

## Evaluation of pasting and anti-nutritional properties of wheat-plantain flour blends fortified with velvet bean

T. K Adebayo \*, M.B Olaoye, O. A Idowu and I. G Lawrence

*Department of Food Technology, School of Applied Sciences, Federal Polytechnic, Offa, Kwara State, Nigeria.*

World Journal of Advanced Research and Reviews, 2023, 20(03), 687–698

Publication history: Received on 24 October 2023; revised on 06 December 2023; accepted on 09 December 2023

Article DOI: <https://doi.org/10.30574/wjarr.2023.20.3.2484>

### Abstract

Wheat flour is a powder made from the grinding of wheat used for human consumption. It is a flour of choice in confectionary industries due to the component gluten. Plantain is a popular dietary staple crop in Nigeria due to its versatility and good nutritional value. It is starchy, the less sweet variety can be used either ripe or unripe, they are very good sources of carbohydrate for more than 50 million people. Velvet bean (*Mucuna pruriens*), belongs to the Fabaceae family, it is part of various legumes which is not commonly used by people as a result of anti-nutrients. Velvet bean is commonly grown in the tropical and subtropical part of the world. This study therefore investigated effect of inclusion of velvet bean on the pasting and anti-nutritional factors of wheat-plantain flour blends. The procured velvet bean and plantain were thoroughly washed, peeled, dried and converted into flours. Wheat, plantain and Velvet flours composite were prepared in the ratio 240:37.5:22.5, 210:60:30 and 150:105:45 respectively and 100% wheat flour was used as the control. The samples were evaluated for their pasting and anti-nutritional properties. Pasting revealed that peak ranged from 1928.50-4972.50 Trough, 1054.00-3563.00, breakdown 692.50-1408.00, final viscosity 2077.00-5789.50, setback 968.00-2226.00, peak time 5.10-5.79 min and pasting temperature 80.79-83.14 °C. Anti-nutritional factors revealed that Tannin ranged from 20.01-219.25, Oxalate 24.56-448.79, trypsin inhibitors 10.31-20.70, Phytate 5.67-6.44 and Saponin 0.00-1.87 mg/100g. Addition of plantain and velvet beans flours significantly ( $p < .05$ ) improved the final viscosity, peak, trough and the setback of the flour blends. The phytochemical properties of the composites indicated significant ( $P < .05$ ) oxalate, phenolic, flavonoid and saponin increased which makes them suitable as anti-aging, anti-inflammatory, anti-oxidant, anti-hypertensive agents

**Keywords:** Velvet bean; Plantain; Pasting; Anti-nutritional factors; Wheat

### 1. Introduction

Wheat flour is a finely ground powder prepared from grain or other starchy plant foods and used in baking. Although flour can be made from a wide variety of plants, the vast majority is made from wheat. It is nutritious, easy to store and transport and can be processed into various types of food. Wheat is considered a good source of protein, minerals, B-group vitamins and dietary fiber (Shewry, 2009) although the environmental conditions can affect nutritional composition of wheat grains with its essential coating of bran, vitamins and minerals; it is an excellent health-building food. Dough made from wheat flour is particularly well suited to baking cake, bread, biscuit, chin-chin, etc. because it contains a large amount of gluten, a substance composed of strong, elastic proteins. Wheat is also used as animal feed, for ethanol production, brewing of wheat beer, wheat based raw material for cosmetics, wheat protein in meat substitutes and to make wheat straw composites. Wheat germ and wheat bran can be a good source of dietary fiber helping in the prevention and treatment of some digestive disorders. The key characteristic, which has given it an advantage over other temperate crops, is the unique properties of dough formed from wheat flours, which allow it to be processed into a range of breads and other baked products (including cakes and biscuits), pasta and noodles, and other processed foods. Wheat flour as the major ingredient for bakery products has dominated other potential sources

\* Corresponding author: T. K Adebayo

of flour for bakery products. However, the high cost of wheat flour has led to a rise in the cost of bakery products in Nigeria and indeed other countries in Sub-Saharan Africa (Ikpeme *et al.*, 2012).

Plantain (pronounced plan-tane or plan-tin) is a species of the genus *Musa* and is generally used for cooking, in contrast to the soft, sweet banana, which is sometimes called the dessert banana. The occupants of North America were first to be introduced to the banana plantain. The term “banana” in the United States and Europe colloquially refer specifically to the banana variety and not plantain. The word “banana” is often used incorrectly to describe other plantain varieties as well, when in fact the generic name is “plantain”. The correct terms for the various varieties of plantains include: banana plantain, cooking plantain, and bocadillo plantain. All are members of the genus *Musa* and are indigenous to the tropical region of Southeast Asia, including the Malay Archipelago and northern Australia. Traditionally, plantain leaves are used like plates for several dishes, such as Venezuelan Hallacas.

The genus *Mucuna* (velvet bean), belonging to the Fabaceae family, sub family Papilionaceae, includes approximately 150 species of annual and perennial legumes. Among the various underutilized wild legumes, the velvet bean *Mucuna pruriensis* widespread in tropical and sub-tropical regions of the world. It is considered a viable source of dietary proteins (Janardhanan *et al.*, 2003; Pugalenti *et al.*, 2005) due to its high protein concentration (23–35%) in addition its digestibility, which is comparable to that of other pulses such as soybean, rice bean, and lima bean (Gurumoorthi *et al.*, 2003). It is therefore regarded a good source of food. Cover crops have a role in the nitrogen-fixing bacteria and improvement of soil fertility by restoration of soil nutrients. Enormous use of chemical fertilizer and water in soil makes soil infertile, to overcome this problem, farmers are implementing traditional methods to enhance soil fertility. *Mucuna* is one of the best examples of a cover crop that has a rich source of biological natural products, which will increase and enhance the soil fertility and fix atmospheric nitrogen (Donati *et al.*, 2005).

---

## 2. Material and methods

Velvet bean, plantain and wheat flour were purchased from Owode market, Offa, Kwara State, Nigeria. The equipment used were made available from the department of Food Technology, Federal Polytechnic Offa, Nigeria. All chemicals that were used are of food standard and analytical grade.

### 2.1. Methods

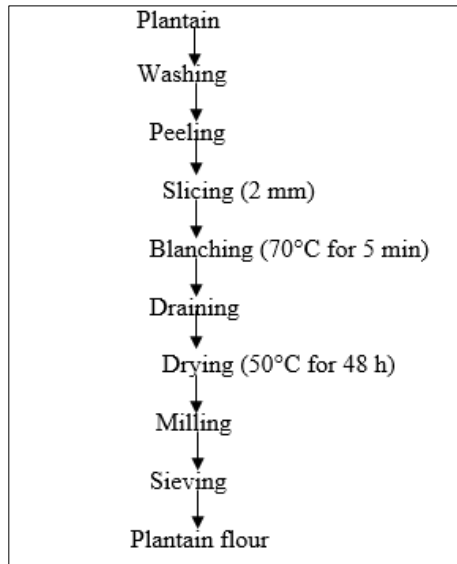
#### 2.1.1. Sample preparation

##### Preparation of plantain flour

Plantain flour was prepared following the processing steps described by Kure *et al.*, (2012). Plantain fingers were separated from the bunches, washed, peeled manually and sliced to (2 mm thickness) using a stainless-steel kitchen slicer. The sliced chips were blanched at 70 °C for 5 min, and dried in a cabinet drier at 50°C for 48 h. The dried slices were milled, sieved and packaged in a low density polyethylene bag; and stored at ambient conditions for subsequent use. See figure 3.1

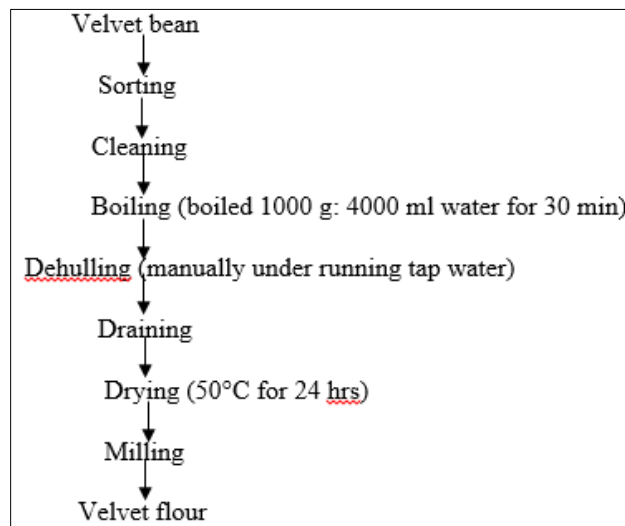
##### Preparation of boiled-velvet beans into flour

Velvet beans were processed into flour as described by Balogun and Olatidoye (2010). About 1000 g of matured velvet beans seed were sorted cleaned to remove extraneous materials like stones and defective seeds. The seeds were introduced into already boiling distilled water (1000:4000 g/ml) and boiled for 30 min. The seeds were dehulled manually and washed thoroughly under running water and drained. The seed was oven-dried at 50°C for 24 hrs and milled into flour (300µm). see figure 3.2



Source: (Kule *et al.*, 2021)

**Figure 1** Flow chart for the production of plantain flour



Source: (Balogun and Olatidoye, 2010)

**Figure 2** Flow chart for the production of Soaked-velvet bean flour

## 2.2. Composite Flour Preparation

Boiled-velvet bean flour and plantain flour composite flours were prepared by blending them with wheat flour. The composite flour of wheat-plantain-velvet beans (240:37.5:22.5, 210:60:30 and 150:105:45 respectively and 100% wheat flour was used as the control.

## 2.3. Pasting Properties

The amylograph text determines the viscosities of slurry from the finely ground composite flour blends through a preprogrammed heating and cooling cycle. A Rapid Visco-Analyser, RVA (Model RVA-SUPER3, USA) was used to assess the viscosity of the formulated complementary flours according to Ikegwu (2010). The pasting characteristics of the composite flour samples were analysed using a Rapid Visco- Analyzer (RVATECMaster, Perten instrument-2122833, Australia). About 3 g of composite flour sample blends were weighed into a dried empty canister, and then 25 mL of distilled water was dispensed into the canister containing the sample. Two point five gramme of composite flour sample blends was weighed into a dried cannister; then 25 ml of distilled water was dispensed into the cannister containing

the sample. The solution was thoroughly mixed and the cannister was returned into the analyzer. The slurry was heated from 50 to 95 °C with a holding time of 2 min followed by cooling to 50 °C with 2 min holding time. Peak viscosity, trough, breakdown, set back, final viscosity, peak time and pasting temperature was read from the pasting profile with the aid of Thermocline for Windows Software connected to the computer.

#### 2.4. Determination of Anti-nutritional Factors

Anti-nutritional factors such as oxalate, phytate, tannin and trypsin inhibitors of the composite flour sample blends were determined.

#### 2.5. Determination of oxalate

Oxalate was studied by the method described by Munro, (2000) with slight modification. 1g of sample was weighed into a 250 ml conical flask. 75 ml of 3NH<sub>2</sub>SO<sub>4</sub> was added to it. It was filtered using a Whatman No 1 filter paper. 25 ml of filtrate was pipette into a beaker and 2 drops of methyl red indicator was added. It was heated to boil. While hot against 0.05 M KMnO<sub>4</sub> solution was titrated until a faint pink colour persists for at least 30 seconds. The Oxalate content was calculated by taking 1ml of 0.05 M KMnO<sub>4</sub> as equivalent to 2.2 mg oxalate

Calculation

$$\text{Oxalate (mg/kg)} = \frac{\text{Titre value} \times 2.2 \times \text{DF}}{W}$$

Where 2.2 mg = Mass equivalent oxalate value of 1 ml of 0.05 M KMnO<sub>4</sub> solution

DF= Is Dilution Factor. That is total volume of sample divided by volume of portion used for titration

W = Sample weight in g

#### 2.6. Determination of phytate (phytic acid)

Phytate (Phytic Acid) was studied by the method described by Russel, (2008) with slight modification. 2 g of sample was weighed into a 250 ml conical flask. 100 ml of 2% concentrated HCl was added, and then it was allowed to soak for 3 h. It was filtered. 50 ml of the filtrate was pipetted into a 250 ml beaker. 107 ml of distilled water was added to improve acidity. Then 10 ml of 0.3% ammonium thiocyanate solution was added as indicator. It was titrated with standard iron iii chloride (FeCl<sub>3</sub>) solution which contains 0.00195 g iron/ml until a brownish yellow colour appear and persist for 5 min. calculate the phytic acid content as shown below.

$$\text{Phytic acid g/kg} = \frac{0.00195 \times \text{volume of FeCl}_3 \text{ consumed} \times \text{DF}}{\text{Sample wt}}$$

DF: Total volume of extraction solvent added/volume of aliquot taken for the titration

#### 2.7. Determination of tannin

Tannin was studied by the method described by AOAC(2000). 1 g of dry well blended sample was weighed into a flask then 10 ml of distilled water was added and agitated. It was leaved to stand for 30 min at room temperature. It was centrifuged at 2500 rpm for 15 min. 2 ml of supernatant was measured into a 10 ml volumetric flask; 1 ml of foliccalteu reagent was Added. 2 ml of saturated Na<sub>2</sub>CO<sub>3</sub> solution was added to it. 10 ml of solution was diluted with distilled water. Then it was incubated for 30 min at room temperature

##### 2.7.1. Standard tannic acid

The procedure 1 to 9 was repeated for tannic acid standards 20, 40, 60, 80, 100, 120 mg/l from a stock of 500 ppm (50 mg of Tannic acid standard dissolved in 100 ml of distilled water) excluding centrifugation (procedure 4)

The absorbance's of the above Tannic acid concentrations was read off at a wavelength of 725 nm .Draw a calibration curve for the tannic acid standards. That is absorbance against concentration

The absorbance of the sample down the concentration axis was extrapolated by tracing to obtain the tannic acid concentration of the sample

Calculation

$$\text{Tannic Acid content (mg/kg)} = \frac{\text{Conc. obtained in mg/l} \times \text{volume of sample} \times \text{DF}}{\text{Sample weight}}$$

DF: Dilution factor. If not diluted, then DF = 1

### 2.8. Determination of trypsin inhibitor

Trypsin inhibitor was studied by the method described by Prokopet and Unlenbruck, (2002). 1g of dry well blended sample was weighed into a flask. 50 ml of 0.5 M NaCl was added then it was stirred for 30 min. It was centrifuged at 1500 rpm for 5 min. Filtrate was decanted keep. 10 ml of filtrate was pipetted into another flask. 2 ml of standard trypsin solution of known concentration (say 2 mg/l) was added to the 10 ml filtrate. The absorbance at 410 nm was measured using 10 ml of same substrate (the sample filtrate) as blank. 1 mg, 2 mg, 4 mg, 6 mg, 8 mg, and 10 mg/l standard trypsin inhibitor was prepared and measured their absorbencies at 410 nm. A standard grave of absorbance was plotted against concentration. The absorbance of the sample down the concentration axis was extrapolated by tracing to obtained the trypsin inhibitor concentration of the sample

Calculation

$$\text{Trypsin inhibitor content (mg/kg)} = \frac{\text{Conc. obtained in mg/l} \times \text{volume of sample} \times \text{DF}}{\text{Sample weight}}$$

### 2.9. Determination of saponin

The method of Obdoni, (2001) was used 20 g ( $W_0$ ) of well blended composite flour samples were weighed into conical flasks, 100 ml of 20% aqueous ethanol were added and the content was heated in hot water bath for 4 h with continuous stirring at 50 °C; then they were filtered and re-extracted with 200 ml of 20% ethanol. Both extracts were combined and the volumes of extract were reduced to 40 ml by evaporating in a water bath maintained at 90 °C. The concentrated extracts were moved into a 250 ml separating funnel and 20 ml of diethyl ether (petroleum ether) were added and shaken vigorously. The clear ether layers were discarded and the water layers were kept. About 60 ml of n-butanol was added to the water layer in the separating funnel. The combined butane layers were washed twice with 10 ml of 5% aqueous NaCl and collected in a weighed petri dish ( $W_1$ ). Dry the petri dish in an oven at about 90 °C. The petri dish was re weighed and recorded as  $W_2$

Calculation:

$$\% \text{ Saponin content} = \frac{W_2 - W_1}{W_0} \times 100$$

### 2.10. Statistical Analysis

Data generated from this study were analyzed using Analysis of Variance (ANOVA). Values were expressed as mean  $\pm$  standard error of mean (SEM) from three determinations. Differences in mean were compared using Duncan multiple test range.  $P < 0.05$  was considered significant (Osuocho, *et al.*, 2018).

---

## 3. Results and discussion

The result of the pasting properties of the composite flour blends are shown in Table 1.

When heat is applied to starch based foods in the presence of water, a series of changes occur known as gelatinization and pasting which influence the quality and aesthetic considerations in food industry, as it affects the texture, digestibility and starchy foods (Adebowale, 2005). The Peak viscosity result of the analysis showed that sample CSC had a least peak viscosity (1928.50 RVU) value and sample CSD had the highest value (4972.50 RVU). There is significant difference ( $p > 0.05$ ) in peak viscosities of samples. The result obtained for control sample (2472.50 RVU). The finding of (Ocheme *et al.*, 2018) for both control value (1492 RVU) and composite (wheat-groundnut flour blends) value (1036 to 1379 RVU) obtained were low compare to both the control sample and composite flour value obtained in this present work. Peak viscosity reflects the maximum viscosity developed during or soon after the heating portion of the pasting test and it gives an indication of the viscous load to be encountered during mixing (Maziya-Dixon *et al.*, 2005). Peak viscosity has been reported to be closely associated with the degree of starch damage and high starch damage results

in high peak viscosity (Sanni *et al.*, 2008). High peak viscosity is an indication of high starch content which also relate to water binding capacity of starch which means the flour blends produced in this research work are of high starch content. The result obtained for trough value ranged from 1054.00 to 3563.00 RVU. For sample CSC has the least value and sample CSD having the highest value. There was significant difference ( $p < 0.05$ ) in the trough viscosity of the flour varieties. Trough viscosity is the minimum viscosity value in the constant temperature phase of the rapid visco analyzer pasting profile. In simple terms, trough viscosity is the point at which the viscosity reaches its minimum during either heating or cooling processes. It measures the ability of the paste to withstand breakdown during cooling. The significantly high trough viscosity observed in this study indicates the tendency of the composite flour to breakdown during cooking. The values obtained in this study are higher than the range of 608 to 820 RVU for wheat and groundnut flour blend as reported by Ocheme *et al.*, (2018). The breakdown viscosity is an index of the stability of the starch and a measure of the ease with which the swollen granules can be disintegrated Ocheme *et al.*, (2018).

**Table 1** Pasting properties of flour blends

Sample (RVU)	CSA	CSB	CSC	CSD
Peak	2472.50±3.54 <sup>b</sup>	2659.00±2.83 <sup>c</sup>	1928.50±3.54 <sup>a</sup>	4972.50±3.54 <sup>d</sup>
Trough	1782.50±3.54 <sup>b</sup>	1908.00±1.55 <sup>c</sup>	1054.00±1.41 <sup>a</sup>	3563.00±0.41 <sup>c</sup>
Breakdown	692.50±3.54 <sup>a</sup>	751.50±0.89 <sup>b</sup>	873.50±4.94 <sup>c</sup>	1408.00±0.00 <sup>d</sup>
Final viscosity	2747.50±0.71 <sup>b</sup>	3028.00±1.41 <sup>c</sup>	2077.00±1.41 <sup>a</sup>	5789.50±1514.10 <sup>d</sup>
Setback	968.00±0.00 <sup>a</sup>	1120.00±1.41 <sup>c</sup>	1024.00±0.00 <sup>b</sup>	2226.00±1.41 <sup>d</sup>
Peak time (min)	5.19±0.01 <sup>a</sup>	5.10±0.14 <sup>a</sup>	5.79±0.01 <sup>b</sup>	5.12±0.02 <sup>a</sup>
Pasting temp (°C)	81.55±0.00 <sup>b</sup>	81.24±0.37 <sup>ab</sup>	83.14±0.01 <sup>c</sup>	80.79±0.01 <sup>a</sup>

Values are means ± standard deviation of measurements. Different letter in the same column indicate significant different ( $p < 0.05$ ).

**Key:** Sample CSA-300 g wheat flour; Sample CSB -240 g wheat flour + 37.5 g Plantain flour + 22.5 g velvet bean; Sample CSC -210 g wheat flour + 60 g Plantain flour + 30 g velvet bean; Sample CSD -150 g wheat flour + 105 g Plantain flour + 45 g velvet bean

The breakdown viscosity result increased from 692.50 RVU in control sample to 1408.00 RVU in sample CSD. The result obtained from the sample CSA (control sample) was lower than composite samples. This could be an indication that the starch of wheat flour is more stable than those of plantain and velvet bean flour. The result obtained in this work was higher than 170 RVU obtained by Adebawale *et al.*, (2005) for lafun flour. Also, the breakdown result obtained for control samples was similar to the result obtained for control of (672 RVU) by Ocheme *et al.*, (2018). It has been reported that the lower the breakdown viscosity, the higher the ability of the sample to withstand heating and shear stress during cooking and form stable paste (Adebawale *et al.*, 2005). There was significant difference in the breakdown viscosities of the samples ( $p < 0.05$ ). The hold period of the pasting test during which sample is held at high temperature (95°C) with mechanical shear stress (rapid constant and continuous mixing) is usually accompanied by breakdown in viscosity. This is as a result of further disruption of starch granules resulting in the leaching out of amylose molecules into solution which align in the direction of the shear. The ability of a sample to withstand this breakdown in viscosity i.e. withstand heating and mechanical shear stress that is usually encountered during processing is measured by breakdown viscosity and it is an important factor for many processes especially those requiring stable paste and low retrogradation/syneresis.

The final viscosity is the change in the viscosity after holding cooked starch at 50°C. It is one of the most common parameter used to define the quality of a particular starch-based sample, as it indicates the ability of the material to form a viscous paste or gel after cooking and cooling as well as the resistance of the paste to shear force during stirring (Adebawale, 2008). The result of the final breakdown followed the same pattern of breakdown viscosity with sample CSD having the heat score of 5789.50 RVU while sample CSC (2077.00 RVU) had the least value. The result showed significant differences ( $p < 0.05$ ). The result obtained for final viscosity in this work was high to the range value (1342 to 1751 RVU) obtained by Ocheme *et al.*, (2018) in wheat flour and groundnut flour blends. High final viscosity obtained in this work is desirable in paste as it indicates the ability of the starch-based food to form a viscous paste or gel after cooking and cooling (Adebawale *et al.*, 2008) and it is useful in predicting and defining the final textural quality of starchy foods. The mouldability of the dough which is influenced by the final viscosity is one of the factors that determine the consumer acceptability of the composite flour.

The setback result ranged from 968.00 to 2226.00 RVU for sample CSA and CSD respectively. The samples showed significant difference between each other ( $p < 0.05$ ). The phase of the pasting curve after cooling of the sample to 50°C is known as setback region and it shows the tendency of starch to re-associate and retrograde. Also the setback value has implication on digestibility; low setback value indicate low retrogradation tendency and consequently improved paste/dough digestibility; this is because retrogradation is known to increase resistance of starchy foods to enzymatic hydrolysis. From the result of Ocheme *et al.*, (2018) it was observed that the setback value obtained was 734 to 896.5 RVU which was low to the result obtained in this present work. Setback observed in sample CSA indicates that the sample will retrograde faster when cooled. Adebowale *et al.*, (2008) reported lower setback time for yam flour blend with cassava flour. Also sample CSC of composite flour showed lower setback which could lead to higher retrogradation during cooling. This is because the higher the setback value, the lower the retrogradation during cooling and the lower the staling rate of the product made from the flour. Lower setback during the cooling of the paste indicates greater resistance to retrogradation (Sanni *et al.*, 2004)

The peak time result ranged from 5.10 to 5.79 min for sample CSB and CSC respectively. The result showed insignificant difference between the samples ( $p < 0.05$ ). The peak time which is a measure of the cooking time for the samples produced are considerably higher than 4.53 min reported for tapioca by Arinola and Ogunbusola, (2013) and significantly lower to 6.33-7.00 reported by Arinola, (2016) for gari roasted for different period but within the range value (5.67 to 6.00 min reported by Ocheme *et al.*, (2018) for wheat-groundnut flour. Peak time values reported in this work are higher than the peak time values of 5.13-5.80 min and 5.01-6.30 min reported for instant yam- breadfruit composite flour and germinated tigernut flour, respectively (Adebowale *et al.*, 2008; Chinma *et al.*, 2007). The peak time would determine the amount of energy required to cook the sample.

The pasting temperature results ranged from 80.79 to 83.14 °C for sample CSD and CSC respectively. The result showed that there was insignificant difference between sample CSA, CSB and CSD ( $p < 0.05$ ). The pasting temperature obtained in this work was similar to the pasting temperature obtained 88.00 to 89.58 °C for wheat and groundnut flour blends by Ocheme *et al.*, (2018). The pasting temperature gives an indication of the gelatinization time during processing. It is the temperature at which the first detectable increase in viscosity is measured and is an index characterized by the initial change due to the swelling Ocheme *et al.*, (2018).

### 3.1. The Result of Antinutritional Properties

**Table 2** Antinutritional properties of cake flour produced

Sample (mg/100 g)	CSA	CSB	CSC	CSD
Tannin	20.01±0.20 <sup>a</sup>	99.33±0.50 <sup>b</sup>	198.05±0.27 <sup>c</sup>	219.25±0.98 <sup>d</sup>
Oxalate	24.56±0.23 <sup>a</sup>	32.93±0.13 <sup>b</sup>	41.07±0.07 <sup>c</sup>	448.79±0.29 <sup>d</sup>
Trypsin inhibitor	10.31±0.17 <sup>a</sup>	17.28±0.49 <sup>b</sup>	20.70±0.46 <sup>c</sup>	20.55±0.11 <sup>d</sup>
Phytate	5.67±0.11 <sup>a</sup>	5.92±0.08 <sup>b</sup>	6.39±0.05 <sup>c</sup>	6.44±0.08 <sup>d</sup>
Saponin	0.00±0.00 <sup>a</sup>	1.39±0.05 <sup>b</sup>	1.75±0.06 <sup>c</sup>	1.87±0.02 <sup>d</sup>

Values are means ± standard deviation of measurements. Different letter in the same column indicate significant different ( $p < 0.05$ ).

**Key:** Sample CSA -300 g wheat flour; Sample CSB-240 g wheat flour + 37.5 g Plantain flour + 22.5 g velvet bean; Sample CSC -210 g wheat flour + 60 g Plantain flour + 30 g velvet bean; Sample CSD -150 g wheat flour + 105 g Plantain flour + 45 g velvet bean

The result of anti-nutritional properties of the composite flour blends is shown in Table 2.

The tannin content of cake composite flours ranged from 99.33 mg/100 g to 219.25 mg/100 g for sample CSA and CSD respectively. The control sample (100 % wheat flour) was very low in tannin content compare to the composite flour this could be due to the present of velvet bean flour in composite flour used. The result showed significant difference between the samples ( $p < 0.05$ ). The range value obtained in this work was higher than the range value 8.4 to 22.89 mg/100 g and 23.67 to 36.97 mg/100 g, for extruded and unextruded legumes respectively in research of Haile *et al.*, (2021).

Also Olatunde *et al.*, (2019) reported 2.22 mg/100 g in sample 100% velvet beans flour which was low to the value obtained. Olatunde also observed increased in tannin as the percentage of velvet bean increased. The tannin content of the formulas increased with increasing the proportion of velvet bean flour in the formulation. This increase might be due to high anti-nutritional (tannin) contents of velvet bean. The finding of the present study was in agreement with

Samuel et al., (2012) who reported that the amount of tannin in bread increased as the amount of soybean flour increased. Tannins cause decrease iron absorption, alter excretion of cations, increase excretion of proteins and essential amino acids, and consequently damage the intestinal tract, depress growth, and enhance carcinogenesis (Anuonye et al., 2012). Tannins are present in virtually all parts of plants and are known to inhibit trypsin, chymotrypsin, amylase, and lipase activities (Anuonye et al., 2012).

Oxalic acid and its salts can have deleterious effects on human nutrition and health, particularly by decreasing calcium absorption and aiding the formation of kidney stones (Bhandari and Kawabata, 2004). The oxalate contents of the composite flours differed significantly ( $p < .05$ ) with values ranging between (24.56 – 48.79 mg/100g). The highest oxalate content (48.79 mg/100g) was observed in CSD (150 g wheat flour, 105 g plantain flour and 45 g velvet bean flour) while CSA (300 g wheat flour) had the least value (24.56 mg/100g). The results showed that increase in level of plantain-velvet bean flour supplementation significantly ( $p < .05$ ) increased the oxalate contents of the composites. Oxalates when present in large quantity in foods (above 50mg/100g) chelate some metal ions and render them insoluble and hence, the metal ions cannot be absorbed in the intestine (Sanni et al., 2013). Therefore, the lower oxalate contents of the composites in this study render them safe for consumption. The oxalate contents of wheat- unfermented-fermented sweet orange peel flours blends (0.10 – 0.30%) by Akubor and Nwawi (2019) are lower than the values obtained for oxalate contents of composite flours in this study. On the flip side, Gwer et al. (2020) reported (38.80 – 42.40 mg/100g) for composited wheat-enzymatically modified tacca biscuits which are in conformity with the findings of the current work. High oxalate diet can increase the risk of renal calcium absorption and has been implicated as a source of kidney stone (Gwer et al. 2020).

The mean results for the trypsin inhibitor of the composite flours showed that the values ranged between (10.31 – 20.70 mg/100g). CSA significantly ( $p < .05$ ) had the highest trypsin inhibitor (20.70 mg/100g) while the least value (10.31 mg/100g) was observed in CSA. Addition of plantain and velvet bean flour improved the trypsin inhibitors of the composites as their level of supplementation increased. Similar findings had been reported by Olorunfemi et al. (2021) whose study reported increase in trypsin inhibitor (11.54 – 25.42 mg/100 g) for acha-mango-soy flour. Our findings are higher than the values (0.03 – 0.07 mg/100 g) reported by Gwer et al. (2020) and those of Sodipo et al. (2019) for provitamin-A biofortified maize and germinated lentil seeds complementary diet (0.43 – 0.66 mg/100 g). However, the trypsin inhibitor for maize *ogi* co-fermented with pigeon pea (12.50 – 61.11 mg/100 g) by Okafor et al. (2017) are not in consonance with the findings of this investigation. Processing methods including soaking, dehulling and degradation inflicted through heat treatment such as roasting and boiling have been proven to be effective measures towards reduction in trypsin inhibitor (Gwer et al., 2020).

Trypsin inhibitor result ranged from 17.32 to 61.00 mg/100 g. For control sample and sample produced from 45 g velvet bean flour. The result showed significant difference between the samples. The presence of T. inhibitor in foods has been reported to constitute an important handicap to the effective utilization of its nutrients in human nutrition. Most legumes-based diets have poor bioavailability of nutrients as a result of the presence of antinutritional factors. Trypsin inhibitor in legumes has been reported to be a limiting factor for their effective and efficient utilization (Bamigboye and Adepoju, 2015). The high level of trypsin inhibitor of sample CSD flour can be attributed to the high presence of velvet bean. However, Doss et al., (2011) reported the value of trypsin inhibitor in jack bean seed to be 378.3% which was very high to the trypsin inhibitor value obtained in this research work. Also, the result of Olatunde et al., (2019) result (17.95 to 23.73 mg/100 g) for cake produced from composite flour of wheat flour, pigeon pea and sweet potato was within the range reported. Trypsin inhibitor may hamper protein digestibility, however, it is thermo liable and may be destroyed with application of heat (Ohizua et al., 2016; Olatunde et al., 2019).

Phytate value ranged from 6.63 to 13.73 mg/100 g. The result showed that sample CSD had the highest value (13.73 mg/100 g) while sample CSB had the least value (6.63 mg/100 g). The result showed significant difference between the samples ( $p < .05$ ). The result obtained in this work was high compared to the findings of Haile et al., (2021) for the production of extruded and unextruded oat-soybean flour blends having the value (0.66 mg/100 g) and (0.96 mg/100 g) respectively. The average daily intake of phytate was estimated to be 2,000–2,600 mg for vegetarian diets as well as diets of inhabitants of rural areas of developing countries and 150–1,400 mg for mixed diets (Reddy,2001). Phytate content which varied from 0.48 mg/100 mg to 1.41 mg/100 g which showed increase in value obtained; the same trend was followed. The higher the inclusion of velvet bean increased in research of Olatunde et al., (2019). Velvet beans are rich in phytate and the presence of this compound may reduce the bioavailability of minerals such as iron, magnesium, calcium in the flour blends. The value of phytate obtained in the present study is lower compared to the acceptable concentrations. This might be due to processing conditions followed during sample preparation and baking. This result was in agreement with previous findings. Liener, (2000) reported that phytate content of bread increased as the amount of soybean flour increased in the bread. This increase is because of the high amount of phytate found in velvet bean. Tajoddin et al., (2011) also reported that phytate content is high in legumes and it decreases the bioavailability of



essential minerals and protein by forming insoluble phytate–mineral and phytate–protein complexes. Phytate present in raw materials and foods of plant origin is suggested to be a significant factor responsible for lowering the availability of minerals and some proteins (Shimelis and Rakshit, 2005). Phytates consumption may lead to a lower mineral absorption (Gupta et al., 2015). They also have negative impact on the activity of digestive enzymes and act through chelation of mineral cofactors or interaction with protein (Reddy and Sathe, 2001).

The results showed increase in phytate contents of the composites with increased level of plantain-velvet bean flour substitution. These values are higher than the report (1.28 – 3.18%) of Omobolanle et al. (2017) for phytates of wheat-watermelon seeds-pawpaw seeds-ben oil seeds-golden melon seeds cookies and those reported by Akubor et al. (2017) for African locust bean-wheat flour blends (1.81 – 2.00 mg/100g). Phytates are considered antinutrients when available in large quantity (>3 g/100g by virtue of their ability to chelate divalent metals and prevent their absorption (Onimawo and Akubor, 2012). The higher phytate contents of the composite flours in this study could therefore result in decrease in protein digestibility through forming complexes and also by interacting with enzymes such as trypsin and pepsin (Umaru et al., 2007).

Saponin result ranged from 3.07 to 5.11 mg/100 g. with sample CSA having the lowest value and sample CSD having the highest value. The result showed significant difference between the samples ( $p < 0.05$ ). The saponin value observed in this study was higher to the value of 1.41-3.13 mg/100 g for complementary food from malted millet, plantain and soybean blends (Bolarinwa et al., 2016). Saponin are water-soluble glycosides in which the non-sugar moiety is a steroid. They are gastric irritants but may also exhibit hypocholesterolemic activity, however at larger quantities; they have toxic properties causing haemolysis of the red blood cells (Price et al., 1987). Saponins are known to possess both beneficial (cholesterol lowering) and deleterious (cytotoxic permeabilization of the intestine and paralysis of the sensory system) properties (Price et al., 1987). The low recorded in this study was significantly higher than ( $p < 0.05$ ) the results of Eleazu et al., (2011) who recorded significant values of saponin 1.827 in unripe plantain flour. Saponins possess membranolytic properties that assist in the formation of micelles with bile salt in the body. This property of saponins inhibits absorption of lipids (cholesterol) and facilitates its excretion via the intestinal tract (Blaustein et al., 2006). The saponin contents of the composite flours ranged between (0.00 – 1.87 mg/100g) with CSD (1.87 mg/100g) having the highest level of saponin (1.87 mg/100g) while there was no presence of saponin in CSA (300 g wheat flour). There were significant differences between the saponin contents of the composite flours at 95% confidence level which indicated that addition of plantain-velvet bean flours to the blends significantly ( $p < .05$ ) had saponin improving capabilities. The saponin contents of wheat-sweet orange peels (0.09 – 0.26%) reported by Akubor and Nwawi (2019) are slightly in conformity with the findings of this study but not in agreement (453 – 570 mg/100g) reported for wheat-enzymatically modified tacca flour by Ojewumi et al. (2021). Saponins have beneficial effects on blood cholesterol level; reduce cancer risk, increase bone health, stimulation of the immune system and also an antioxidant (Sun et al., 2009).

---

#### 4. Conclusion

In conclusion, the results showed that all the supplemented samples increase significantly ( $p < 0.05$ ) with an increase in the addition of velvet bean flour. The same trend was observed in the pasting properties of the flour blends, especially on the final viscosity values.

---

#### Compliance with ethical standards

##### *Acknowledgment*

We obliged to all staff members of Food Technology Department, Federal Polytechnic, Offa for their valuable contributions in their respective fields.

##### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

---

#### References

- [1] Adebowale, A. A., Sanni, L. O., Ladapo, F. O. (2008). Chemical, functional and sensory properties of instant yam bread fruit, Nigerian Food Journal, 26, 2 – 12.
- [2] Adebowale, A.A., Awoyale, W.O., Sanni, L.O., and Fetuga, G.O., (2005). Quality of gari (roasted cassava mash) in Lagos State, Nigeria. Niger. Food J., 26, 125–130

- [3] Adebowale, A.A., Wahab, B.A., Sanni, S.A., Sobukola, O.P., Obadina, O.A., Kajihusa, O.E., Adegunwa, M.O., Sanni, L.O. and TomLins, K. (2016). Effect of species, pretreatments, and drying methods on the functional and pasting properties of high-quality yam flour. *Food Science and Nutrition*, 4(1), 50–58. <https://doi.org/10.1002/fsn3.260>
- [4] Adebowale, Y.A., Adeyemi, I.A. and Oshodi, A.A (2005). Functional and Physico-chemical properties of flour of six mucuna species. *Africa Journal of Biotechnology*, 4(12): 146-1468.
- [5] Adeniji, T.A., Sanni, L.O., Barimalaa, L.S., and Hart, A.D., (2007). Anti-nutrient and heavy metals in some new plantain and banana cultivar. *Nigerian Food Journal*, 25(2): 165– 170.
- [6] Akubor P.I, Onoja U.S, Gemar D.I and Chinmma C.E (2019). Evaluation of complementary food formulated from local staples and fortified with calcium, iron and zinc. *J. Nutri. Food Sci.* 4: 326-392
- [7] Akubor, P.I., and Nwawi, D.O., (2019). Phytochemical composition, physical and sensory properties of bread supplemented with fermented sweet orange peel flour. *Innovare journal of food science*, 7(4): 1 – 6
- [8] Akubor, P.I., Onuh, J.O., and Orishagbemi, C.O., (2017). Evaluation of the Phytochemical Composition and Pasting Characteristics of African Locust Bean Pulp Flour, Wheat Flour and Blends. *Asian Journal of Biotechnology and Bioresource Technology*, 1(4): 1-8
- [9] Anuonye J. C (2012). Some functional properties of extruded acha/soybean blends using response surface analysis. *Afr. J. Food Sci.* 6(10): 269-279.
- [10] AOAC (2000): Association of Official Analytical Chemists, 15th edition, Analytical Chemists, Washington, DC, 123-129.
- [11] Balogun, I.O., and Olatidoye, O.P., (2012). Chemical Composition and Nutritional Evaluation of Velvet Bean Seeds (*Mucuna utilis*) For Domestic Consumption and Industrial Utilization in Nigeria. *Pakistan Journal of Nutrition*, 11 (2): 116 – 122.
- [12] Bamigboye, A.Y. And Adepoju, O.T. (2015). Effects of processing methods on nutritive values of “Ekuru” from two cultivars of beans (*Vigna unguiculata* and *Vigna angustifoliata*). *African Journal of Biotechnology*, 14 (21), 1790-1795
- [13] Bhandari, M. R., and Kawabata, J. (2004). Assessment of antinutritional factors and bioavailability of calcium and zinc in wild yam (*Dioscorea* spp.) tubers of Nepal. *Food Chemistry*, 85(2), 281– 287.
- [14] Blaustein, M.P., Zhang, J., Chen, L., and Hamilton, B.C., (2006). How does salt retention raise blood pressure? *Am J Physiol Regul Integr Comp Physiol.*, 290: R514–R523
- [15] Bolarinwa, I. F., Abioye, A. O., Adeyanju, J. A. and Kareem, Z. O. (2016): Production and Quality Evaluation of Biscuits Produced from Malted Sorghum-Soy Flour Blends. *Journal of Advances in Food Science and Technology*; 3(3): 107-113.
- [16] Chinma, C. E., and Gernah, D. I. (2007). Physicochemical and sensory properties of cookies produced from cassava/soyabean/mango composite flours. *Journal of Food Science and Technology*, 5(3), 256–260.
- [17] Donati, D., Lampariello, L.R., Pagani, R., Guerranti, R., Cinci, G., Marinello, E., (2005). Antidiabetic oligocyclitols in seeds of *Mucuna pruriens*. *Phytotherapy Res.*, 19, 1057-1060.
- [18] E.O Ojewumi., O.S., Omoba and O.O Awolu (2021): Nutritional properties of wheat flour supplemented with modified tacca (*Tacca involucreta*) flour for production of healthy biscuits. *Bulletin of the National Research Centre* 46(1):196
- [19] Eleazu CO, Okafor PN, Amajor J, Awa E, Ikpeama AI and Eleazu KC (2011). Chemical Composition, antioxidant activity, functional properties and inhibitory action of unripe plantain (*M. paradisiaca*) flour. *African Journal of Biotechnology*. 2011;10(74): 16948-16952.
- [20] Gurumoorthi, P., Pugalenth, M., Janardhanan, K., (2003). Nutritional potential of five accessions of a south Indian tribal pulse *Mucuna pruriens* var. *utilis*; II. Investigation on total free phenolics, tannins, trypsin and chymotrypsin inhibitors, phytohaemagglutinins, and in-vitro protein digestibility. *Trop. Subtrop. Agroecosys.*, 1, 153-158.
- [21] Gwer, J.H., Igbabul, B.D., and Ubwa, S.T., (2020). Micronutrient and Antinutritional Content of Weaning Food Produced from Blends of Millet, Soya Beans and Moringa oleifera Leaf Flour. *EJFOOD, European Journal of Agriculture and Food Sciences*, 2(5): 1-7
- [22] Haile Tesfaye Duguma, Sirawdink Fikreyesus Forsido, Tefera Belachew and Oliver Hensel (2021). Changes in Anti-nutritional Factors and Functional Properties of Extruded Composite Flour

- [23] Ikegwu, O. J., Okechukwu, P. E. and Ekumankana, E. O. (2010). Physico-chemical and pasting characteristics of flour and starch from Achi (*Brachystegia eurycoma*) seed. *Journal of Food Technology*, 8(2):58-66. DOI: 10.3923/jftech.2010.58.66
- [24] Ikpeme-Emmanuel, C. A., Ekpeyoung, I. O. and Igile, G. O. (2012). Chemical and Protein Quality of Soybean (*glycine max*) and Tigernut (*Cyperus esculentus*) Based weaning food; *Journal of Food Research*, 1(2): 246 – 254
- [25] Janardhanan, K., Gurumoorthi, P. and Pugalenthi, M. (2003). Nutritional potential of five accessions of a South Indian tribal pulse, *Mucuna pruriens* var. *utilis*. Part I. The effect of processing methods on the contents of L-Dopa, phytic acid, and oligosaccharides. *Journal of Tropical and Subtropical Agro-ecosystems*, 1, 141-152.
- [26] Kure OA, Banigo EJ, Daniel EA.(2012) Studies on the proximate composition and effect of flour particle size on acceptability of biscuit produced from blends of soybeans and plantain flour. *Nem Tech Scope J.* ;3(2):17–22.
- [27] Liener, I. E. (2000). Non-Nutritive Factors and Bioactive Compounds in Soy - Soy in Animal Nutrition, ed J. K. Drackley, Savoy, IL: Federation of Animal Science Societies.
- [28] Maziya Dixon B. Ezeagu, E, and Tarawalli G., (2003). Seed characteristics and nutrient and antinutrient composition of 12 *Mucuna* accessions from Nigeria. *Tropical and subtropical Agroecosystems*. 1: 2003; 129-140
- [29] Munro, A.B., (2000). Oxalate in Nigerian vegetables. *W.A.J. Biol. Appl. Chem*; 12(1):1418.
- [30] Obdoni B, Ochuko P. (2001). Phytochemical studies and comparative efficacy of the crude extracts of some homostatic plants in Edo and Delta States of Nigeria. *Global Journal of Pure Applied Sciences*; 8: 203 – 208.
- [31] Ocheme B. Olajide E.A, Chiemela E.C, Caleb M.Y and Ugochkwu H.A (2018). Proximate composition, functional and pasting properties of wheat and groundnut protein concentrate flour blends.
- [32] Ohizua, E.R., Adeola, A.A., Idowu, M.A., Sobukola, O.P., Afolabi, T.A., Ishola, R.O., Ayansina, S.O., Oyekale, T.O. and Falomo, A. (2017). Nutrient composition, functional, and pasting properties of unripe cooking banana, pigeon pea, and sweet potato flour blends. *Food Science Nutrition*, 5(3), 750-762
- [33] Okafor, O.E., Ujowundu, C.O., Kalu, F.N., Emejulu, A.A., Nkwonta, C.G., Nwosunjoku, E., (2010). *Afr. J. Pharm. Pharmacol.*, 4, 811-81.
- [34] latunde, S.J., Ajayi, O.M., Ogunlakin, G.O., and Ajala, A.S., (2019). Nutritional and sensory properties of cake made from blends of pigeon pea, sweet potato and wheat flours. *Food Research*, 1 – 7
- [35] Olatunde, S.J., Odebunmi, O.F., Abioye, V.F. and Oladimeji, T.E (2020). Quality assessment of gluten-free bread from pro-vitamin A cassava and velvet bean flour. *Food Research* 4 (6) : 1988 - 1994 (December 2020) [Journal homepage: http://www.myfoodresearch.com](http://www.myfoodresearch.com)
- [36] Olorunfemi, O.B. and Ogundare, A.O., (2007). Antimicrobial efficacy of the leale of *Dioclea reflexa*, *Mucana pruriens*, *Ficus asperifolia* and *Tragia spathulata*. *Res. J. of Microbiol.*, 2, 392-396.
- [37] Omobolanle. O., Michael, I., Adefunke, B., Oluwatoyin, A, and Olamiji, A., (2017). Evaluation of Potentials of some selected seeds' flours as partial Substitute for Wheat in Cookies production. *International Journal of Scientific & Engineering Research*, 8(3): 740 – 752
- [38] Onimawo, I.A., and Akubor, P.I., (2012). *Food Chemistry (Integrated Approach with biochemical background)*. 2nd edn. Joytal Printing Press, Agbowo, Ibadan, Nigeria
- [39] Osuocha, K.U., Okafor, I.J., and Nweke, E.O., (2018). Evaluation of the mineral and vitamin compositions of leaves of *Alchornea cordifolia* and *Thaumatococcus danielli*. *Asian J. Res. Biochem.* 3(4): 1–6
- [40] Price KR, Johnson IT, Fenwic CR (1987). The chemical and biological significance of saponins in food and feeding stuff. *Unpublished Crit. Rev. Food Sci. Nutr.* 1987;26:27-135.
- [41] Prokopet, G. and K.W. Unlenbruck, (2002). Protectine eine nen kalsse anti-kowperahlich verbindungen dish. *Ges. Heit*; 23: 318
- [42] Pugalenthi, H., Vadivel, V. and Siddhuraju, P. (2005). Alternative food/feed perspective of an underutilized legumes (*Mucuna pruriens*) var. *utilis*- a Review. *Plant foods human nutrition*; 60(4): 201 - 218
- [43] Pulkkinen M, Gautam M, Lampi AM, Ollilainen V, Stoddard F, Sontag- Strohm T, Piironen V (2015). Determination of vicine and convicine from faba bean with an optimized high-performance liquid chromatographic method. *Food Res. Int.* 76(1): 168–177

- [44] Reddy, N.R., and Sathe, S.K., (2001) Occurrence, distribution, content, and dietary intake of phytate. (1st edn), Food Phytates, CRC Press, USA, pp. 1-280.
- [45] Russel, H.S., (1980). India-New England Before the May Flower. University Press of New England Handover
- [46] S.O., Arinola and M.E. Ogunbusola (2013). Effect of defatted groundnut cake on the proximate, pasting and sensory properties of cassava tapioca. *Journal of Microbiology and Biotechnology Research*, 3(2):5-8
- [47] Samuel, O., Oppong, D., Eric, A., Eric, B., and Patrick, S., (2015). Proximate Composition and Some Functional Properties of Soft Wheat Flour. *International Journal of Innovative Research in Science, Engineering and Technology*, 4 (2): p. 753-758
- [48] Sanni, A. A., Fadimu J.F, L. O. Adebowale (2018). "Effect of drying methods on the chemical composition, colour, functional and pasting properties of plantain (*Musa parasidiaca*) flour," *Croatian Journal of Food Technology, Biotechnology and Nutrition*, vol. 13, no. 1-2, pp. 38–43, 2018. View at: [Publisher Site](#) | [Google Scholar](#)
- [49] Shewry, P.R. (2009) Wheat. *Journal of Experimental Botany*, 60, 1537-1553.
- [50] Shimelis, A. E., and Rakshit, S. K. (2005). Proximate composition and physicochemical properties of improved dry bean (*Phaseolus vulgaris* L.) varieties grown in Ethiopia. *Food Eng. Bioprocess Technol. Progr.* 38, 331–338. doi: 10.1016/j.lwt.2004.07.002
- [51] Sodipo, M., Oluwagbenga, A., Jolayemi, O., and Lawal, O., (2020). Development and nutritional evaluation of a complementary diet from fermented provitamin-a-biofortified maize (*Zea mays* L.) and germinated lentil seeds (*Lens culinaris*). *Croatian Journal of Food Science and Technology*, 12(1): 90-100
- [52] Sun, A.Y., Wang, Q., Simonyi, A., and Sun, G.Y., (2009). Botanical phenolics and brain health. *Neuromolecular Med.* 10: 259–74
- [53] Tajoddin, M. D., Shinde, M., and Lalitha, J. (2011). In vivo reduction the phytic acid content of mungbean (*Phaseolus aureus* L.) cultivars during germination. *Am. Eurasian J. Agr. Environ. Sci.* 10, 127–132.
- [54] Umaru, H.A., Adamu, R., and Nadro, M.S., (2007). Levels of antinutritional factors in some wild edible fruits on Northern Nigeria. *Afr J Biotechnol.*, 6: 1935 – 1938