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Effect of Soybean Flour Supplementation and Cooking on proximate composition, minerals and Sensory evaluation of corn flour

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ABSTRACT

The study focuses on the impact of supplementing corn flour with soybean flour and different cooking methods on sensory evaluation. Mineral content and composition of corn-based products Corn and soybeans are nutritious staples, with soybean flour enriching food products with protein and essential amino acids. Investigating these factors, cooking techniques influence the sensory attributes and nutritional quality of food. The study aims to optimize the sensory and nutritional qualities of corn-based products supplemented with soybean flour. In a study examining the effects of supplementing corn flour with varying levels of soybean cake and cooking, it was found that supplementing with 3, 5, and 7% soybean flour led to a slight increase in protein content. Cooking further increased the protein content while total mineral contents (K, Ca, Mn, Fe, Cu, and Pb) decreased. Moisture content decreased compared to the control, but ash fiber, oil, carbohydrate, and total energy levels varied. Corn flour porridge supplemented with 7% soybean flour was preferred by panellists for colour, aroma, taste, and overall acceptability compared to other supplemented flour porridges. These results illustrate how adding soybean flour to corn-based goods can improve their sensory qualities and nutritional value. The total nutritional profile can be enhanced and the protein level raised by adding soybean flour; furthermore, the finished product's sensory qualities can be improved to increase consumer appeal. Soybean is an essential ingredient in functional foods as it is a beneficial source of protein. 45% contain most of the essential amino acids, vitamins, and minerals. Soybean is also rich in lysine and tryptophan, two of the essential amino acids that are limited in cereals. Soybean protein is also rich in Ca, P, and vitamins A, B, C, and D. Soybean is also a useful source of polyunsaturated fatty acids such as linoleic acid, which accounts for approximately 50 percent of the total fat content and is beneficial for health.

Keywords: Cooking methods, Corn flour, Mineral content, Protein content, Sensory evaluation, and Soybean flour.

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INTRODUCTION

Maize is a versatile crop, serving as food and fuel for humans and feed for animals (poultry and livestock). Its highly nutritious grains can be used as raw material for numerous industrial products (**Afzal et al., 2009).**

In many countries, lime-treated corn contributes 31% of the total protein intake and 45% of the energy intake, while beans supply 24% of the protein and 12% of the calories. However, such a diet may be deficient in protein quality, quantity, and energy **(Bressani et al., 1978)**. To address these deficiencies, corn can be supplemented with its limiting amino acids, lysine, and tryptophan, or preferably with whole soya beans. Incorporating soybeans not only enhances the amount and quality of consumed protein but also boosts energy intake due to their high oil content.

The quality of soybean meal is usually determined by measuring its protein, crude fiber, and moisture content. Urease activity and KOH Protein Solubility (KOHPS) determine whether the soybean meal is optimally processed.

Soybean (Glycine max) is a legume species native to East Asia, widely cultivated for its edible beans with numerous uses **(Anders, 2013)**. Soybeans have a relatively low carbohydrate and high protein content, along with various health-promoting compounds. The combined soybean oil and protein content comprise approximately 60% of the dry beans by weight (with protein at 40% and oil at 20%). The remaining composition includes 35% carbohydrates and about 5% ash. Soybeans consist of roughly 8% seed coat or hull, 90% cotyledons, and 2% hypocotyl axis or germ **(P. C. Obinna et al., 2018)**.

Soybean contains a high level of anti-nutritional factors. Raw soybeans include various anti-nutritional agents such as trypsin inhibitors, phytic acid, and saponins. Trypsin inhibitors can stop either trypsin or chymotrypsin from working. This slows down the breakdown of protein in food, lowers the absorption of amino acids, and makes food less digestible **(Roy et al., 2010)**. These anti-nutrients should be removed to improve the nutritional quality and organoleptic acceptability of legumes so that they can be effectively used as potential human food. Processing methods can also enhance the nutritional value of soybeans by increasing the bioavailability of amino acids, vitamins, and protein digestibility. **Okagbare and Akpodiete (2006)** also observed that techniques of processing seeds to reduce anti-nutritional elements have been a big issue for most farmers. Against this background, this research seeks to analyze the processing methods of soybean seeds' nutritional and anti-nutritional qualities **(Pele et al., 2016)**. The active lectin content of soybean flour depended on the processing method used. The highest level found was for raw seeds (3600 μg/g), and the lowest was for texturized flour (12.9 μg/g). Direct human consumption foods contain various lectin concentrations.

Soybean is also a useful source of polyunsaturated fatty acids such as linoleic acid, which accounts for approximately 50 percent of the total fat content and is beneficial for health **(Taha & Wasif, 1996).**

Soybean seeds are well-known for their high protein content and nutritional benefits. They are processed into a wide variety of food products **(Yang & James, 2013),** including soybean flour, which is a versatile food ingredient. Soybean flour is often combined with grains like corn to enhance the overall nutritional profile of food products. The sensory attributes, mineral content, and composition of corn-based products can be influenced by cooking methods and soybean flour supplementation. To investigate this further, a study has been conducted to determine how cooking techniques and the addition of soybean flour impact the sensory evaluation, mineral content, and composition of corn-based products.

MATERIALS AND METHODS

Materials:

Corn Grains:

Corn Grains were obtained from the Department of Agronomy, Faculty of Agriculture, University of Khartoum, Shambat, Sudan.

Soybeans Seeds:

Soybean seeds were brought from Omdurman local market.

Chemicals:

All chemicals used in this study were of reagent grade.

Methods:

Cooking:

Cooking of the sample was performed by suspending the flour of each sample in distilled water in the ratio of 1:2 (flour: water, w/v) and the slurry will be shaken to avoid lumps while boiling in a water bath for 20 min. The viscous mass will be spread out thinly in dishes and oven-dried at 70℃. The dried flakes were milled into fine flour by Roller mill to pass through a 0.4mm screen and stored at4℃ for further analysis.

Preparation of Grains Sample:

The grains were cleaned, freed from foreign seeds, broken and shrunken ones, then milled into fine flour using a Roller mill to pass through a 0.4 mm screen and stored in polyethene bags at 4℃for further analysis.

Preparation of soybean sample:

The seeds were defatted using hexane solvent and dried in a hot air oven at 70℃for 3-4 hours**(Di et al., 2022)**, then milled into fine flour using a Roller mill to pass through 0.4mm and stored in polyethene bags at 4℃ for further use.

Preparation of Porridge samples:

The porridge samples were prepared by mixing 100 g of each (soya and corn flour) using corn flour with and without supplements (soybean) and 1 g of table salt with 235 mL of hot water. The corn flour with and without supplements (soybean) was cooked at 90°C by stirring for 10 min. Then, the product was cooled for further analysis of sensory acceptability.

Supplementation:

Defatted soybean seeds flour was added using Pearson square nutritive value of corn flour by 3, 5, and 7%, respectively. To increase the number of composite flour samples after supplementation will be three samples.

Proximate composition

Determination of chemical component:

Moisture content %

Moisture content was determined according to the method of **AOAC, (2000)**. In a dried, cooled, and weighed dish, (previously heated to 130 ± 3°C), 2 g accurately weighed (well-mixed test portion), dried for 1 h in an air oven provided with an opening for ventilation and maintained at 130 ± 3°C. (1 h drying period begins when the oven temperature is 130°C.) The dish was transferred to the desiccator and weighed soon after room temperature was reached. Flour residue was reported as total solids and loss in weight as moisture (indirect method).

$$\mathbf{Moisturecontent}\ (\%) = \frac{\mathbf{W_2 - W_1}}{\mathbf{weightofsample}} \times \mathbf{100}$$

Where:

W1 = the weight of the empty crucible.

W2 = the weight of the crucible + sample after drying

Ash Content %:

The ash content of the samples was measured according to the **AOAC method (2000)**. 3–5g well-mixed test portions were weighed into the shallow, relatively broad ashing dish that had been ignited, cooled in a desiccator, and weighed soon after reaching room temperature. Then ignited in the furnace at 550°C (dull red) until light gray ash results, or to constant weight. Cooled in a desiccator and weighed soon after room temperature reached.

Calculation:

$$\boldsymbol{Ash}(\%) = \frac{\boldsymbol{W_2 - W_1}}{\boldsymbol{weightofsample}} \times \mathbf{100}$$

Where:

$\mathbf{W_1}$ = Weight of empty crucible

$\mathbf{W_2}$ = the weight of the crucible plus sample after ignition.

S = Weight of sample.

Crude Fiber Content (%):

The crude fiber content was determined by the method of **AOAC (2000)**. Crude fiber is the loss on ignition of dried residue remaining after digestion of the sample with 1.25% (w/v) H_2SO_4 and 1.25% (w/v) KOH solutions under specific conditions.

Two-gram powder samples were digested with 0.128 M H_2SO4 with 2 or 3 drops of octanol and were digested for 30 minutes. Were washed and filtered with hot water the acid was removed, further Residue was boiled with 0.223 M KOH for 30 minutes, and then was rinsed with boiling water and acetone. The residue was dried in an oven at 130^{o}C for 2 hours and ignited in a muffle furnace at 500 °C for 3 hours. The loss of weight represented the crude fiber. The crude fiber was calculated as follows:

$$\boldsymbol{Crude\ fiber}\ (\%) = \frac{\boldsymbol{Loss\ in\ weight\ on\ ignition}}{\boldsymbol{weight\ of\ samples}} \times \mathbf{100}$$

Protein content:

The protein content of the samples was determined by the Macro-Kjedahl technique according to the **AOAC, (2000)**. (0.7–2.2g) weighed test portions were placed in the digestion flask. 0.7 g HgO was added, 15g powdered K_2SO_4, and 25 ml H_2SO_4. The flask was placed in an inclined position and heated gently until frothing ceased then boiled briskly until the solution was clear and then 30 min longer (2 h for test portions containing organic material).

Cooled, 200 ml H_2O were added, cooled < 25°C, 25mL of the sulfide solution were added, and mixed to precipitate Hg. A few Zn granules were added to prevent bumping, tilt flask, and a layer of NaOH was added without agitation. (For each 10 ml H_2SO_4 used, or its equivalent in diluted H_2SO_4, 15 g added solid NaOH or enough solution to make contents strongly alkaline.) Immediately flask was connected to the distilling bulb on the condenser, and, with the tip of the condenser immersed in standard boric acid and 5–7 drops indicator (methyl red + bromocresol green) in a receiver, the flask was rotated to mix contents thoroughly; then heated until all NH_3 had distilled (150 ml distillate). The receiver was removed, a tip of the condenser was washed and titrated excess standard HCl (0.02 N) was in distillate with standard NaOH solution. Corrected for blank determination on reagents.

N% = [(mL standard acid molarity acid) – (mL standard NaOH molarity NaOH)] 1.4007/g test portion

Multiply percent N by 5.7 to obtain percent of protein.

Oil content %:

The crude fat was determined according to methods of **AOAC (2000)** using the Soxhlet apparatus as follows;

About 5–10g crushed test portions were accurately weighed. Without previous drying, extracted in Soxhlet with petroleum ether for 6 h. The extract was filtered through the small hardened paper into a weighed vessel, paper was washed finally with a small portion of hot fresh solvent. The solvent was distilled at a temperature of 100°C and the vessel containing the residue was dried in an air oven for 1 h at 100–105°C. Reported as % oil to the third decimal place.

The percentage crude fat content was calculated using the following equation:

$$\boldsymbol{Crudefat}\ (\%) = \frac{\boldsymbol{W_2 - W_1}}{\boldsymbol{S}} \times \mathbf{100}$$

Where:

W_1 = the weight of the empty extraction flask.

W_2= the weight of the extraction flask after the extraction process with oil.

S = sample weight.

Carbohydrates content %:

The total carbohydrates were calculated by difference according to **AOAC, (2000)** using the formula;

$$\boldsymbol{Total\ CHO} = \mathbf{100} - (\boldsymbol{Mositure}\ \% + \boldsymbol{Fat}\ \% + \boldsymbol{Protein}\ \% + \boldsymbol{Ash}\ \% + \boldsymbol{fiber}\ \%)$$

Total energy (Calorific Value):

Energy was calculated as described by **Sukkar (1985)** using the Atwater factor. One gram of carbohydrates provides (4 K calories), 1 gram of protein provides (4 K calories) and one gram of fat provides (9K calories).

C. (g) × 4= KCal of carbohydrate.

P. (g) × 4 = KCal of protein.

F. (g) ×9 = Kcal of fat.

Determination of Minerals content:

The determinations of the mineral contents were carried out using an X-ray fluorescence spectrometer (XRF) Described by **(Chopra & Pathak, 2015; Feng et al., 2021; Ferri et al., 2015, and Dóra, et al., 2014)**. The used equipment is a brand Pan analytical, Axios max 4.0 k w, XRF device. The X-ray fluorescence spectrometry as an instrumental analytical method can determine the elemental composition of solid and fluid samples from a minimal prepared sample size.

The sample was treated by ignition in a muffle furnace until its color turned to gray white color and weighed 10 grams to mix well with cellulosic material, then the sample was transferred into the aluminum disc and pressured to a minimum volume by a pressure machine before examination.

In the course of the process, the sample is shot by the X-ray thus the atoms within the sample get into an excited position so typical characteristic radiation for particular elements is emitted. The energy (wavelength) of these characteristic radiation changes element by element and this fact is considered as the bottom line of the qualitative element analysis. The intensity of characteristic radiation of the element is commeasurable to its concentration which permits the qualitative analysis.

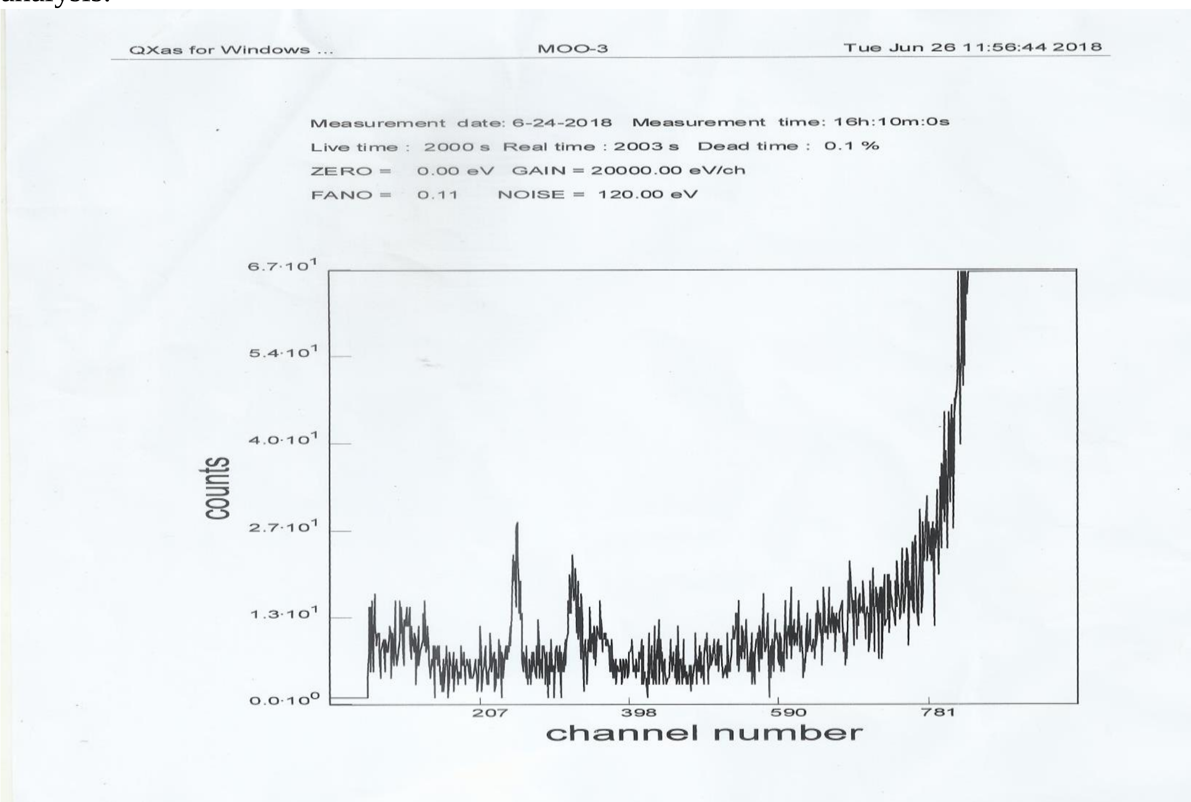


Figure 1 Standard Graph of Minerals Determination (XRF)

Sensory Evaluations:

The samples were assessed organoleptically by a hedonic test according to the procedure described by **Ihekoronye and Ngoddy (1985)**.

Fifteen semi-trained assessors were provided coded samples and asked to evaluate the aroma, taste, color, and overall acceptability of the samples according to the scoring (Hedonic). A key table was given to the panellists to guide them.

The hedonic test depends on the range of:

(9-8) as excellent

(7-6) as very good

(5-4) as good

(3-2) as fair

(1) as poor.

Statistical Analysis

All data were subjected to statistical analysis, each determination was carried out and analyzed in triplicate and figures were then averaged. Data was assessed by the analysis of Variance (ANOVA) **Gomez, k and Gomez, A. (1984)**. Duncan Multiple Range Test (DMRT) was used to separate means. Significance was accepted with P≤ 0.05.

RESULTS AND DISCUSSION

Table 1: Proximate composition of Corn flour and Soybean flour

Parameter (%)	Soybean	Corn Flour
Crude Protein	45.060±0.00a	11.250±0.070f
Moisture	3.255±0.778d	4.230±0.156a
Fibre	3.770±0.339d	3.475±0.063e
Oil content	17.550±0.070a	4.695±0.106c
Ash	4.435±0.007a	1.570±0.014d
Carbohydrate	25.93±0.184f	74.78±0.268b
Energy Kcal	441.91±1.371a	386.375±0.403c

**** Means not sharing a common letter in the same column is significantly different (p≤0.05) according to the least significant test (LSD).***

****Each value in the Table is a mean of three replicates ±S. D.***

Proximate Composition:

Proximate Composition of Soybean flour and Corn flour:

Table 1 displays the chemical compositions of Soybean flour and Corn flour. The current investigation found that the moisture content of the sample was significantly higher at 4.230% compared to soybean, which had a moisture content of 3.26% (p≤0.05). The moisture content was 3.26%, differing from that reported by **(Farzana, and Mohajan, 2015)**, reported 3.97% for Soybean flour. Moisture content of Corn flour was 4.23%, lower than that reported by **(Oladapo, et al., 2017)**, reported 9.74% for maize. The protein composition of (Soybean (45.060%) has a much greater crude protein content than maize flour (11.250%)). The percentage of soybean flour was determined to be 45.060%, which exceeds the range stated by **Etiosa et al. (2017)** of 37.69%. In contrast, the percentage of corn flour was discovered to be 11.25%, which is lower than the value of 13.18% published by **Oladapo et al. (2017)** for corn flour.

The crude fiber content of (is not substantially different(p≤0.05) between soybean (3.770%) and corn flour (3.475%)) The percentage of soybean flour was determined to be 3.8%, which is lower than the published range of 6.27% by **Uwem et al. in 2017**. On the other hand, the percentage of corn flour was discovered to be 3.48%, which is higher than the reported range of 2.51a±0.02 - 1.97c±0.01 by **Adeoti et al., 2013**. The oil extracted from Soybean flour was determined to have a defatted content of 17.55%, which is lower than the previously reported value of 28.2% by **(Etiosa, et al., 2017)**. Soybean oil is highly unsaturated and rich in oleic, linoleic, and linolenic acids, as told by **(Obinna, et al., 2018)**. The oil content of Corn flour was determined to be 4.7%, corresponding with the value of 4.3% reported by **(Kaur, et al., 2013)** for Corn flour. Because of its various nutritional advantages, soybeans (Glycine max L.) are one of the most important sources of oil and protein in the world **(Villalobos et al., 2016)**.

The carbohydrate content of (Corn flour (74.78%) has much higher (p≤0.05) carbohydrate content than soybean (25.93%)) Soybean flour was determined to be 25.93%, lower than the range of 34.97% - 39.86% indicated by **(Eshun, 2012)**. The carbohydrate content of Corn flour was 74.78%, lower than the figure of 84.31% reported by **(Ikya, et al., 2013)** for proximate composition, nutritional, and sensory aspects of fermented maize and full-fat soy flour blends for "agidi" manufacturing. The total energy (Soybean (441.91%) has a significantly higher ($p \leq 0.05$) energy content (in kilocalories) than corn flour (386.375%)) of Soybean flour was found to be 441.91 kcal, lower than the 469.80 kcal reported by **(Etiosa, et al., 2017)**, who informed the mineral and proximate composition of Soybean. The total energy of Corn flour was 386.38 kcal, which was much lower than that reported by **(Ikya, et al., 2013)**, which claimed 416.6 kcal for maize.

Effect of supplementation with 3, 5, and % Soybean flour cooking on proximate composition of Corn flour:

Moisture content %:

As shown in **Table 2** the moisture content of Corn flour was found to be 4.23%, supplementation with 3, 5, and 7% Soybean flour significantly ($P \leq 0.05$) decreased the moisture of Corn flour to 4.1, 4.12, and 4.19%, respectively. The decrease in moisture of corn flour may be due to the lower value of moisture in Soybean flour. Cooking of Corn flour Supplementation with 3,5and7% Soybean flour insignificantly ($P \leq 0.05$) decreased to 3.680, 3.560%, and 3.900%, respectively. The decrease in moisture after cooking could be due to the moisture of cooked samples in a hot air oven. Soy flour has been an ingredient in Western bread making due to its improving effects on dough handling and product quality. It is also a source of high-quality protein, because of its high lysine content compared with other cereal proteins.

Ash content %:

We measured the ash content of raw corn flour to be 1.570%, as shown in **Table 2.** The addition of soybean flour at concentrations of 3%, 5%, and 7% resulted in a substantial increase ($P \leq 0.05$) in the ash content of maize to 1.640%, 1.725%, and 1.770%, respectively. The addition of 3% soybean flour (1.640%) to raw corn flour is significantly different ($P \leq 0.05$) compared to the addition of 3% cooked corn flour (1.730%), 5% cooked corn flour (1.765b), and 7% cooked corn flour (1.8205%). The addition of 5% soybean flour to raw corn flour at a rate of 1.725% is significantly different from the inclusion of 7% cooked corn flour at a rate of 1.820%. The addition of 7% soybean flour to raw corn flour at a level of 1.770b% does not show a significant difference compared to the addition of 7% soybean flour to cooked corn flour at a level of 1.820%. The ash content, which consists of inorganic substances such as minerals, tends to increase with supplementation and is often higher in the cooked state than in the raw state. This suggests that cooking may lead to a concentration of mineral content in food.

Crude fiber content (%):

As shown in **Table 2** the fiber content of Corn flour was found to be 3.475%, supplementation with 3% Soya bean flour significantly ($P \leq 0.05$) decreased the fiber content to 3.310 %, whereas with 5and7% to insignificantly ($P \leq 0.05$) increased the fiber content to 3.495, 3.655%respectively. A match with trends in an increase in fiber content was reported by **(Tasnim et al., .2015)** who reported that an increase in the proportion of soy flour reduces the fiber content of soy-mushroom biscuits. Cooking of Corn flour significantly ($P \leq 0.05$) increased the fiber content supplementation with 3, 5, and 7% Soya bean flour to 4.205, 4.590, and 5.480%, respectively. The increase in fiber content of Corn flour may be due to the high content of Soybean flour with fiber.

Protein Content:

As shown in **Table 2**, the protein content of Corn flour was found to be 11.250%; supplementation with 3, 5 and 7% Soya bean flour significantly ($P \leq 0.05$) increased the protein content to 11.955, 12.335, and 13.330%, respectively. The supplementation of low-protein foods with rich-protein diets increases the protein quantity of the former **(Azhari et al., 2015)**. Cooking significantly ($P \leq 0.05$) did not affect the protein content of Corn flour supplemented with 3,5 and 7% Soya bean flour, Soy bean supplementation enhances the nutritional value of proteins as well as the sensory and rheological characteristics of food products made from wheat and maize **(Ali et al., 2010)**.

Oil content %:

As shown in **Table 2** the oil content of Corn flour was found to be 4.695% supplementation with 3.5 and 7% Soya bean flour significantly ($P \leq 0.05$) increased the oil content to 5.395, 5.410 and 5.635%, respectively, The increase in Oil content in the present study may be explained as soya bean flour is globally considered as the number one edible oil source, containing a higher percentage of Oil than corn flour, The increased fat content in the study could be due to the increase in the proportion of soy flour in the flour blend. Cooking is significantly ($P \leq 0.05$) increasing the oil content of Corn flour supplemented with 3, 5, and 7% Soybean flour to 2.535, 3.330, and 3.390% respectively. The decrease in oil content after cooking may be due to the evaporation of volatile oils.

Carbohydrate content:

As seen in **Table 2** the carbohydrate content of corn flour was found to be 74.78%, supplementation with 3,5 and 7% Soya bean flour insignificantly ($P \leq 0.05$) decreased the carbohydrate to 73.61, 72.915 and 71.425% respectively. Cooking is significantly ($P \leq 0.05$) increasing the carbohydrate of corn flour supplemented with 3% soya bean flour to 75.995%, while the flours supplemented with 5% and7% Soya bean flour had insignificant ($P \leq 0.05$) decrease (74.75) and (73.38%), respectively, decrease in carbohydrates after cooking may be due to the solubility of the majority of mono and oligosaccharides in hot water.

Table 2: Effect of cooking on proximate Corn flour supplemented with different ratios of defatted Soybean flour.

Supplementation Levels (%)	Treatment	Crude Protein (%)	Moisture content (%)	Fibre content (%)	Oil content (%)	Ash content (%)	Carbohy drate (%)	Energy Kcal (%)
0	Raw	11.250± 0.070f	4.230± 0.156a	3.475± 0.063e	4.695± 0.106c	1.570± 0.014d	74.78± 0.268b	386.375± 0.403c
3	Raw	11.955± 0.021d	4.090± 0.141a	3.310± 0.113e	5.395± 0.278b	1.640± 0.057d	73.61± 0.481c	390.815± 0.643d
	Cooked	11.855± 0.050e	3.680± 0.099c	4.205± 0.021c	2.535± 0.035e	1.730± 0.014c	75.995±0 .219a	374.215± 0.361e
5	Raw	12.335± 0.021c	4.120± 0.042a	3.495± 0.050e	5.410± 0.156b	1.725± 0.007c	72.915±0 .276d	389.69± 0.382b
	Cooked	12.005± 0.007d	3.560± 0.127c	4.590± 0.028b	3.330± 0.184d	1.765± 0.092b	74.75±0. 438b	376.99± 0.071d
7	Raw	13.330± 0.071b	4.185± 0.078a	3.655± 0.063d	5.635± 0.007b	1.770± 0.014b	71.425±0 .233e	389.735± 0.587b
	Cooked	12.030± 0.042d	3.900± 0.014b	5.480± 0.41a	3.390± 0.269d	1.820± 0.014 b	73.38± 0.382c	372.151± 0.315 f

**** Means not sharing a common letter in the same column is significantly different ($p \leq 0.05$) according to the least significant test (LSD)***

****Each value in the Table is a mean of three replicates ±S. D (AOAC. (2000).***

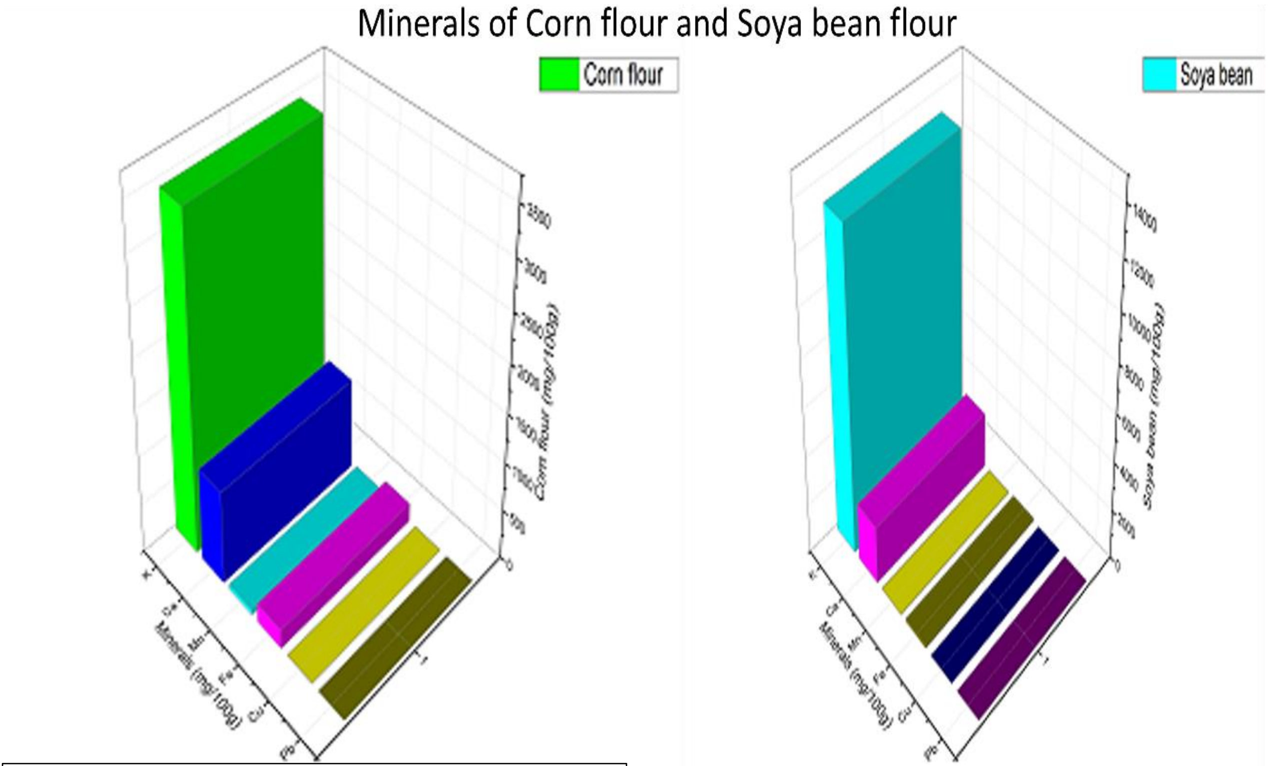
Total energy:

As shown in **Table 2** the total energy of corn flour was found to be 386.375kcal, supplementation with 3, 5and 7% Soya bean flour significantly ($P \leq 0.05$) decreased the total energy to 390.815, 389.69and 389.735kcal, respectively. Cooking significantly ($P \leq 0.05$) decreased the total energy of corn flour supplemented with 3, 5 and 7% soya bean flour to 374.215, 376.99, and 372.151kcal, respectively the decreased total energy due to the decreased carbohydrate contents during cooking.

Determination of Minerals content:

Total minerals of Corn flour and Soya bean:

The total mineral contents of Corn flour and Soya bean flour shown in **Figure1**. K content of Corn flour and Soya bean flour were found to be 3440 and 13200 mg/100g, respectively. This was higher than the value of 400.00 mg/100g reported by **(Herbert, 2017)** who found in the Mineral content of normal maize grain, the Calcium content of Maize was found to be 955mg/100g which was higher than the range of 18.33 – 89.33mg/100g of Corn flour reported by **(Awad et al.,2011)**. And that of Soya bean was 2340mg/100g, which was higher than the Value 300.36 mg/100 g reported by **(Ogbemudia et al., 2017)** who found in the Mineral content of Soya bean. The manganese content of Corn flour was found to be 53mg/100g, lower than value127 mg/100g of Maize reported by **(Jeffrey, 2013)** and **(Siyuan, and LiRui, 2018)** and The Soya bean was 54.4 mg/100g, lower than value 258.24 mg/100g of soya bean reported by **(Ogbemudia et al., 2017)**, Fe content of Corn flour and Soya bean flour were found to be191and126 mg/100g, respectively. which was higher than value2.71 mg/100g reported by **(Siyuan, and LiRui, 2018)** found in the mineral content of copper content of corn flour to be 5.42mg/100g, higher than value0.31mg/100g reported by **(Jeffrey, 2013)** found in Mineral content of Corn flour, and that Soya bean flour was found7.57 mg/100g, Lead content of Corn flour found to be 0.932mg/100g, and that Soya bean flour found 1.07 mg/100g.



Minerals	K	Ca	Mn	Fe	Cu	Pb
Soya bean	13200	2340	54	126	7.6	1.07

Minerals	K	Ca	Mn	Fe	Cu	Pb
Soya bean	13200	2340	54	126	7.6	1.07

Figure 1: Total (mg/100g) and Minerals of Corn flour and Soya bean flour.

Effect of supplementation with 3, 5 and 7% Soya bean flour and cooking on total minerals of Corn flour:

Potassium (K):

As shown in Table 3 the K content of Corn flour was found to be 3440 mg/100g, it was significantly (P≤0.05) increased to 9100, 3090, and 6460 mg/100 g after supplementation with 3, 5, and 7% Soya bean flour, respectively. A low finding was (287mg/100) reported by **(Siyuan, and Li Rui, 2018)** Cooking significantly (P≤0.05) increased the potassium content of Corn flour supplemented with 3 and 7% Soya bean flour to 6330 and 6920 mg/100 g, respectively. While significant (P≤0.05) increase was observed after supplementation with 7% Soya bean flour to 6000 mg/100 g.

Calcium Ca:

As shown in **Table 3** the Ca content of Corn flour was found to be 955mg/100g, it was significantly (P≤0.05) increased to 1790, 1540and 1700mg/100g after supplementation with 3, 5, and 7% Soya bean flour, supplementation with 3and 5% Soya bean it was higher than that of 7%soya bean flour. A similar finding was reported by **(Akubor, and Faya, 2018)** reported that the Ca content of noodles was significantly (P≤0.05) increased after supplementation with soybean protein improving the mineral composition of the noodles due to the excellent mineral composition of soybean flour. Cooking significantly ($P \leq 0.05$) increased the calcium content of corn flour supplemented with 3, 5and 7% Soya bean to 1590, 1840and 1660mg/100g, respectively. Cooking increases the Ca content of whole Corn flour; the increase in Ca content may be attributed to the reduction in phytic acid content.

Manganese Mn:

In the current study in Table 3, the Manganese content of Corn flour was found to be 53mg/100g, it was significantly ($P \leq 0.05$) increased to 64.1mg/100g after supplementation with 3% Soya bean flour, but not detected after supplementation with 5 and 7% Soya bean flour, that means less than machine readability. Cooking significantly ($P \leq 0.05$) increased the Manganese content of Corn flour after being supplemented with 3, 5and 7% Soya bean to 71.1, 66.4and 57mg/100g, respectively. Content of Mn 71.1 mg/100g was detected higher in 3% Soya bean flour than others. The improvement of Manganese corn flour may be due to the reduction of phytic acid content, but the decrease may be attributed to the utilization of the ash by microorganisms during the growth.

Table 3: Effect of cooking on total (mg/100g) Minerals of Corn flour supplemented with 3, 5 and 7% Soya bean flour

Supplemented levels (%)	Treatment	K	Ca	Mn	Fe	Cu	Pb
0	Raw	3440±2.673c	955±0.788d	53±0.543c	191±0.054d	5.42±0.221d	0.932±1.208d
3	Raw	9100±1.673a	1790±0.658a	64.1±0.398b	279±0.065b	10.1±0.198a	2.29±0.987a
	Cooked	6330±1.346b	1590±0.765c	71.1±0.543a	246±0.894c	7.54±0.216c	1.18±0.390c
5	Raw	3090±1.233c	1540±0.568c	0±0.000d	239±0.98c	4.18±0.322d	0.981±0.226d
	Cooked	6920±1.267b	1840±0.503a	66.4±0.324b	307±1.037a	9.12±0.111a	2.04±0.435a
7	Raw	6460±1.393b	1700±0.546b	0±0.000d	232±1.567c	8.31±0.098b	1.84±0.924b
	Cooked	6000±1.934b	1660±0.546c	57±0.324c	304±1.657a	9.52±0.389a	1.66±0.321b

Mean ±SD values having the same superscript within a column are insignificantly different (P≤0.05) according to DMRT.

Iron Fe:

As presented in **Table 3** the Iron content of Corn flour was significantly (P≤0.05) increased to 279, 239and 232mg/100g after supplementation with 3, 5, and 7% Soya bean, respectively. Iron content cooking significantly (P≤0.05) increased the Iron content of Corn flour supplemented with 3, 5and 7% Soya bean flour to 246, 304and 307mg/100g, respectively. The increment in supplementation and cooking Fe may be attributed to the reduction of phytic acid.

Lead Pb:

Table 3 shows the Lead content of corn flour it was significantly (P≤0.05) increased to 2.29, 0.981and 1.84mg/100g, respectively. Supplementation with 5%Soya bean flour increased the value of Pb more than those others. Cooking significantly (P≤0.05) increased the Pb content of Corn flour supplemented with 3, 5and 7% soybean to 1.18, 2.04, and 1.66mg/100g, respectively. Increase in Lead Content with Soya Bean Flour: Corn flour's lead content rose when soya bean flour was added, with 5% soya bean flour being the highest lead content recorded. This implies that lead contamination in the finished product could originate from soybean flour. Cooking had the effect of increasing the lead level of corn flour that had been added to soybean flour. This might be the result of interactions between lead and other ingredients in the flour combination or the release of lead during cooking.

Copper Cu:

As seen in **Table 3** the Cu content of Corn flour was significantly (P≤0.05) to 10.1, 4.18, and 8.31mg/100g, respectively. The value of Cu was lower in 5% supplemented Soya bean flour than the others. Cooking significantly (P≤0.05) increased the Copper content of Corn flour supplemented with 3, 5and 7% Soya bean to 7.54, 9.12, and 9.52mg/100g, but it was supplementation with 3%Soya bean flour lower than supplemented with 5and 7% Soya bean flour, respectively. High levels of Maillard browning products can have adverse health effects and so is a poor way to make food more nutritious, with the only mineral that seems consistent being iron (although it has also found an increase in sodium after boiling) due to increased energy density when moisture is removed.

Sensory evaluation of corn flour supplemented with 3, 5 and 7% Soya bean

The sensory evaluation of cooking Corn flour supplemented Soya bean flour with 3, 5, and 7% Soya beans are shown in **Table 5**. These results are presented as mean values of the panellist's scores. According to the performance of the panellists, the majority gave a sensory preference for the colour of the Corn flour supplemented with thick porridge with 7%, 5%, and 3% Soya bean, respectively, sensory preference for both taste and flavour was also recorded by Corn flour supplementation cooking with 7%Soya bean flour, while the poor taste was recorded by supplemented thick cooking with 3% Soya bean, For General acceptances the supplemented cooking products with 3,5 and7% Soya bean had increased score, respectively. As the similar reported by **(Taghdir et al., 2017)** the results obtained from corn flour supplemented and cooked with 3.5 and 7% Soya bean had preferred Aroma, colour, and Taste and were generally acceptable, while the corn flour supplemented and cooked product with 7%Soya bean has a high score in colour compared to the corn flour supplemented and cooking product with 3%Soya bean product.

Table 5: Sensory evaluation of cooked Corn flour supplemented with different ratios of Soya bean flour.

Supplementation level (%)	Aroma	Taste	Colour	General
Cooked 3%	5.118± 1.80a	4.706±2.64a	4.7059±2.42a	4.765±1.79a
Cooked 5%	5.294±2.45a	5.118±1.83a	5.529±2.12a	5.588±1.94a
Cooked 7%	5.823±2.01a	5.589±1.83a	6.1765±2.13a	5.824±5.60a

**** Means not sharing a common letter in the same column is significantly different (p≤0.05) according to the least significant test (LSD).***

****Each value in the Table is a mean of three replicates ±S. D.***

CONCLUSION

The proximate composition of the addition of soybean flour to corn flour, along with the cooking method, significantly altered the mineral content and sensory evaluation of the finished product. All data were subjected to statistical analysis, each determination was carried out and examined in triplicate and figures were then averaged. Data was examined via the analysis of Variance (ANOVA) **Gomez, and Gomez, (1984)**. Duncan Multiple Range Test (DMRT) was employed to differentiate means. Significance was accepted with P≤ 0.05. Soy flour has been used in western bread manufacturing because of its improved effects on dough management and product quality. It is also a source of high-quality protein because of its high lysine content. Compared with other cereal proteins, the enhanced flour's protein content climbed while its overall mineral content declined and the amount of moisture was lowered. There were fluctuations in the quantities of ash fiber, oil carbs, and total energy. Soy flour has been an addition to Western bread manufacturing because of its enhanced impact on dough handling and product quality. According to the sensory test, corn flour porridge with 7 percent soybean flour added was recommended for its aroma, color, taste, and general. To increase flavour and digestibility, soy flour is often dry-roasted after grinding. It may be used in baking recipes. Soya powder is formed by roasting the soybeans before grinding. Soya powder is finer than soy flour and usually has a better. These results illustrate how adding soybean flour to maize-based items can increase their sensory attributes and nutritional value. The total nutritional profile can be enhanced and the protein level raised by adding soybean flour because it is a hormonally active diet. However, soya can also be endocrine-disrupting, suggesting that intake has the potential to cause adverse health effects in certain circumstances, particularly when exposure occurs during development. These results illustrate how adding soybean flour to corn-based goods can improve their sensory qualities and nutritional value. The total nutritional profile may be boosted and the protein level elevated by adding soybean flour; furthermore, the completed product's sensory attributes can be improved to promote consumer appeal. Soy foods may be useful for patients with chronic renal dysfunction, CKD dialysis patients, and those with a kidney transplant as a low-saturated-fat, cholesterol-free meat replacement similar to animal protein. Soy is similarly a high-quality protein but is plant-based. Instead, all things considered, this study offers insightful information about how cooking and soybean flour supplementation affect the nutritional and sensory qualities of corn-based goods to optimize the ratios for the intended nutritional and sensory effects as well as to investigate the possible applications of soybean flour supplementation in other food products. Additional research is recommended. This means that it has a slower effect on blood sugar levels, which can help regulate insulin levels and reduce the risk of type 2 diabetes. Additionally, soy flour is rich in antioxidants, which can help reduce inflammation and protect against chronic diseases such as heart disease, cancer, and Alzheimer's disease.

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