EFFECT OF ACHA AND SPROUTED SOYBEANS FLOUR ON THE QUALITY OF WHEAT BASED COOKIES.

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ABSTRACT

Cookies was produced from wheat (*Triticum,spp)*, acha (*Digitaria exilis)*, and sprouted soybean (*Glycine max*) flour blends. The acha and soybean were processed into flour and used to substitute wheat flour at different proportions with 100:0:0 wheat, acha and sprouted soybeans flour (WAS) as the control, 60:30:10, 50:40:10, 45:45:10, 40:50:10 and 35:55:10 (WAS). The functional properties of the wheat, acha and sprouted soybean flour blends, physical properties and proximate compositions of the cookies were determined. The functional properties of the flour samples shows that the bulk density, wettability, water absorption capacity, oil absorption capacity and gelatinization temperature ranged from 0.63 g/ml-0.99 g/ml, 10.21-12.98 g/sec, 6.53-12.52 g/g, 0.52-0.66 g/g and 63.7-65.1^{o}C respectively. There were significant differences ($p<0.05$) in all the values. The proximate composition of cookies sample showed that crude protein, crude fat, crude fibre, ash, moisture and carbohydrate content ranged from 12.14-16.48 %, 2.10-3.74 %, 1.76-2.55 %, 2.75-8.61 %, 9.18-9.50 % and 59.37-72.06 % respectively. The physical properties of cookies showed that the weight, diameter, thickness and spread ratio ranged from 15.61-17.11g; 61.59-63.20mm; 9.88-11.99mm and 5.28-6.24 respectively. The reference sample had the highest sensory scores for all the attributes. There was significant difference ($p<0.05$) in the colour, texture and aroma but there was no significant difference ($p>0.05$) in the taste and overall acceptability.
KEYWORDS: functional properties, physical, proximate composition, temperature, thickness.

1.0 INTRODUCTION

Cookies are traditionally made from soft wheat and belong to nutritious convenience foods with long shelf life. Soft wheat flour has been the major ingredient used in the production of cookies and other pastry products, but they can also be made with non-wheat flours such as sorghum, maize, pearl millet, plantain, *acha* grain, Soybean [1]. In recent years, government has through intensive collaboration with research institutes encouraged the use of composite flours in the production of cookies and related food products such as bread [2].

Composite flour can be described as a mixture of several flours obtained from root, tuber, cereal and legume, with or without the addition of wheat flour, been created to satisfy specific functional characteristics and nutrient composition [3].
Wheat (*Triticum* spp) is a grass that is cultivated worldwide. Globally, it is the most important human food grain and ranks second in total production as a cereal crop behind maize, the third being rice. Wheat grain is a staple food used to make flour for leavened, flat and steamed breads, cookies, cakes, pasta, spaghetti, macaroni, noodles, couscous and also for fermentation to make beer, alcohol, vodka or biofuel [4].
Soy bean *(Glycine max)* a grain legume, is one of the richest and cheapest sources of plants protein that can be used to improve the diet of millions of people especially the poor and low income earners in developing countries because it produces the greatest amount of protein used as food by man. Soybeans

is an excellent source of protein (40-45%); hence the seeds have the highest food value of all plant food consumed in the world; Soybeans have 3% lecithin, which is beneficial for brain development [5].

Sprouting is the practice of soaking, draining, and leaving seeds or grains until they germinate or sprout. The increasing interest in functional and healthy food products has promoted the use of germinated soya bean flour in the manufacture of foods for human consumption [6]. It is known that sprouting induces increase in free limiting amino acids and available vitamins with modified functional properties of seed components [7-8]. Sprouting is form from seeds during germination of seeds. The sprouts are outstanding sources of protein, vitamins and minerals and they contain such in the respect of health-maintaining important nutrients like glucosinolate, phenolic and selenium-containing components of isonflavon inside the soybeans. As the sprouts are consumed in the beginning of the growing phase, their nutrient concentration remains very high [9].

Acha (*Digitaria exilis)* is a cereal, traditionally consumed whole as "*tuwo*", couscous, "*gwate*", *achajollof* and *kununacha* [10]. *Acha* is reported to have a high pentosan (3.3%), hence, a high water absorption capacity that could be utilized in baking [11]. *Acha* is rich in micronutrients like iron and iodine (28.5 mg/100g and 22.9 mg/100g, respectively) and has about 73% carbohydrates [12]. *Acha* is considered as health grains in a sense that they are often consumed whole and are gluten-free [13]. *Acha* is uniquely rich in methionine and cysteine and evokes low sugar on consumption; an advantage to diabetics [14].

The broad objective of this research was to produce and evaluate the quality of cookies from wheat, *acha* and sprouted soybean flour blends to produce composites flours and cookies from wheat, *acha* and sprouted soybean flour blends.

2. MATERIALS AND METHODS

2.1 Source of raw materials

The wheat flour (*Triticum eastrum)* and yellow type of soybean (*Glycine max*) were purchased from kaura Namoda main Market Zamfara State. The *Acha* (*Digitaria exilis Staph*) grains, was purchased from Tudun wada main market, Jos, plateau State of Nigeria. The raw materials were properly cleaned by removing extraneous matter prior to their subjection to different processing treatments.

2.2 Processing Methods

2.2.1 Preparation of Acha Flour

Acha flour was produced using the method of Ayo *et al.* [15]. *Acha* grains were winnowed to remove chaff and dust. Adhering dust and stones were removed by washing in water (sedimentation) using local calabashes. The washed and destoned grains were dried in a cabinet drier at 45°C to a moisture content of about 12%. The dried grains were milled using attrition milling machine and the flour sieved to pass through a 0.4mm mesh size. The *acha* flour was packaged in air tight containers for use as presented in Fig. 1.

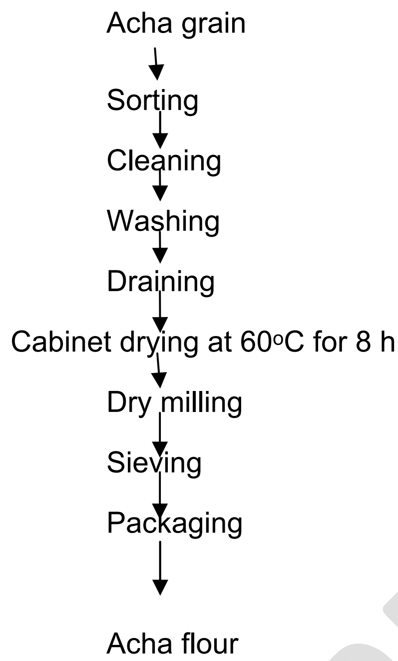

Figure 1: Production of A*cha* flour (Modified from Ayo *et al*.[15])

2.2.2 Processing of Sprouted Soybeans Flour

Sprouting soybean flour was produced by modifying the method described by Iwe [16] as shown in Figure 2. Soybean seeds (2000 g) were sorted, cleaned, washed and soaked overnight in a stainless steel bucket containing clean tap water. The soybeans were spread on a clean jute bag and covered to screen from direct sun light. Water containing small amount of calcium hypochlorite $(Ca(ClO)_2$ to discourage the growth of microorganisms, water was sprinkled twice a day at the intervals of nine (9) h. The seeds were allowed to germinate for 96 h at room temperature and cabinet dried at 60°C for 8 h, devegetated by hand rubbing, winnowed and milled into flour using hammer mill (Bremmer, Germany). The flour was sieved with the aid of a 425 µm sieve (Endecotts Ltd, London, England) to obtain a uniform particle size of flour which was packaged in polyethylene bag and stored at 4-6°C till needed as presented in Fig. 2.

Soybeans seed
↓
Sorting
↓
Washing
↓
Soaking overnight (12h)
↓
Draining
↓
Sprayed on a jute bag and screened from direct sun light for 96 h at room temperature
↓
Cabinet drying at 60^{o}C for 8 h
↓
De vegetated (removal of plumules)
↓
Winnowing
↓
Dry milling
↓
Sieving
↓
Packaging
↓
Sprouted soybeans flour

Figure 2: Production of sprouted soybeans flour (modified Iwe [16])

2.2.3 Formulation blends of wheat *acha* and sprouted soybeans flours

Based on the proximate compositions, wheat, sprouted soybeans and *acha* flour was used for the production of cookies formulation. The ingredient *used* for *cookies* production such as sugar, fat, baking powder, milk and salt are presented as shown below on Table 1.

Table 1: Mixture of Wheat, Acha and Sprouted Soybeans Cookies

Sample code (WAS)	wheat flour (%)	*Acha* flour (%)	sprouted soybean flour %)	Sugar (g)	Fat (g)	Baking powder (g)	Milk (g)	Salt (g)
100:0:0	100	00	00	120	250	1	50	1
60:30:10	60	30	10	120	250	1	50	1
50:40:10	50	40	10	120	250	1	50	1
45:45:10	45	45	10	120	250	1	50	1
40:50:10	40	50	10	120	250	1	50	1
35:55:10	35	55	10	120	250	1	50	1

Key: WAS= Wheat, *Acha* and Sprouted Soybeans flour blends

2.2.4 Production of cookies from wheat, acha and sprouted soybeans flour blends

The method described by Ndife *et al.*[17] with modification was used in the production of blends of wheat, *acha* and malted soybean flour cookies. Sugar (120g) was added to 250g of margarine in a Kenwood mixer and mixed at medium speed until fluffy. Milk powder were added while mixing and then mixing continued for about 30 min. Sifted flour blends, baking powder were slowly added to the mixture; and treaded to form dough. It was then rolled on a flat rolling board sprinkled with flour to a uniform thickness of about 0.4cm; circular cookies of 5.8 – 6.0cm diameter were cut, placed in oiled baking trays and baked in the oven at 180^{o}C for 15 min. Other samples with different blends ratio and the control with 100% wheat flour were baked in the same manner.

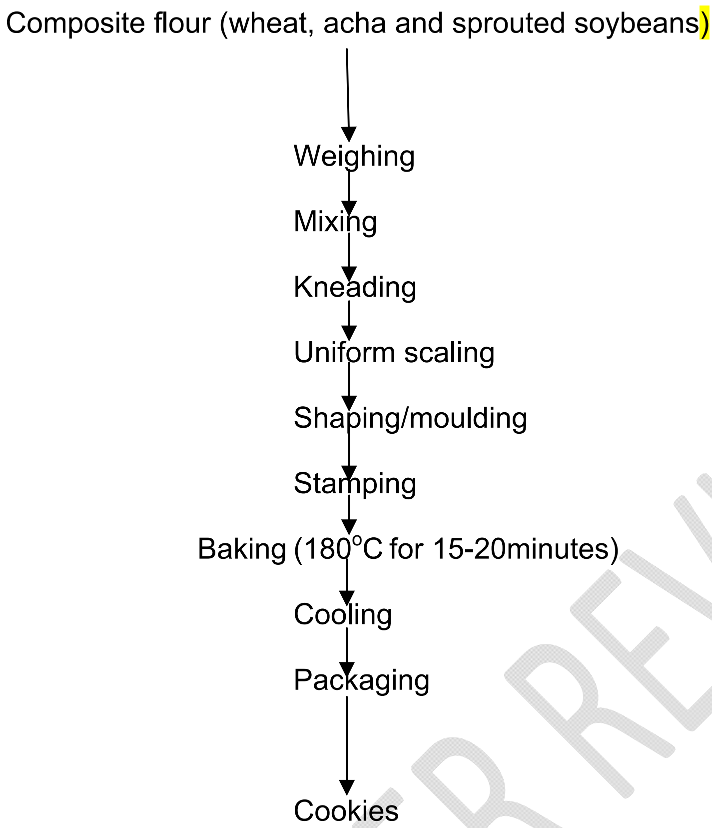

Figure 3: Production of Cookies from wheat, *acha* and sprouted soybean (modified Ndife *et al*. [17])

2.5 Determination of functional properties of the composite cookies from wheat, acha and sprouted soybeans flour blends.

2.5.1 Bulk density

A 50 g the flour sample was weight into a 100 ml measuring cylinder. The cylinder was tapped continuously until a constant volume was obtained. The bulk density (g cm-3) was calculated as weight of flour (g) divided by flour volume (cm^3) method described by Onwuka [18].

2.5.2 Wettabillity

The method described by Onwuka [18] was used. One gram of each of the flour samples was weighed out using an analytical balance and were each added into a 25ml graduated measuring cylinder with a diameter of 1cm. the finger was then placed over the open end of the cylinder in each case, inverted and was clamped at a height of 10cm from the surface of a 600ml beaker containing 500ml of distilled water. The finger was then removed and the test sample was allowed to be dumped. The wettability was recorded as the time required for the sample to become completely wet.

2.5.3 Gelatinization

Gelatinization temperature was determined by Onwuka [18]. 1 g flour sample was weighed accurately in triplicate and transferred to 20 ml screw capped tubes. 10 ml of water was added to each sample. The samples were heated slowly in a water bath until they formed a solid gel. At complete gel formation, the respective temperature was measured and taken as gelatinization temperature.

2.5.4 Water and Oil absorption capacity

Water and oil absorption capacities of the flour samples were determined by Onwuka [18] methods. One gram of the flour was mixed with 10 ml of water/oil in a centrifuge tube and allowed to stand at room temperature (30 ± 2ºC) for 1 h. It was then centrifuged at 200 x g for 30 min. The volume of water or oil on the sediment water measured. Water and oil absorption capacities were calculated as ml of water or oil absorbed per gram of flour.

2.5.5 Determination of proximate composition of the composite cookies from wheat, acha and sprouted soybeans flour blends.

2.5.5.1 Moisture Determination

Moisture content was determined using the air oven dry method of AOAC [19]. A clean dish with a lid was dried in an oven at 100°C for 30min. It was cooled in desiccators and weighed. Two (2) grams of sample was then weighed into the dish. The dish with its content was then put in the oven at 105°C and dried to a fairly constant weight. The loss in weight from the original sample (before heating) was reported as percentage moisture.

$$\% \, Moisture = \frac{weight\ loss\ (W2-W3)}{Weight\ of\ Sample\ (W2-W1)}\ x\ 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where: W_1 = weight of dish, W_2 = weight of dish + sample before drying, W_3 = weight of dish + sample after drying.

2.5.5.2 Crude Protein Determination

The Kjeldahl method as described by AOAC [19] was used to determine the percentage crude protein. Two (2) grams of sample was weighed into a Kjeldahl digestion flask using a digital weighing balance (3000g x 0.01g 6.6LB). A catalyst mixture weighing 0.88g (96% anhydrous sodium sulphate, 3.5% copper sulphate and 0.5% selenium dioxide) was added. Concentrated sulphuric acid (7ml) was added and swirled to mix content. The Kjeldahl flask was heated gently in an inclined position in the fume chamber until no particles of the sample was adhered to the side of flask. The solution was heated more strongly to make the liquid boil with intermittent shaking of the flask until clear solution was obtained. The solution was allowed to cool and diluted to 25ml with distilled water in a volumetric flask. Ten (10) ml of diluted digest was transferred into a steam distillation apparatus. The digest was made alkaline with 8ml of 40% NaOH. To the receiving flask, 5ml of 2% boric acid solution was added and 3 drops of mixed indicator was dropped. The distillation apparatus was connected to the receiving flask with the delivery tube dipped into the 100ml conical flask and titrated with 0.01 HCl. A blank titration was done. The percentagenitrogen was calculated from the formula:

$$\% \, Nitrogen = \frac{(S-B)\times 0.0014\times 100\times D}{sample\ weight} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where, S = sample titre, B = Blank titre, S - B = Corrected titre, D = Diluted factor

% Crude Protein = % Nitrogenx 6.25 (correction factor).

2.5.5.3 Crude Fat Determination

Fat was determined using Soxhlet method as described by AOAC [19].Samples were weighed into a thimble and loose plug fat free cotton wool was fitted into the top of the thimble with its content inserted into the bottom extractor of the Soxhlet apparatus. Flat bottom flask (250ml) of known weight containing 150 – 200ml of 40 – 60°C hexane was fitted to the extractor. The apparatus was heated and fat extracted for 8h. The solvent was recovered and the flask (containing oil and solvent mixture) was transferredinto a hot air oven at 105°C for 1 h to remove the residual moisture and to evaporate the solvent. It was later transferred into desiccator to cool for 15 min before weighing.Percentagefat content was calculated as

$$\% \, Crude\ Fat = \frac{weight\ of\ extracted\ fat}{Weight\ of\ Sample}\ x\ 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

2.5.5.4 Crude Fibre Determination

The method described by AOAC [19] was used for fibre determination. Two (2) grams of the sample was extracted using Diethyl ether. This was digested and filtered through the california Buchner system. The resulting residue was dried at 130 ± 2°C for 2 h, cooled in a dessicator and weighed. The residue was then transferred in to a muffle furnace and ignited at 550°C for 30 min, cooled and weighed. The percentagecrude fibre content was calculated as:

$$\% \, Crude\ fibre = \frac{Loss\ in\ weight\ after\ incineration}{Weight\ of\ original\ food} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

2.5.5.5 Ash Determination

The AOAC [19] method for determining ash content was used. Two (2) gram of sample was weighed into an ashing dish which had been pre-heated, cooled in a desiccator and weighed soon after reaching room temperature. The crucible and content was then heated in a muffle furnace at 550°C for 6-7 h. The dish was cooled in desiccator and weighed soon after reaching room temperature. The total ash was calculated as percentage of the original sample weight.

$$\% \, Ash = \frac{(W3-W1)}{(W2-W1)} \, x \, 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(5)}$$

Where:

W1 = Weight of empty crucible,

W_2 = Weight of crucible + sample before ashing,

W_3 = Weight of crucible + content after ashing.

2.5.5.6 Carbohydrate Determination

Carbohydrate content was determined by difference as follows:

$$\% \, Carbohydrate = 100 - (\%moisture + \%Protein + \%Fat + \%Ash \, + \, \%Fibre) \ldots \ldots 6$$

2.5.6 Determination of physical properties of the cookies from wheat, acha and sprouted soybeans flour blends.

The weight of the cookies was determined using Electronic compact weighing balance (model KDBN2010) as described by AOAC [19]. The thickness (mm) and diameter (mm) of the cookies were measured with digital vernier calipers with 0.01mm precision according to the method of Ayo *et al*. [15]. And spread ratio was also determined according to the method of spread ratio was determined according to method described by Okaka [20].

2.5.7 Sensory evaluation of the cookies from wheat, acha and sprouted soybeans flour blends.

Sensory evaluation of the cookies was carried out according to the method described by Ihekoronye and Ngoddy [21].

2.6 Statistical Analysis

The Data obtained was subjected to analysis of variance (ANOVA) and means separated by Fisher's least significant difference test using Genstat statistical package, version 17.0

3. RESULTS AND DISCUSSION

3.1 Functional properties of cookie from wheat, acha and sprouted soybeans flour blends

The functional properties of wheat, acha and sprouted soybeans flour blends is presented in Table 2: The results showed that the bulk density ranged from 0.63-0.99 g/ml, Wettability ranged from 0.21-12.98 g/sec, Water absorption capacity ranged from 6.53-12.52 g/g, oil absorption capacity ranged from 0.52-0.66 g/g and Gelatinization temperature ranged from 63.7-65.1^{o}C respectively. Bulk density is a function of particle size which is inversely proportional to bulk density [22]. Bulk density is also an important parameter for determining the ease of packaging and transportation of particulate or powdery foods,there was a gradual increase of the bulk density with increase in the addition of *acha* flour with constant percentage of the sprouted soybeans. This result is in agreement with Joel et al. [23] which have bulk density of 0.60g/ml-0.85g/ml. The higher bulk density is desirable for greater ease of dispersibility and reduction of paste thickness; while low bulk density of flour is a good physical attribute when determining transportation and storability.

The wettability of the flour sample blends are significantly different from each other, which indicated that the particles size of the formulated samples were totally hydrated between 10.21 to 12.96 seconds. With the highest value of 12.98 seconds in sample 35:55:10 (WAS) and the lowest value of 10.21seconds in sample 100:0:0(100% wheat flour). This may be due to the small particle sizes of the samples, as well as the hygroscopic nature of the *acha* and sprouted soybeans flour. The cookies wettability increased by allowing more water penetration within its matrix with increasing addition of *acha* and sprouted soybeans flour. This may be due to increased fiber content that has been shown to retain water [24].
Soybeans flour remains same for all cases except the only wheat flour cookies, thus increased amount of acha might be the reason for the decrease in water absorption capacity. This result conforms to the work of Malomo et al. [25], while the WAC decreases with increasing protein content. Water absorption characteristic represents the ability of the product to associate with water under conditions when water is limiting such as dough and pastes. Water absorption capacity represents the ability of the products to associate with water under conditions when water is limiting such as dough’s and pastes.
The oil adsorption capacity (OAC) decreases as the wheat flour content decrease. The contribution of *acha* and sprouted soybean flour on the Oil Adsorption Capacity was the least. Oil absorption capacity is attributed mainly to the physical entrapment of oils. It is an indication of the rate at which protein binds to fat in food formulations [22]. Oil absorption capacity is useful in formulation of foods such as sausages and bakery products. Fat increases the leavening power of the baking powder in the batter and improves the texture of the baked product.

The gelatinization temperature of the flour samples blends generally increased with increasing addition of *acha* and sprouted soybean flour. Increasing fiber content appears to delay gelation and subsequently its temperature. Thus, higher heat energy is required to attain significant gelation. Case *et al*.[26] reported that waxy and regular maize gelatinize at 62-72°C, whereas high-amylose starches begin to swell below 100°C, temperatures greater than 130°C are required to fully disperse these starches. This is because more amylose molecules are involved in the crystalline regions of the high amylose starch than in waxy and regular starches [27].

Table 2: Functional properties of wheat, acha and sprouted soybeans flour blends

Sample Code (WASSF)	Bulk density (g/ml)	Wettability (g/sec)	Water absorption capacity (g/g)	Oil absorption capacity (g/g)	Gelatinization temperature (^oC)
100:0:0	0.63^{a}±0.01	10.21^{a}±0.01	12.52^{a}±0.01	0.66^{d}±0.01	63.73^{a}±0.28
60:30:10	0.69^{b}±0.01	10.64^{b}±0.01	9.85^{b}±0.01	0.62^{c}±0.01	63.97^{ab}±0.05
50:40:10	0.72^{c}±0.01	11.23^{c}±0.01	9.22^{c}±0.01	0.60^{bc}±0.01	63.94^{ab}±0.08
45:45:10	0.83^{d}±0.00	11.88^{d}±0.02	7.85^{d}±0.01	0.57^{b}±0.01	64.16^{b}±0.06
40:50:10	0.93^{e}±0.01	12.32^{e}±0.01	7.36^{e}±0.06	0.53^{a}±0.01	64.59^{c}±0.06
35:55:10	0.99^{f}±0.01	12.98^{f}±0.01	6.53^{f}±0.03	0.52^{a}±0.02	65.12^{d}±0.01
LSD	0.02	0.02	0.07	0.03	0.31

Values are means ± standard deviations of duplicate duplications. Means in same column with same superscript are not significantly (p>0.05) different

Key: WAS= Wheat, *Acha* and Sprouted Soybeans flour blends

Table 3: Proximate composition of cookies from wheat, acha and sprouted soybeans flour blends

Sample Code (WASSF)	Moisture (%)	Crude protein (%)	Crude fat (%)	Ash (%)	Crude fibre (%)	Carbohydrate (%)
100:0:0	9.18^{a}±0.21	12.14^{a}±0.25	2.10^{a}±0.17	2.75^{a}±0.24	1.76^{a}±0.10	72.06^{a}±0.47
60:30:10	9.47^{b}±0.01	14.82^{b}±0.01	2.87^{b}±0.01	7.22^{b}±0.00	1.97^{b}±0.01	63.64^{b}±0.05
50:40:10	9.45^{b}±0.01	15.50^{c}±0.20	3.40^{c}±0.00	7.56^{c}±0.00	2.21^{c}±0.01	61.75^{c}±0.03
45:45:10	9.50^{b}±0.00	16.25^{d}±0.00	3.60^{d}±0.00	8.25^{d}±0.00	2.40^{d}±0.00	60.80^{d}±0.00
40:50:10	9.45^{b}±0.00	16.34^{d}±0.01	3.74^{d}±0.02	8.50^{e}±0.00	2.52^{e}±0.01	60.05^{e}±0.04
35:55:10	9.45^{b}±0.00	16.48^{d}±0.01	3.75^{d}±0.00	8.40^{e}±0.00	2.55^{e}±0.00	59.37^{f}±0.01
LSD	0.21	0.32	0.17	0.24	0.10	0.48

Values are means ± standard deviations of duplicate duplications. Means in same column with same superscript are not significantly (p>0.05) different

Key: WAS= Wheat, *Acha* and Sprouted Soybeans flour blends

3.2 Proximate composition of the cookies samples from wheat, acha and sprouted soybeans flour blends

The result of the proximate composition of cookies from wheat, *acha* and sprouted soybeans flour blends is presented in Table 3. Thus showed that the moisture content ranged from 9.18-9.50 %, crude protein ranged from 12.14-16.48 %, crude fat ranged from 2.10-3.75 %, ash ranged from 2.75-8.50 %, crude fibre ranged from 1.76-2.55 % and carbohydrate ranged from 59.37-72.06 % . There were significant differences (P<0.05) among the entire samples except for sample 45:45:10, 40:50:10 and 35:55:10 (WAS) cookies samples which were not significantly different from each other. The increase in protein content was due to the high content of protein in the sprouted soybean and *acha* flour. Therefore, sprouted soybeans and *acha* flour served a complementary purpose in increasing the protein content of the cookies products based with wheat flour and also helps in providing the limiting protein (lysine and tryptophan). The increases in protein content are within the range with the findings of Ikuomola et al. [28]

but do not agree with the value reported by Atobatele, [29]. The sprouted soybean and *acha* fortified cookies will help to alleviate diseases like kwashiorkor that result from higher carbohydrate and high glycemic index food intake. The crude fat contents of the cookies sampleswere significantly different (p<0.05) amongst six samples. The values of the fat content ranged from 2.10-3.75%. The lowest value was observed in sample 100:0:0 (100% wheat flour) cookies 2.10 % and this is relatively low compared to the values 4.50 % obtained by Joel et al. [23]. The highest value was observed in sample 34:55:10 this could be due to sprouted soybeans added and at different percentage and constant *acha* flour substituted.

The highest fibre value was recorded in sample 35:55:10 cookies and the lowest value in sample 100:0:0. This result indicated that both *acha* and sprouted flour contain larger amount of crud fiber than wheat flour. This could be the reason that an increasing in fiber content was observed as the proportion of *acha* and sprouted soybean flour were added. Similar result was also reported by Manoela et al. [30] in their study of blending wheat flour with residue from king palm processing which contains higher fiber content than wheat flour. This was as a result of increased in the supplementation with acha flour.
The ash content of the cookies samples increased with increase in the substitution of wheat flour with *acha* and sprouted soybeans 2.75% to 8.50%. Increase in the ash content indicates that the samples with high percentage of ash will be good sources of minerals. *Acha* seeds are excellent sources of potassium, phosphorus, magnesium, sodium, calcium and iron [31].The ash contents of the cookies samples ranges from 2.75-8.50 %. The samples were different at 5% level of significance (p<0.05). Sample 35:55:10 Cookies had the highest value of 8.50 % while sample 100:0:0 (100% wheat flour) cookies had the lowest value of 2.75 %. Higher ash contents indicated that the mineral content is higher in the *acha* and sprouted soybean flour than in the wheat flour. It was observed that there was an increase in the ash contests of the cookies with increasing level of sprouted soybean flour in the cookies samples.
The moisture content for sample 100:0:0 cookies was the least 9.18 % significantly less than that found for other formulations. This result is in agreement with other study of Joel et al. [23] which reported moisture contents of 7.24-9.85 % from wheat and full fat soybeans. However, the present study was not in agreement with the study of Ikuomola et al. [28] whic reported moisture content of 3.34-4.06% respectively which could be as a result of supplementing wheat with acha and sprouted soybeans flour.
Carbohydrate content decreased with increased substitution of *acha* and sprouted soybeans flour from 72.06 % to 59.37 %. There was significant difference (p>0.05) between the carbohydrates content of the cookies samples. The reason of reduction in carbohydrate content of the cookie could be due to an increasing in protein, moisture, fat, ash and fiber content of the cookies as the proportion of *acha* flour in the formulation was increased at constant sprouted soybean substitution. A reduction in carbohydrate content was also reported by Manoela et al. [30] in their study of blending wheat flour with residue from king palm processing which contains a higher fiber, ash and fat content than wheat flour.

Table 4: Physical properties of the cookies from wheat, acha and sprouted soybeans flour blends

Sample Code (WAS)	**Weight (g)**	**Diameter (mm)**	**Thickness (mm)**	**Spread ratio**
100:0:0	15.61^{a}±0.01	63.20^{a}±0.01	11.99^{a}±0.01	5.28^{a}±0.01
60:30:10	16.02^{b}±0.01	62.09^{b}±0.01	10.50^{b}±0.01	5.91^{b}±0.00
50:40:10	16.30^{c}±0.01	61.98^{c}±0.02	10.29^{c}±0.01	6.02^{bc}±0.00
45:45:10	16.71^{d}±0.02	61.88^{d}±0.04	10.21^{cd}±0.01	6.06^{c}±0.01
40:50:10	16.97^{e}±0.03	61.69^{e}±0.01	10.07^{d}±0.04	6.13^{cd}±0.02
35:55:10	17.11^{f}±0.01	61.59^{f}±0.01	9.88^{e}±0.18	6.24^{d}±0.11
LSD	0.04	0.05	0.18	0.12

Values are means ± standard deviations of duplicate duplications. Means in same column with same superscript are not significantly (p>0.05) different

Key: WAS= Wheat, *Acha* and Sprouted Soybeans flour blends

3.3 Physical properties of cookie samples from wheat, acha and sprouted soybeans flour blends

The result of the physical properties of the cookies from wheat, *acha* and sprouted soybeans flour blends is as presented in Table 4. The results shows significant different in weight, diameter, thickness and spread ratio at ($p<0.05$) for samples 100:0:0, 60:30:10, 50:40:10, 45:45:10, 40:50:10 and 35:55:10 wheat, *acha* and sprouted soybeans (WAS). The weight of the cookies samples increased as a result of the increase level of *acha* and sprouted soybean flour substitution, there was significant difference ($p>0.05$) between the various cookies samples. The findings were in contrary to the observation of some researchers who reported significant reduction in the weight of cookies produced from soya bean supplemented with wheat flour [15], cowpea-wheat [20], millet-sesame flour [32], bambara groundnut-maize flour [33] respectively.

There was a significant difference ($p<0.05$) among the value obtained for the cookie diameter supplemented with *acha* and sprouted soybean flour. As the proportion of *acha* flour increased in the formulation, a decreased in the average cookie diameter was observed. The thickness of the cookies was found to be significantly influenced both by blend proportion and baking temperature ($p>0.05$). However a decreased in the average thickness of the cookies was observed as the proportion of *acha* flour was increased in the formulation with constant sprouted soybean flour. The control (100% wheat) cookie showed a larger thickness (11.99mm) as compared to the other blend proportion. A similar decreased in the average cookie thickness was also reported for cookie prepared with Wheat and sweet potato flour [34], and wheat and residue from king palm processing [30]. The average spread ratio of the cookies showed significantly decreased as the proportion of *acha* flour was increased in the formulation at constant percentage of sprouted soybean flour. The cookie which was made from 100% wheat flour spread larger as compared to the blend proportion. According to Manoela et al. [30] the spread ratio of cookies is strongly correlated to the water absorption capacities of flour.

Table 5: Sensory attributes of the cookies from wheat, acha and sprouted soybeans flour blends

Sample Code (WASSF)	**Appearance**	**Taste**	**Texture**	**Aroma**	**Overall acceptability**
100:0:0	$7.90^{a}±0.97$	$7.35^{a}±1.09$	$7.70^{a}±1.03$	$6.95^{a}±0.94$	$7.55^{a}±1.05$
60:30:10	$7.35^{ab}±1.14$	$7.30^{a}±1.08$	$7.00^{b}±0.97$	$6.55^{ab}±0.94$	$7.40^{a}±1.05$
50:40:10	$6.80^{bc}±1.24$	$7.15^{a}±1.04$	$6.70^{b}±0.98$	$6.50^{ab}±0.95$	$7.30^{a}±1.17$
45:45:10	$6.75^{bc}±1.02$	$7.25^{a}±1.07$	$6.55^{b}±1.15$	$6.40^{ab}±0.82$	$7.10^{a}±1.29$
40:50:10	$6.45^{c}±1.23$	$7.10^{a}±1.17$	$6.30^{b}±1.22$	$6.30^{b}±1.03$	$7.10^{a}±1.29$
35:55:10	$6.45^{c}±1.19$	$7.05^{a}±1.19$	$6.45^{b}±1.19$	$6.15^{b}±0.93$	$7.05^{a}±1.32$
LSD	0.71	0.69	0.69	0.59	0.75

Means in same column with same superscript are not significantly ($p>0.05$) different

Key: WASSF= Wheat, *Acha* and Sprouted Soybeans flour blends

3.4 Sensory attributes of the cookie samples from cheat, acha and sprouted soybeans flour blends

The result of the sensory attributes of the cookies from wheat, *acha* and sprouted soybeans flour blends is as presented in Table 5. The results showed significant difference in appearance, texture and aroma but no significant difference in taste and overall acceptability ($p<0.05$) for differents formulations. The brown appearance observed from the cookies samples resulting from Maillard reaction which always associated with baked foods. There were significant ($p<0.05$) difference among the sample means for all appearance. An increase in the substitution level of *acha* and sprouted soybean flour resulted in a

decrease in appearance scores. Cookie produced from samples 40:50:10 and 35:55:10 scored least 6.45 in terms of appearance while the control (100 % wheat flour) cookies had the highest score of 7.90 for appearance. The scores for the appearance decreased with increase in the amount of *acha* flour in the blend, and substitution with 10% constant sprouted soybeans flour also contributed to the decrease in the appearance. The taste of cookies ranged from 7.05-7.35, there were no significant ($p>0.05$) deference among the cookie the samples. The texture of the cookies samples were not significantly different ($p>0.05$) from each other, but significantly different from sample 100:0:0 (100% wheat flour), sample 60:30:10 (WAS) had the next highest rating to the sample from sample 100:0:0. Aroma is another attribute that influences the acceptance of baked food products even before they are tasted. Substitution of wheat flour with either *acha* flour or sprouted soybeans flour at different levels significantly ($p<0.05$) affect the sensory score of aroma. The highest score of 6.95 in aroma was observed in sample 100:0:0, while sample 35:55:10 scored the least 6.15. The findings were in close agreement with the findings of Ikubor, [5], who studied the effect of soybeans flour on the functional properties and the potential of soybean and cassava flour blends in cookies production.
The Aroma, appearance, texture and taste indeed influence the overall acceptability of the cookies samples. There was no significant ($p\leq0.05$) difference between control sample and the other samples in terms of the overall acceptability. The control sample had the highest score of approximately 7.55 and sample35:55:10 had the lowest score of approximately 7.05. The final sensory analysis conducted by the panelist was the overall acceptability of the cookie. The overall acceptability of the cookie was significantly influence by the blend proportion ($p< 0.05$).

CONCLUSION

This study was able to develop composite flour from *acha* and sprouted soybeans for cookies production. The functional properties and proximate composition were elucidated. Acceptable cookies were produced from wheat, *acha* and sprouted soybean flour blends with the 60:30:10 been the most acceptable followed by the 50:40:10 level of supplementation.

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