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Formulation of an Improved Nutritional Quality Composite Flour for Bakery Products Using Wheat and Sologold Sweet Potato

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ABSTRACT

The formulation of high nutritional quality composite flour for use in producing bakery products is essential and advantageous health wise to consumers of these products. Therefore in this study, various formulated ratios (0:100, 10:90, 20:80, 30:70, 40:60, 50:50, 60:40, 70:30, 80:20, 90:10, and 100:0 denoted as A2, B9, B8, B7, B6, B5, B4, B3, B2, B1 and A1 respectively) of wheat and sologold sweet potato flour were made. The pure wheat A1 and pure sologold sweet potato A2 served as basis of assessing the nutritional contribution of sologold sweet potato flour at various ratios with wheat flour. The proximate properties, mineral, vitamins and beta carotene were determined in the various ratios formulated. More so, the best blend was selected based on desirability index of the formulated composite flours. Results revealed that B6 (40% wheat and 60% sologold sweet potato) had the highest desirability index of 0.65164. Hence, was selected as the best blend (composite) flour. The nutritional profile of the chosen B6 sample are as follows: moisture content (10.12%), crude fiber (3.21%), ash content (2.61%), protein content (5.80%), oil extract (5.20%), NFE (74.10%), sodium (0.13mg/g), calcium (2.08mg/g), magnesium (0.07mg/g), potassium (2.14mg/g), vitamin C (0.30μg/g), Vitamin A (24.6μg/g) and beta-carotene content (27.5μg/g). This profile showed valuable positive impact of sologold sweet potato flour on the nutritional characteristics of the developed B6 composite flour. Comparison of the blend B6 with some existing formulated composite flours, revealed that the developed composite flour B6 will likely have added advantage to the well-being of those that will consume its bakery products. Thus the B6 Blend (composite) flour is recommended for use in baking.

INTRODUCTION

Flour plays a crucial role in baking. It provides structure, texture and flavour to baked goods. Also, it is the foundation of bread, cakes, cookies, pastries and other baked products (Tamaroh & Sudrajat, 2021). When wheat flour is hydrated and mixed, the gluten protein will form an elastic network. The network will trap gases produced by yeast or leavening agents. This leads to the rising of dough coupled with a light, airy texture in the baked goods (Aziz *et al.*, 2018; Oloniyo *et al.*, 2021). Flour is a staple ingredient in many food products; and wheat flour is the most widely used. However, the increasing prevalence of wheat-related allergies, dietary restrictions and the need for diversification in the food industry have prompted search for alternative sources of flour (Ahemen *et al.*, 2018; Tamaroh & Sudrajat, 2021). The potential sources of flour other than wheat include maize, rice, barley, sorghum, millet, oat, legume flours (such as soybean, chickpea, lentil), tuber flours (such as cassava, potato) and other locally available grains and pulses. Two or more sources of flour may be combined to harness the beneficial attributes of each component (Aburime *et al.*, 2020; Wang *et al.*, 2020). It also create a versatile and balanced flour blend that can be used in various food applications. The composition of composite flour can be varied to give the desired characteristics. (Azizi & Rao, 2005; Samia, 2013; Pycia & Ivanisora, 2020). Composite flour could be used in various food applications, including bread, biscuits, cakes, pastries, noodles, and other bakery and food products (Haruna *et al.*, 2018).

Chinelo & Nnenna (2016) studied the nutritional quality of bread made from composite flour that consist of wheat, sweet potato (yellow fleshed) and tiger nut flours. The findings indicated slight decrease in the protein content of the bread samples when sweet potato and tiger nut supplementation increases. More so, the crude fibre content was found to increase; but there was no significant change (P<0.05) in the ash and fat contents. Carbohydrate which was the major component ranged from 73.47– 79.42%. Awolu *et al.* (2017) investigated a composite flour that consist of rice, sweet potato and soybean flours. The result showed an increase in protein content above 10% when compared with 100% wheat flour. The composite (85.694% rice flour, 11.806% sweet potato and 2.5% soybean) and (95% rice flour, 2.5% sweet potato flour and 6.765% soybean), specifically had high levels of ash, fibre and protein contents. In addition, all the samples had carbohydrate content above 70 g/100g.

Fabian & Nwamaka (2016) evaluated the nutrient compositions of bread fortified with sesame seed. It was found that full fat and defatted sesame seed meal respectively had 31.28% and 46.00% carbohydrate, 23.07% and 29.9% protein, 31.05% and 11.89% fat, and 13.20% and 12.14% crude fibre. Fortification with sesame seed improved the nutrient composition and storage stability of the bread. The fortification with 20% full

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fat or defatted sesame seed flours respectively increased protein from 11.80% to 13.93% or 14.89%, crude fibre from 1.63% to 3.44% or 5.25%, fat from 0.15% to 6.80% or 3.85%, but decreased carbohydrate from 55.44% to 50.37% or 48.68%. Lee-Hoon *et al.* (2017) determined the chemical properties of VitAto potato flour (VitAto), orange-fleshed sweet potato flour (OFSP) and purple-fleshed sweet potato flour (PFSP). The VitAto, OFSP and PFSP were at 20% with wheat flour. The composite was used to produce sponge cake. Sponge cake without sweet potatoes flour served as control (WSPSC). The chemical properties of these prepared sponge cakes were determined. The proximate composition revealed that VitAto contained highest protein (4.59%) while PFSP had the highest ash (1.67%) and crude fiber (2.73%) content. Addo & Oyeleke (2004) evaluated the proximate compositions of orange fleshed sweet potato and red Bambara groundnut for possible application in the production of high protein and pro-vitamin A enriched snacks for consumers. The flour blends were formulated in ratio 60:40, 50:50, 40:60, 30:70 respectively for orange fleshed sweet potato and red bambara groundnut. The protein and fat were observed to increase from 12.95±0.05% (60:40) to 16.87±0.02% (30:70) and 2.17±0.03% (60:40) to 3.05±0.04% (30:70) respectively. Ash and carbohydrate decreased from 2.52±0.04% (60:40) to 2.27±0.05% (30:70) and 60.38±0.44% (30:70) to 69.09±0.30% (60:40) respectively.

However, one of the varieties of potato that seems to be essential for utilization as a blend with wheat is sologold sweet potato. This is due to its high nutritional composition, functional properties and sensory attributes (Adegunwa *et al.*, 2017). The nutritional composition of sologold sweet potato includes macronutrients (carbohydrates, proteins, and fats) and micronutrients (vitamins, minerals, and antioxidants). These specific attributes makes sologold sweet potato an attractive ingredient for composite flour formulation (Amandikwa *et al.*, 2015). The utilization of Sologold sweet potato will reduce food waste and also enhance its potential application in baked products. Generally, composite flour offers significant advantages in bakery products in terms of improved nutritional profile, enhanced technological properties and economic viability (Liu *et al.*, 2020; Obomeghei *et al.*, 2020). Therefore, this study is aimed at formulating composite flour from Sologold sweet potato and wheat to have an improved nutritional qualities for bakery products.

MATERIALS AND METHODS

Equipment and Sourcing of Materials

The major material used for this study was fresh sologold sweet potatoes, which was collected in Nigeria from National Root Crops Research Institute Umudike, Abia State and wheat flour (Dangote brand). The equipment used were hammer mill, mechanical sieves, electronic weighing balance, stop watch, electronic dough mixer, electronic PH meter, desiccators, stirrer, volumetric flasks, pipettes, beakers, crucibles, bowls, soxhlet apparatus, digestion flask, rapid visco-analyzer, ultraviolet/infrared and spectrophotometer.

Production of Sologold Sweet Potato Flour

Twenty kilograms (20kg) of fresh sologold sweet potato tubers were washed thoroughly, drained and peeled. The tubers were chopped to chips of 5mm thickness and then soaked in 2.5% Sodium Metabisulphate for 30 minutes. The pre-treated sologold potato chips were drained and divided into one hundred and fifty grams (150g) each. The samples were then dried in hot air oven set at temperature of 55^0C. The samples were removed when constant weights were obtained in three consecutive readings. The dried chips were crushed and milled with hammer mill into flour. The milled flour was sieved to fine particle size range of 0.295 to 0.462 mm. The proximate properties of the produced sologold sweet potatoes flour were carried out.

Production of Wheat-Sologold Sweet Potato Flour Blend

The formulation of composite flour was carried out using completely randomized design (CRD) as shown in Table 1.

Table 1: Wheat-sologold sweet potato flour formulation

Samples	Flour Blend Ratio	SSPF (g)	WF (g)
A1	100% WF, 0% SSPF	0	300
B1	90% WF, 10% SSPF	30	270
B2	80% WF, 20% SSPF	60	240
B3	70% WF, 30% SSPF	90	210
B4	60% WF, 40% SSPF	120	180
B5	50% WF, 50% SSPF	150	150
B6	40% WF, 60% SSPF	180	120
B7	30% WF, 70% SSPF	210	90
B8	20% WF, 80% SSPF	240	60
B9	10% WF, 90% SSPF	270	30
A2	0% WF, 100% SSPF	300	0

SSPF= Sologold sweet potato flour, WF= Wheat flour

Determination of the Proximate Properties of Composite Wheat-Sologold Sweet Potato Flour

The composite flour proximate properties such as crude protein, moisture content, crude fat, crude ash, crude fiber and carbohydrate were determined as prescribed by AOAC (2016). All analyses were carried out in triplicates and the average values were recorded.

Determination of Moisture Content

Each sample (5g) were weighed into a porcelain dish of known weight and heated in a hot air oven at 105 °C for 3 hours. The samples were then cooled in a desiccator and weighed. The samples were consequently heated, weighed and cooled until a constant weight was attained. The formula used to calculate the moisture content was:

Moisture (g/100g) = $(W_2\text{-}W_3) / (W_2\text{-}W_1) \times 100$ (1)

Where:

W_1 = Weight of container + empty dish (g)

W_2 = Weight of container + sample before drying (g)

W_3 = Weight of container + sample after drying (g)

Determination of Ash Content

Sample 5 g was weighed into a porcelain crucible dish and then placed in a muffle furnace set at 550 °C for 5 hours until a white grey ash was obtained. The crucible was cooled in a desiccator and reweighed. The percentage ash content was calculated.

The formula used was:

Ash (g/100g) = $(W_3\text{-}W_1) / (W_2\text{-}W_1) \times 100$ (2)

Where:

W_1 = Weight of crucible

W_2 = Weight of crucible + sample before ash (g)

W_3 = Weight of crucible + sample after ash (g)

Determination of Crude Protein

Crude protein contents of the sample was determine using micro-Kjeldahl method. Each sample 2 g was weighed in a digestion flask. Tablet of Kjeltec catalyst was added to each flask containing 15 ml of concentrated sulphuric acid. Each flask was heated on pre heated digester set at 420 °C for about 30 minutes in a fume cupboard and digested until a clear homogenous mixture is obtained. After digestion, the flask was removed from the heater, cooled and the content diluted with about 50 ml of distilled water. The flask was then placed in the micro-Kjedahl analyzer (distillation unit) where it received 50 ml of 40% NaOH automatically. The mixture was subsequently heated up to release ammonia which was distilled into a conical flask containing 25 ml of 2% boric acid for about 4 minutes. Addition of mixed indicator; Bromocresol green and methyl red during the distillation process, the ammonia combined with boric acid form ammonium borate solution which was then titrated against 0.1 M hydrochloric acid until a purplish-grey end point was attained. The percentage nitrogen was calculated. The % crude protein was obtained by multiplying % g nitrogen by a factor of 6.25.

Crude protein (g/100g) = % nitrogen x 6.25 (3)

Determination of Crude Fibre

Crude fibre was determine according to the method of Owoso *et al*., (2000). Each of the sample (2g) was diluted in 100 ml distilled water in a conical flask 20 ml of 1.25% sulphuric acid was added and boiled gently for 30 min. The sample was then cooled and filtered. The filtrate was subjected to treatment using 1.25% sodium hydroxide. The residue was washed with 20 ml of ethanol and petroleum ether and then dried at 150 °C. The sample was weighed and ashed at 600 °C for 90 minutes, cooled and reweighed and the percentage of crude fibre was calculated.

Determination of Oil Extract

Oil extract was determine using the Soxhlet extractor with a reflux condenser and a distillation flask (previously weighed). 2g each of the samples was weighed into a fat free extraction thimble plugged with cotton wool and placed in the appropriate chamber of the extractor. The distillation flask was filled to two third capacities with petroleum ether and boiled on a heating mantle; the refluxing continued until the extractor siphones over 4 hours. Thereafter, n-hexane was recovered into a clean container until almost all was distilled out of the distillation flask. The remaining solvent in the mixture without the oil in the distillation flask was evaporated by introducing distillation flask to an oven set at 70 °C. The flask was allowed to cool subsequently in a desiccator after which the final weight of the flask was determined. The difference in the final and initial weight of the distillation flask represents the oil extracted from the sample.

Determination of Carbohydrate (Nitrogen free extract)

The % carbohydrate content (Nitrogen free extract) was calculated by differences:

Carbohydrate (%) = 100 – (% moisture + % ash content + % crude protein + % crude fibre + % crude fat). (4)

Determination of Vitamins and Beta-Carotene of Composite Wheat-Sologold Sweet Potato Flour

The determination of vitamins and beta-carotene of composite wheat-sologold sweet potato flour blends were carried out using AOAC (2016). 10 grams each of the flour samples were weighed using analytical weighing balance. Each sample was then transferred to a clean, dry container and kept covered to prevent moisture absorption. 60% ethanol was used as solvent for extraction of vitamins. 100 mL of the solvent was added to 2grams of each flour sample. The mixture was stirred thoroughly for 5 minutes and thereafter allowed to settle for 30 minutes. The mixture was then centrifuged at 3000 rpm for 10 minutes to separate the liquid extract from solid particles. Series of standard solutions of vitamin A, vitamin C and beta-carotene were prepared with known concentrations. Spectrophotometer was used to measure the absorbance of each standard solution at specific wavelengths relevant to each vitamin. Calibration curves were plotted for each vitamin by plotting the absorbance values against the corresponding known concentrations. The concentrations of vitamin A, vitamin B, and beta-carotene in each flour sample was obtained from the calibration curves. The results were expressed in micrograms per gram to quantify the level of each vitamin in each flour sample.

Determination of the Minerals in Wheat-Sologold Sweet Potato Composite Flour

The determination of the mineral's composition in wheat-sologold sweet potato flour blends was carried out using AOAC (2016). 5grams of each flour sample was weighed using analytical weighing balance. The flour sample was transferred into a digestion vessel followed by addition of 100mL concentrated nitric acid. The digestion vessel was covered and heated using a Bunsen burner until digestion was completed and thereafter allowed to cool to room temperature. The digested sample was then transferred to a volumetric flask and diluted with deionized water to 500mL; then mixed thoroughly to ensure homogeneity. The diluted sample was filtered and the undissolved particles discarded while the filtrate was collected in a clean container. The atomic absorption spectrophotometer was used to obtain calibration curves for each of the mineral to be tested in the sample. The absorbance or emission intensity of the diluted and filtered sample was measured and used to determine the concentration of each mineral based on the calibration curve. Calculation of the mineral content in each flour sample was done by multiplying the concentration of each mineral element by the dilution factor and the weight of the original sample. The results were expressed in milligrams per gram of each flour sample.

RESULTS AND DISCUSSION

Proximate Composition of Wheat-Sologold Sweet Potato Composite Flour

The proximate properties of the wheat-sologold sweet potato flour blends determined are as presented in Figure 1. The average moisture content of the flour samples

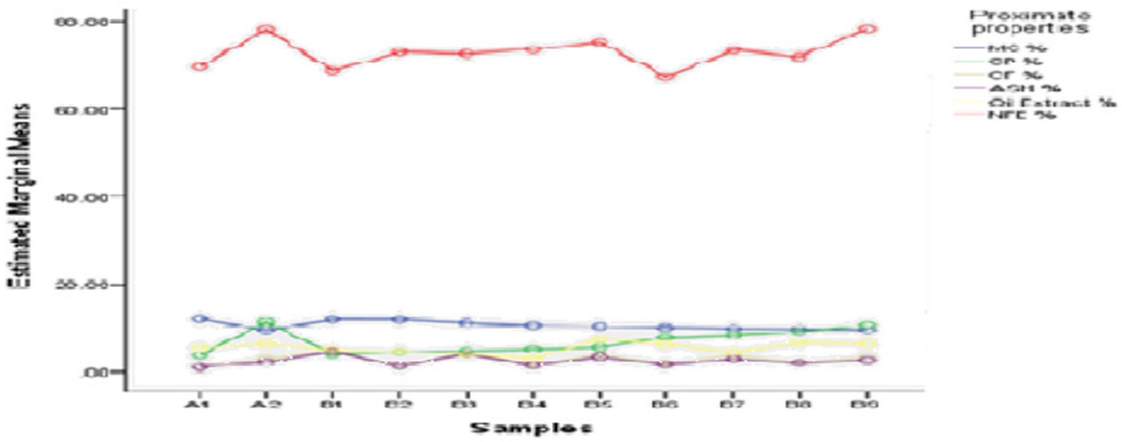

Figure 1: Proximate properties of wheat-sologold sweet potato flour blends

range between 9.60%- 11.90%. Sample B1 with 90.00% wheat flour and 10.00% SSPF recorded the highest value of moisture content (11.90%); while B9 with 10.00% wheat flour and 90.00% SSPF recorded the lowest value of 9.60%. The average moisture content of sample A1 (100% wheat and 0% SSPF) and sample A2 (0% wheat and 100% SSPF) were 12.02% and 9.52% respectively. However, flour with water activity range of 6-12% is considered as intermediate water activity flour. (Malomo *et al*., 2012). This implies that the composite could have reasonable life span before microbial spoilage. Moreover, the ash content of the composite flour samples is not significant ($p>0.050$) and ranges between 4.62% - 0.96% with blend A1 having lowest value (0.96%) and blend A2 highest value (4.62%). This shows that the sologold sweet potato flour supplies the blend with minerals. The average crude protein content of the flour blends ranges between 6.35% - 3.96%. Blend B1 (90.00% wheat flour and 10.00% SSPF) recorded the lowest value (3.96%) while blend B9 (90.00% wheat flour and 10.00% SSPF) recorded the highest value of 6.29%.

However, sample A1 (100% wheat and 0% SSPF) recorded average crude protein content of 3.76% while sample A2 (0% wheat and 100% SSPF) recorded 6.35%. This indicates that the major supplier of crude protein in the blend is sologold sweet potato. The average crude fibre content of the entire flour blends ranges between 4.08% - 1.31%. Blend B1 (90.00% wheat flour and 10.00% SSPF) recorded the lowest value (1.31%) while blends B9 (10.00% wheat flour and 90.00% SSPF) recorded the highest value (3.72%). However, sample A1 (100% wheat and 0% SSPF) recorded average crude fibre content of 1.03% and sample A2 (0% wheat and 100% SSPF) has 4.08%. Therefore, sample A2 (sologold sweet potato) is a good source of fibre and may compensate the deficiency in daily dietary fibre. According to Malomo *et al*., (2012) high content of dietary fibre has an impact on food by reducing the rate of glucose breakdown and absorption. The oil extract content of Blend B1 (90.00% wheat flour and 10.00% SSPF) was the lowest with value of 4.78% while blend B9 (10.00% wheat flour and 90.00% SSPF) recorded the highest value of 5.48%. However, sample A1 (100% wheat and 0% SSPF) average oil extract content of was 4.70% while sample A2 (0% wheat and 100% SSPF) recorded 5.63%. Oil extract is important since it enhances the organoleptic and preservative properties especially when available at optimum percentage. More so, analysis on Nitrogen free extract (NFE) in the composite flour showed that blend B6 with 40.00% wheat flour and 60.00% SSPF had the lowest value (74.10%) while blend B9 (10.00% wheat flour and 90.00% SSPF) recorded the highest value of 78.20%. The sample A1 (100% wheat and 0% SSPF) recorded average NFE of 77.55% and sample A2 (0% wheat and 100% SSPF) recorded 72.24%. The nitrogen free extract (NFE) indicates the presence of non-fibrous and soluble carbohydrate such as sugars and starches. Also samples with high NFE are more digestible than those with low NFE. Generally, based on the proximate composition of each blend, the composite flour B6 was considered and preferred to have good nutritional attributes. The statistical analysis of variance carried out on the proximate properties of the wheat-sologold sweet potato blends are presented in Table 2. From Table 2, the average moisture content of the flour blends is not significant (p>0.050). More so, average protein content of the flour blends showed that the difference in the protein content of the composite flour samples is significant (p ≤ 0.050). The average crude fibre content of the flour blends showed that the fibre content of the composite flour samples is not significant (p>0.050). Also, the average oil extract content of the flour blends is not significant (p>0.050). However, average nitrogen free extract content of the composite flour samples is significant (p≤0.050). This implies that the composite flour samples are soluble carbohydrates.

Table 2: ANOVA of the Proximate Composition of composite wheat-sologold flour

Composition		Sum of Squares	Df.	Mean Square	F	Sig.
MC	Between Groups	33.58208	24	1.399253	0.0690	1.6432
	Within Groups	.021	1	.002		
	Total		25			
Protein	Between Groups	115.4589	22	5.248133	13.1284	0.0358
	Within Groups	.076	1	.006		
	Total		23			
Ash	Between Groups	3.970558	24	0.016544	0.301059	0.5883
	Within Groups	.00	1	.000		
			25			
Crude fibre	Between Groups	2.264032	23	0.098436	0.0443	0.8554
	Within Groups	1.43	1			
	Total		24			
Oil extract	Between Groups	18.8314	1	0.856234	3.062318	0.4112
	Within Groups	0.5	22			
	Total		23			
NFE	Between Groups	194.1467	1	8.089446	6.487882	0.0372
	Within Groups	.001	24	.000		
	Total	1011.583	25			

Mineral Composition of Composite Wheat-Sologold Flour

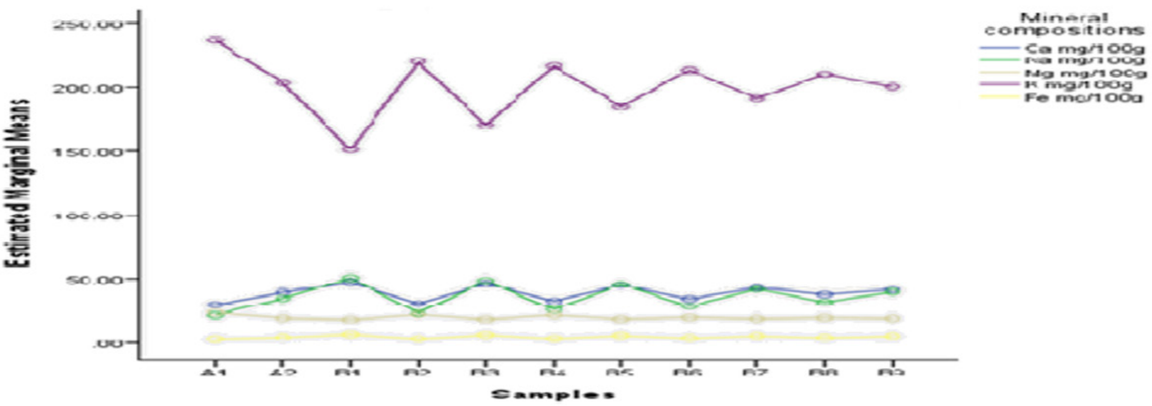

Figure 2: Mineral composition of composite wheat-sologold sweet potato flour blends

Table 3: ANOVA of the mineral composition of composite wheat-sologold flour

Composition		Sum of Squares	Df.	Mean Square	F	Sig.
Ca	Between Groups	314.58	1	9550.63	4.1909	0.029
	Within Groups	5	8	.02		
	Total	319.58	9			
Na	Between Groups	274.02	1	3277.81	3.6907	0.043
	Within Groups	5	8	.04		
	Total	279.02	9			
Mg	Between Groups	299.94	1	5198.80	9.4308	0.309
	Within Groups	5	8	.03		
	Total	304.94	9			
K	Between Groups	303.61	1	7158.7	4.0407	0.018
	Within Groups	5	8	.01		
	Total	308.61	9			
Fe	Between Groups	306.11	1	6301.55	1.5907	0.122
	Within Groups	5	8	.05		
	Total	311.11	9			

The mineral composition and its ANOVA for wheat-sologold sweet potato composite flour blends are presented in Figure 2 and Table 3 respectively.
The sample, (A1) with 100% wheat and 0% SSPF recorded low values of mineral compositions when compared with SSPF and the composite flour. This may be attributed to the high mineral content of SSPF. Also, the statistical analysis of variance showed that the magnesium and iron contents of the composite flour samples are not significant ($p>0.050$). Moreso, calcium, sodium and potassium contents are significant ($p\leq0.050$). The higher percentage of calcium, sodium and potassium in sologold sweet potato flour influenced the composite flour samples. Generally, blend B6 chosen based on proximate composition of the composite flour contains reasonable percentages of these minerals.

Vitamin Composition of Composite Wheat-Sologold Flour

The vitamin composition and ANOVA of composite wheat-sologold sweet potato flour blends are given in Figure 3 and Table 4 respectively.

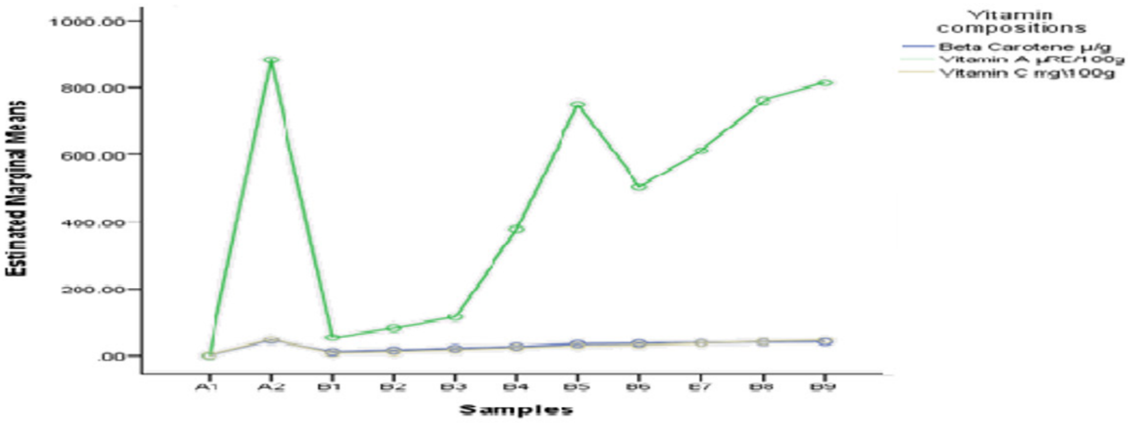

Figure 3: Vitamin composition of composite wheat-sologold sweet potato flour blends

Table 4: ANOVA of the vitamin composition of composite wheat-sologold flour

Composition		Sum of Squares	Df.	Mean Square	F	Sig.
Beta Carotene	Between Groups	938.98	3	94965.6	0.772828	0.045
	Within Groups	3	8	.02		
	Total	941.98	11			
Vitamin A	Between Groups	199.627	3	91920.5	0.723912	0.036
	Within Groups	3	8	.04		
	Total	199.630	11			

Vitamin C	Between Groups	735364	3	66542.34	0.723912	0.040
	Within Groups	6	8	.05		
	Total	735370	11			

The sample A1 (100% wheat and 0% SSPF) recorded zero value for beta-carotene, vitamin A and C. However, sample A2 (0% wheat and 100% sologold sweet potato) had beta-carotene vitamin A and C. Hence the presence of these vitamins in the composite flour is attributed to the high vitamin content of SSP flour. From Table 4, the statistical analysis of variance for average vitamin composition of the flour sample blends shows that the difference in the beta carotene,
vitamin A and vitamin C contents of the composite flour samples are significant (p≤0.050). However,
sample blends with high vitamins and beta carotene are high in antioxidants and may enhance the immune system and protect the body from free radicals. In overall, the B6 composition is well fortified with these vitamins.

Desirability Index of Nutritional Properties of Composite Wheat-Sologold Sweet Potato Flour

The desirability index of all the nutritional properties of composite wheat-sologold sweet potato flour is shown

Table 5: Desirability index of nutritional properties of composite wheat sologold sweet potato flour

SamPle	WF	SSPF	BetCµg/g	VitAµg/g	Vit Cµg /g	MC%	AC %	CP %	CF %	OE %	NFE%	Camg/g	Namg/g	Mgmg/g	Kmg/g	Desirability	
A1	100	0	0.0	0.0	0.0	12.02	0.96	3.76	1.03	4.70	77.55	1.90	0.15	0.10	2.37	0.33205	
B1	90	10	06.3	03.1	0.07	11.90	1.25	3.96	1.31	4.78	73.43	2.05	0.15	0.09	1.52	0.38320	
B2	80	20	11.1	07.4	0.11	11.86	1.40	4.53	1.68	4.86	75.82	2.07	0.14	0.09	2.20	0.49881	
B3	70	30	16.5	12.5	0.16	11.14	1.57	4.82	1.89	4.90	72.87	2.10	0.14	0.08	1.71	0.56585	
B4	60	40	20.6	15.2	0.22	10.54	1.95	5.15	2.68	5.00	75.23	2.09	0.14	0.08	2.17	0.55483	
B5	50	50	23.2	19.0	0.25	10.35	2.18	5.62	3.11	5.13	72.42	1.95	0.13	0.08	1.86	0.50433	
B6	40	60	27.5	24.6	0.30	10.12	2.61	5.80	3.21	5.20	74.10	2.08	0.13	0.07	2.14	0.65164	Selected
B7	30	70	30.6	0.30	35.85	9.83	2.89	5.92	3.28	5.31	72.77	2.02	0.12	0.07	1.92	0.60762	
B8	20	80	35.0	0.33	40.50	9.74	3.37	6.15	3.30	5.40	73.46	2.04	0.12	0.07	2.10	0.60187	
B9	10	90	38.2	0.35	45.25	9.60	4.12	6.29	3.72	5.48	72.30	2.01	0.11	0.06	2.00	0.59660	
A2	0	100	42.4	0.38	47.18	9.52	4.62	6.35	4.08	5.63	72.24	2.06	0.10	0.05	2.04	0.52047	

in Table 5.

The sample with the highest desirability is selected as the optimum composite flour sample. The selected sample is B6 with 40% wheat and 60% sologold sweet potato flour and has 0.65164 desirability. This indicates that B6 is the optimum composite flour, and it is likely to give the desired qualities of bakery product with the following attributes: moisture content (10.12%), crude fibre (3.21%), ash content (2.61%), protein content (5.80%), oil extract (5.2%), carbohydrate, NFE (74.1%), calcium (2.08mg/g), sodium (0.13mg/g), potassium (2.14mg/g), vitamin C (0.3μg/g), Vitamin A (24.6μg/g) and beta-carotene content (27.29μg/g).

Comparative Analysis of Selected Existing Composite Flours and the Wheat-Sologold Sweet Potato Composite Flour Used for Bakery Products

The nutritional properties of the chosen best blend (composite flour) B6 developed were compared with some selected existing composite flour meant for bakery products and are presented in Table 6.

Table 6: Some nutritional properties of selected existing composite flour samples and the developed composite flour (B6)

Composite Flour	Blend ratio	Protein (%)	CHO (%)	Fat (%)	Fiber (%)	Vitamins	Minerals (mg/g)	Reference
Wheat-sologold	60:40	5.8	74.1	5.2	3.21	A,C, β-carotene	Sodium, calcium, magnesium, potassium	Researcher (authors)
Rice, potatoes and soybeans	85:12:3	12.5	74.2	8.4	1.9	B	Magnesium	Awolu *et al.*, (2017)
Wheat-yam	60:40	6.9	66.3	6.9	3.6	B	Magnesium, Phosphorus	Amandikwa *et al.*, 2015
Wheat- corn	70:30	2.3	78.5	1.2	4.3	B	Magnesium, Potassium	Aburime *et al.*, 2020
Wheat-soybeans	80:20	14.9	30.6	21.1	3.2	B	Iron, Calcium, Potassium	Lee-hoon *et al.*, (2017)
Wheat, potato and bambara nut	60:30:10	16.9	60.4	6.0	2.1	B	Iron, Magnesium	Addo & Oyeleke (2004)
Wheat-sesame	80:20	13.9	48.8	3.9	3.4	B	Iron, Magnesium, Phosphorus	Fabian & Nwamaka (2016)
Wheat, tiger nut and potatoes	70:20:10	3.8	73.5	2.2	2.8	B	Calcium, Iron, Magnesium	Chinelo & Nnenna (2016)
Wheat-Coconut	70:30	4.0	57.0	16.0	4.0	C	Iron, Potassium	Adegunwa *et al.*, (2017)
Wheat-vitAto potato	80:20	4.6	81.5	0.8	2.2	A	Iron, Magnesium	Lee-hoon *et al.*, (2017)

The composite flour samples in Table 6 shows that the blends with grains, legumes and tubers have high nutritional compositions. Hence, grains, legumes and tubers are recommended as composite constituents. In addition, the developed composite flour (B6) has added advantage of containing more minerals and vitamins content than existing composite flour from various studies as presented.

CONCLUSION

The nutritional qualities of the developed composite flour (40% wheat and 60% sologold sweet potato) will likely have positive impact on the health of the consumer of its bakery products.

RECOMMENDATION

The 40% wheat and 60% sologold sweet potato composite flour (B6) should be encouraged for utilization in Bakery products.

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