



## Physicochemical and Functional Properties of Pumpkin (*Cucurbita Pepo*) Pulp Flour and Acceptability of its Inclusion in Cake

Eke-Ejiofor Joy<sup>1</sup>, Victor-Uku Esther Chidinma<sup>1\*</sup> and M. O. Akusu<sup>1</sup>

<sup>1</sup>Department of Food Science and Technology, Rivers State University, Nigeria.

### Authors' contributions

This work was carried out in collaboration among all authors. Author EJ designed the study and wrote the protocol, author VEC performed the statistical analysis and wrote the first draft of the manuscript. Author AMO managed the analyses of the study. All authors managed the literature searches, read and approved the final manuscript.

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### ABSTRACT

A study of the Physico-chemical and functional properties of pumpkin / wheat flour blends and sensory attributes of cakes made from the flour blends where evaluated in the food science laboratory of Rivers State University. The physico-chemical analysis were carried out using standard AOAC methods with 100% wheat flour serving as control. Result of chemical analysis of wheat/pumpkin composite flour blends ranged from 6.51 – 11.78%, 0.58 – 6.74%, 5.81 – 11.97%, 0.90 – 1.56%, 0.51 – 6.93% and 72.22 – 73.68% for moisture, ash, protein, fat, crude fiber and carbohydrate, respectively. There was a decrease in moisture, fat, protein and carbohydrate and an increase in ash, and crude fiber as the level of pumpkin flour substitution increased. Starch, amylose and amylopectin ranged from 37.68 – 83.82%, 8.76 – 24.64 % and 28.92 – 59.18%, respectively. The lowest starch (37.68%) content was recorded in pumpkin flour made entirely of pumpkin. Depending on the mixing ratios between flour and pumpkin flour, a wide range of functional properties were recorded, including 1.04 – 5.30 ml/g water absorption capacity, 0.58 – 0.61 g/ml bulk density, 8.50 – 16.50% least gelation concentration, 1.07 – 54.26% foaming capacity, 0.00 – 27.84% foaming stability, 53.71 – 93.33% swelling capacity, 45.46 – 48.49%

\*Corresponding author: Email: [esthervictoruku@gmail.com](mailto:esthervictoruku@gmail.com);

emulsion capacity and 35.50 – 56.02% emulsion stability. Sensory evaluation of the cakes showed no significant difference ( $p > 0.05$ ) in general acceptability between the control and up to 70% substitution with pumpkin flour. The scores ranged from 2.61 – 8.22, 4.13 – 7.13, 5.04 – 7.70, 3.87 – 7.70 and 2.74 – 7.83 for taste, appearance, colour, mouthfeel and general acceptability respectively. Incorporation of pumpkin flour to wheat flour increased the ash and crude fiber content of the composite flour.

**Keywords:** Pumpkin; physico-Chemical Properties; functional and sensory attribute; cakes.

## 1. INTRODUCTION

Pumpkin (*Cucurbita pepo*) is a genus of herbaceous vines, belonging to the *Cucurbitaceae* family [1], the family includes several vegetable crops cultivated worldwide. They are economically and nutritionally important crops [2]. According to the report of Burkill in the useful Plants of West Tropical Africa, the whole (leaf shoot, fruit, seed and flower) has found use as food, in medicine, cosmetics, arts, musical instrument, games, toys etc [3]. Pumpkin is scientifically a fruit due to its seed content though it is regarded as a vegetable with high vitamins and minerals, a source of antioxidants; beta-cryptoxanthin and beta and alpha-carotene [4]. The level of anti-nutrients is lower than is obtained in most other Nigerian vegetables [5]. The yellow to pink fruit pulp makes it a rich source of vitamin A (Messian and Fagbayida, 2004). In many parts of Nigeria, it is grown for its fruits and leaves which are consumed as a vegetable [6]. However, the cultivation and utilization of indigenous pumpkin in Nigeria is declining. Though Pumpkin flour could be used to supplement cereal flour in bakery products, soups, instant noodles and as a natural coloring agent in pasta and flour mixes [7,8], the consumption in Nigeria is still restricted to the traditional rural pattern despite the opportunities for value addition. Dependence on wheat and other foreign food are on the increase, and some of these foods are lacking in natural micronutrients and are laddered with unhealthy additives. This shift is causing some locally grown healthy food crops to fade away and possibly go extinct. Some of these crops have the potentials of boosting the National foreign exchange with proper value addition. Nigerian Pumpkin (*Cucurbita Pepo*), has been neglected, underutilized, unpopular and at the risk of fading away, due to reduced cultivation and non-diversification of its consumption pattern. There is an information gap as to its nutritional importance, domestic and industrial application by both urban and rural dwellers. Formulation of snacks from the flour will create more awareness

of the crop and its nutritional and health importance by the populace especially urban dwellers, increase demand for the crop which would enhance crop production and farmers' income, create extended domestic and industrial application as well as provide alternative to wheat and become a source of very vital phytonutrients. As the global population continue to grow, it has become imperative to explore more locally available but neglected plants, in other to tackle the dwindling food supply and micronutrient deficiency challenges.

## 2. MATERIALS AND METHODS

Pumpkin was sourced locally from the open market in the South-South/ South-East region of Nigeria). The wheat flour, castor sugar, margarine, eggs, baking powder, vanilla, and milk were purchased from bakery shop in Port-Harcourt.

### 2.1 Pumpkin Flour Processing

The flour processing followed the method described by Mepba et al. [9] with modification. The pumpkin was washed, peeled and cleaned of seed and fibrous core, cut into thin slices of about 1 cm thickness, then washed in cold water and blanched (1.25%  $\text{NaHSO}_3$  solution at 80°C for 10 min). The slices were dehydrated in a Delonghi food dehydrator at 60°C for 48 h, the dried pumpkin slices were milled into flour using a Retch Muhle 2880 hammer mill. Flour obtained was sieved through a 250  $\mu\text{m}$  aperture sieve and packed in a two-ply medium density (0.926 – 0.949g/cc) polythene Ziploc bag.

Proximate composition of the Wheat/Pumpkin flour Blends was determined according to standard method of AOAC [10]

### 2.2 Moisture Content

Clean crucibles were dried in hot air oven at 105°C for 30 min to a constant weight and then cooled in a desiccator ( $W_1$ ). 2 g of each of the

samples to be analyzed was weighed into the different moisture pans ( $W_2$ ) and dried at 105° C for 4 hours, until a constant weight is reached ( $W_3$ ).

$$\% \text{ Moisture Content} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where:  $W_1$  = Initial weight of empty crucible,  $W_2$  weight of crucible + sample before drying and  $W_3$  weight of crucible + sample after drying.

### 2.3 Determination of Ash

A marked crucible was heated in a furnace at 500 - 550°C for 2 - 3 hours, the crucible was subsequently transferred into desiccators and cooled for 30 minutes and the weight taken ( $W_1$ ). About 2 g of sample was weighed into the pre-weighed crucible dish ( $W_2$ ) and charred over a hotplate (initially at low temperature to avoid spattering and the temperature was gradually increased until smoking ceases). The -charred samples was incinerated in a furnace at 500-550°C until the residue was uniformly white or nearly white, the crucible was then transferred to a desiccator and cooled to room temperature and the weight taken ( $W_3$ ). Percentage ash was calculated using the formula

$$\text{Ash}(\%) = \frac{W_2 - W_1}{W_2 - W_3} \times 100$$

Where:  $W_1$ = weight of crucible,  $W_2$ = weight of crucible + sample and  $W_3$  = weight of crucible + ash

### 2.4 Determination of Crude Protein

Crude protein was determined by Kjeldahl method.

#### 2.4.1 Blank

Two reagent blanks (containing all reagents used in nitrogen analysis except the sample) was included in every batch of analysis and the reagent nitrogen subtracted from the sample nitrogen.

#### 2.4.2 Test sample

10 g of the samples to be analyzed was weighed into a 500 mL digestion flask and 5-7 g of catalyst 20 mL of concentrated  $H_2SO_4$  and 1 glass bead (to prevent solution from bumping) added to it. The mixture was placed in the digester, it was initially digested at low temperature to prevent frothing and then boiled briskly until the solution was clear and free of carbon, the digest with added 100 mL of distilled water and 70 mL of 50% NaOH was distilled into 500 mL Erlenmeyer flask containing 50 mL of 4% boric acid with indicator (until about 150 mL distillate is obtained). The distillate was titrated with standardized 0.1N HCl until the first appearance of pink colour (volume of acid used was recorded to the nearest 0.05 mL). The percentage protein was calculated with this expression:

$$\text{Nitrogen}(\%) = \frac{[(tv - \text{blank}) \times \text{Normaltyofacid} \times 1.4]}{\text{weightofsample}}$$

Protein (%) = % total nitrogen x 6.25 (nitrogen conversion factor)

Where, tv = titre value.

**Table 1. Wheat/Pumpkin Blend Formulation**

Blend	Wheat (%)	Pumpkin (%)
WP1 (control)	100	0
WP2	90	10
WP3	80	20
WP4	70	30
WP5	60	40
WP6	50	50
WP7	40	60
WP8	30	70
WP9	20	80
WP10	10	90
WP11	0	100

Key: WP1 – (100:0) Wheat/ Pumpkin, WP2 – (90:10) Wheat/Pumpkin, WP3 – (80: 20) Wheat/ Pumpkin, WP4 – (70:30) Wheat/ Pumpkin, WP5 – (60:40) Wheat/ Pumpkin, WP6 – (50:50) Wheat/Pumpkin, WP7 – (40:60) Wheat/ Pumpkin, WP8 – (30:70) Wheat/ Pumpkin, WP9 – (20:80) Wheat/ Pumpkin, WP10 – (10:90) Wheat/ Pumpkin, WP11 – (0:100) Wheat/ Pumpkin

## 2.5 Total Fat

Determination of total fat was by Soxhlet extraction. 2 g sample ( $W_1$ ) was weighed into a thimble of soxhlet extraction apparatus fitted with reflux condenser and 500 mL round bottom flask filled with 300 mL Petroleum ether, the thimble was sealed with cotton wool, the extractor was allowed to reflux for 6 hours, the thimble was removed and ether extract transferred to pre-weighed conical flask ( $W_2$ ), the solvent was evaporated on a water bath at 70 - 80°C. The extracted fat was dried in an oven at 100 ± 5°C, cooled in a desiccators and weighed ( $W_3$ ).

$$\text{Total fat(\%)} = \frac{W_3 - W_2}{W_1} \times 100$$

Where:  $W_1$  = Weight of sample,  $W_2$  = Weight of conical flask and  $W_3$  = Weight of conical flask with the extracted fat.

## 2.6 Determination of Crude Fiber

Crude fiber was determined by AOAC [10] method. Two grams of the sample was weighed into a boiling 200 mL of  $H_2SO_4$  (1.25%) and allowed to boil for 30 minutes. The solution was filtered through muslin cloth fixed to a funnel and then washed with boiling water until its completely free from acid. The residue was reintroduced into 200ml boiling NaOH and allowed to boil for another 30min and then further washed with boiling water. The final residue was drained and transferred to a silica ash crucible dried in the oven to constant weight and cooled. Percent crude fiber was calculated using the expression

$$\text{crude fibre(\%)} = \frac{(\text{Loss in weight on ignition})}{\text{weight of sample}} \times 100$$

## 2.7 Determination of Carbohydrates

Carbohydrates was estimated as the difference between 100 and the total sum of moisture, fat, crude fiber, protein and ash.

$$100\% - (\% \text{ Ash} + \% \text{ Protein} + \% \text{ Fat} + \% \text{ Moisture} + \% \text{ Fiber})$$

## 2.8 Determination of Starch, Amylose and Amylopectin Content

Starch and Amylose were determined by the method of Onwuka [11]. Amylopectin was determined by difference of starch and amylose.

### 2.8.1 Starch

2.5 g of the sample was mixed with 50 mL of cold water in a 250 mL round bottom flask and allowed to stand for 1 hour, 20 mL of conc. HCl and 150 mL of distilled water was added and the mixture refluxed for 2 hours, cooled and neutralized with 5N NaOH and made up to mark with distilled water. The glucose content was determined using anthrone reagent. Series of glucose solution with dilution ranging from 0.04 to 0.2 mg per mL was used to obtain a glucose standard curve; 5 mL of anthrone reagent was added to 1 mL each of the glucose standards and sample solutions and properly mixed and boiled for 20 minutes in a water bath for the colour to develop. The tubes were cooled and absorbance read at 620nm against a blank containing 1 mL of distilled water and 5 mL of anthrone reagent. The concentration of the test sample was obtained from the absorbance by interpolation.

$$\text{mass of starch} = \text{mass of glucose} \times 0.9$$

### 2.8.2 Amylose

10 mL of 0.5N KOH was added to 10 mg of the sample in 100 mL beaker and dispersed uniformly using a stirring rod, the dispersed sample was transferred into a 50 mL volumetric flask and made up to mark with distilled water. 5 mL of the test solution was transferred to 50 mL flask and 5 mL of 0.1N HCl followed by 0.5 mL iodine reagent, the content was made up to mark. The absorbance was read in a Spectrophotometer at 625nm after it stood for 5 minutes. The amylose concentration was extrapolated from a standard curve of pure amylose concentration (2 – 10 mg) using the absorbance.

$$\text{Amylopectine (\%)} = \% \text{ Starch} - \% \text{ Amylose}$$

## 2.9 Determination of Minerals of the Pumpkin Flour

Mineral content was determined by the method described by AOAC, [10].

### 2.9.1 Preparation of test Sample

Samples were homogenized and ashed according to the method as described in 2.2.2, the ash was dissolved with 5 ml of 1N  $HNO_3$  and the solution transferred into a 50ml volumetric flask, the crucible was washed several times with 1N  $HNO_3$  to ensure complete removal of the ash

and filtered using Whatman No 541 filter paper. The filtrate was diluted to mark with 1N HNO<sub>3</sub>. The test solutions were used for the determination of mineral Content (Fe, P, Mn, Ca, Mg, K, Zn and Na).

## 2.10 Determination of Phosphorus

10 ml of 0.1 mg/ml phosphate standard solution (to obtain 1 mg P) and 5ml of test solution were pipetted into 100ml volumetric flask respectively, to each flask 10ml of 6N HNO<sub>3</sub>, 10ml of 0.25% ammonium monovanadate and 10ml of 5% ammonium molybdate was added, the solutions were diluted to mark with deionized water, mixed well and allowed to stand for exactly 15min to allow complete color development. The absorbance of each solution in 1cm cell at 400 nm was measured with UV-VIS spectrophotometer using reagent blank for auto zero. using the formula:

$$\text{Phosphorus mg/100 g} = \frac{\text{Abs}_{\text{sam}} \times 1 \times V_0 \times 100}{\text{Abs}_{\text{std}} \times V_p \times W}$$

Where:

Abs<sub>sam</sub> = absorbance of sample, Abs<sub>std</sub> = absorbance of standard (1mg/mL)

Vo = total volume (mL), Vp = volume of diluted sample (mL) and W = sample weight (g)

Test results reported in mg per 100 g sample,

## 2.11 Determination of Calcium, Magnesium, Potassium, Iron, Zinc, Manganese and Sodium

Calcium, Magnesium, Potassium, Iron, Zinc, Manganese and Sodium were determined using Atomic absorption Spectrophotometer (AAS)

### 2.11.1 Standard preparation

1ml certified Calcium, Magnesium, Potassium, Iron, and Zinc. Manganese and Sodium Standards were pipetted into a 50ml volumetric flask respectively and diluted to volume with 1N HNO<sub>3</sub>, the solution was mixed by slowly inverting the flask 10 times, from the working standard 0.4, 0.8, 1.2, 1.6, and 2.0 µg/ml calibration standards were prepared.

### 2.11.2 Test solution

10ml each of the prepared test samples were pipetted into a 50ml volumetric flask and made up with 1N HNO<sub>3</sub>. The absorbance of the prepared standards and test solutions were

measured with Atomic Absorption Spectrophotometer (AAS) against reagent blank (calcium at 422.7nm, magnesium at 285.2nm, Iron at 248.3nm, Zinc at 213.8nm, Sodium at 589.0nm, Manganese at 285.21nm and Potassium at 766.49nm). The measurements were carried out according to the following order: water, reagent blank (0 ppm, to set zero), standards (from the lowest concentration to the highest), and test solution. The system was washed with water after each test solution reading. Results were calculated using the expression:

$$X(\text{mg}/100\text{g}) = \frac{C_0 \times \text{total volume (mL)} \times \text{dilution} \times 100}{\text{weight of sample (g)} \times P \times 1000}$$

Where:

X = mineral being assayed, C<sub>0</sub> = Concentration of the sample in mg/L from the calibration curve (mg/L), P = Sample solution taken and 1000 = Conversion of mL to L

## 2.12 Functional Properties of Wheat / Pumpkin Flour Blends

Water Absorption Capacity and Oil Absorption Capacity were determined by the method of Dwiani et al. [12], Foaming Capacity and Stability, Emulsion Capacity and Stability, Least Gelation Concentration and Swelling Capacity were by the method of Chandra et al. [13], While Bulk Density was by the method of Maninder et al. [14]

### 2.12.1 Water absorption capacity [12]

One gram of sample (W<sub>0</sub>) was weighed into a pre-weighed 15 mL centrifuge tubes (W<sub>1</sub>). 10 mL of distilled water was added and mixed using a vortex at the highest speed for 2 minutes. After the mixture was thoroughly wetted, the samples were allowed to stand at room temperature for 30 minutes, and then centrifuged at 3000 rpm for 25 minutes at 20°C, the supernatant was decanted and the centrifuge tube containing sediment weighed (W<sub>2</sub>). Water Absorption capacity (grams of water per gram of sample) was calculated as:

$$WAC = \frac{(W_2 - W_1)}{W_0}$$

Where: WAC = water absorption capacity, W<sub>0</sub> = weight of the dry sample (g), W<sub>1</sub> = weight of the tube plus the dry sample (g), W<sub>2</sub> = weight of the tube plus the sediment (g).

### 2.12.2 Oil absorption capacity [12]

One gram (W<sub>0</sub>) was weighed into pre-weighed 15 mL centrifuge tubes and thoroughly mixed with

10 mL ( $V_1$ ) of soy oil using a vortex mixer, samples were allowed to stand for 30 minutes. The sample–oil mixture was centrifuged at 3000 rpm for 20 minutes at 20°C, the supernatant was carefully poured into a 10 mL graduated cylinder immediately after centrifugation, and the volume was recorded ( $V_2$ ). Oil absorption capacity (milliliter of oil per gram of sample) was calculated with the expression:

$$OAC = \frac{(V_1 - V_2)}{W_0}$$

Where: OAC = oil absorption capacity,  $V_1$  = the initial volume of oil used,  $V_2$  = the volume of supernatant oil decanted,  $W_0$  = Weight of sample used.

### 2.12.3 Foaming capacity and stability [13]

One gram of flour sample was added 50mL distilled water at  $30 \pm 2^\circ\text{C}$  in a graduated cylinder, the suspension was mixed and shaken vigorously for 5minutes to foam, the volume of foam at 30 seconds after whipping was expressed as foaming capacity using the formula:

$$\text{Foaming Capacity (\%)} = \left\{ \frac{\text{vol after whipping} - \text{vol before whipping}}{\text{vol before whipping}} \right\} \times 100$$

The volume of foam 1hour after whipping was calculated as foam stability

$$\text{Foam stability} = \left\{ \frac{\text{vol after 1 hr} - \text{vol before whipping}}{\text{vol before whipping}} \right\} \times 100$$

### 2.12.4 Emulsion capacity and stability [13]

One gram of sample, 10 mL of distilled water and 10 mL of soybean oil were prepared in calibrated centrifuge tubes, the emulsion was centrifuged at 2000rpm for 5minutes, and the ratio of the height of emulsion layer to the total height of the mixture was calculated as emulsion capacity in percentage. The emulsion stability was expressed as the ratio of the height of emulsified layer to the total height of mixture after heating the emulsion contained in the calibrated centrifuge tubes in water bath for 30 minutes at 80°C, cooling under running tap water and centrifuging for 15 minutes at 2000rpm.

### 2.12.5 Bulk density

Bulk density determination was by method as described by Maninder et al. [14]. The samples were filled gently into a 10 mL graduated cylinders, the bottom of the cylinders were tapped gently on a laboratory bench until there was no more diminution of sample level at the

10ml mark. The weight of the sample was taken and bulk density calculated as weight per unit volume.

$$\text{Bulk Density (g/mL)} = \frac{\text{weight of sample (g)}}{\text{volume of sample (mL)}}$$

### 2.12.6 Least gelation concentration

Flour dispersions of 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, and 30 % (w/v) was prepared in 5 mL distilled water and then heated at 90°C for 1hour in water bath, the contents were cooled under tap water and kept for 2 hours at  $10 \pm 2^\circ\text{C}$ . The least gelation concentration was determined as the least concentration at which samples from inverted tube did not slip.

### 2.12.7 Swelling capacity

100 mL graduated cylinder was filled with sample to 10 mL mark, distilled water was added to give a total volume of 50 mL, the top of the graduated cylinder was tightly covered and mixed by inverting the cylinder. The suspension was inverted again after 2 minutes and left to stand for a further 8 minutes, the volume occupied by the sample was taken after the 8th min [13].

## 2.13 Recipe for Production of Cake

The recipe for cake production followed the method as described by Bivan and Eke-Ejiofor, [15] with some modifications.

Margarine and sugar were creamed manually for 10 minutes in a stainless steel bowl until light and fluffy. Egg was beaten for 3 minutes and added to the creamed mixture gradually while beating continuously. Flour samples and baking powder was gradually folded into the mixture until batter is formed. The batter was then filled into cup cake pans and baked in a pre-heated oven at 150°C for 45 minutes. Baked cake was cooled and packed in airtight Ziploc bags for sensory evaluation.

## 2.14 Sensory Evaluation

The sensory evaluation of the cakes was by the method of Iwe [16]. A 20 man semi-trained panelist who were neither sick nor allergic to any of the raw materials were used to evaluate taste, appearance, colour, mouthfeel and general acceptability of the cakes using a 9 point hedonic scale (9 = liked extremely, 8 = liked very much, 7 = liked, 6 = liked mildly, 5 = neither liked nor disliked, 4 = disliked mildly, 3 = disliked, 2 = disliked very much and 1 = disliked extremely).

**Table 2. Recipe for Cake**

<b>Ingredient</b>	<b>Quantity(g)</b>
Flour (different blends of Wheat/Pumpkin flour as described in table 3.1)	200
Caster sugar	120
Margarine	120
Eggs	4 (assuming each egg weighs about 50g)
Baking powder	1

*Bivan and Eke-Ejiofor, [15]*

## 2.15 Statistical Analysis

Data obtained from this study was subjected to a one-way Analysis of Variance (ANOVA). Turkey's multiple comparison test was used to separate the means at  $p < 0.05$  using MINITAB 16.

## 3. RESULTS AND DISCUSSION

### 3.1 Results

Tables 3 and 4 shows the results of the chemical composition of the pumpkin flour and wheat / pumpkin flour blends respectively and Tables 5 and 6 shows the results of functional properties of the flour blends and average sensory scores of the wheat / pumpkin flour based cakes respectively.

## 4. DISCUSSION

### 4.1 Physico-chemical Properties

Pumpkin flour showed a moisture content of 6.51% (Table: 1), the standard limit for moisture content in wheat flour is 15.5% maximum [17]. The result of this present study is lower than 7.90% reported by Nguyen and Nguyen [18] but higher than 3.73% reported by El-khatib and Muhieddine [19], there was a significant decrease in moisture content of the wheat /Pumpkin flour blends as the level of substitution of pumpkin flour increased (Table 2). This is similar to the result of wheat / tigernut composite flour reported by Ade-Omowaye et al. [20]. Moisture content is a significant factor of food safety as it is critical in food packaging and storage. high moisture content promotes microbial growth and enzymatic activities that leads to spoilage of stored food, in most cases moisture content above 14% promotes fungal growth [21]. The reduced moisture content with increase in pumpkin flour ratio will improve the keeping quality (shelf life) of the composite flour

[22]. The ash content of 6.74% as shown in Table 3 suggests that pumpkin pulp flour can be used as enrichment to foods deficient in mineral, incorporation of pumpkin flour in wheat flour increased the ash content of the composite flour with the value ranging from 0.58 - 6.74% (Table: 4) ash content is an indication of the amount of mineral in a food sample. The ash content of pumpkin flour of the present study was higher than the values reported by; Norfezah et al. [23] 5.62%, and Saeleaw and Schleining [24] 5.37%. However, Adebayo et al. [25] reported ash content of pumpkin pulp powder up to 15.988%. Ash content of the various wheat/ pumpkin composite flour blends is similar to the trend reported by Erasedo [26]. The increase in ash content will impact a higher nutritive value on the composite flour. The result of the crude fiber content of the pumpkin flour was 6.93% (Table 3). Similar work undertaken by Usha et al. [27] and Adebayo et al. [25] reported crude fiber content of 3.0785% and 11.463% respectively. Crude fiber is a measure of indigestible component of plant food [28], it is very significant in gastrointestinal health as it helps to soften and increase the bulk of stool making it easier to pass stool, reducing the risk of constipation, other benefits may include maintenance of body weight, lowering the risk of heart disease, diabetics and certain cancers [29]. There was a significant increase in crude fiber as the pumpkin ratio of the composite flour blends increased, the result of the crude fiber ranging from 0.51 – 6.93% (Table: 4) is comparable to the result of a similar study by Bhat and Bhat [30]. The pumpkin pulp flour showed a Protein content of 5.81% (Table: 3) this is higher than the value reported by Adebayo et al. [25] 3.07% and Norfezah et al. [23] 1.30%, but lower than the value reported by El-khatib and Muhieddine [19] 7.81%. Protein content of the composite flour blends (Table 4) ranged from 5.81 – 11.97%. The protein content was observed to decrease significantly as pumpkin flour ratio increases; similar trend was reported by Erasedo [26], according to Al-Dmoor, [31] 7 – 9% protein content of flour produces the

best cake. The fat content of the present study (0.90%) compares with the findings of Nguyen and Nguyen [18] who reported fat content of 0.85%, the low fat content makes it ideal for people on low fat diet. The fat content of the Wheat/pumpkin composite flour blends ranging from 0.90 – 1.56% showed a decrease as the pumpkin ratio increase, however there was no significant difference ( $p > 0.05$ ) across the blends. Erasedo [26] in a similar study reported an increase in fat content as pumpkin ratio increases. Carbohydrate ranging from 72.22 – 75.85% showed an increase up to 40% substitution then subsequently decreased with sample WP11 (0:100 – wheat / pumpkin composite flour blend) having the lowest value. The starch content of the pumpkin flour in this present study was found to be 37.68% consisting of 8.76% amylose and 28.92% amylopectin, this is lower than 48.30% reported by El-khatib and Muhieddine [19] for starch and 16.18% reported by Yin and Wang [32] for amylose, the result is however higher than the values (0.9% to 3.0%) reported by Pereira et al (20[33]20) for amylose. Starch, amylose and amylopectin ranging from 37.68 – 83.82%, 8.76 – 24.64% and 28.92 - 59.12% respectively decreased significantly as pumpkin ratio increases. 100%wheat flour (control) has the highest content of starch and correspondingly highest content of amylose and amylopectin. The lower starch content of pumpkin flour could be due to conversion of starch to sugar during fruit ripening [34].

Starches with low amylose content is usually high in glycemic index [35]. Amylose content of 2-12% is classified as very low [36]. Though the amylose result of this present study fall within the very low amylose range, the low starch and high fiber content makes it ideal for diabetics, Yoshinari et al. [37] reported that a group of rats fed with pumpkin paste concentrate maintained a lower glucose level.

The result of the mineral analysis shows potassium -2924mg/100g, magnesium - 42.41mg, iron -33.35mg/100g and calcium - 28.48mg/100g as the predominant minerals with Potassium being the most abundant, similar works by Adubufuor et al. [38], Amin et al. [39] and Mayer [40] reported Potassium as the most abundant mineral in pumpkin pulp flour. The result for calcium is similar to the value reported by Mayer [40]. The result shows phosphorous as the least abundant at 0.23mg/100g, Amin et al. [39] reported similar low value of phosphorous 1.36mg/100g, however Adubufuor et al. [38] reported a value of 295.75mg/100g for phosphorous. Manganese 1.06mg/100g and zinc 1.83mg/100g were found to be higher than the 0.40mg/100g for manganese and 0.23mg/100g for zinc reported by Amin et al. [39], while the result for sodium at 11.99mg/100g was lower than 20.75mg/g reported by the same work. The variation in the mineral content may be due to changes in agricultural practice, soil types and varieties grown [40].

**Table 3. Chemical Properties of Pumpkin Pulp Flour**

Parameter	Composition (%)
Moisture	6.51 ± 0.13
Ash	6.74 ± 0.34
Crude Protein	5.81 ± 0.41
Total Fat	0.90 ± 0.42
Crude Fiber	6.93 ± 0.30
Carbohydrate	72.22 ± 1.23
Starch	37.68 ± 0.23
Amylose	8.76 ± 0.20
Amylopectin	28.92 ± 0.20
<b>MINERALS (mg/100g)</b>	
Magnesium	42.41 ± 0.01
Calcium	28.48 ± 1.56
Manganese	1.06 ± 0.00
Iron	33.35± 0.12
Zinc	1.83 ± 0.01
Sodium	11.99 ± 1.05
Potassium	2924 ± 2.83
Phosphorus	0.23 ± 0.01

*Means are ± standard deviation of triplicate analysis*



**Table 4. Chemical Composition (%) of Wheat/Pumpkin Composite Flour Blend**

Sample Code	Moisture	Ash	Protein	Fat	Crude Fiber	Carbohydrate	Starch	Amylose	Amylopectin
WP1	11.78 <sup>a</sup> ± 1.42	0.58 <sup>g</sup> ± 0.35	11.97 <sup>a</sup> ± 0.05	1.56 <sup>a</sup> ± 0.05	0.51 <sup>f</sup> ± 0.17	73.68 <sup>abc</sup> ± 0.11	83.82 <sup>a</sup> ± 0.36	24.64 <sup>a</sup> ± 0.15	59.18 <sup>a</sup> ± 0.15
WP2	11.60 <sup>a</sup> ± 0.52	1.07 <sup>g</sup> ± 0.05	10.48 <sup>ab</sup> ± 1.47	1.53 <sup>a</sup> ± 0.05	0.58 <sup>f</sup> ± 0.10	74.70 <sup>ab</sup> ± 0.07	76.19 <sup>b</sup> ± 0.11	21.59 <sup>b</sup> ± 0.21	54.60 <sup>b</sup> ± 0.21
WP3	10.74 <sup>ab</sup> ± 0.07	1.87 <sup>f</sup> ± 0.21	9.79 <sup>abc</sup> ± 1.03	1.31 <sup>a</sup> ± 0.05	1.23 <sup>e</sup> ± 0.06	74.89 <sup>ab</sup> ± 0.12	71.33 <sup>c</sup> ± 0.26	20.68 <sup>c</sup> ± 0.06	50.65 <sup>c</sup> ± 0.06
WP4	9.54 <sup>abc</sup> ± 0.63	2.54 <sup>e</sup> ± 0.11	9.46 <sup>abcd</sup> ± 1.34	1.30 <sup>a</sup> ± 0.11	1.82 <sup>e</sup> ± 0.03	75.48 <sup>a</sup> ± 0.06	70.11 <sup>d</sup> ± 0.81	20.31 <sup>c</sup> ± 0.14	49.80 <sup>cd</sup> ± 0.12
WP5	8.81 <sup>bcd</sup> ± 2.70	2.88 <sup>e</sup> ± 0.19	9.04 <sup>bcd</sup> ± 1.18	1.29 <sup>a</sup> ± 0.08	2.09 <sup>de</sup> ± 0.02	75.85 <sup>a</sup> ± 0.09	65.57 <sup>e</sup> ± 0.19	17.73 <sup>d</sup> ± 0.15	47.84 <sup>d</sup> ± 0.15
WP6	7.77 <sup>cd</sup> ± 0.48	3.65 <sup>d</sup> ± 0.29	8.71 <sup>bcd</sup> ± 0.99	1.19 <sup>a</sup> ± 0.19	2.88 <sup>d</sup> ± 0.10	75.83 <sup>a</sup> ± 0.04	64.53 <sup>f</sup> ± 0.20	14.35 <sup>e</sup> ± 0.13	50.18 <sup>c</sup> ± 0.13
WP7	7.34 <sup>cd</sup> ± 0.19	4.45 <sup>c</sup> ± 0.15	8.01 <sup>bcd</sup> ± 1.07	1.10 <sup>a</sup> ± 0.19	4.41 <sup>c</sup> ± 0.02	74.54 <sup>ab</sup> ± 0.22	63.64 <sup>f</sup> ± 0.12	13.15 <sup>f</sup> ± 0.06	50.49 <sup>c</sup> ± 0.06
WP8	7.11 <sup>cd</sup> ± 0.76	4.72 <sup>c</sup> ± 0.47	7.11 <sup>cde</sup> ± 0.71	1.00 <sup>a</sup> ± 0.4	4.79 <sup>c</sup> ± 0.02	75.01 <sup>a</sup> ± 0.23	60.40 <sup>g</sup> ± 0.05	12.51 <sup>g</sup> ± 0.26	47.89 <sup>d</sup> ± 0.25
WP9	7.08 <sup>cd</sup> ± 0.50	5.44 <sup>b</sup> ± 0.17	6.88 <sup>def</sup> ± 0.20	0.92 <sup>a</sup> ± 0.44	5.26 <sup>bc</sup> ± 1.10	74.06 <sup>abc</sup> ± 0.52	53.46 <sup>h</sup> ± 0.09	11.44 <sup>h</sup> ± 0.13	42.02 <sup>e</sup> ± 0.13
WP10	6.85 <sup>d</sup> ± 0.37	6.36 <sup>a</sup> ± 0.17	6.03 <sup>ef</sup> ± 0.23	0.91 <sup>a</sup> ± 0.38	6.23 <sup>ab</sup> ± 0.12	72.79 <sup>bc</sup> ± 1.17	41.71 <sup>i</sup> ± 0.24	9.39 <sup>i</sup> ± 0.13	32.32 <sup>f</sup> ± 0.13
WP11	6.51 <sup>d</sup> ± 0.13	6.74 <sup>a</sup> ± 0.34	5.81 <sup>f</sup> ± 0.41	0.90 <sup>a</sup> ± 0.42	6.93 <sup>a</sup> ± 0.30	72.22 <sup>c</sup> ± 1.26	37.68 <sup>j</sup> ± 0.23	8.76 <sup>j</sup> ± 0.20	28.92 <sup>g</sup> ± 0.20

Means are ± standard deviation of triplicate analysis. Means within a column that do not share the same letter are significantly different. **Key:** WP 1(Control) = 100% Wheat Flour, WP2 = (90: 10) Wheat/ Pumpkin Flour Blend, WP3 = (80: 20) Wheat/ Pumpkin Flour Blend, WP4 = (70:30) Wheat/ Pumpkin Flour Blend, WP5 = (60:40) Wheat/ Pumpkin Flour Blend, WP6 = (50:50) Wheat/ Pumpkin Flour Blend, WP7 = (40:60) Wheat/ Pumpkin Flour Blend, WP8 = (30:70) Wheat/ Pumpkin Flour Blend, WP9 = (20:80) Wheat/ Pumpkin Flour Blend, WP10 = (10:90) Wheat/ Pumpkin flour Blend and WP11 = (0:100) Wheat/ Pumpkin Flour Blend

**Table 5. Functional properties of Wheat /Pumpkin Flour Blends**

Sample Code	WAC (mlg <sup>-1</sup> )	OAC (mlg <sup>-1</sup> )	BD (gml <sup>-1</sup> )	LGC (%)	FC (%)	FS (%)	SC (%)	EC (%)	ES (%)
WP1	1.04 <sup>e</sup> ± 0.10	1.62 <sup>h</sup> ± 0.02	0.58 <sup>a</sup> ± 0.02	8.50 <sup>d</sup> ± 0.71	54.26 <sup>a</sup> ± 0.99	27.84 <sup>a</sup> ± 0.25	53.71 <sup>e</sup> ± 2.62	45.46 <sup>de</sup> ± 0.01	35.50 <sup>h</sup> ± 0.35
WP2	1.43 <sup>de</sup> ± 0.18	1.70 <sup>g</sup> ± 0.01	0.59 <sup>a</sup> ± 0.01	10.50 <sup>cd</sup> ± 0.71	33.82 <sup>b</sup> ± 0.21	20.78 <sup>b</sup> ± 0.08	58.93 <sup>d</sup> ± 2.52	45.07 <sup>e</sup> ± 0.50	45.01 <sup>g</sup> ± 0.01
WP3	1.97 <sup>cde</sup> ± 0.07	1.72 <sup>fg</sup> ± 0.01	0.60 <sup>a</sup> ± 0.02	10.50 <sup>cd</sup> ± 0.71	27.73 <sup>c</sup> ± 0.96	15.79 <sup>c</sup> ± 0.33	70.51 <sup>d</sup> ± 1.81	45.47 <sup>de</sup> ± 0.03	47.35 <sup>i</sup> ± 0.04
WP4	2.43 <sup>bcd</sup> ± 0.11	1.74 <sup>efg</sup> ± 0.00	0.60 <sup>a</sup> ± 0.01	12.50 <sup>bc</sup> ± 0.71	22.05 <sup>d</sup> ± 1.37	12.43 <sup>d</sup> ± 0.30	77.18 <sup>c</sup> ± 1.53	45.81 <sup>d</sup> ± 0.02	51.06 <sup>e</sup> ± 0.06
WP5	2.65 <sup>bcd</sup> ± 0.15	1.76 <sup>ef</sup> ± 0.01	0.61 <sup>a</sup> ± 0.00	12.50 <sup>bc</sup> ± 0.71	22.11 <sup>d</sup> ± 0.16	11.11 <sup>e</sup> ± 0.00	77.91 <sup>c</sup> ± 1.65	46.51 <sup>c</sup> ± 0.00	52.64 <sup>d</sup> ± 0.01
WP6	2.87 <sup>bcd</sup> ± 0.13	1.79 <sup>e</sup> ± 0.01	0.60 <sup>a</sup> ± 0.01	12.50 <sup>bc</sup> ± 0.71	22.22 <sup>d</sup> ± 0.00	11.11 <sup>e</sup> ± 0.00	84.17 <sup>b</sup> ± 1.81	47.01 <sup>bc</sup> ± 0.001	53.01 <sup>d</sup> ± 0.01
WP7	3.00 <sup>bcd</sup> ± 0.45	1.85 <sup>d</sup> ± 0.03	0.58 <sup>a</sup> ± 0.01	12.50 <sup>bc</sup> ± 0.71	7.72 <sup>e</sup> ± 1.39	0.21 <sup>t</sup> ± 0.01	86.30 <sup>b</sup> ± 0.00	47.47 <sup>b</sup> ± 0.14	54.16 <sup>c</sup> ± 0.00
WP8	3.61 <sup>abc</sup> ± 0.37	1.89 <sup>d</sup> ± 0.01	0.58 <sup>a</sup> ± 0.01	12.50 <sup>bc</sup> ± 0.71	4.08 <sup>ef</sup> ± 0.10	0.20 <sup>f</sup> ± 0.01	87.34 <sup>b</sup> ± 0.94	48.35 <sup>a</sup> ± 0.19	55.09 <sup>b</sup> ± 0.02
WP9	4.02 <sup>ab</sup> ± 0.41	2.20 <sup>c</sup> ± 0.00	0.59 <sup>a</sup> ± 0.02	12.50 <sup>bc</sup> ± 0.71	3.26 <sup>t</sup> ± 1.54	0.19 <sup>t</sup> ± 0.01	88.37 <sup>ab</sup> ± 0.00	48.48 <sup>a</sup> ± 0.01	55.17 <sup>b</sup> ± 0.10
WP10	4.08 <sup>ab</sup> ± 0.36	2.41 <sup>b</sup> ± 0.01	0.58 <sup>a</sup> ± 0.02	14.50 <sup>ab</sup> ± 0.71	3.26 <sup>f</sup> ± 1.54	0.05 <sup>f</sup> ± 0.07	89.56 <sup>ab</sup> ± 0.78	48.48 <sup>a</sup> ± 0.00	55.84 <sup>a</sup> ± 0.07
WP11	5.30 <sup>a</sup> ± 1.28	2.81 <sup>a</sup> ± 0.01	0.59 <sup>a</sup> ± 0.00	16.50 <sup>a</sup> ± 0.71	1.07 <sup>f</sup> ± 1.51	0.00 <sup>f</sup> ± 0.00	93.33 <sup>a</sup> ± 0.00	48.49 <sup>a</sup> ± 0.01	56.02 <sup>a</sup> ± 0.01

Means are ± standard deviation of triplicate analysis. Means within a column that do not share the same letter are significantly different.

Key: WAC = Water Absorption Capacity, OAC = Oil Absorption Capacity, BD = Bulk Density, LGC = Least Gelation Concentration, FC = Foaming Capacity, FS = Foaming Stability, SC = Swelling Capacity, EC = Emulsion Capacity and ES = Emulsion Stability; WP1 = (100%) Wheat Flour, WP2 = (90: 10) Wheat/ Pumpkin Flour, WP3 = (80: 20) Wheat/ Pumpkin Flour, WP4 = (70:30) Wheat/ Pumpkin, WP5 = (60:40) Wheat/ Pumpkin, WP6 = (50:50) Wheat/ Pumpkin Flour, WP7 = (40:60) Wheat/ Pumpkin Flour, WP8 = (30:70) Wheat/ Pumpkin Flour, WP9 = (20:80) Wheat/ Pumpkin Flour, WP10 = (10:90) Wheat/ Pumpkin, WP11 = (0:100) Wheat/ Pumpkin Flour

**Table 6. Sensory Score of Wheat/Pumpkin Flour Based Cake**

<b>Sample Code</b>	<b>Taste</b>	<b>Appearance</b>	<b>Colour</b>	<b>Mouthfeel</b>	<b>General Acceptability</b>
KWP1(control)	8.22 <sup>a</sup> ± 0.90	7.13 <sup>a</sup> ± 1.4	7.70 <sup>a</sup> ± 1.1	7.70 <sup>a</sup> ± 0.93	7.83 <sup>a</sup> ± 1.92
KWP2	8.17 <sup>a</sup> ± 0.89	7.13 <sup>a</sup> ± 1.10	7.70 <sup>a</sup> ± 0.88	7.48 <sup>ab</sup> ± 1.16	7.39 <sup>a</sup> ± 1.88
KWP3	8.13 <sup>a</sup> ± 0.82	7.09 <sup>a</sup> ± 1.20	7.61 <sup>a</sup> ± 1.20	6.87 <sup>abc</sup> ± 1.79	6.96 <sup>a</sup> ± 2.08
KWP4	7.48 <sup>ab</sup> ± 1.08	6.74 <sup>a</sup> ± 0.92	7.23 <sup>ab</sup> ± 0.74	7.22 <sup>abc</sup> ± 1.04	6.48 <sup>ab</sup> ± 2.00
KWP5	7.04 <sup>abc</sup> ± 1.43	6.61 <sup>a</sup> ± 1.23	6.57 <sup>abc</sup> ± 1.47	6.78 <sup>abc</sup> ± 0.90	6.87 <sup>a</sup> ± 1.91
KWP6	6.78 <sup>bc</sup> ± 1.00	5.78 <sup>ab</sup> ± 1.70	6.30 <sup>bc</sup> ± 1.22	6.04 <sup>bcd</sup> ± 1.22	6.13 <sup>ab</sup> ± 1.84
KWP7	6.65 <sup>bc</sup> ± 1.27	5.74 <sup>ab</sup> ± 2.05	6.26 <sup>bcd</sup> ± 1.71	5.91 <sup>cd</sup> ± 1.20	6.00 <sup>ab</sup> ± 2.24
KWP8	5.91 <sup>c</sup> ± 1.96	5.74 <sup>ab</sup> ± 2.05	6.22 <sup>bcd</sup> ± 1.68	5.91 <sup>cd</sup> ± 1.98	5.96 <sup>ab</sup> ± 2.10
KWP9	5.91 <sup>c</sup> ± 1.20	5.00 <sup>bc</sup> ± 2.02	5.83 <sup>cd</sup> ± 1.67	5.09 <sup>de</sup> ± 1.81	4.65 <sup>bc</sup> ± 2.19
KWP10	5.83 <sup>c</sup> ± 1.90	4.52 <sup>bc</sup> ± 1.76	5.04 <sup>d</sup> ± 1.46	4.57 <sup>de</sup> ± 2.23	4.78 <sup>b</sup> ± 1.92
KWP11	2.61 <sup>d</sup> ± 1.95	4.13 <sup>c</sup> ± 1.69	5.78 <sup>cd</sup> ± 1.00	3.87 <sup>e</sup> ± 1.60	2.74 <sup>c</sup> ± 1.88

Means are ± standard deviation. Means within a column that do not share the same letter are significantly different

**Key:** KWP1 (Control) – 100% Wheat based cake, KWP2 – (90: 10) Wheat/ Pumpkin based cake, KWP3 – (80: 20) Wheat/ Pumpkin based cake, KWP4 – (70:30) Wheat/ Pumpkin based cake, KWP5 – (60:40) Wheat/ Pumpkin based cake, KWP6 – (50:50) Wheat/ Pumpkin based cake, KWP7 – (40:60) Wheat/ Pumpkin based cake, KWP8 – (30:70) Wheat/ Pumpkin based cake, KWP9 – (20:80) Wheat/ Pumpkin based cake, KWP10 – (10:90) Wheat/ Pumpkin based cake, KWP11 – (0:100) Wheat/ Pumpkin based cake

## 4.2 Functional Properties

The functional properties of the wheat/pumpkin composite flour as shown in Table 5 showed a significant increase in water absorption capacity (WAC) from 1.04 – 5.30 mL/g with an increase in the ratio of pumpkin flour, the same trend was reported by Adubufor et al. [38] and Imran et al. [41]. WAC enhances the digestibility of starch (Iwe and Onadipe, 2001). The increase in WAC of the samples as the pumpkin flour ratio increases may be attributed to the high fiber content of the pumpkin flour. Oil absorption capacity (OAC) of the composite flour ranging from 1.62 – 2.82mL/g increased significantly with increase in pumpkin ratio, this is similar to the significantly higher ( $p < 0.05$ ) oil absorption capacity of pumpkin pulp flour to wheat flour reported by Nooraziah and Komathi [42]. Oil absorption capacity plays a crucial role in retaining the flavor of food and enhances mouthfeel [43]. There was an increase in the least gelation concentration (LGC) as pumpkin ratio increased with the result ranging from 8.50 - 16.50%, this may be due to the decrease in the protein and starch content of the flour as the Pumpkin flour portion increases. Gelation is directly related to higher protein concentration due to greater intermolecular contact during heating [44]. The result is consistent with the range of values reported by Abbey and Ayuk [45] for African yam bean (16-20%) and Chandra et al [13] for a composite of wheat, rice, green gram and potato flour (8-10%). Foaming capacity (FC) and foaming stability (FS) as shown in Table 6 decreased significantly from 54.26 to 1.07% and 27.84 to 0% respectively) as the proportion of the pumpkin flour in the composite increases, Chandra et al. [13] in a similar work substituting wheat flour with a combination of rice, green gram and potato flour up to 45% substitution level reported an increase in the FC and FS ranging from 12.92 to 17.60% and 1.94 to 13.40% respectively, the reduced protein content of the Wheat / pumpkin composite flour as the pumpkin ratio increases may have contributed to the low foaming capacity since foaming capacity is a measure of the interfacial area created by protein during foaming (Hasmadi et al. [46]. The swelling capacity (SC) of the various blends of composite flour increased significantly with increase in pumpkin ratio with 100% pumpkin flour having the highest value. Swelling Capacity measures, the ability of starch to swell on the absorption of water, which is an indication of the associative forces in the starch granules [47] The swelling capacity of flour is a function of the

amylopectin content of the starch [48], the higher the amylopectin content of starch the higher the swelling capacity. The increase in the swelling capacity may be attributed to the high amylopectin content of the pumpkin starch. The result of this present study is similar to the trend reported by Adubufor et al. [38]. Similarly, [49] reported a higher swelling capacity of Pumpkin flour than wheat flour. The emulsion capacity (EC) and emulsion stability (ES) of the composite flour blends ranged from 45.07 – 48.49% for EC and 35.50 – 56.02% for ES as shown in Table 5. The result showed an increase in EC and ES as the pumpkin ratio increases. Bulk density of the different blends of the wheat / pumpkin composite (Table 5) flour ranging 0.58 – 0.60g/ml showed no significant difference ( $p > 0.05$ ). Bulk density is influenced by the particle size and density of the flour and is very important in material handling and packaging in the food industry (Kul [50] (kani et al., 1996). Similar range of values ( $0.51 - 0.61/\text{cm}^3$ ) were reported by Adubufor et al. [38], however [18] in a similar work reported a range of  $0.69$  to  $0.91\text{g}/\text{cm}^3$ .

## 4.3 Sensory Scores

Mean sensory scores of cakes produced from the different blends of wheat/pumpkin composite flour (Table 6) showed no significant difference ( $p > 0.05$ ) in taste between the control and up to 40% substitution level with pumpkin flour. The mean score for appearance of the cake samples ranging from 4.13 – 7.13 showed no significant difference in the samples up to 70% substitution levels in comparison with the control (100% wheat flour based cake), The mean score for colour of the cake samples ranged from 5.04 – 7.70, there was no significant difference between the control and up to 40% substitution level, sample KWP2 (90:10 – wheat/pumpkin composite flour based cake) had the highest score while sample KWP10 (10:90 – wheat/pumpkin composite flour based cake) had the lowest for colour among the different wheat /pumpkin composite flour cakes. The mean score of the result of the evaluation of mouth feel of the different test samples ranging from 3.87 – 7.70 showed no significant difference ( $p > 0.05$ ) up to 30% substitution level in comparison with the control. General acceptability result ranging from 2.74 – 7.83 shows that cake produced from wheat/pumpkin composite flour had a good acceptability up to 70% substitution level as there was no significant difference between the control (100% wheat flour based cake) and up to 70% substitution level. Similar results were reported

by Aljahani and Al-khuriaief [51] and Hosseini et al. [52] for various sensory attributes evaluated in similar studies. The results of the sensory attributes of this present study showed that cakes can be substituted with up to 70% pumpkin flour based on general acceptability.

## 5. CONCLUSION

Pumpkin (*Cucurbita Pepo*) was successfully processed into flour and blended with wheat flour to produce cakes. The moisture content of pumpkin flour was found valuable for storage, the ash and mineral content showed that pumpkin flour could be used as enrichment to foods deficient in the mineral. Pumpkin flour was also found to be a good source of fiber and protein, pumpkin flour was found to be low in starch, the low starch content and high fiber make it ideal for diabetics. Incorporation of pumpkin pulp flour to wheat flour impacted positively on the blends; the reduced moisture content with increase in pumpkin flour ratio will improve the keeping value (shelf life) of the composite blends and an increase in ash and fiber will impact a higher nutritional value. The functional properties of the composite flour make it suitable for use in product development. The made cakes from the flour blends compared favorably with the control up to 70% inclusion level. These imply that pumpkin flour has a high potential for extended domestic and industrial application.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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