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CHEMICAL AND SENSORY QUALITY OF CAKES FORMULATED WITH WHEAT, SOYBEAN AND CASSAVA FLOURS

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ABSTRACT

The work investigated the effects of substituting 10%, 15% or 20% of sprouted or blanched soybean flour and 30% cassava flour for wheat flout in cakes. Peeled cassava roots fermented (24h) in excess water at 27±2^{0}C were rinsed out of water, sundried for 6 days and oven-dried (50^{0}C) for 16h before being milled into flour. Flour was sieved through sieves of 160µm pore sizes. Soybean sample (1000g) soaked in excess water at 27±2^{0}C for 16h was sprouted for 48h. Another 1000g of soybean sample was hot-water blanched (5minutes). Both sample were dehulled, sun-dried (6 days), and oven-dried (50^{0}C) for 16h. The soybean samples were milled into flour. Cake sample were baked from blends of 30% cassava flour, 60, or 50% wheat flour, and 10%, 15% 20% sprouted or blanched soybean flour. Control sample were baked from 100% wheat flour. The flours and cakes were analyzed for chemical composition while only the cakes were evaluated for sensory properties. Soy flours had the highest protein and fat contents with 42.15% protein and 25.88% fat for sprouted, and 21.80% protein and 23.93% fat for blanched samples. Sprouting improved protein and fat contents of soy flours. Increasing soy flour in cakes increased protein (and fat) contents of cake samples. Protein content of cakes with 100% wheat flour was 11.23% but increased to 12.13% and 13.08% for 15 and 20% sprouted soy flour substitution, and to 12.18 and 12.49% for 15 and 20% blanched soy flour substitution. Sensory scores indicated high acceptability for all the cake samples

KEYWORDS: Chemical composition, soy flour, cassava flour, wheat flour, cakes

Cakes are unleavened pasties made mainly from wheat flour, shortening, sugar, egg, milk and little or no baking power (a mixture of cereal flour, sodium carbonate and sodium bicarbonate). Cakes are enjoyed globally by both adults and children. The presence of gluten protein only in wheat makes wheat a unique ingredient for pastry products (Rhona, 1983). Gluten protein forms elastic dough with air sacks. Unfortunately wheat is expensive and is not produced in Nigeria due to the country's unfavourable climate of the crop. Wheat flour is also deficient in some essential amino acids needed by human.

Nigeria is endowed with root crops particularly cassava which is cheap and used as staple food many Nigerians. Cassava is however a starchy food crop. Soybean is exclusively high in protein (40%) and is the most nutritious of all the beans (Adedoya, 2001; Nwamarah 2005). Soybean protein has amino acid profile superior to other plant protein. About half of the carbohydrate content (20%) in soybean is crude fibre which suppresses many degenerative diseases in human.

Attempts have been made by many researchers to complement wheat flour with non-wheat flour, particularly legume flours for pastry product (Okaka and Isieh, 1990, Onweluzo et al., 1995). The amount of soybean consumed globally is currently relatively low; and there is increasing public interest for more utilization of the product because of its high dietary protein and many disease preventive properties. This work was poised to produce high nutrient and acceptable cakes made from complementary blends of wheat, cassava and soybean flours.

MATERIALS AND METHODS

Materials

Cassava roots (*Manihot esculenta crantz*) were purchased from Doma market while soybean seeds (*Glycine max*), wheat flour (Golden penny brand), and sucrose. Hydrogenated fat, eggs, vanilla and salt were purchased from Lafia main market, all in Nasarawa state, Nigeria. All laboratory reagents used were of analytical quality.

Processing of Cassava Flour

Cassava tubers were peeled, washed, with clean water, and diced into cubes which were sulphited for 2 minutes in 1% sodium metabisulphite solution, according to the method of Kordyles(1990). Cubes were rinsed out and

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soaked in excess volume of clean water at room temperature (27±2^{0}C) for 24h with 8 hourly changing of water. Cubes were washed severally with clean water, sun-dried for 6 days and then oven-dried at 50^{0}C for 16h. The sample was milled in a hammer mill (Retch 5657, GMbH, Germany) into fine flour, and sieved through metal sieves of 160µm pore size. Flours were wrapped in polyethylene bags and stored in airtight containers until used.

Processing of Soybean Flours

Dirt, stones, and immature seeds were sorted out of wholesome soybean seeds. Seeds were batched into 2 samples of 1000g each. One of the samples was soaked in excess cold water for 16h to activate the enzyme in the viable seeds for sprouting, and then washed out of the water. The seeds were then spread on a wire mesh placed on a plat form and covered with a muslin cloth. Fresh, cold water was sprinkled twice daily on the seeds which were allowed to spout for 48h. The sprouted seeds were dehulled, washed, sun dried for 6 days and then oven-dried at 50^{0}C for 6h to equilibrate moisture. Rootlets were then removed. The second sample was blanched (95-98^{0}C) for 5 minutes in excess boiling water containing 2% trona (Potash), drained and then manually dehulled. The seeds were sun-dried for 6 days and then oven-dried at 50^{0}C for 16h to equilibrate moisture. Both samples were milled in a hammer mill (Retch 5657, GmbH, SRGermany) into flour and sieved through a metal sieve of 160µm pore size. Flours were sealed in polyethylene bags in airtight containers, stored at room temperature (27±2^{0}C) until used.

Table 1: Flour blends for cake production

Flour blend sample (%)	Cassava Flour(%)	Wheat flour (%)	Soybean (soy flour (%)
WF	-	100	-
CWS_1	30	60	10
CWS_2	30	55	15
CWS_3	30	50	20
CWB_1	30	60	10
CWB_2	30	55	15
CWB_3	30	60	20

C= Cassava, F=Flour, W=Wheat flour, S_1 S_2 S_3 = 10%, 15%, 20% sprouted soybean flour WF=100% wheat flour. B_1, B_2 B_3 = 10%, 15%, 20% blanched soybean flour

Flour Blends for Cake Preparation

The flour blends from wheat, cassava and soy flours were as shown in table 1. The negative control sample had 100% wheat flour while other sample had 30% cassava flour and 10%, 15% or 20% of sprouted or blanched soy flours. Each sample was blended in a rotary mixer (Gallenkamp, England) to get a unified composite mix. Each of the flours was sieved through a metal sieve of 160µm pore size prior to blending.

Cake Making Procedure

The cake recipe was composed of 500g of flour, 200g of sugar, 8 whole eggs, 200g of butter, 150g of condensed milk, and 25g of baking powder (a mixture of cereal flour, sodium carbonate and sodium bicarbonate), 10g of vanilla and 10g of salt. The cakes were baked at the Food Laboratory, Home and Rural Economics Department, College of Agriculture Lafia, Nassarawa State, Nigeria. Cakes were baked according to the method of Rhona (1983). The sugar and butter were creamed together until light and fluffy. Vanilla essence was added, and the mixture creamed a little more. The eggs were broken and the liquid content beaten together for a while. This was added to the creamed mixture and beaten together. Then, the flour, baking powder and salt were sieved together, and folded alternately with the milk into the creamed mixture. This was creamed until smooth. The batter was then cut into round shapes and filled into prepared cake pens (greased with vegetable oil) to about 2/3 the can volumes. These were baked at oven temperature of 183^{0}C for about 45mins. After baking, cakes were cooled and then packed in tray pans, ready for chemical and sensory evaluations.

Chemical Analysis

Moisture, crude protein, fat, ash and fibre contents were determined by the Official Methods of AOAC (2000). Moisture was determined by difference in weight after heating in a vacuum oven at 105^{0}C for 4h or until constant weight was obtained. Crude protein was calculated from the formula, % Nitrogen x 6.25, after determining nitrogen content by digestion analysis. Crude fat was determined by the ether extraction techniques, using Soxhlet apparatus (All-Clevenger apparatus). Crude fibre content was obtained as the resulting dry residue after treating the defatted sample (2g) with 200ml of 0.225N H_2SO_4, and with 100ml of 2.5% of NaOH, solution. Ash was determined by calculating the net weight of a known sample after heating in a muffle furnace at 550^0C for about 2h, and then finding the percentage of ash in the samples. Calcium content was measured using Atomic Absorption Spectrophotometer (AAS) as described by Onwuka (2005). The homogenized, dry sample (1g) was digested by wet digestion method, using a mixture of 650ml concentrated nitric acid (HNO_3), 80ml perchloric acid and 200ml concentrated H_2SO_4 Calcium content was then extrapolated from a calibrated curve made from a standard solution containing 1000mg Ca^{+2}ions. Phosphorus was determined by the method of Onwuka (2005).

Sensory Analysis

Twenty trained panellists of ages between 20-46 years and comprising 12 females and 8 males were drawn from 38 volunteers from the staff and students of the Faculty of Agriculture, Shabu-Lafia campus, Nassarawa State University, Keffi, and college of Agriculture, Lafia, Nasarawa state, Nigeria. Prior to the selection, volunteers were interviewed to assess their knowledge about cake quality characteristics, and the degree of preference of their consumption of market cakes. The best 20 who showed high preference for consumption of market cakes, based on the number of consumptions per week, were selected and trained according to the spectrum methodology (Mellgaard et al., 1991). Predetermined sensory attributes of cakes were used for them to become familiar with definitions and references to these when tested. Each sample was rated on perceived intensities of standard sensory attributes (acceptability, flavour, texture and colour) using a 9-point hedonic scale with 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 and 9 = liked extremely. Scores were collated and analysed statistically.

Statistical Analysis

All the results were analyzed with SAS computer software (SAS; 2002 -2003). The analysis of variance (AVOVA) mixed procedure (Mixed) and Fisher's least significant difference (LSD) tests were carried out to ascertain significant effects at $P<0.05$ level of significance among treatments.

RESULTS AND DISCUSSION

Chemical Composition of Cassava, Wheat and Soybean Flours

Table 2 shows the chemical composition of fermented (24h) cassava flour, wheat flour and raw, sprouted (72h) or hot-water blanched (5mins) soy flours. Cassava flour had 73.77% digestible carbohydrate. The high carbohydrate content in cassava is not unusual as cassava has long been known as a carbohydrate-giving food.

Raw soybean flour had 35.7% protein, 30.82% digestible carbohydrate, 18.79% fat, 7.89% water, 4.42% ash and 2.35% fibre. Sprouting soybean increased protein (42.15%), fat (25.88%) and crude fibre (13.24%) but decreased digestible carbohydrate (14.19%) and ash (4.24%) contents. The increased protein, fat and crude fibre contents might be due to hydrolysis of complex organic polymers to simpler nutrients during sprouting (Osho and Adenekan, 1992). Also the decreased carbohydrate content in the sprouted soybean flour might be attributed to use of the nutrient as a readily available energy source during sprouting. Despite the increased protein (42.15%) and fibre (13.24%) contents in the sprouted soybean flour, moisture content was reduced (4.25%). This could be as result of the high fat content (25.88%) which may have blocked the water-binding sites of protein, and also due to higher proportion of water insoluble fibres in the crude fibres with how water-holding capacity in the sprouted soybean flour. Blanched soybean flour on the other hand had reduced protein (21.8%) and ash (3.58%) contents than the raw soybean flour but had increased digestible carbohydrate (38.48%) content. Part of the soluble crude protein may have leached into water during blanching but the increased digestible carbohydrate may be due to hydrolysis of complex polymers to simpler digestible carbohydrate. Raw soybean flour had 18 mg/g calcium and 27 mg/g phosphorus; blanched soybean flour had 46 mg/g calcium and 104 mg/g phosphorus, while sprouted soybean flour had 50 mg/g calcium and 78 mg/g phosphorus.

Table 2: Chemical composition of soybean, cassava and wheat flours

Flour samples	Moisture (%)	Crude protein (%)	Crude fibre (%)	Crude fat (%)	Total ash (%)	Carbohyd-rate (%)	Ca Mg/g	P Mg/g
Cassava flour	7.66±0.02	5.50±0.11	17.39±0.92	1.26±0.01	2.26±0.00	73.77±1.27	22±20	150±14.0
Wheat flour	13.70±0.11	15.40±0.23	2.54±0.03	2.94±0.00	1.92±0.03	59.5±1.03	31±3.0	92±2.0
Raw soybean flour	7.89±23	35.7±1.9	2.35±0.03	18.79±0.10	4.42±0.02	30±0.59	18±3.1	27±10
Sprouted soybean flour	4.25±0.01	42.15±2.11	13.24±1.00	25.88±1.23	4.24±0.01	14.19±1.03	50±30	78±2.0
Hot-water blanch soybean flour	3.83±0.01	21.80±2.01	12.25±1.00	23.93±1.17	3.58±0.02	38.48±1.19	46±40	104±1.0

Chemical Composition of Cake Sample

Table 3 shows the chemical composition of cake sample baked from 100% wheat flour, and composite flours of cassava (30%), wheat flour (60%,55%,50%) and sprouted or blanched soybean flour (10%, 15%, 20%). Substituting cassava and soybean flours for wheat flour affected chemical composition of cake samples. The control sample (WF) with 100% wheat flour had the least protein (11.23%), crude fibre (5.15%) and crude fat (20. 64%) but the highest carbohydrate (47.13%) contents. Substituting cassava and soybean flours for wheat flour increased crude protein, fat and fibre contents but decreased digestible carbohydrate content in the cake samples. Moisture content increased with increasing sprouted soybean flour but deceased with increasing blanched soybean flour in the cake samples in table 3.

Crude protein (11.23%) of the control cake sample increased to 12.13% and 13.03% in the samples with 15% and 20% substituted sprouted soybean flour; and to 12.4% and 13.81% in the samples with 15% and 20% substituted blanched soybean flour respectively. Also, crude fibre (5.15%) of the control cake sample increased to 11 03% and 13.14%, respectively in the samples with 15% and 20% substituted sprouted soybean flour. Substituting soybean flour for wheat flour to increase protein, crude fibre and fat in the cake samples is of health benefit to consumers. Protein is needed for physiological functioning and reducing protein-energy malnutrition; crude fibre is anti-diabetic while vegetable fat is a good source of energy and helps in absorption of most fat soluble vitamins and minerals (WHO, 2004; Okaka and Isieh 1990).

Table 3: Chemical composition of cakes made from wheat, cassava and soybean Flour blends

Flour composition code	Moisture (%)	Crude Protein (%)	Crude Fibre (%)	Crude Fat (%)	Total Ash (%)	Carbohydrate	Calcium (ca) (%)	Phosphorus (P) (%)
WF	14.30±1.11	11.23±0.77	5.15±0.88	20.64±1.82	0.85±0.04	47.13±2.23	0.28±0.00	0.01±0.00
CWS_1	16.06±1.14	11.27±0.88	9.63±0.68	24.42±1.90	0.86±0.01	40.18±1.30	0.24±0.01	0.11±0.02
CWS_2	16.00±1.08	12.13±0.87	11.03±0.71	26.38±1.68	0.85±0.01	33.70±1.05	0.20±0.00	0.13±0.01
CWS_3	15.9±1.33	13.08±1.01	13.14±0.81	27.89±1.33	0.98±0.00	23.11±1.03	0.26±0.02	0.13±0.02
CWB_1	13.41±0.98	12.49±1.02	11.18±0.84	22.01±1.87	0.73±0.02	40.09±1.52	0.23±0.00	0.11±0.00
CWB_2	12.67±1.00	12.18±1.03	9.13±0.50	22.49±2.00	0.78±0.04	40.3±2.00	0.21±0.02	0.09±0.00
CWB_3	14.40±1.07	13.81±1.03	13.81±0.79	21.87±1.55	0.81±0.000	34.94±1.82	0.26±0.04	0.10±0.00

C=Cassava flour S_1 S_2, S_3 = 10%, 15%, 20% sprouted soybean flour, B_1 B_2 B_3 = 10% 15% 20% blanched soybean flour

Carbohydrate content (47.13%) of the control cake sample deceased to 33.7% and 23.7% when prepared with 15% and 20% substituted sprouted soybean flour; and to 40.13% and 34.14% when prepared with 15% and 20% substituted blanched soybean flour respectively. The reduced carbohydrate content in the cake sample is vital to reduce the risk of diabetes resulting from high glycemic index. The nutrient content of the cake sample were improved with locally sourced cassava and soybean and their incorporation is advocated for more cake supply in the country.

Sensory Evaluation

Table 4 shows the sensory scores reported by sensory panellists who evaluated quality of the cake samples. The sensory attributes (colour, flavour, mouthfeel and texture) were not affected significantly ($P < 0.05$) by the 30% cassava flour, and 10% 15% or 20% soybean flour substitution for wheat flour in the cake samples. However sensory scores for colour and texture increased slightly with increasing soybean substitution. Sensory scores on a 9-point hedonic scale ranged from 7.85% to 8.60 for the sensory attributes evaluated and indicated high acceptability of the cake samples by the assessors. None of the attributes had score below the mean mark (4.5) of the maximum score (9) of the scale. Thus 30% cassava flour, and 10%, 15% or 20% soybean flour substitutions for wheat flour did not reduce sensory quality of the cake samples. The result suggested that soybean and cassava flour could economically be substituted for wheat flour in cake production to improve the nutrient content without reducing the sensory quality. Modified recipes with either of reduced shortening or use of defatted soybean or a combination of both are recommended for production of dietetic cakes acceptable to everybody.

Table 4: Mean score of sensory attributes of cake sample

Flour composition code	Colour	Flavour	Mouth Feel	Texture
WF	7.95	8.40	8.00	8.10
CWS_1	8.35	8.15	8.25	8.25
CWS_2	7.95	7.95	7.85	8.15
CWS_3	8.05	8.20	8.05	7.95
CWB_1	8.05	8.60	7.08	8.30
CWB_2	8.25	8.25	8.15	8.30
CWB_3	8.40	8.40	8.00	8.30
Grand mean	8.14	8.28	8.01	8.19
Significance	0.40^{NS}	0.04^{NS}	0.52^{NS}	0.25^{NS}
LSD	0.49	0.39	0.47	0.42

C= Cassava flour, S_1, S_2, S_3 = 10%, 15%, 20% sprouted soybean flour, B_1, B_2 B_3 = 10%, 15%, 20% blanched soybean flour, NS = No significant difference among treatments at ($P>0.05$)

CONCLUSION

The result showed that cake sample containing soybean and cassava flours were comparable in quality and acceptability to those made with 100% wheat flour. Cake samples containing cassava and soy flours had higher protein, carbohydrate and fat content than those made of 100% wheat flour. The cake samples were acceptable to the panellists in terms of colour, flavour, month feel and texture. From data obtained from this work, recipes containing cassava flour, full-fat or defatted soy flour and reduced shortening are advocated to produce more acceptable cakes of high quality for all age groups.

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