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Quality Assessment of Cookies produced from Wheat Flour, Soybean Protein isolate and *Aframomum danielli*

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Abstract

The study aimed to evaluate cookies' physiochemical properties produced from composite flour of wheat, soybean protein isolate, and *Aframomum danielli.* Soybean and *Aframomum danielli* seeds were processed into soy protein isolate and flour, respectively, which was used to substitute wheat flour in varying proportions to give samples W100 (control), W90, W80 and W70 for preparation of cookies. Proximate, mineral composition and functional properties were carried out on the cookies samples using standard methods. A nine-point hedonic scale was used to evaluate the organoleptic characteristics of the cookies. The result of the proximate content shows an increase in moisture, protein, fat and ash. In contrast, the crude fibre and carbohydrate content decreased with the increase in the level of substitution with soy protein isolate and *Aframomum danielli,* and these ranged between 4.02-5.70%; 12.68-21.30%; 17.98-25.69%; 0.40-1.49%; 4.54-1.18% and 60.38- 44.64% respectively. The composite flour's functional properties increased from 18.60- 22.08 g/ml; 15.06 -18.65 g/ml; and 8.40- 12.06 g/ml for water absorption capacity, oil absorption capacity and swelling capacity, respectively. The mineral content increased in calcium, sodium, potassium and zinc while the magnesium content decreased. Cookies produced from 100% wheat flour was most preferred. However, the overall acceptance among the composite cookies was ranked to sample W70 having 24% soy protein isolate and 8% *Aframomum danielli* substitution. This result shows that acceptable and enriched cookies as snacks can be prepared from composite flour of wheat, soy protein isolate and *Aframomum danielli.*

Keywords: Cookies, composite flour, soy protein isolate, *Aframomum danielli*

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Introduction

Local raw materials now used as a substitute for wheat flour increase the production of confectionery products (Noor and Komathi, 2009; Abdelghafor *et al*., 2011). Composite flour has been considered advantageous in developing countries as it encourages the use of locally grown crops as flour which reduces the importation and dependence on wheat flour (Hasmadi *et al.*2014). The use of non-wheat materials of local origin has been reported in producing cookies, bread, biscuits and other snacks (Gomez *et al.*, 2003; Abayomi *et al.,* 2013; Olapade and Adeyemo, 2014; Adeyeye and Akingbala, 2015).

Cookies are appetizing ready-to-eat products, convenient and inexpensive food made from unleavened dough have become popular in Nigeria as a snack food among children and adults (Abayomi *et al.*2013; Olapade and Adeyemo, 2014; Adeyeye and Akingbala, 2015).

Soy proteins are unique among plant proteins due to their relatively high biological value and presence of essential lysine, which is a limiting amino acid in most cereals, while the defatted soy flour is a cheaper, convenient and richest source of protein (Riaz, 2006; Tripathi and Mishra 2005). The isolates are highly refined soy protein products that represent the major protein fraction of the soybean. Soy protein isolate supplies a high quality of protein that contains all essential amino acids needed for growth. Soy protein isolate is equal in quality to animal products and has been reported to contain protein (89.31%), ash (2.92%), fat (1.63%) and fibre (0.46%) (Adeyeye *et al.* (2017).

Aframomum danielli is a preservative spice belonging to the genus *Aframomum* of the family *Zingiberaceae*. It has been shown that the essential oils from *A. danielli* fractions possess anti-oxidative property and can be an excellent natural source of food preservatives which could be utilized in the food industry (Jaiyeoba *et al.*2017). However, Aroyeun *et al.* (2011) have demonstrated that the monoterpene of the essential oil of *Aframomum danielli* could stop food spoilage, yeast and mycotoxin producing moulds.

There is a need to develop a snack food product that will allow consumers to feed on improved formulations with substantive benefits from wheat-soy combinations at a minimal cost.

This study aims to evaluate the physicochemical properties and consumer acceptability of cookies produced from wheat flour, enriched with soy protein isolate and spiced with *Aframomum danielli.*

Materials and Methods

Soybean seeds were obtained from the Institute of Agricultural Research and Training, Ibadan, while fresh pods of Aframomum danielli were from Ogbagi in Akoko, Ondo State, Nigeria.

The ingredients used to produce the cookies, such as wheat flour, baking powder, flavour, sugar, butter, emulsifier and packaging materials, were purchased from Ikole market, Ekiti State.

Preparation of defatted soy flour and soy protein isolate

Soybean seeds were cleaned manually, dehulled, and oven-dried. Seeds were milled using Brabender Blender, sieved using a mesh sieve and defatted with n-hexane using Soxhlet apparatus for five h. The defatted flour was desolventized at room temperature (25°C) for five hours and later in the oven at 60°C for two hours.

Soy protein isolates were prepared from defatted soy flour with some modifications using the method described by Fatoumata *et al.* (2013). The defatted soy flour was dispersed in distilled water at a flour to water ratio of 1:10 (W/V), the pH was adjusted to 10 with 1M NaOH and stirred for three hours using a magnetic stirrer at room temperature. The extract was separated by centrifugation at 4300 x g for 20 min. Residues were re-extracted twice as described above, and extracts were combined. Protein was precipitated by adjusting the pH to 3.5 with 1M HCl before centrifugation at 4300 x g for 20 min. The protein isolate residue obtained was washed twice with distilled water, it was resuspended in distilled water, and the pH was adjusted to 7.0 with 1M NaOH before freeze-drying. The dried soy protein isolates were stored in a desiccator at room temperature.

Preparation of *Aframomum danielli* powder

The seeds of *Aframomum danielli* were removed from the pods and cleaned of the extraneous materials. The seeds were winnowed and milled into powder using a hammer mill. The powder was then sieved with a wire mesh to obtain fine powder and stored in a desiccator at room temperature (Adegoke and Gopalan, 1998).

Composite flour sample formulation

The wheat flour, protein isolates, and Aframomum danielli were blended. Four different samples of composite flour blends coded as W100 (control), W90, W80, and W70 were obtained from the formulation shown in Table 1.

Table 1: Composite flour formulation (%)

Samples	Wheat flour	Soy protein isolates	*Aframomum danielli*
W100	100	0	0
W90	90	8	2
W80	80	16	4
W70	70	24	6

Production of cookies

The cookies were produced from the different flour blends using the method described by Olapade and Adeyemo (2014). The sugar (60 g) and baking fat (40 g) was creamed in a Kenwood mixer, the composite flours (200 g) were blended with other baking ingredients; salt (2.0 g), skimmed milk (15 g), baking powder (2 g) and water (150 mL) was added to smoothen the dough. The resulting dough was kneaded and cut into uniform sizes using a cutter. The dough was baked in preheated oven at 220 °C for 20 min; the cookies were allowed to cool and packed in High-Density Polyethylene film and stored at room temperature for subsequent analyses. The biscuits from 100% wheat flour were used as a control sample.

Proximate Analysis of the cookies

The proximate chemical content (moisture content, protein content, crude fat content, crude fibre content, ash content) of the cookies was determined using the standard AOAC (2005) method. The total carbohydrate content was estimated by difference.

Determination of mineral components

The cookie samples from the composite blends were digested by the wet ashing method before mineral content determination. The atomic absorption spectrophotometer was used for calcium and magnesium, the flame photometry (Perkin Elmer, model 402) for potassium and sodium (Abulude *et al.*2007), while the phosphorus content was determined colorimetrically using Spectrophotometer (JENWAY 6305) as described by Nielson (2003).

Determination of the functional properties

The functional properties of the composite flour blends, such as the water absorption capacity (WAC), Oil absorption capacity (OAC) and the swelling capacity (SC), were determined using the method described by Onwuka (2005).

Sensory evaluation of the cookies

The Sensory profile of cookies produced from the composite blends was evaluated by 20 untrained panellists familiar with cookies products, selected from students of the Federal University, Oye Ekiti. Quality parameters evaluated were taste, colour, flavour/aroma, texture, appearance and overall acceptability, using a 9-point hedonic scale from like extremely (9) to dislike extremely (1) as described by Iwe (2010).

Statistical Analysis

One-way Analysis of Variance (ANOVA) was used to compare the result means, and Duncan's multiple range test separated the means. All statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) Version 22.0 (IBM, 2016), and significance was taken at a 5% level of probability.

Results and Discussion

Proximate composition of the cookies

The results of the proximate content of the cookies are shown in Table 2. The moisture content of the cookies ranged from 4.02 to 5.70%, which was significantly ($p \leq 0.05$) different. The moisture content increased with increasing substitution of the wheat flour with soy protein isolates and *Aframomum danielli*. Abayomi *et al.* (2013) reported a lower moisture content of 3.43-2.13% for cookies produced from blends of sweet potatoes and fermented soybean flour, while Adeyeye (2016) while Adeyeye *et al.* (2017) reported a higher moisture content of 8.96-9.16% and 8.59-6.96% for cookies produced from wheat-sorghum flour and maize-soy protein isolate respectively. However, the moisture content obtained was within the recommended 10% range for dry food products, indicating good storability.

The protein content of the cookies ranged from 12.68% to 21.30%, which was significantly different ($p \quad 0.05$), with sample W70 having the highest protein content (21.30%). The protein content of the cookies increased with increasing soy protein isolates and *Aframomum danielli* substitution in the blends. The increase in the protein content of the composite cookies could be due to high protein reported in soybean (Basman and Koksel, 2008) and soy protein isolate (Adeyeye *et al.*, 2017). Similar high protein of 13.8-21.7% was reported by Abayomi *et al.* (2013) for cookies produced from potatoes and fermented soybean flour, while Adeyeye *et al.* (2017) reported protein 11.62-29.11% for maize flour cookies enriched with soy protein isolates.

The fat content of the cookies ranged from 17.98 to 25.69%, which increased with increasing substitution with soy protein isolates and *Aframomum danielli.* The high-fat content observed could be attributed to the *Aframomum danielli* added, which was high in essential oils (Adegoke and Gopalan, 1998), the soy protein isolates, and the type of fat incorporated for baking. However, Adeyeye *et al.* (2017) reported a lower fat content of 8.45-9.22% for cookies produced from wheat and soy protein isolate.

The Ash content of all the samples ranged from 0.40 to 1.49%, which was significantly different ($p \leq 0.05$). The ash content increased with increasing substitution in the blends, attributed to the higher mineral content reported in soybean (Sanni, 2008). However, the ash content observed was lower than 3.74-2.87% reported by Adeyeye *et al.* (2017) and 2.20-2.57% reported by Abayomi *et al.* (2013).

Table 2: Proximate composition of the cookies (%)

Sample	Moisture	Protein	Fat	Ash	Fibre	Carbohydrate
W100	4.02 ± 0.00^{d}	12.68 ± 0.07^{d}	17.98 ± 0.08^{d}	0.40 ± 0.00^{d}	4.54 ± 0.06^{a}	60.38 ± 0.16^{a}
W90	4.55 ± 0.00^{c}	15.20 ± 0.03^{c}	21.29 ± 0.50^{c}	0.82 ± 0.00^{c}	3.16 ± 0.00^{b}	54.98 ± 0.21^{b}
W80	5.63 ± 0.01^{b}	16.20 ± 0.03^{b}	22.55 ± 0.23^{b}	1.06 ± 0.00^{b}	2.45 ± 0.03^{c}	52.11 ± 0.28^{b}
W70	5.70 ± 0.00^{a}	21.30 ± 0.10^{a}	25.69 ± 0.25^{a}	1.49 ± 0.00^{a}	1.18 ± 0.00^{d}	44.64 ± 0.40^{c}

Means with the same superscripts within the same column are not significantly different ($p \leq 0.05$).

The crude fibre content of the cookies reduced from 4.54 to 1.18%, which could be due to a reduction in wheat flour in the blends as the substitution level increased. A similar lower fibre content (1.69-2.87%) was reported for maize flour cookies enriched with soy protein isolates (Adeyeye *et al.* 2017), while a higher fibre content (3.3-5.7%) for wheat and soy composite flour was reported by Ndife *et al.* (2014).

The carbohydrate content reduced from 60.38 to 44.64%, increasing the substitution proportion in the composite blends. The results observed in this study is similar to the reports of Okoye *et al.* (2008) for the decrease in carbohydrate content (73.4-34.9%) for wheat-soybean cookies. Oluwamukomi *et al.* (2011) and Adeyeye *et al.* (2017) also reported a decreased carbohydrate content of 69.2-74.5% and 63.3-49.8% for wheat-cassava soy composite flour cookies and maize- soy protein isolates cookies, respectively.

Functional properties of the composite flour

The results of the functional properties of composite flour blends are presented in Table 3. Water absorption capacity ranged from 18.60 to 22.08 g/ml, increasing the level of soy protein isolates and *Aframomum danielli* substitution. The water absorption capacity (WAC) is important in developing ready-to-eat foods, as high WAC may assure product cohesiveness (Housson and Ayenor, 2002). The high WAC of composite flours is an indication that the flours can be used in the formulation of foods such as sausage, cookies, dough, processed cheese and bakery products (Niba *et al.,*2002). Also, flour's ability to absorb water has been reported to improve dough making potentials (Iwe and Onadipe, 2001).

Oil absorption capacity (OAC) of the flour samples ranged from 15.06 to 18.65 g/ml, increasing the substitution of wheat flour with soy protein isolates and *Aframomum danielli.* Oil absorption capacity is an important parameter of flour used in baking (Ikpeme *et al.*,2010) as it reflects the emulsifying capacity. Oil absorption capacities also reflect better mouthfeel and flavour retention in baked products. The swelling capacity (SC) ranged from 8.40-12.06 g/ml, increasing the substitution of wheat flour with soy protein isolates and *Aframomum danielli*. The swelling capacity indicates amylase, which influences the quantity of amylose and amylopectin present in the composite flour. The swelling capacity of composite flours could enable good thickening and bulk and criteria for a good quality product (Achinewhu *et al.*,1998).

Table 3: Functional properties of composite flours

Sample	WAC (g/ml)	OAC (g/ml)	SC (g/ml)
W100	18.60±0.06^{c}	15.06±0.00^{d}	8.40±1.29^{d}
W90	18.86±0.12^{c}	16.45±0.12^{c}	9.80±1.33^{c}
W80	20.04±0.14^{b}	17.89±0.10^{b}	10.05±1.41^{b}
W70	22.08±0.15^{a}	18.65±0.13^{a}	12.06±1.58^{a}

Means with the same superscripts within the same column are not significantly different ($p \leq 0.05$)

Mineral composition of the cookies

The results of the mineral composition of the cookies are presented in Table 4. There was an increase in calcium, sodium, potassium and zinc content, while the magnesium content was observed to decrease as the substitution level of wheat flour with soy protein isolates and *Aframomum danielli* in the composite flour increased. The calcium content ranged from 12.75-17.75 mg/100g, with the highest value observed in sample W70, while the lowest was obtained from the control sample W100. Ayo *et al.*(2010) and Dabels *et al.*(2016) also reported an increased calcium content in composite cookies.

The magnesium content, sodium content, potassium content and zinc content ranged from 8.91 to 7.86 mg/100g, 166.70 to 212.32 mg/100g, 86.35 to 126.00 mg/100g and 1.12 to 1.75 mg/100g respectively. The mineral contents obtained show that the cookies produced can be nutritionally beneficial for children, adults, and older people who require high calcium intake for strong bones and body development.

Table 4: Mineral Composition of the composite flour

Sample	Ca mg/g	Mg mg/g	Na mg/g	K mg/g	Zn mg/g
W100	12.75±0.05^{d}	8.91±0.20^{a}	166.70±0.80^{c}	86.35±0.25^{d}	1.12±0.05^{d}
W90	14.45±0.15^{c}	8.89±0.01^{a}	184.08±1.30^{b}	108.00±1.20^{c}	1.23±0.03^{c}
W80	15.60±0.20^{b}	8.44±0.02^{b}	188.24±1.00^{b}	118.00±1.50^{b}	1.40±0.01^{b}
W70	17.75±0.15^{a}	7.86±0.02^{c}	212.32±1.10^{a}	126.00±1.00^{a}	1.75±0.08^{a}

Means the with same superscripts within the same column are not significantly different ($p \leq 0.05$)

Sensory evaluation of the cookies

The sensory evaluation of the cookies samples is presented in Table 5. Conventional cookies produced from 100% wheat flour was rated most in colour, texture, aroma, taste and overall acceptability than those produced from wheat flour substituted with protein isolates and *Aframomum danielli* composite flour. This observation may be due to the dark greyish colour and strong taste and flavour imparted by the *Aframomum danielli,* which may have contributed to the trend observed in panellists response in overall acceptability.

Substitutions of wheat flour with protein isolates and *Aframomum danielli* in cookies were observed to be comparatively acceptable to the panellists. Among the substituted cookies samples, the sample W70 produced from 24% protein isolates and 6% *Aframomum danielli* substitution was observed to be the most acceptable cookies. This observation shows that composite flour from wheat flour, soy protein isolates and *Aframomum danielli* substitution could produce organoleptically acceptable cookies that benefit the consumers both young and old.

Table 5: Sensory evaluation of the enriched cookies

Sample	Colour	Texture	Aroma	Taste	Crumb	Appearance	Acceptability
W100	7.80±0.29^{a}	7.40±0.30^{a}	7.1±0.71^{a}	7.30±0.26^{a}	6.70±0.30^{a}	6.70±0.52^{b}	7.30±0.30^{a}
W90	5.90±0.55^{c}	6.10±0.31^{c}	5.70±0.54^{b}	6.30±0.33^{b}	6.40±0.45^{a}	6.80±0.33^{b}	6.20±0.21^{c}
W80	6.50±0.48^{b}	6.10±0.60^{c}	5.10±0.62^{c}	6.30±0.70^{b}	6.30±0.54^{a}	7.00±0.37^{a}	6.60±0.26^{b}
W70	6.60±0.58^{b}	6.50±0.48^{b}	5.80±0.61^{b}	6.10±0.94^{b}	6.30±0.40^{a}	7.10±0.41^{a}	6.80±0.49^{b}

Means with the same superscripts within the same column are not significantly different ($p \leq 0.05$).

Conclusion

The study shows that cookies produced from a composite flour blend of wheat, soy protein isolates, and Aframomum danielli were nutritionally high in protein, fat, and mineral content like calcium, sodium, potassium, and zinc all wheat cookies. The high protein content in the wheat-soy protein isolates supplemented with *Aframomum danielli* cookies would benefit developing countries like Nigeria, where many people can hardly afford high protein foods. Though the 100% wheat flour cookies were the most acceptable sample, sample W70 with 24% soy protein isolates and 6% Aframomum danielli was the most acceptable cookie among the substituted samples.

Recommendation

This study recommends that highly nutritious ready-to-eat cookies produced from this composite flour with improved nutritional and functional properties can serve as snacks and an important quality dietary food source for children and adults

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