}{1}$$

Where:

W1 = Weight of empty filter paper

W2 = Weight of paper + sample before defatting

W3 = weight of paper +sample after defatting and drying.

3.9.9.2 Determination of Vitamin (Riboflavin)

Exactly 5m1 of each sample was dispersed in l00mls of 5% ethanol solution in distilled water. The mixture was shaken for an hour mechanically and filtered. An aliquot (10mls) of the filtrate was mixed with an equal volume (l0mls of 5% potassium permanganate ($KMnO_4$) solution and 10mls of 30% hydrogen peroxide solution (H_2O_4) was added to it. The above treatment was also given to a 10ml portion of standard riboflavin solution as well as a reagent blank and sample were allowed to stand over a water bath for half an hour and 2mls of 40% $NaSO_4$ solution was added to each of them. This was made up to 50ml in a volumetric flask. Their respective absorbance (sample and standard) were measured in spectrophotometer at 510nm wavelength. Readings were taken the reagent blank at zero. Riboflavin content was calculated as:

$$\text{Riboflavin mg/100g} = 100 \; X \frac{Au}{W} X \frac{Cx}{As} VF \frac{xD}{V}$$

Where:

V = Volume of sample

W = Weight of sample analyzed

Au = Absorbance of sample

As = Absorbance of standard solution

C = Concentration of standard solution

Vf = Total volume of filtrate

VA = Volume of filtrate analyzed

D = Dilution factor where applicable

Determination of Functional Properties

Determination of Bulk density

The bulk density of the flour sample was determined by the method of Okaka and Potter (1979).

Determination of Water Absorption Capacity (WAC)

This was determined using the method of …... (1974).

Determination of swelling capacity

The method described by Ukpabi and Ndimele (1990) was used.

Statistical Analysis

The experiment was laid out in a completely randomized design (CRD). Data was subjected to Analysis of variance (ANOVA) using statistical package for social sciences (SPSS). Duncan's new multiple range test (DNMRT) was used to compare the treatment means. Statistical significance was accepted at $p<0.05$ (Steel and Torre, 1980).

Results and discussions

Table 1: The nutrient composition of the doughnut from different blend

	% Mc	% Protein	% Fat	% Fiber	% Ash	% CHO	EV
A	$11.18^{b} \pm 0.35$	13.07^{a}	17.4^{a}	1.87^{a}	2.63^{a}	53.83	424.32^{a}
		±0.10	±0.16	±0.01	±0.02	±0.39	±4.09
B	11.47	11.84^{b}	16.89	1.63^{b}	2.49^{b}	55.66	422.01^{a}
	ab	±0.09	a	±0.01	±0.04	bc	±5.82
	±0.01		±1.13			±1.13	
C	11.49	10.90^{c}	16.48	1.35^{c}	2.47^{bc}	57.29	421.12
	ab	±0.19	a	±0.01	±0.01	b	a
D	11.44	9.57^{d}	15.53	1.13^{d}	2.41^{c}	60.10	416.81^{a}
	ab	±0.10	a	±0.01	±0.04	a	±13.46
	±0.05		±2.72			±2.81	
E	11.53	8.88^{e}	16.08	1.02^{e}	2.41^{c}	60.08	420.59^{a}
	a	+0.08	a	+	+0.06	a	+3.05
F	+0.06	9.40^{d}	+0.61	0.03	2.94^{e}	+0.57	480.46^{b}
	11.01	±0.10	3.66^{d}	1.18^{c}	±0.34	83.70^{f}	±0.02
	+0.02		+0.50	+0.20		+1.4	

Values are mean ± standard deviation of two replications. Means with the same superscripts (abcdef) in the same column are not significantly different. Means with different superscripts in the same column are significantly different.

90% Pigeon pea flour and 10% wheat flour doughnut

80% Pigeon pea flour and 20% wheat flour doughnut

70% Pigeon pea flour and 30% wheat flour doughnut

60% Pigeon pea flour and 40% wheat flour doughnut

50% Pigeon pea flour and 50% wheat flour doughnut

100% wheat flour doughnut.

Table 1 showed that the products contains protein ranging from 8.88 to 13.07. The test sample (A) had the highest protein (13.07) that was significantly different (p<0.05) from the rest as well as the control (9.40).

Wheat like other cereal is deficient in lysine while legumes are deficient in methionine and cystein but high in lysine, hence legumes complement cereals effectively. This report validates those of Odunfa, 1985; Dhingraand, 2005; Onoja and Obizoba, 2010. The carbohydrate value of doughnut produced from flour blend ranged from 53.83 to 60.08 though lower (p<0.05) than the control (83.70%). The high content of carbohydrate in the doughnuts might be ascribed to the individual food materials. The control had the highest (83.70) and the value for the test doughnut ranged from 53.83-60.08 Which were significantly different (p<0.05) from the control (83.70). The high lipid level is good and acceptable because lipids perform several biological functions. Lipids are storage compounds, triglycerides serves as reserved energy of the body. Lipids are important for cell membranes structure in eukaryotic cells. They serve as source for fat soluble vitamins A, D, E and K.

Table 2: The vitamins composition of doughnut from different blend

	Vit A	Vit	Vit	Vit	Vit C
		B1	B2	B3	
A	126.08	1.12^{a}	0.04^{a}	0.45^{a}	1.88^{a}
	^{a}	±0.01	±0.0	±0.37	±0.10
	±0.60				
B	115.00	0.10^{a}	0.03^{b}	0.20^{a}	1.52^{a}
	^{b}	±0.01	±0.01	±0.00	±0.09
	±0.62				
C	89.23^{c}	0.61^{a}	0.21^{a}	0.28^{a}	1.52^{a}
	±0.36	±0.04	±0.16	±0.28	±0.09
D	76.78	0.03^{a}	0.02^{b}	0.13^{a}	1.41^{a}
	^{d}	±0.03	±0.01	±0.00	±0.00
	±0.00				
E	65.20^{e}	0.27^{a}	^{b}	0.24^{a}	1.35^{a}
	±0.35	±0.36	±0.01	±0.19	±0.10

Table 2 presents the mean mineral composition of the doughnut. The result showed that vitamin (A) is high compared to other (B) vitamins. Consequently, it is good and recommended for good sight.

Table 3: Sensory score of doughnut from pigeon pea flour bled with wheat flour

Samples	Taste	Appearance	Flavor	Texture	General
A	3.90^{bc}	4.85^{ab}	4.15^{b}	4.70^{ab}	4.50^{b}
	±1.77	±1.79	±1.93	±1.87	±1.79
B	3.70^{c}	4.15^{b}	3.95^{b}	4.00^{b}	4.25^{b}
	±2.52	±2.06	±2.33	±2.29	±2.07
C	5.15^{ab}	5.40^{a}	5.95^{a}	5.65^{a}	5.80^{a}
	±1.84	±1.43	±1.67	±1.95	±1.58
D	5.00^{bc}	5.70^{a}	4.70^{ab}	4.50^{ab}	5.70^{a}
	±2.03	±1.38	±1.81	±1.99	±1.56
E	5.40^{a}	5.90^{a}	5.45^{a}	5.20^{ab}	5.70^{a}
	±1.85	±159	±1.85	±2.19	±1.9
F					

Table 3 presents the mean sensory evaluation scores of the doughnuts. The judges observed that the doughnut from the test sample E blend had much higher organoleptic attribute (flavor, taste, appearance, texture and general acceptability) than those from other test samples. There was however, significant difference (p<0.05) in the texture between the test sample and the control. Although the sensory attributes of doughnuts from those of the control and other test blend, were lower than those of the control, they were however acceptable. There was a significant difference (p<0.05) in the degree of panelists neither liked nor disliked the doughnuts from test sample C, D, and E.

Conclusion

This study will afford a unique opportunity to families and the food industry on the utilization of pigeon pea in production of varieties of foods.

It will help families and snacks food industries in the production of nutritious snacks food which will no longer be seen as empty calories or junks.

Also, it will improve the acceptability of pigeon pea flour due to its nutritive and health benefits, thereby encouraging the consumption of snacks foods by children and adults of all age.

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