

## CHEMICAL AND SENSORY EVALUATION OF SOY-FORTIFIED CASSAVA-WHEAT BISCUIT

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### ABSTRACT

*This study evaluated the effect of substituting 20% cassava flour fortified with 5%, 10% and 20% of fermented and blanched soy flours for wheat flours in biscuit production. Cassava roots, fermented and blanched soy bean seeds were processed into flours. Biscuits were baked from blends of 20% cassava flour, 75%, 70% or 65% wheat flour and 5%, 10% and 15% soy flours. Control samples were baked with 100% wheat flour. Chemical and sensory qualities of flours and biscuits were evaluated. Soy flours had highest protein and fat contents among flour samples. Fermented (24 hours) soy flour had 46.28% protein and 24.05% fat while blanched soy flour had 26.40% protein and 21.80% fat indicating increased nutritive value for fermented soy flour. Cassava flour had the least protein content of 4.9 % but highest carbohydrate content of 74.04%. Protein and fat contents of biscuits increased with increasing soy fortifications. Substitution with cassava flour did not adversely affect qualities. Sensory scores indicated high acceptability for treated biscuit samples.*

**Key word:** Soy flour, cassava flour, quality evaluation, biscuits

### INTRODUCTION

Biscuits constitute major component of human snacks in most part of the world. It is an unleavened crisp, sweet pastry made from wheat flour, shortening (hydrogenated fat) and sugar, and is usually made light by the addition of baking powder (a mixture of sodium carbonate, sodium bi phosphate and cereal flour) (O'Brien *et al.*, 2003). Wheat flour constitutes the basic ingredient for biscuit production because of its gluten proteins, which are not present in flours of other cereals (Kent, 1975). Gluten protein forms elastic dough during baking and gives high organoleptic quality to the finished product (Ihekoronye and Ngoddy, 1985). Unfortunately wheat production is low in Nigeria due to poor climatic condition unfavourable to the crop. Also wheat flour is low in the much-needed protein, particularly the essential amino acids to replace the costly animal protein. In attempts to reduce cost and increase protein content, fortification with legume flours in pastry production have long been advocated, and many researchers have ventured into this field. Flours of common legumes like pigeon pea, cowpea, *Azalia Africana* and soybean have been investigated (Okaka and Ishieh, 1990; Onweluzo *et al.*; 1995). Soybean was shown to be extremely rich in nearly all the essential amino acids needed by man (Cook and Briggs, 1977). Soybean has presently become relatively scarce and expensive. Fortunately,

Nigeria is potentially endowed with root crops particularly cassava which is cheap and used as staple food in most homes. This work was designed to economically complement and fortify wheat flour and cassava with fermented or blanched soy flours for biscuit production.

### MATERIALS AND METHODS

**Materials:** Fresh cassava roots (*Manihot esculenta Crantz*) were purchased from a local farmer in Doma market while soy bean seeds (*Glycine max*), wheat flour (golden penny brand), sugar, hydrogenated fat, condensed milk powder, salt and baking powder were purchased from commercial stockers at Lafia main market, all in Nasarawa State, Nigeria. All laboratory reagents used were of analytical quality.

**Processing of cassava flour:** Cassava roots were peeled, washed and sliced into cubes, which were sulphited in 1% sodium metabisulphite solution for 1min according to the method of Kordyles (1990). Cubes were rinsed and then soaked in excess volume of clean water for 24h at room temperature (27±1 °C) with 8 hourly changing of soak water. Cubes were washed, sun dried for 6 days and then oven dried (Gallenkamp, England) at 50°C for 16h to equilibrate moisture. Cubes were milled in a hammer mill (Retch 5657, GmbH, German) and sieved through a metal sieve of pore size 160 µm. Flours were wrapped in black polythene bags and

stored in airtight containers at room temperature ( $27 \pm 1^{\circ}\text{C}$ ) until when used

**Processing of soybean flour:** Clean sorted soybean seeds were batched into 2 samples of 500g each for different pre milling treatments. One sample was fermented by soaking in excess clean water with 6 hourly changing of soak water for 24h, after which seeds were dehulled manually, drained, washed and rinsed with clean water. A second sample was blanched by soaking in boiling water containing 2% Natron trona, for 5 minutes. It was then washed and rinsed with clean water. Both samples were sun dried for 5 days before being equilibrated for moisture in hot air even (Gallenkamp, England) at  $50^{\circ}\text{C}$  for 5h. Samples were milled in a hammer mill (Retsch5657, Germany) and then sieved through a metal sieve of pore size  $160\mu\text{m}$ . Flours were wrapped in black polythene bags and stored in airtight containers at room temperature ( $27 \pm 2^{\circ}\text{C}$ ) until when used.

**Flour blends and production of biscuits:** Wheat, (Golden penny brand), cassava and soy flours were each sieved through a metal sieve of  $160\mu\text{m}$  pore size before being batched into different blends. The control samples contained 100% wheat flour. The experimental flour blends were composed of 20% cassava flour; 75%, 70%, and 65% wheat flour; and 5%, 10%, and 15% fermented or blanched soy flours respectively. The blend are shown in Table 1. Each blend was mixed homogeneously in a rotary mixer.

The biscuit recipe contained 500g of flour, 150g of vegetable fat, 120g of sugar, 100g of condensed milk, 35g of baking powder (a mixture of cereal flour, sodium bicarbonate and sodium acid phosphate), 1.5g of vanilla and 235ml of water. Biscuits were baked according to the method of Rhona (1983) in the Food Laboratory of Home and Rural Economics Department, College of Agriculture, Lafia, Nasarawa State. Vegetable fat was rubbed into the dry ingredients and water added piece meal, as the dough is kneaded into stiff meal dough. Dough was rolled out into thin light sheet of about 0.6 cm on a sheeting board and then stamped out into heart shaped cuts of about 2.5cm in diameter. Cuts were then placed in thinly greased pans, covered with cheese cloth to proof for 20min before being baked, for about 30min at oven temperature of  $180^{\circ}\text{C}$

**Table 1: Flour blends for Biscuit**

**Production**

FLOUR LENDS (Ratio)	CASSAVA flour %	WHEAT Flour %	SOYBEAN (SOY) Flour
CW S (0:100:0)	0.00	100	0.00
CWS (20:75:5)	20	75	5.00
CWS (20:70:10)	20	70	10.00
CWS (20:65:15)	20	65	15.00

C=cassava flour, W= wheat flour S= soy flour

**Chemical analysis:** Moisture, crude protein, fat, fibre and ash were determined in duplicates by official methods (AOAC, 2000). Moisture was determined as loss in weight after heating in a vacuum oven for 4 h at  $105^{\circ}\text{C}$ . Nitrogen was determined by digestion analysis, and crude protein calculated from  $'\text{N} \times 6.25'$ , where N=nitrogen content. Crude fat was determined by ether extraction technique, using Soxhlet apparatus. Ash was determined as residual weight after heating in a muffle furnace at  $550^{\circ}\text{C}$  for 2hours. Calcium was determined as described by Onwuka (2005). The homogenized, dried sample material (1g) was weighed accurately and digested in 20ml acid mixture (650 ml conc.  $\text{HNO}_3$ , 80ml perchloric acid (PCA), and 20ml conc.  $\text{H}_2\text{SO}_4$ ) in closed tetrafluoro methaxil vessel of milestone MAS -1200 microwave (milestone Sr-L Sonisole B. G., Italy) digestion system. The digested sample was diluted with distilled water and enough  $\text{SrCl}_2$  solution containing 10,000 mg/ml  $\text{Ca}^{2+}$  to yield 1,500mg/ml of  $\text{Sr}^{2+}$  in the final solution. Using the appropriate wavelength and lamp of the Atomic Absorption Spectrophotometer (AAS),  $\text{Ca}^x$  was extrapolated from a calibration curve made from a standard by the method of Fiske and Sabbarrow as described by Onwuka (2005).

**Sensory analysis:**

A 20-member trained panelists of ages between 18-37years and comprising 14 females and 6 males were selected from 31 volunteers from staff and students of Faculty of Agriculture, Nasarawa State University, Keffi and College of Agriculture, Lafia, both in Lafia, Nasarawa State, Nigeria. The panelists were trained for 2 hours according to the spectrum methodology (Mellgaard *et al.*, 1999) to become familiar with predetermined definition and references to biscuit sensory attributes. Each attribute was scored based on its intensity scaled on a 9-point hedonic scale (1=disliked extremely, 2=disliked very much, 3=disliked moderately, 4=disliked slightly, 5=neither liked nor disliked, 6=liked slightly, 7 = liked moderately, 8 = liked very much, 9 = liked very extremely) for colure, flavor, mouth feel and texture.

**Statistical analysis:** All biscuit sample data were analyzed statistically. Completely randomized design (CRD) model was used for the experiment while the sensory scores were analyzed with GENSTAT computer software (GENSTAT, 2005) using the analysis of variance (ANOVA) mixed procedure (Mixed), and Fisher's least significant difference (F-LSD) to determine significant level at  $P < 0.05$  among treatments.

## RESULT AND DISCUSSION

### CHEMICAL COMPOSITION

The chemical composition of flours of cassava, wheat, and fermented and blanched soybean are shown in Table 2. Fermented soy flour had higher protein content (46.28%) of about twice but lower carbohydrate content (10.14%) of about thrice those of blanched soy flour (20.40% protein and 35.90% carbohydrate). Fermented soy flour also had increased contents of crude fibre(17.88%), fat (24.05%) and calcium(0.49%) than blanched soy flour which had 11.45% crude fibre, 21.80% fat and 0.38% calcium, but decreased content of moisture(3.43%) and phosphorus(0.80%) than blanched soy flour which had 3.99% moisture and 0.89% phosphorus. The changes were not unexpected. Some

of the complex polymers of the bean may have hydrolyzed to more simple units while the more soluble components may have solubilised and leached into water during fermentation (Achinewhu and Isichei, 1990).. Cassava flour had low crude fat (1.26%) and protein (5.50%) but very high carbohydrate content (73.77%). Cassava is naturally carbohydrate-giving food. The 73.77 % carbohydrate content of cassava is higher than that of wheat flour (56.91%). Wheat flour was low in crude fibre, fat, ash and protein contents. Fermentation known to improve the nutritive value and functional properties of many food products (Sharma and Caralli, 2004) is highly exhibited in the fermented soy flour whose protein content increased from 26.40% for the blanched sample to 46.28 %.

**Table 2: Chemical composition of flours**

	Moisture %	Protein %	Fibre %	Fat %	Ash %	CHO %	Ca %	P %
Fermented Soy flour	3.43 ±0.05	46.28 ±0.08	17.88 ±0.5	24.05 ±0.05	3.65 ±0.05	10.14 ±0.11	0.49 ±0.01	0.80 ±0.00
Blanched soy flour	3.99 ±0.02	20.40 ±0.00	11.45 ±0.05	21.80 ±0.65	4.45 ±0.01	35.90 ±0.00	0.39 ±0.01	0.89 ±0.00
Cassava flour	7.66 ±20.00	5.50 ±0.00	17.39 ±0.04	1.26 ±0.00	2.08 ±0.02	73.77 ±0.09	0.22 ±0.00	1.56 ±0.02
Wheat flour	13.70 ±0.14	12.93 ±0.04	2.60 ±0.00	2.94 ±0.02	1.89 ±0.01	56.91 ±0.01	0.41 ±0.01	0.92 ±0.02

Key: CHO=Carbohydrate, =Calcium, P Phosphorus Mean ± Standard Deviation

**Table 3: Chemical composition of biscuit samples**

	Moisture (%)	Protein (%)	Fibre (%)	Fat (%)	Ash (%)	CHO (%)	Ca (%)	P (%)
CWS 0:100:0	5.50 ±0.00	9.29 ±0.02	9.23 ±0.02	16.32 ±0.04	0.90 ±0.09	60.27 ±0.09	0.32 ±0.01	0.90 ±0.00
CWSF 20:75:5	3.38 ±0.02	9.31 ±0.01	7.21 ±0.07	17.32 ±0.00	0.94 ±0.00	65.63 ±0.00	0.34 ±0.01	0.89 ±0.08
CWSF 20:70:10	4.31 ±0.01	10.18 ±0.01	6.81 ±0.02	17.93 ±0.04	1.02 ±0.20	58.92 ±0.06	0.28 ±0.02	0.55 ±0.00
CWSF 20:65:15	2.84 ±0.02	10.43 ±0.00	5.29 ±0.01	18.79 ±0.04	0.09 ±0.1	58.60 ±0.00	0.24 ±0.04	0.08 ±0.00
CWSB.20: 75:5	4.90 ±0.01	12.91 ±0.01	3.41 ±0.00	19.31 ±0.20	1.00 ±0.04	57.31 ±0.80	0.26 ±0.01	0.90 ±0.01
CWSB20: 70:10	4.67 ±0.00	15.36 ±0.04	1.80 ±0.20	22.15 ±0.00	1.00 ±0.00	56.31 ±0.91	0.27 ±0.01	0.09 ±0.01
CWSB20: 65:5	3.89 ±0.09	18.64 ±0.30	1.04 ±0.02	23.89 ±0.02	1.37 ±0.01	50.89 ±0.09	0.26 ±0.02	0.07 ±0.02

CWS=Cassava, Wheat and Soy flours; CWSF=Cassava, Wheat and Fermented Soy flours; CWSB=Cassava, Wheat and Blanched Soy flours; Ca=Calcium, P=Phosphorus. Mean ± SD

**Table 4: Mean scores for sensory attributes of biscuits**

	Colour	Flavour	Mouth Feel	Texture	Over All Acceptably
C W S (0:100:0)	8 .08	7 .70 <sup>a</sup>	7 .85	7 .55 <sup>ab</sup>	7 .95
C W S B (20:75:5)	8 .00	7 .70 <sup>a</sup>	7 .50	8 .05 <sup>b</sup>	7 .30
C W S B (20:70:10)	8 .05	7 .30	7 .20	7 .30 <sup>a</sup>	7 .80
C W S B (20:65:15)	7 .75	7 .45	7 .75	7 .00 <sup>a</sup>	7 .80
C W S F (20:75:5)	8 .24	8 .50	7 .35	7 .05 <sup>a</sup>	7 .80
C W S F (20:70:10)	8 .15	8 .25	7 .40	7 .70 <sup>ab</sup>	7 .85
C W S F (20:65:15)	8 .20	8 .40	7 .65	7 .25 <sup>a</sup>	7 .95
AVERAGE MEAN	8 .06	7 .47	7 .53	7 .41 <sup>a</sup>	7 .78
SIGNIFICANCE	0 .34 <sup>ns</sup>	0 .88 <sup>ns</sup>	0 .33 <sup>ns</sup>	0 .03 <sup>*</sup>	0 .32 <sup>nes</sup>
L S D	0 .41	0 .79	0 .60	0 .68	0 .57
S E	0 .21	0 .40	0 .30	0 .34	0 .29
C V	2 .7	7 .9	5 .8	6 .0	4 .0

C= Cassava flour W= Wheat flour SB Blanched soy flour SF Fermented soy flour

## Chemical and Sensory Evaluation of Soy-Fortified Cassava-Wheat Biscuit

The chemical compositions of biscuits with or without 20% replacement with cassava flour, and 5%, 10%, or 15% fortification with soy flour are shown in Table 3. The moisture (5.50%) and crude fibre (9.23%) for the control decreased respectively to 4.31% and 2.84 % and to 7.21% to 5.29% for 5% and 15% fortification with fermented soy flour; and to 4.90% to 3.89% and to 3.41% to 1.08% for 5% to 15 % fortification with blanched soy flour respectively. Crude protein (9.29%) and fat (16.32%) contents for the control increased to 9.31% and 18.64% for 5% to 15% fermented soy flour, and to 17.32% to 23.89% for 5% to 15% blanched soy flour. The increased protein and fat contents of samples were due to fortification with soy flours, which are high in protein and fat. Conversely carbohydrate content decreased from 60.27% for the control to 57.31% and to 50.89% for 5% and 15% blanched soy flour. The differences in composition of the biscuit were expected due to the replacement of wheat flour with protein-rich soy and high carbohydrate cassava flours that have different contents of moisture, ash, protein, fat and carbohydrate, and responded differently to baking (Singh *et al.*, 1989). When wheat flour is replaced with soy and cassava flours, the nutritional value of the products appreciated while the cost reduced drastically.

**SENSORY ANALYSIS**

The sensory scores of biscuits evaluated by the trained panel are shown in Table 4. The colour, flavour, mouthfeel and overall acceptability of biscuits were not significantly affected by the 20% cassava flour and 5%, 10% or 15% soy flour replacements for wheat flour. However colour scores increased slightly while flavour and mouth-feel decreased slightly as the substitutes increased. This could be attributed to the compatibility and blending of cassava and soy flour mixtures in complementing wheat flour characteristics in the samples. Texture was significantly affected ( $P < 0.05$ ) by substitution with cassava and soy flours. Biscuit samples with 20% cassava and 5% soy flour substitutes differed significantly ( $P < 0.05$ ) from every other sample. As the proportions of soy flour in the blends increased from 5% to 10% and 15%, differences in texture among samples became minimal and non-significant. This further confirms the complementary functional compatibility of cassava and soy flours with wheat flours in baking. None of the sensory attributes had mean sensory scores significantly lower ( $P < 0.05$ ) than the grand mean scores for the samples. Biscuits with blanched or fermented soy flours had no noticeable differences in sensory scores except in chemical compositions.

The results suggested that soy and cassava flour could economically be used to replace wheat flour in biscuit production and could yield products of highly acceptable quality. Biscuits with soy and cassava flour were mostly higher in protein and were more acceptable than the whole-wheat samples. Supplementation of wheat flour with cassava and soy flours for biscuit production is advantageous. However modified recipes with either of reduced shortening or use of defatted soy flour or both are recommended for dietetic biscuits that would be consumed by anybody.

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