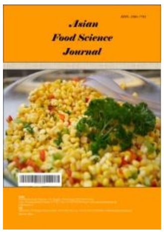

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# Phytochemical, Pasting and Proximate Composition of Improved Weaning Food

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### *Authors' contributions*

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

**Aim:** Phytochemical, proximate, and pasting qualities of weaning food processed from grains, legumes along with vegetables were examined in this study.

**Methods:** Fermented maize, defatted soybean and carrot powder were combined at different proportions. Phytochemical, pasting, and nutritive composition were evaluated using standard procedures.

**Results:** The results showed that Flavonoid and tannin were very low, ranging from 2.07 mg/100 g-0.02 mg/100 g and 2.05 mg/100 g-0.02 mg/100 g respectively. Fermented maize had the least flavonoids (0.02 mg/100 g) and tannin (0.02 mg/100 g). This was followed by carrot, which had flavonoid 0.63 mg/100 g and Tannin 0.63 mg/100 g, the highest was defatted soybean with flavonoid 2.07 mg/100 g and tannin 2.05 mg/100 g in that increasing order. Sample A which was fermented maize, had the highest saponin (21.43%). Next was carrot i.e. sample C (7.51%). The least saponin recorded was in defatted soybean sample B (3.56%). Sample A showed the highest (2208cP) peak viscosity and was followed by B (1473cP), D (903.0cP), C (781.0cP), and E (408cP) in that decreasing order. The breakdown viscosity ranged from 97cP to 923cP. The highest break down viscosity was sample A (923cP), followed by sample B (500cP), sample D

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sample C (206cP), and sample E (97cP). The highest final viscosity (FV) was observed in sample A (2099cp), next was sample B (1535cp), sample D (1058cp), sample C (936cp), while the least was sample E (522cp). The moisture content ranged from 7.91-11.05%. Sample E had the least moisture (7.91%), next was C (9.45%), A (9.68%), D (10.21%) and B (11.05%) in that increasing order.

**Conclusion and Recommendation:** It was obvious from this study that fermented maize when used as weaning food increases the starch digestibility as well as the pasting properties of weaning foods. Hence, maize should be fermented before it is used as a weaning food.

*Keywords: Proximate; pasting properties; phytochemical; cereal; legume.*

## 1. INTRODUCTION

Infant malnutrition is a problem in the developing world and these led to attempt in investigation, advancement, and increase by both localized and foreign institutions. However, the formulations of quality meals through cheap and promptly accessible raw materials have gotten awareness in numerous advanced homelands [1]. A major problem in developing countries has been malnutrition and it has affected infant death, poor intellectual development of infants, as well as reduced protection to disease and thus silences growth [1]. During the pivotal change phase protein-energy malnutrition is observed during the period babies foods are changed to adult foods.

Many infants start to eat supplementary semisolid foods at the age of 5–6 months. The important period in a child’s life is the weaning phase. Integrated baby food plays an important part in diet during this period [2].

The breast milk at 6 months is below the infants’ dietary need for energy and nutrients (WHO, 2018). Thus, the supplementation of infants' food with absorbable, healthy rations is important for normal advancement. Semi-solid and liquids apart from milk produced by human mammary gland or baby food that supply the needed nutrients, minerals, and vitamins required by babies as well as growing kid are referred to as complementary foods. Cereals and legumes are energy source. The majority of households in Nigeria, minerals, and proteins form a stable food (Onimawo, 2010) ‘Akamu’ is a popular fermented gruel produced from cereals such as corn, millet, sorghum, or mixtures of two or all of the cereals. This fluid form or viscous regularity of ‘akamu’ has made it one of the most acceptable meals for complementary food for infants. Although, the poor balanced nutrients in such foods made it essential to be complemented with proteins, minerals, vitamins, and other vital nutrients to help the growth of the weaned babies which is vital.

In most under developed countries maize product is used for human consumption, while it is mainly for commercial use as well as livestock feed in the developed world [3]. The commonly used cereal in the world today is maize (*Zea mays L., Poaceae*) next to wheat and rice considering the area of planting and overall productivity. The nutritive content includes protein (10.3%), starch (60.5%), sugar (1.2%), crude fiber (2.5%) as well as other substances [4]. It has dietary fiber that is high (12.19%). Although, it is low in 'trace minerals and ascorbate [5]. The protein composition in maize differs in popular types ranging from 8 to 11% of the kernel weight [6]. Protein is proportionately good when it comes to sulphur- containing amino acids, methionine and cystine, notwithstanding it is reduced in lysine and tryptophan [7].

Development of technologies has increased the different forms in which maize is eaten. It is processed into better quality products in addition its productivity as well as utilization possesses greatly been promoted. Maize fermentation is advantageous. It introduces probiotic bacteria. The consumption of fermented foods result in useful microbes as well as biological catalyst which are additional to overall intestinal flora for necessary wholesome use [8].

There is a short supply of soybeans in some regions and cannot be reached by the poor-paid workers; this has improved the production cost of soy-based weaning food, thereby lowering its affordability [9]. This research examined the nutritive content, phytochemical as well as pasting properties of inexpensive, locally and readily available raw materials Maize (*Zea mays*), Soybeans (*Glycine max)* and Carrot (*Daucus carota*) ) used for the production of complementary food.

## 2. MATERIALS AND METHODS

**Source of Materials:** Yellow maize, soybean, as well as carrot were bought in the City of Benin and Auchi, Edo State, Nigeria.

**Production of Defatted Soybeans Flour:** *Glycine max* flour (defatted), this was processed by the procedure reported by [10] with slight modifications. Soybean seeds (Two kilograms) were manually sorted, washed, the hulls were removed and dehydrated in a cabinet (dryer) at the temperature of 45°C. A blender with model Scanfrost, SFKAB409 was used to ground dried seeds and allowed it go through a netting filter (150 µm) for the sake of having desired cooked full-fat soybean flour. The full-fat soybean flour was defatted with soxhlet extraction using hexane as solvent. The defatted soybean flour was preserved for further analysis in an air tight container.

**Production of Maize flour:** Two and a half (2.5) kilo of maize grains were prepared by the traditional wet milling process. During this process, the maize was sorted, washed and steeped in sufficient water under ambient condition for a period of 72 h. The water for steeping was changed daily further more on the 3rd day, it was drained and wet milled with a disc attrition mill. A muslin cloth was used to sieve the wet- milled slurry/ gruel. The slurry was settled before decanting. The wet paste was gotten by removing excess water using a muslin cloth and later sun-dried for three days. The drying was done in a cabinet drier at 50°C for 8 hours. Meal was dried and ground in a hammer mill and finally filtered into flour. The fermented maize flour was preserved in cellophane as well as held in a cool and dry place till it was needed for product formulation.

**Carrot Flour Production:** The method described by [11] was used. Carrot (about I kg) was cleaned in distilled water to remove irrelevant substances. The washed carrots were manually skinned, cut into slices with a kitchen slicer. The sliced carrot was spread thinly on flat surface and allowed to dry in an oven at temperature of 40 ± 2°C. The dried chips were withdrawn as soon as steady weight was achieved. The dried carrot was ground to fine powder; filtered, as well as bottled in food grade plastic containers that were air-tight.

**Procedure for Pasting Properties:** The pasting qualities of the flour blend were evaluated by Rapid Visco Analyser (RVA). The quantity of material utilized was evaluated by the instrument by introducing the moisture content (14%). The mixture was energetically and completely turned till no lumps were seen. The mixture was moved into a canister, introduced into the paddle coupling correctly. The dimension was commerced by lowering the motor tower of the instrument. The test was admitted to start and end in agreement to the pre-set time and condition.

### Evaluation of Phytochemical

**Flavonoid:** This was evaluated by the method [12]. Sample (10g) was extracted continuously with 80% aqueous methanol (100 mL) at ambient condition. The filtrate was put in a crucible, allowed to dry (water bath), as well as measured until constant weight is obtained.

**Alkaloid:** Alkaloid was evaluated using alkaline precipitation gravimetric procedure described by [13]. Sample (5g) was put in 10% acetic acid (50mL) solution in ethanol in a 250 mL beaker. Mixture was rocked and permitted to settle for 4 h before being separated using filter paper (Whatman No. 42). The filtrate was concentrated to one-quarter of its initial volume by drying in a steam bath.

The alkaloid in the extract was determined by the drop-wise addition of ammonium hydroxide ($NH_4OH$) till it became turbid. Filtration with a weighed filtered paper was used to recover alkaloid precipitate and washed with ammonia solution (1%), later dried in an oven at 80°C for 1 h. It was later cooled in desiccators and reweighed. The weight of the alkaloid was calculated and expressed as a percentage of the analyzed sample.

$$\%\ \text{Alkaloid} = \frac{W_2 - W_1 \times 100}{W\ 1}$$

Where:
W= sample
$W_1$= empty filter paper
$W_2$= paper + alkaloid precipitate

**Saponin:** Saponin evaluation was by the method of [14]. Sample (20 g) was put in 20% ethanol (200 mL). The suspension was heated over a hot water bath for 4 h at 55°C.The combination was sieved as well as the residue re-extracted using an extra 20% ethanol (200 mL). The combination of the extract was dropped to 40 mL over a water bath at 90°C. The concentration was moved in a

250 mL funnel and diethyl (20 mL) ether was included and mixed energetically. The aqueous layer was obtained but the ethyl layer was discarded. The purification procedure was done again. N-butane extract (60 mL) was cleaned twice using 5% sodium chloride (10 mL). After evaporation, sample was dried inside an oven until consistent weight was recorded.

**Tannin:** This was evaluated by Follins Dennis's spectrophotometric procedure established by [15]. A sample (5 g) was spread in distilled water (50 mL). The combination was left to rest for 30 min under ambient condition as well as rocked at every 10 min interval. At the completion of the 30 min, the combination was sieved using filter paper (Whatman) and the filtrate was used for the experiment. Two milliliters (2 mL) of the solution were calculated into a 50 mL measuring vessel. Likewise, 5 mL of both tannic acid solution and distilled water were calculated separately into different flasks. 35 mL of distilled water was further used to dilute them separately and Follin- Dennis reagent (1 mL) added to individual flask, and saturated sodium carbonate solution (2.5 mL) was added up. The content of individual flask was made up to 50mL. Absorbance was fixed at 620 nm wavelength.

**Starch Digestibility (*In vitro*)**: *In vitro* starch digestibility (IVSD) was evaluated [16]. Sample (50 mg) was mixed with 0.2 M phosphate buffer (pH 6.9) (1 mL). 0.5 mL Pancreatic alpha-amylase (100 unit / mg) was added and incubated for 2 h at 37$^{o}$C. 3, 5-DNS (2 mL) was included immediately. The combination was heated for duration of 5-15 minutes in a boiling water bath. 40 % potassium-sodium tartarate solution (1.0 mL) was included, and allowed to cool at 35 °C. The solution was filtered with a filter of 0.45 nm and measured to 25 mL using distilled water. Absorbance was fixed at a wavelength (550 nm). A standard curve was made with maltose and data were determined.

**Proximate Analyses:** These were determined by standard methods [17]. At 105$^{o}$C in an air oven (Thermo Scientific-UT 6200, Germany) moisture was evaluated. Lipid was evaluated with Gerhardt Soxtherm SE- 416, Germany model for soxhlet extraction. Evaluation of protein was the Kjeldahl procedure. The efficiency of the nitrogen values was calculated using acetanilide values and multiplied by a factor of 6.25 to get protein value. Ash was evaluated in a muffle furnace (Carbolite AAF-11/18, UK) for 24 h at 550$^{o}$C. Carbohydrate was evaluated by difference.

**Statistical Analysis:** Data obtained from this experiment were analyzed by subjecting to one-way analysis of Variance (ANOVA) in randomized block design. Significant difference was tested using Duncan's multiple range test. Genstat statistical package (software) 2005, 8th edition was used.

## 3. RESULTS AND DISCUSSION

Fermentation is a known and accepted means of producing complementary foods. Maize, millet, and sorghum are fermented food products that are very popular. Numerous researches have explored local cereals, legumes, and nuts for the processing of complementary food. The results was significant ($p<0.05$) among the flour blends with regards to moisture content (Table 2). This ranged from 7.91-11.05%. Sample E had the least (7.91%) moisture content. Next were C (9.45%), A (9.68%), D (10.21%) and the highest moisture content was B (11.05%) in that increasing order. The low moisture in these flour blends reflects their shelf stability [1].

**Table 1. Formulation of complementary food blends**

| | Level of substitution | | |
|---|---|---|---|
| **Sample Id** | **Cereal** | **Legume** | **Vegetable** |
| A | 100.00 | 0.00 | 0.00 |
| B | 85.00 | 10.00 | 5.00 |
| C | 60.00 | 30.00 | 10.00 |
| D | 65.00 | 20.00 | 15.00 |
| E | 50.00 | 50.00 | 0.00 |

**Table 2. Proximate composition (flour blends)**

| | Sample | | | | | |
|---|---|---|---|---|---|---|
| **Proximate Composition** | **A** | **B** | **C** | **D** | **E** | **SED** |
| Moisture (%) | $9.68^{c}$ | $11.05^{a}$ | $9.45^{d}$ | $10.21^{b}$ | $7.91^{e}$ | 0.02 |
| Protein(%) | $5.69^{e}$ | $10.03^{d}$ | $18.11^{b}$ | $14.44^{b}$ | $26.78^{a}$ | 0.03 |
| Ash(%) | $0.27^{e}$ | $1.69^{d}$ | $2.66^{b}$ | $1.79^{c}$ | $4.93^{a}$ | 0.02 |
| Fiber(%) | $0.44^{d}$ | $0.31^{e}$ | $2.19^{a}$ | $1.28^{b}$ | $0.89^{c}$ | 0.02 |
| Fat(%) | $11.10^{c}$ | $10.19^{d}$ | $10.14^{d}$ | $11.26^{b}$ | $11.74^{a}$ | 0.04 |
| Carbohydrate (%) | $72.82^{a}$ | $66.73^{b}$ | $57.44^{d}$ | $61.03^{d}$ | $47.84^{e}$ | 0.06 |
| Energy (Kcal/100g) | $413.7^{a}$ | $391.8^{b}$ | $373.6^{d}$ | $388.4^{c}$ | $369.4^{e}$ | 0.73 |

*Means having the same letters along the rows are not significant (p>0.05) [1]*
*SED=Standard error difference of means*

Sample E had the highest (26.78%) protein content. This was followed by C (18.11%), D (14.44%), B (10.03%). The least was A (5.69%). An important nutrient composition in complementary foods is the protein content; it is a good source of essential amino acids. To improve cellular function, integrity, ensuring normalcy of health, and growth dietary protein is necessary [1]. Sample E (4.93%) had the highest ash content. Next was C (2.66%), D (1.79%), B (1.69%), the least was A (0.27%). Significant differences (p<0.05) existed in the fat content among the flours. The largest was seen in sample E (11.74%). Next were D (11.26%), A (11.10%), B (10.19%) and C (10.14%) in decreasing order. Fat is very necessary for the infants and growing children because of its energy density and absorption of fat-soluble vitamins; For long product shelf stability, low fat is beneficial through reduction of susceptibility to oxidative rancidity [1]. The highest carbohydrate and energy values were seen in Sample A (72.82 and 413.7%) respectively.

The phytochemical of the raw materials used in this study was significant (p<0.05) (Table 3).

Flavonoid as well as tannin was the least available anti-nutrients observed in this study. Their presence in these raw materials was significant (p<0.05), and was very low, ranging from 2.07mg/100g to 0.02mg/100g and 2.05mg/100g to 0.02mg/100g respectively. Fermented maize had the least flavonoids (0.02mg/100g) and Tannin (0.02mg/100g). This was followed by Carrot, which had flavonoid 0.63mg/100g and Tannin 0.63mg/100g. The highest was defatted soybean with flavonoid 2.07mg/100g and tannin 2.05mg/100g in that increasing order. The flavoniods and tannin obtained in this study were not different from the report of [18], who reported that tannin are bound to some nutrients such as proteins and carbohydrates.

Saponin content in the raw materials was significant (p<0.05). Sample A (fermented maize) reported the highest saponin (21.43%). Next was sample C carrot (7.51%). The least saponin recorded was sample B defatted soybean (3.56%) in decreasing order. Saponin possesses beneficial (cholesterol-lowering) and deleterious effects. Also, the alkaloid composition of the raw materials was significant (p<0.05), and the percentage was very low except for sample A fermented maize which had the highest alkaloid (40.14%), this was followed by sample B defatted soybean (11.29%), while the least was observed in sample C carrot (6.37%). In doses of excess 20g/100g, alkaloid causes gastrointestinal upset and neurological disorders [18].

**Table 3. Phytochemicals in the raw plant materials**

| | Treatments | | | |
|---|---|---|---|---|
| **Anti nutrient** | **Fermented Maize flour** | **Defatted soybean flour** | **Carrot powder** | **SEM** |
| Flavonoid (mg/100g) | $0.02^{c}$ | $2.07^{a}$ | $0.63^{b}$ | 0.01 |
| Tannin (mg/100g) | $0.02^{c}$ | $2.05^{a}$ | $0.63^{b}$ | 0.01 |
| Saponin (%) | $21.43^{a}$ | $3.56^{c}$ | $7.51^{b}$ | 0.32 |
| Alkaloid (%) | $40.14^{a}$ | $11.29^{b}$ | $6.37^{c}$ | 0.07 |
| Vitamin A (unit/g) | $164.17^{a}$ | $261.09^{b}$ | $848.56^{a}$ | 0.01 |

*Means having the same letters are not significant (p>0.05)*
*SEM= Standard error of mean*

Carrot (Sample C), had the highest vitamin A (848.56uit/g) and was significant ($p<0.05$) from other raw materials. Next was sample B defatted soybean (261.09uit/g). The least for vitamin A was sample A fermented maize (164.17uit/g). The highest vitamin A observed in sample C was expected since carrot is a vegetable and contains beta-carotene.

The pasting characteristics of complementary food from maize flour supplemented with soybean and carrot was significant ($p<0.05$) (Fig. 1-5). Sample A showed the highest (2208cP) peak viscosity and was significant ($p<0.05$) from other samples, followed by B (1473cP), D (903.0cP), C (781.0cP). The lowest was sample E (408) in that decreasing order.

The capacity of starch to rise freely before its physical breakdown is called the peak viscosity. The peak viscosity in this study ranged from 408cP to 2208cP. From the results, it was evident that the more the fermented maize incorporation, the more the peak viscosity. The degree of swelling of granule during heat application could also be referred to as peak viscosity. These results agreed with the report of Ragaee and Abdel-Aal (2006) that starch with higher rising potential result to peak viscosity that is high. Starch rising is associated with amylopectin behavior [19].

Sample A (1285cp) recorded the highest trough value. Next were B (973cp), D (674cP), C (575cP), while the least was E (311cp) in decreasing order. It was observed that the higher the fermented maize in the blend, the higher the trough value recorded. The trough value ranged from 311 to 1285cP. The possibility of the paste to withstand breakdown in the course of cooling is measured by the trough, which was significantly ($p<0.05$) higher in flour blends. Trough at the lowest hot paste viscosity is trough viscosity/holding strength which is determined by the rate of amylose–lipid complex formation as well as the rate of amylose exudation, granule rise [20].

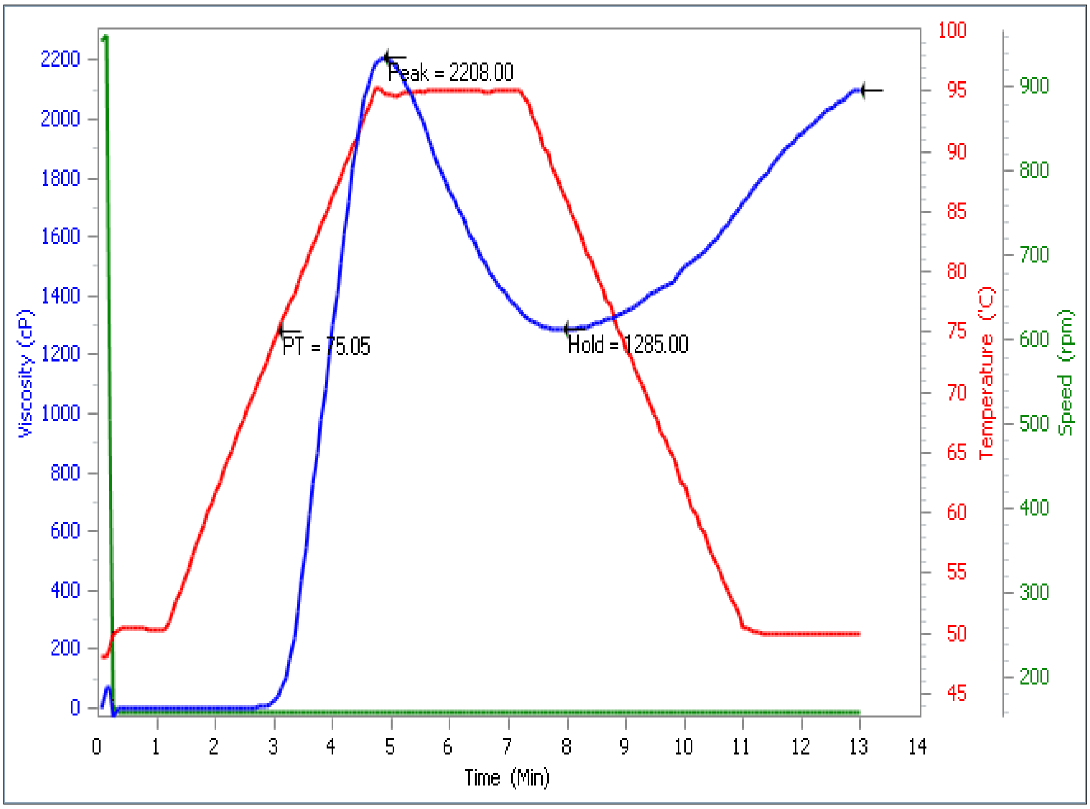

**Fig. 1. Blend A (100% fermented maize)**

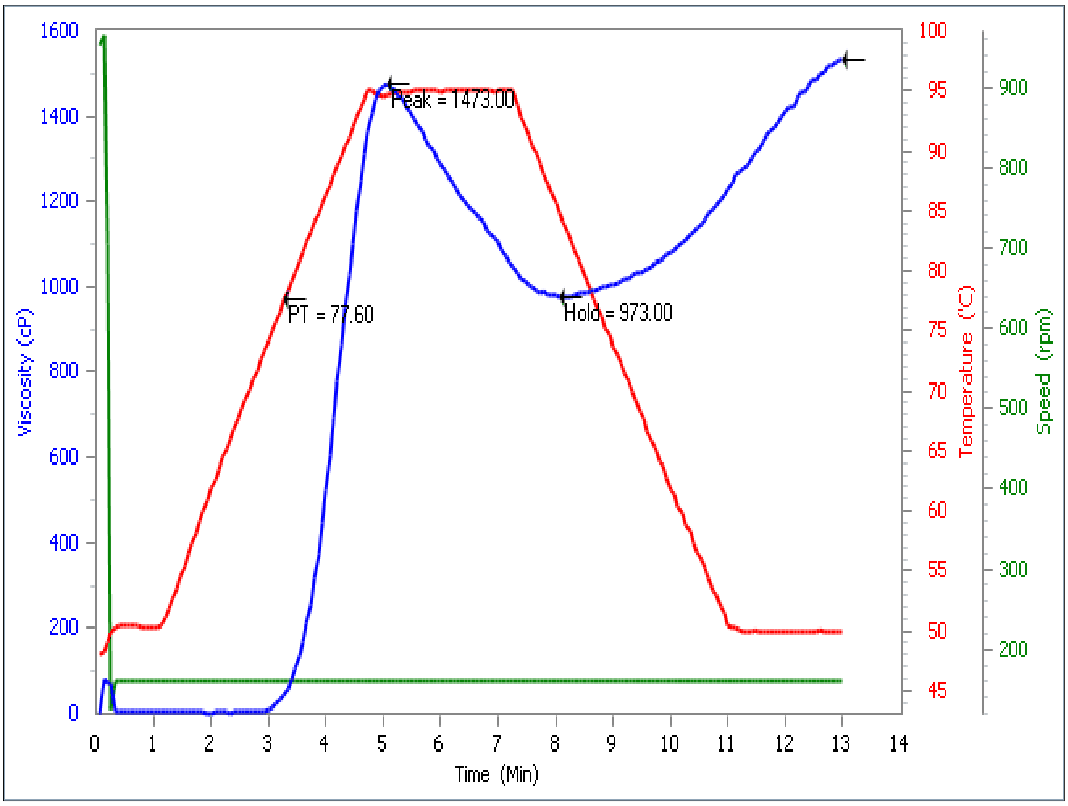

**Fig. 2. Blend B (85% fermented maize, 10% soybean and 5% carrot**

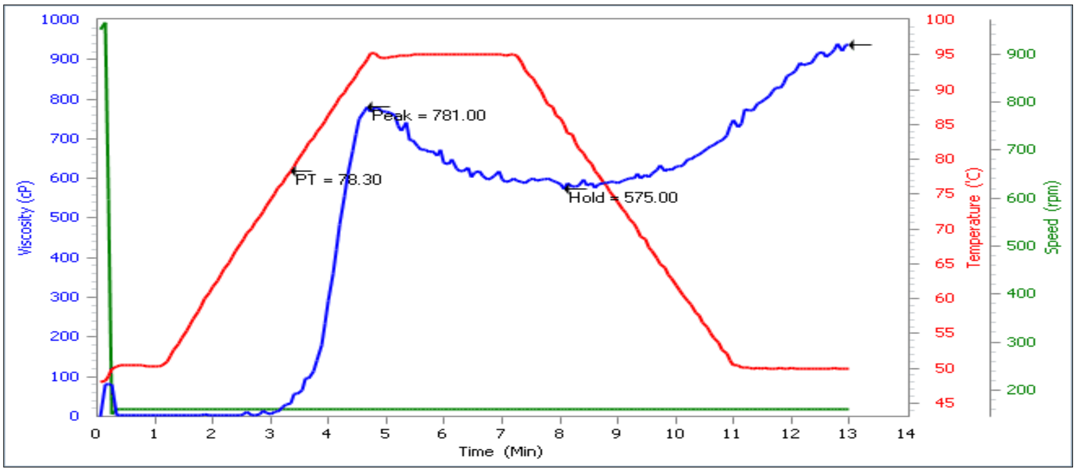

**Fig. 3. Blend C (60% fermented maize, 30% soybean and 10% carrot**

Additional necessary pasting attribute include the Breakdown viscosity. High heating and mechanical shear stress in the course of RVA analysis disrupt starch, resulting in alignment and amylose leaching out [21]. The breakdown viscosity expresses paste stability during processing. The breakdown viscosity ranged from 97cP to 923cP. The highest breakdown viscosity was sample A (923cP), next was B (500cP), D (229cP), C (206cP), and the least was E (97cP) in decreasing order. The lower strenght of the product reflects better breakdown viscosity. The disparity in peak viscosity as well as the minimum viscosity in the course of heating is showed by the breakdown viscosity. The more granule disruption or lower possibility of starch to withstand shear force in the course of heating application shows higher breakdown viscosity [22].

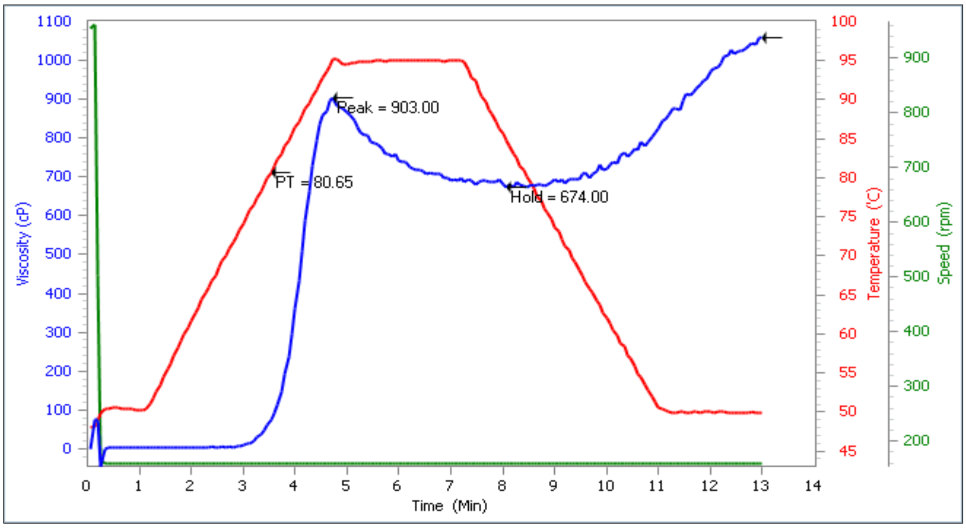

Fig. 4. Blend D (65% fermented maize, 20% soybean and 15% carrot

The formation a gel by the flour sample during processing is determined by the final viscosity. The FV was significant ($p<0.05$) among the blends. The largest FV was observed in sample A (2099cp), next was B (1535cp), D (1058cp), C (936cp), and the least E (522cp) in that decreasing order. It was obvious from this study that FV increases with an increasing quantity of fermented maize flour.

The set back viscosity in the blends was significant ($p<0.05$). Sample A had the highest value (814cp). Next were B (562cp), D (384cp), C (361cp). The least was E (211cp). It was obvious that fermented maize increased setback viscosity. The setback viscosity ranged from 211cp to 814cp.

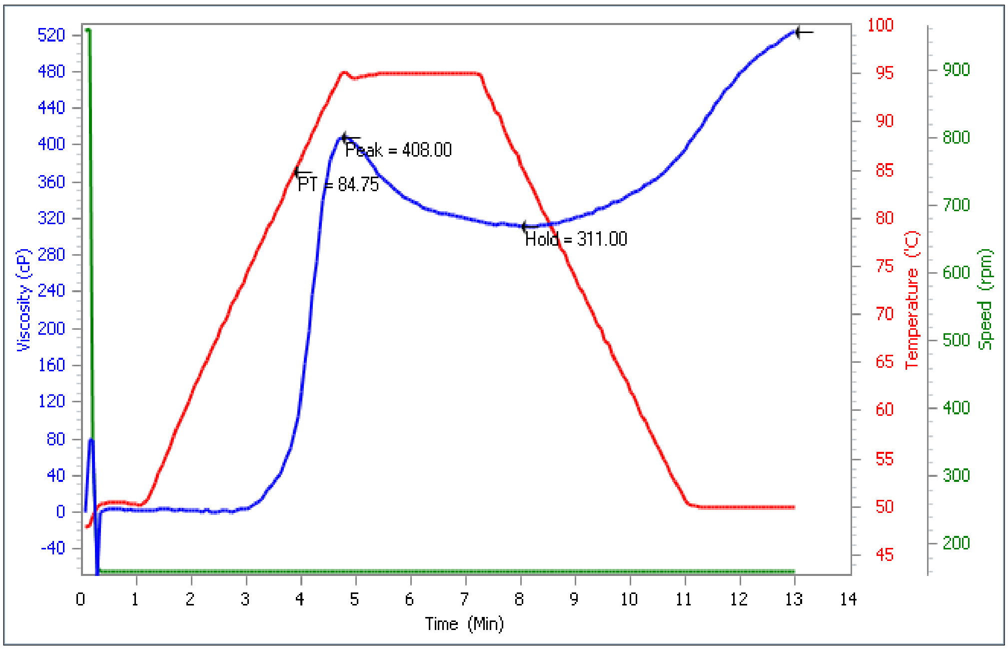

Fig. 5. Blend E (50% fermented maize and 50% carrot

The peak time (PT) measures time of cooking. Sample B had the highest PT (5.07mins), next was sample A (4.87mins), D and E had equal PT (4.73mins). The PT ranged from 4.67 to 5.07mins.

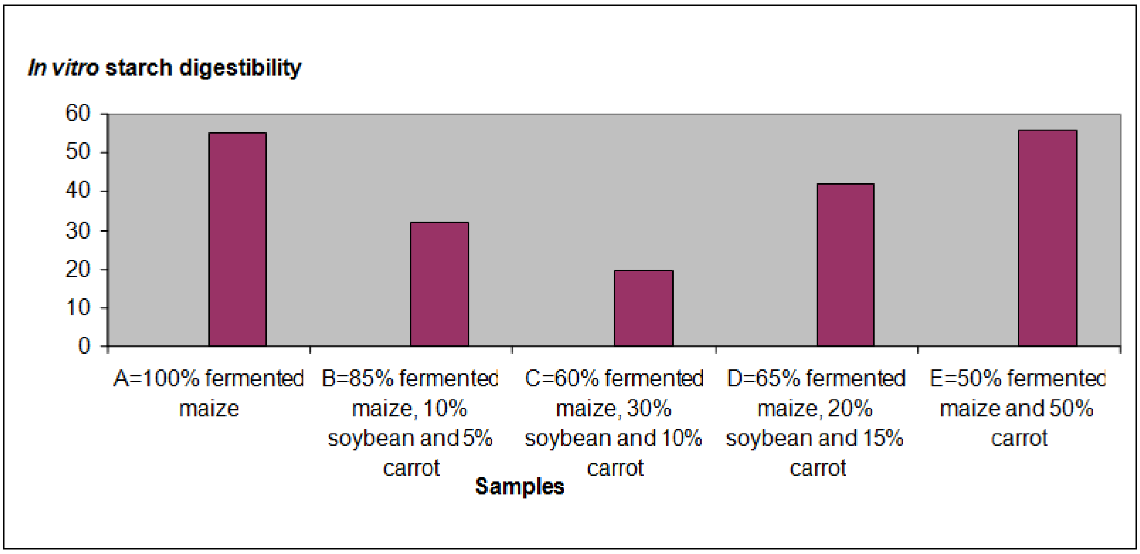

**Fig. 6. Starch digestibility of flour blends**

Pasting temperature measures the lowest heat that is needed to cook a sample of food. The attainment of pasting temperature is important to ensure gelatinization, sweetness and the next gel formation during processing. The temperature for viscosity to rise is the pasting temperature (PTT). In his research, the pasting temperatures were significant ($p<0.05$). This ranged from 75.1°C to 84.75°C. The highest pasting temperature was observed in sample E (84.75°C), next was D (80.65°C), C (78.30°C), B (77.60°C), the least was A (75.05°C). The pasting temperature decreased with decreasing fermented maize inclusion.

Fig. 6 is *in vitro* starch digestibility (IVSD) of complementary food obtained from maize flour supplemented with soybean and carrot. A significant difference ($p<0.05$) was seen among blends. Results showed that fermentation improves starch digestibility. The starch digestibility showed significant increased ($p<0.05$) in blends. Sample E (55.86mg/g) had the highest IVSD, next was A (55.09mg/g), D (42.01mg/g), B (32.14mg/g) while the least was C (19.50mg/g) in that decreasing order. The lowest IVSD observed in sample C (19.50mg/g) could be attributed to the least amount of fermented maize in the blend. According to [23], the fermentation process increases starch digestibility. The IVSD increased due to the Pre-process activity (fermentation). This may be due to the fermenting microorganism producing organic acids that loose the granule sites for starch, for amylolytic actions to be carried out by them [24]

## 4. CONCLUSION AND RECOMMENDATIONS

It is obvious that the fermentation of maize for the production of weaning food helps to break down sugars and starches that allow for the possible digestibility of fermented foods. Besides, it also influences positively the reduction of anti-nutrients in the diet particularly tannin, flavonoids and increases pasting properties such as peak viscosity. It was observed that the higher the fermented maize inclusion in the diet the higher the peak viscosity. Fermented maize equally increased the trough value. An Increase in the breakdown viscosity and final viscosity were also observed as a result of the use of fermented maize. The defatted soybean equally reduced anti-nutrients particularly tannins and flavonoids but not as much as the fermentation process of maize. The inclusion of carrot powder is a good source of beta carotene. It increased the amount of vitamin A in the diet, which is needed for clear vision in children. The results of this study showed that maize should be fermented before use as a weaning food in order to increase starch digestibility and pasting properties

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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