CHEMICAL COMPOSITION AND SENSORY EVALUATION OF COOKIES PRODUCED FROM RED VARIETY OF SORGHUM, GROUNDNUT AND SOYBEAN FLOURS

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Abstract

Cookies are flat dry sweet biscuits eaten on a large scale across all age categories in both low and high income nations where non-communicable diseases are on the increase. The experimental study was carried out to evaluate the sensory properties, chemical composition (proximate), minerals (Ca, Mg, P and Zn), vitamins (pro-vitamin A,BI, B2 and E), anti-nutrients (tannin, phytate, saponin) of four formulated composite flour cookies. They were produced from sorghum flour (SF), groundnut flour (GF), soybean flour (SOF) and wheat flour (WF) and determined using standard procedures.Three of the formulated composite flour cookies contained no wheat flour and were blended using the following ratio: (A=70%SF:20%SOF:10%GF, B=60%SF:20%SOF:20%GF and C=50%SF:30%SOF:20%GF), respectively. The fourth sample (control) had 100% wheat flour and 15 panelists evaluated the organoleptic properties of the cookies. The proximate composition showed that the dry matter of the cookies ranged from 94.74% (D)-96.58% (A), moisture content ranged from 3.42% (A)-5.26% (D), ash content ranged from 2.27% (D)-3.73% (C), crude fiber ranged from 2.55% (D)-4.0% (C), crude protein ranged from 10.87% (D)-26.92% (B), fat content ranged from 12.25% (D)-40.43% (B), carbohydrate contents ranged from 20.98% (B)-66.80% (D) and the energy values ranged from 1759.49kjoules (D)-2321.87kjoules (B). Mineral compositions are as follows: calcium=10.40mg/100g (C)-15.20mg/100g (A), magnesium=5.30mg/100g (A,C)-7.20MG/100G (B), phosphorus=31.00mg/100g (D)-40.0mg/100g (C) and zinc=2.00mg/100g (A)-5.15MG/100G (D). The cookies had significant amounts of pro-vitamin A (5.56ug/100g (D)-8.21ug/100g (B), vitamin E (2.43mg/100g (D)-4.76mg/100g (B), low vitamin BI and B2 (0.21mg/100g (A)-0.44mg/100g (B) and 0.14mg/100g (D)-0.38mg/100g (B), respectively. Organoleptically, all the experimental samples were similarly accepted with the control, although sample B was more acceptable.The study showed that enriching sorghum flour with soybean and groundnut flours in cookies production improved their nutritional value and could be used to reduce the dependency on wheat flour.

Keywords: Chemical Composition, Sensory Evaluation, Cookies

Introduction

Cookies are flat dry crisp biscuits which may be sweetened or unsweetened according to preference. Cookies and other baked food products areagroup of food items sold in ready- to-serve forms. They are energy-dense foods that are high in fat and sugar and are consumed globally as snacks by both children and adults. According to Okaka (2009), cookies are a form of confectionary products usually dried to a low moisture content. They tend to be larger with a softer chewer texture when compared to biscuits. Nwosu (2013) noted that all biscuits contribute valuable quantities of iron, calcium, protein, calorie, fiber and some of the B-vitamins to our diets. However, they contribute substantially to the human's daily energy needs due to the fact that they are energy-dense. Their intake together with other highly-refined and processed foods is one of the major causes of overweight and obesity globally.

The prevalence of overweight and obesity is on the increase globally. Specifically in 2016, more than 1.9billion adults 18years and older were overweight and of these over650million were obese (World Health Organization (WHO)(2016). In Africa, the number of children who are overweight or obese has nearly doubled from 5.4million in 1990 to 10.6million (WHO, 2016). Overweight and obesity are risk factors in other chronic non-communicable diseases such as diabetes type2, some cancers and cardiovascular diseases. The prevalence of these diseases over the past decades has increased substantially especially in low and middle income countries. For instance, it is estimated that in 2014, about 25million people in Sub-Saharan Africa were living with diabetes. Cancer was responsible for 8.8million deaths globally in 2015. Around one third of cancer deaths was as a result of high body mass index, low fruit and vegetable intake, lack of physical activity, tobacco and alcohol use (WHO, 2016).

Over-nutrition which is as a result of excessive consumption of food energy from also exists alongside under-nutrition as well as the recent one described as hidden hunger. All these constitute the triple burden of malnutrition. In developing countries such as Nigeria, macro and micro nutrients malnutrition and chronic non-communicable diseases such as diabetes type 2, obesity, and hypertension are prevalent (Tiawo,Adesanwo, Dauda, Arise, & Sotunde, 2017). The problem of malnutrition can be solved by exploring and using local food materials here in Nigeria in the production of snacks for the populace. This can contribute in meeting the nutritional needs of individuals. The right formulation of such snacks make the final products to be enriched in terms of nutrient contents.

The demand for wheat flour is on the increase due to the different products produced with it such as noodles, pasta, bread, cookies and biscuits and other fried and baked products. Therefore the use of indigenous flour as a substitute for wheat flour to produce composite flour for baking is necessary. Groundnut is rich in macro and micro nutrients. According to Settaluri, Kandala, Puppala, & Sundaram (2012), 100g of groundnut contains 1.55g of water, 21.51g of carbohydrate, 8.0g of fiber, 49.66g of fats, 23.68g of protein and 2448kj of energy. The fatty acids in groundnut are mainly unsaturated. It is also rich in minerals such as calcium, magnesium and phosphorus. Groundnut is an excellent source of the B-vitamins (niacin, thiamin, riboflavin folate as well as vitamin E and phytochemicals such as flavones, phytoestrogen and other antioxidant compounds (Goldberg, 2003). The nutritional and health benefits of groundnut consumption are many. Li, Brennan, Wedick, Mantzoros, Rifai, & Hu,(2009), reported that intake of 30g of groundnuts per day reduce the risk of developing heart diseases and type 2 diabetes by 30-50%. Also the risk of colorectal cancer may reduce if groundnut is frequently eaten (Suchoszek-Lukaniuk,Jaromin . Korycińska.,& Kozubek, 2011). Daily intake of small amounts of groundnut has been shown to reduce the risk of heart disease (Sabate & Ang, 2009; Sabate,Rose, & Salvado, 2006). The monounsaturated fatty acids, plant proteins, magnesium, potassium, fiber, arginine and many other bioactive components in groundnut could contribute to lowering blood pressure (Appel, 2005). Soybean is a cheap source of quality protein with a good balance of the essential amino acids comparable to that of cow's milk (Belewu &Belewu, 2007). It contains polyunsaturated fatty acids (linoleic and linolenic acids). According to Uwaoma (2015), one kilogram of soybean contains as much protein as 2kilograms of boneless meat or 45cups of cow's milk or 5 dozens of eggs. Soybean has many nutritional and health benefits which includes lowering breast and prostate cancer risks, cholesterol lowering effect and prevents osteoporosis (Pampluna& Roger, 2004).

Sorghum is an important food crop in Nigeria and it is produced on a large scale such that in West Africa, Nigeria is the largest producer and third largest producer globally .Food and Agriculture Organization (FAO) (2019). Sorghum is rich in B-vitamins and for children aged 1-9years, it supplies 26-47% of the World Health Organization nutrient intakes for thiamin, 16-28% for riboflavin, 24-49% for niacin, 31-63% for pantothenic acid and 59-118% pyridoxine (John, 2010). Sorghum is suitable for gluten-free diets because it contains no gluten and it also has no cholesterol. The consumption of sorghum reduces the risk of certain types of cancer in humans (Gomez, Bartolome, Vieira, & Virador, 2001; Yang, Browing, & Awika, 2009).According to Carr, Weller, Schlege, Cuppett, Guderian, & Johnson (2005), sorghum could be used as a food ingredient or dietary supplement to control cholesterol levels in humans. The bran of the grain may also help protect against diabetes and insulin resistance (Farrar, Hartle, Hargrove &Greenspan 2008).

The three food materials examined have been traditionally used in Nigeria in producing different food products. For instance, groundnut is used in producing edible oils for different purposes. The by-product after oil extraction is used in making snacks called 'kwilikwili' commonly eaten all over the country. The seeds can either be boiled or roasted and eaten as snacks. Peanut butter is also another product from groundnut. Soybean is utilized in many forms such as soybean milk, soy flour, tofu (substitute for cheese). Sorghum is used in various food preparations in different parts of Africa and some of the products are To, Bogobe, Ugali, Ogi, Injera, Kisra, Tortilla and Couscous. These show that those three food items are not yet fully utilized for rich economic benefit to Nigeria and the entire world. There is need to increase the utilization of these locally available food materials so as to improve the nutritional qualities of confectionaries. The consumption of cookies produced from these nutrientrich food items (groundnut, soybean and sorghum) will help combat both macro and micro- nutrient malnutrition as well as reduce the prevalence of non-communicable diseases. This experimental work was carried out to determine the chemical composition and evaluate the sensory qualities of cookies produced from groundnut, soybean and sorghum flours.

Objectives of the study

The general objective of the study is to determine the chemical composition and evaluate the sensory qualities of cookies produced from groundnut, soybean and sorghum flours. The specific objectives are to:

1. Produce cookies from groundnut, soybean and sorghum flours.
2. Determine the proximate, selected mineral, vitamin and anti-nutrients contents of the

cookies.

3. Evaluate the organoleptic properties and general acceptability of the cookies.

Materials and Methods

Study design: The study was an experimental study carried out in Diet Therapy Laboratory of the Department of Human Nutrition and Dietetics, Michael Okpara University of Agriculture, Umudike. The groundnut, soybean, sorghum and wheat seeds/grains were purchased from local traders in a market at Umuahia, Abia State, Nigeria. The chemicals used for the analysis were obtained from the National Root Crops Research Institute (NRCRI) Umudike, Abia State.

Sample preparation: The groundnut flour was prepared following the method described by Agoha (2014). The groundnut seeds were sorted to remove dirt and stones and the seedswere weighed, washed and drained. The seeds were then roasted for 10minutes, de-hulled and allowed to cool for 5 minutes. The roasted seeds were then milled and sieved into flour. Figure 1 shows the flow chart for the preparation of groundnut flour. The preparation of soybean flour is shown in Figure 2 according to the method described by Okaka (2005). Soybean seeds were sorted to remove dirt and stones. The cleaned seeds were soaked for 30minutes, de-hulled and dried for 12 hours inan oven at 70^{o}C. The dried seeds were milled and sieved into fine flour. The method described by Houssou and Ayemor (2002) was adopted in the preparation of sorghum flour as outlined in Figure 3. Sorghum grains were sorted and well cleaned and the grains milled and sieved into fine flour. The preparation of wheat flour was done following the method described by Ikuomola, Otutu, & Oluniran(2017) as shown in Figure 4. Wheat grains were sorted to remove dirt and stones. Thereafter, they were cleaned, milled and finally sieved into fine flour.

Table 1

Flour Blends Formulation

Blends	Sorghum (%)	Soybean (%)	Groundnut (%)	Wheat (%)
A	70	20	10	0
B	60	20	20	0
C	50	30	20	0
D	0	0	0	100

Table 2

Recipe for the Production of Cookies

Ingredient	Quantity
Composite flour	500g
Margarine	200g
Sugar	100g
Egg	155ml
Milk(full-fat filled powdered)	$R\frac{1}{2}$ Tbps.
Nutmeg	$\frac{Q}{2}$Tsp.
Vanilla (Liquid)	21ml
Salt	$\frac{Q}{4}$Tsp.
BakingPowder	$\frac{Q}{4}$Tsp.

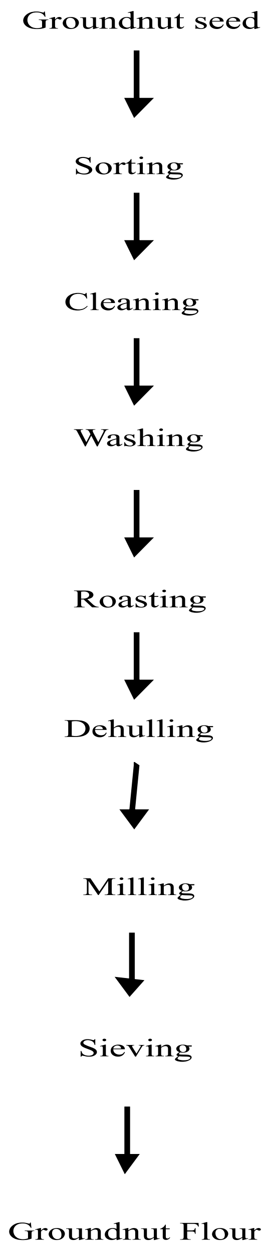

Fig 1: Flow Chart for the preparation of Groundnut Flour

Soybean seeds

↓

Sorting

↓

Cleaning

↓

Soaking (30 minutes)

↓

De-hulling

↓

Oven drying (at 70^0C for 12 hours)

↓

Milling

↓

Sieving

↓

Soybean Flour

Fig 2: Flow Chart for the preparation of Soybean Flour

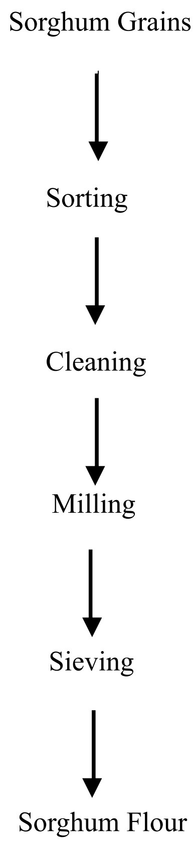

Fig 3: Flow Chart for the preparation of Sorghum Flour

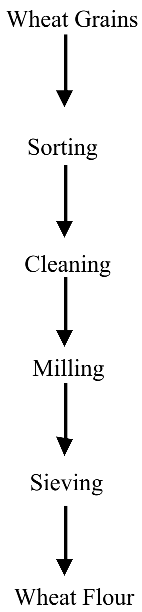

Fig 4: Flow Chart for the preparation of Wheat Flour

Creaming of fat and sugar for 5 minutes

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Mixing of egg and milk for 30 minutes

↓

Adding of Vanilla, nutmeg, baking powder and salt to the creamed mixture

↓

Rolling and cutting of dough

↓

Baking of cut dough at 185^{o}C for 15 or 25 minutes.

↓

Cooling and packaging

Fig 5: Flow chart for the preparation of cookies

Formulation- of composite flours:Table 1 shows the formulation of the flour blend. Sorghum, soybean and groundnut blends were formulated according to the following ratios: 70:20:10, 60:20:20, 50:30:20, respectively while 100% wheat flour served as the control**.**

Production of the cookies: The recipe in Table 2 were used in the production of the cookies as shown in Figure 5 described by Okpala & Ekwe (2013).
Fat and sugar were thoroughly creamed for 5 minutes, then egg and milk were added and further mixed for about 30 minutes. Vanilla, nutmeg, flour, baking powder and salt were added to the cream mixture and all were mixed to form a dough. The dough was rolled and cut into different shapes. The cut dough were then baked at 185^{o}C for 15 or 25 minutes. The same procedure was followed in the production of all the cookie samples. The baked cookies were cooled and packaged.

Chemical analysis: The proximate compositions (moisture, ash, crude fiber, crude protein and carbohydrate contents) of the cookie samples were all determined using the methods described by the Association of Official Analytical Chemist (AOAC) (2006). The mineral (calcium, magnesium, phosphorus and zinc) contents of the cookie samples were determined according to the methods described by AOAC (2006), AOAC (2006), Onwuka (2005) and Carpenter and Hendricks (2003), respectively. Association of Official Analytical Chemist (2010) procedures were used to determine the vitamin (pro-vitaminA, BI and B2 and E) contents of the cookie samples.

Sensory evaluation: The sensory evaluation of the cookie samples was done using 15 panelist made up of students from the College of Applied Food Sciences and Tourism, Michael Okpara University of Agriculture, Umudike. Sensory attributes of colour, taste, texture and general acceptability were evaluated as described by Iwe (2002). A nine point hedonic scale was used to record the ratings of the panelist with nine as the highest score while one was the lowest score. The cookie samples were coded using the letters A, B, C, D and presented orderly,

Statistical analysis: Results from the chemical analysis and sensory evaluation were subjected to analysis of variance (ANOVA). The results were presented as means standard deviation using SPSS windows version 21. Duncan multiple range test was used to separate the means and significant difference was judged at $P < 0.05$.

Results

The proximate composition of the cookie samples is presented in Table 3. The moisture contents of the samples ranged from 3.42%-5.26%. Sample D which served as the control had the highest (5.26%) moisture content while sample A contained the least (3.42%). There were significant differences (P<0.05) in the moisture contents of all the samples. There were significant differences (P<0.05) in the ash contents of all the cookies as they ranged from 2.27% (D)-3.73% (C). Protein contents of the cookie samples also showed significant differences (P<0.05). However, highest protein value was noted in sample B (26.92%) and this was followed by sample C which had 19.76% protein. The control recorded the lowest protein value of 10.87%. Crude fiber contents of the cookies ranged from2.55%-4.01% and the values significantly differed from one another. On the fat contents of the cookies, sample B had the highest value of 40.43%, this was followed by sample C (35.84%), sample A (31.51%) and sample D (12.25%). The carbohydrate contents of all the cookie samples were significantly different (P<0.05) from one another with the control having the highest (66.80%). The energy values of all the cookie samples ranged from 1759.49KJ (D)-2321.87KJ (B) and they differed significantly.

Table 3

Proximate composition of cookies produced from sorghum, groundnut, soybean and wheat flours

Samples	Dry matter (%)	Moisture content (%)	Ash (%)	Crude fiber (%)	Crude protein (%)	Fat (%)	Carbohydrate (%)	Energy value (Kjoules)
A	$96.58^{a}\pm0.02$	$3.42^{d}\pm0.01$	$2.88^{c}\pm0.01$	$3.63^{c}\pm0.01$	$17.31^{c}\pm0.01$	$31.51^{c}\pm0.01$	$41.25^{b}\pm0.01$	$2164.53^{c}\pm0.54$
B	$95.33^{bc}\pm0.69$	$4.17^{b}\pm0.01$	$3.62^{b}\pm0.01$	$3.88^{b}\pm0.01$	$26.92^{a}\pm0.01$	$40.43^{a}\pm0.01$	$20.98^{d}\pm0.01$	$2321.87^{a}\pm0.06$
C	$95.89^{ab}\pm0.01$	$4.11^{c}\pm0.01$	$3.73^{a}\pm0.01$	$4.01^{a}\pm0.01$	$19.76^{b}\pm0.01$	$35.84^{b}\pm0.01$	$32.55^{c}\pm0.01$	$2222.43^{b}\pm0.18$
D	$94.74^{c}\pm0.01$	$5.26^{a}\pm0.01$	$2.27^{d}\pm0.01$	$2.55^{d}\pm0.01$	$10.87^{d}\pm0.01$	$12.25^{d}\pm0.01$	$66.80^{a}\pm0.01$	$1759.49^{d}\pm0.06$

Values are means q standard deviation of duplicate samples.

$^{a-d}$ Means with similar subscripts are not significantly different (p>0.05)

Key:

A= 70% sorghum flour + 20% soybean flour + 10% groundnut flour
B= 60% sorghum flour + 20% soybean flour + 20% groundnut flour
C= 50% sorghum flour + 30% soybean flour + 20% groundnut flour
D= 100% wheat flour

Table 4 presents the mineral contents of the cookie samples. In the Table, calcium contents ranged from 10.40mg/100g (C)-15.20mg/100g(A). Magnesium content was highest in sample B (7.20mg/100g), followed by the control with a value of 5.76mg/100g. Sample C recorded the highest phosphorus content of 40.00mg/100g with the least (31.00mg/100g) noted in sample D which was significantly different (P<0.05) from the rest of the samples. There were significant differences (P<0.05) in the zinc contents of all the cookie samples with the control having the highest (5.15mg/100g) and the least value (2.00mg/100g) was for sample A.

The vitamin compositions and anti-nutrient contents of the cookies are shown in Table 5 and 6, respectively. In Table 5, pro-vitamin A contents of the cookies were significantly different (P<0.05). Sample B contained the highest (8.2ug/100g) pro-vitamin A, this was followed by sample C (7.35ug/100g), sample A (6.64ug/100g) and then sample D (5.56ug/100g). Thiamin contents of the cookies ranged from 0.21mg/100g (C)-0.44mg/100g (B). Riboflavin content of sample B (0.38mg/100g) was significantly higher than the control (0.14mg/100g). There were significant differences (P<0.05) in the vitamin E contents of all the cookies. The values ranged from 2.43mg/100g (D)-4.77mg/100g (B).

Table 4
Mineral Composition Of Cookies Produced From Sorghum, Groundnut, Soybean And Wheat Flours

Samples	Calcium (mg/100g)	Magnesium (mg/100g)	Phosphorous (mg/100g)	Zinc (mg/100g)
A	15.20^{a}±1.13	5.28^{b}±0.07	35.00^{b}±0.14	2.00^{d}±0.00
B	12.80^{ab}±0.00	7.20^{a}±0.07	38.50^{ab}±0.07	3.10^{c}±0.14
C	10.40^{b}±1.13	5.28^{b}±0.07	40.00^{a}±0.14	4.05^{b}±0.07
D	13.60^{a}±1.13	5.76^{ab}±0.00	31.00^{c}±0.14	5.15^{a}±0.21

Values are means ± standard deviation of duplicate samples
$^{a-d}$Means with similar subscripts are not significantly different ($p>0.05$)

Table 5: Vitamins composition of cookies produced sorghum, groundnut, soybean and wheat flour

Samples	Pro vitamin A (μg/100g)	Vitamin B1 (mg/100g)	Vitamin B2 (mg/100g)	Vitamin E (mg/100g)
A	6.64^{c}±0.01	0.21^{c}±0.01	0.23^{b}±0.02	3.68^{c}±0.02
B	8.21^{a}±0.01	0.44^{a}±0.01	0.38^{a}±0.01	4.77^{a}±0.02
C	7.35^{b}±0.01	0.37^{b}±0.01	0.28^{b}±0.02	4.55^{b}±0.02
D	5.94^{d}±0.01	0.37^{b}±0.01	0.14^{c}±0.01	2.43^{d}±0.01

Values are means ± standard deviation of duplicate samples
$^{a-d}$Means with similar subscripts are not significantly different ($p>0.05$)

Table6
Sensory Properties Of Cookies Produced From Sorghum, Groundnut, Soybean And Wheat Flours

ples	Colour	Taste	Flavour	Texture	Mouth feel	General acceptability
ι	6.67^{a}±0.90	6.40^{a}±1.60	6.73^{a}±1.62	6.93^{a}±1.28	6.53^{a}±1.51	6.65^{a}±1.17
;	6.87^{a}±1.25	6.73^{a}±1.03	7.00^{a}±1.51	7.27^{a}±1.03	7.20^{a}±1.21	7.01^{a}±0.64
	7.07^{a}±1.22	6.47^{a}±1.77	6.33^{a}±1.84	7.07^{a}±1.16	6.67^{a}±1.78	6.72^{a}±1.23
	6.47^{a}±2.13	6.87^{a}±2.20	7.07^{a}±1.62	7.20^{a}±1.66	7.27^{a}±1.39	6.97^{a}±1.46

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^{a} Means with similar subscripts are not significantly different ($p>0.05$)

Discussion

Moisture content is the number of water molecules that are incorporated into a food product. It influences the taste, texture, weight, appearance and shelf life of foodstuffs. The higher moisture content observed in sample D could be as a result of the low ash and fat contents found in the sample. Maduekwe, Edeh, & Obizoba (2013), observed that the lower the moisture content of a given food, the higher the shelf life. That means that the samples with low moisture contents will keep longer than those with high moisture contents. The addition of soy flour could as well have contributed to the low moisture contents noted in the cookie samples. In soy and maize flour composite cookies, Atobatele & Afolabi (2016) reported a decrease in moisture content with increase in the addition of soy flour. Higher ash contents were found in the cookie blends and this could be attributed to the high mineral contents of the flours used in the blends. However, this was not the case with the control which was produced with only wheat flour. The ash content of the control contradicted the value of 4.92% reported by Samuel (2016). The study under comparison incorporated sorghum to wheat flour in cookies production and that could have increased the ash contents. Olapade &Adeyemo (2014) produced cookies from blends of wheat, cassava and cowpea flours and reported 3.49% of ash and the value was higher than those reported for sample A and the control in the present study.

Protein contents of the cookie samples increased with increase in soybean and groundnut flours additions. Both flours are from legumes which have high protein contents. This is especially true of soybean which is said to contain the highest amount of protein among the pulses. Specifically, there are 43g of protein per 100g of soybean (William and Akiko, 2000). The Nigerian Food Composition Table reported that milled raw soybean flour contains 30.5g of protein per 100g (Sanusi, Akinyele, Ene-Obong, & Enujigha 2017). Groundnut also contains appreciable quantity of protein and according to Sanusi *et al*. (2017) roasted groundnut contains 18.40g of protein per 100g. Therefore, the addition of those two rich sources of protein to the cookie blends improved the protein contents. Similar to the protein contents, crude fiber contents of the cookie blends increased with increase in soy/groundnut flours addition such that sample C that contained 30% and 20% of soybean/ groundnut flours had the highest value.

Soybean and groundnut are pulses or legumes but are also classified as oilseeds because of their high oil contents. They are processed into edible oils. Their high oil contents could have contributed to the significantly high fat contents of the cookie blends than the control which contained only wheat. Sanusi *et al*. reported that roasted groundnut and raw milled soybean contain 45.60g and 22.1g per 100g, respectively. Generally, cereal grains are not good sources of fat. The high fat contents of the cookie blends may not have adverse health consequences. According to Pelkman (2004), majority of fat in groundnut is heart healthy. The high monounsaturated fatty acids in groundnut lower the total body cholesterol and maintains the good high density lipoprotein cholesterol. Soybean contains high amount of polyunsaturated fatty acids which are also good for the heart. The high fat content of samples A, B and C is a disadvantage especially with regards to shelf life as it may cause rancidity in the cookies during storage. This invariably affects the shelf life, taste and even aroma of the products. The cookies made from 100% wheat flour had the highest carbohydrate content. This is not surprising as cereals generally contain more carbohydrate than legumes. The carbohydrate content of sample D (66.80%) was lower than the 72.00% and 80.3% reported by Madukwe *et al*. (2013) and Olapade & Adeyemo (2014), respectively. The higher carbohydrate contents reported by the studies under comparison could be due to the fact that the authors incorporated other food items such as cassava, cowpea and other legumes to their cookie blends. That means that the root and tuber as well as the legumes added contributed to the increased carbohydrate contents. The other cookie blend samples recorded increased carbohydrate contents as sorghum and soybean flours' addition increased. This indicated that legumes also contribute carbohydrate to our diets. For instance, roasted groundnuts contain 36.11g and raw milled soybean contain 29g per 100g (Sanusi *et al*., 2017). Generally, the lower carbohydrate contents of the cookie samples is good for the general health of both children and adults. Their intakes by both age groups may not contribute to the increased prevalence of diabetes type 2 of which intake of refined carbohydrate is a risk factor.

Energy value is the sum of the energy contributed by the macro-nutrients (carbohydrate, protein and fat) when multiplied by the physiological fuel values, which are 4, 4 and 9 for carbohydrate, protein and fats, respectively. The energy value of foods is expressed in kilocalories but presently, the accepted standard of energy used in human energetics is the joule while kilojoule is a larger amount of energy. Higher energy values were noted for the cookie blend samples and they were all higher than the control as well as the other two studies under comparison. This could be as a result of the addition of soybean and groundnut flours in samples A, B and C. The soybean and groundnut flours contain high amount of fat which yields more kilojoules of energy more than protein and carbohydrate put together.

Minerals and vitamins are important micro-nutrients which play crucial roles in the body. Their deficiencies in the body lead to various deficiency diseases and constitute to 'hidden hunger' in resource poor nations. The calcium content of sample D (control) was higher than that of sample C. This could be because of the small calcium content of wheat. In contrast to the calcium content of sample D reported in this study, Tiawo e*t al*. (2017) reported a lower calcium content of 7.21mg/100g in wheat-sorghum date cookies. This also confirms the earlier argument showing that addition of sorghum flour to wheat flour might have reduced the calcium content of the cookie probably because sorghum contains less calcium than wheat. However, for the other three cookie blend samples in this study, the results indicated that calcium contents increased with increase in sorghum flour and probably decreased with increase in soybean flour addition. This could be due to the fact that samples B and C contained 20% roasted groundnut flourand Sanusi *et al*. (2017) reported that roasted groundnut contain less calcium.However, the use of less sorghum flour in sample C might have contributed to the reduction in the calcium content of the sample. Another probable reason for the reduction in the calcium contents of the cookies may be the use of malted sorghum which has been shown to contain less ash.The results contradicted that by Islamiyat, Adekanmi, James, & Zainab (2016)who noted that calcium content of malted sorghum-soy biscuits increased as the level of soy flour substitution increased in the biscuits. The magnesium contents of the cookie blends likely increased with increase in groundnut flour, although, sample C which contains 20% of groundnut did not record comparable magnesium content with sample B with the same amount of groundnut. This could be because less sorghum was used in the formulation and sorghum contains appreciable amount of magnesium. Sanusi *et al*. (2017) reported that raw red and white sorghum variety contain 311mg of magnesium per 100g.

Phosphorus contents of the cookies increased as soybean and groundnut flours were increased and as sorghum flour was decreased. Even though phosphorus content of raw whole grain red and white varieties were 297 and 249mg per 100g of sorghum respectively as reported by Sanusi *et al*. (2017), but it was lower than 965mg per 100g for soaked, de-hulled, dried and milled soybean flour as reported by the same authors. Thiscould be the reason why increase in soybean flour and decrease in sorghum flour led to the high phosphorus contents in the cookie samples. The same source also noted that roasted groundnut contains 0.69mg of phosphorus. Zinc is an important trace/macro mineral which is vital for a healthy immune system as well as promotion of healthy growth during childhood (Joseph, 2017). The main/ highest sources of zinc are protein rich foods such as meat, poultry, liver, however, substantial amounts of zinc are found in nuts, legumes and whole cereals. The zinc compositions of samples A, B and C increased with increase in soybean and groundnut flours and with decrease in sorghum flour. This might be true as there are substantial amounts of zinc in boiled soybean, raw dried groundnut which according to Sanusi *et al*. (2017) were 1.85mg and 4.70mg per 100g, respectively. The findings were similar to that reported by Atobatele & Afolabi (2016) where the zinc compositions of cookies produced from maize-soy flour blends increased with increase in soybean flour. However, the control had the highest zinc content probably because it was produced from whole wheat flour which is said to contain substantial amount of zinc. From the Nigerian Food Composition Table, white wheat flour contains 2.04mg of zinc (Sanusi *et al*., 2017).

The vitamin contents of the cookie samples followed a similar trend where they all increased as soybean and groundnut flours increased. It was also observed that sampleB (60%sorghum flour+20% soybean flour+ 20% groundnut flour) contained the highest amounts of all the vitamins analyzed. Vitamin E contents of the cookies increased with increase in groundnut flour substitution. For vitamin E, raw dried groundnut contains 10.9mg per 100g and that along with the 1.1mg in red raw whole grain sorghum could have increased the vitamin E content of the cookies especially that of sample B. According to Sanusi *et al*. (2017), raw dried groundnut contains 0.87mg and 0.14mg of thiamin and riboflavin per 100g, respectively and that as well might have improved the riboflavin contents of the samples especially in samples B and C, which were produced with 20% of groundnut flour. The highest vitamins B1 and B2 contents noted in sample B were lower than the 0.73mg and 0.86mg per 100g reported for the fermented sorghum and soybean flour cookies by Adeyeye, Adebayo, Tiamiyu, & Oke (2017). Fermentation of sorghum might have increased the thiamin and riboflavin contents in that work.

Three anti-nutrients (tannin, phytate and saponin) were analyzed in this study and their levels in the cookies were all found to be within the safe limit of less than 1mg/100g. But the control (sample D) contained the least amounts (0.22, 0.07 and 0.06) for tannin, phytate and saponin, respectively. The tannin contents of the cookies increased as soybean flour substitution increased, thus making sample C to have the highest (0.72mg/100g). The tannin contents reported in this study were higher than the values reported by Madukwe *et al*. (2013). All the phytate values noted in this study were lower than the values reported by Opeyemi, Stephen, & Oluwatooyin (2016). Processing methods such as milling, soaking and de-hulling used in processing the food items could have reduced the anti-nutrient levels in the cookies (Anarson, 2017).

On the sensory attributes of the cookies, colour preference of samples A, B and C increased with increase in soybean flour. Maryam, Seyed, Naser, Mojtara, Mahkameh, & Musa (2017) reported similar rating where score for colour of soybean flour bread increased with increase in soybean flour substitution. This may be due to the slightly yellow/golden colour of soybean seeds. The taste score for the control was the highest (6.87) but it was lower than the 7.47 reported by Madukwe *et al*. (2013). This may be due to the differences in the quantities of sugar used for the production of the cookies. In this study, 200g of sugar was used for 500g of flour, while the work under comparison added 330g of sugar to 500g of flour. The flavor scores of samples A, B and C decreased as soybean and groundnut flours were increased. The observation s were in congruent with that of Venkateswari & Parameshwari (2016) who observed that the flour ratings of soybean and wheat flour cookies decreased with increase in soybean flour addition. According to Akubor & Ukwuru (2003), soy flour has beany flavor and that might have affected the flavor scores. The sensory properties of the cookies indicated that sample B (7.01) had the highest mean score and was preferred to the rest of the samples. This was followed by the control (6.97). Gerrard (2002) opined that food proteins could influence the quality of foods. Therefore, Awasthi, Siraj Tripathi, &Tripathi (2012) concluded that incorporating not more than 20% soybean flour to other flours produced acceptable products

Conclusion

The result of this study showed that the samples containing 20% groundnut flour and 20% - 30% soybean flour had the highest moisture, protein, fat, fiber, ash, energy value, phosphorous, vitamin A, vitamin B2 and vitamin E contents. The control (sample D) had the highest content of carbohydrate. The dry matter, vitamin B1, B2, calcium and magnesium content of samples A, B and C were comparable to the wheat flour cookie. It was also observed that sample B (60% sorghum flour + 20% soybean flour + 20% groundnut flour) had the highest value for most of the nutrients.

Organoleptically, the colour, taste, texture, flavor, mouth feel and general acceptability of the cookies compared favorably to the control. Sample B (60% sorghum flour + 20% soybean flour + 20% groundnut flour) scored the highest in the general acceptability. Results from this work have shown that groundnut and soybean flours could be used for substituting sorghum and wheat flour up to 20% level in the production of cookies without adversely affecting the sensory attributes of the cookies. Although, cookies made from higher levels of flour substitution were not significantly different ($p>0.05$) in most of the attributes, they were still fairly accepted by the consumers. The use of this flour will reduce the pressure on wheat flour and help to improve the utilization of groundnut, soybean and sorghum.

Recommendations

The following recommendations were made:

1. Nutrition education should be adopted to teach people the importance of soybean, groundnut and sorghum, as regards to their tremendous potential to promote food security, reduce the risk of non-communicable diseases and alleviate poverty because of their diverse range of positive attributes.
2. Clinical trials on the cookies should be conducted to determine their efficacy in reducing the levels of low density lipoprotein cholesterol, the risk of heart disease, obesity and in maintaining nutritional status.

The use of soybean and groundnut flours should be encouraged among producers of confectionaries as a result of the nutritional benefits to the consumers. However, good manufacturing and good hygiene practices should be given utmost importance during production to avoid microbial contamination that may cause food borne disease

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