

# Proximate Compositions and Functional Properties of Composite Flour Produced with Date Fruit Pulp, Toasted Watermelon Seed and Wheat

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## Abstract

Composite flour of different ratios was formulated from wheat, date palm fruit pulp and toasted watermelon seeds. Various blends ratios produced were CHUY<sub>1</sub> = 90%:5%:5%; CHUY<sub>2</sub> = 80%:10%:10%; CHUY<sub>3</sub> = 70%:15%:15%; CHUY<sub>4</sub> = 60%:20%:20% and CHUY<sub>5</sub> = 50%:25%:25% wheat flour: toasted watermelon seed flour: date fruit pulp flour respectively and CHU = 100% wheat flour. Standard methods were used in the determination of the proximate compositions and functional properties of the flour blends. Mean values of the triplicate samples were subjected to statistical analysis (ANOVA), while Fishers' test ( $p \leq 0.05$ ) was used for separation of means. Various formulations of flour blends produced significant ( $p \leq 0.05$ ) changes in the proximate composition of the flour blends: ash (3.44%-5.84%), moisture (10.55%-11.15%), crude fibre (1.53%-3.67%), crude protein (11.30%-20.00%), crude fat (9.70%-13.38%) and carbohydrate (50.13%-60.00%). There were significant ( $p \leq 0.05$ ) variations in the functional properties of flour blends: bulk density (0.72-0.85 gml<sup>-1</sup>), wettability (14.00-48.55 s), viscosity (2.83-3.85 Nsm<sup>-2</sup>), foam capacity (9.48-11.95%), gelation temperature (60.55-67.55 °C), pH (5.63-6.71) and emulsion capacity (1.52-3.17 g ml<sup>-1</sup>). CHUY<sub>5</sub> flour blend showed better quality in functional properties and proximate composition than other flour blends. CHUY<sub>5</sub> flour blends should be commercialized for large scale productions.

## Keywords

Flour, Blends, Composite, Formulation, Functional, Proximate

## Introduction

Composite flour can be defined as a mixture of different ratios of non-wheat flours obtained from roots and tubers, cereals, legumes, etc., with or without the addition of wheat flour [1, 2]. Composite flour is considered advantageous in developing countries as it reduces the importation of wheat flour and encourages the use of locally grown food crops as flour [3]. Aziah and Komathi [4] reported that there is an increase in the substitution for wheat flour, with local raw materials as a result of a growing market for baked products and confectioneries. Nigeria has not been able to produce wheat in commercial quantities because of climatic and soil conditions. Consequently, nearly all the wheat flour used for snacks and other products are imported [2]. Composite flour technology is important because of the advantage of reducing the huge amount of money spent on wheat flour importation, coupled with the prospects of the utilization of underutilized crops [2, 5].

Wheat is the most desired cereal for the production of confectionary product due to its high gluten content [6]. The high gluten content in wheat contributes greatly to dough sponginess and elasticity [7]. The increasing demands for wheat, as a result of increasing populations, urbanization and changing food habits [8] especially in the developing countries, have led to increased importation [3]. Hence, wheat consuming countries located in tropical regions, which mostly are developing nations, rely on countries located in temperate regions for wheat importation [8]. The dependence on the use of wheat flour is a major constraint in biscuit production [2,9].

Watermelon (*Citrillus lanatus*), is a typical fruit from the *Crucurbitaceae*. It contains seed which have been found effective in baking [10]. The seeds have high fat content (50%) and protein content of (35%) and are also rich in Vitamin A, C and minerals e.g. potassium [11]. In addition, it is a rich source of fiber 39.09% - 43.28% [12] which is a desirable quality in production of cookies. This is because it aids in bowel movement and cleaning of the colon when consumed in the body [13].

Date palm fruit (*Phoenix dactylifera*) locally known as “*debin*” in Hausa language from the family of *Aracaceae* [14], is a known fruit for its sugary taste. The fruit is a drupe in which the outer fleshy part consists of the pulp and the pericarp surrounding a shell of hard endocarp with the seed inside [15]. According to Dada et al. [16], date palm fruits consists of more than 70% sugar mainly glucose and fructose. It is high in energy value thus making it an ideal replacement for sugar (sucrose) in the cookie recipe [9]. It is also of great nutritional benefit because it reduces the risk of increasing blood sugar level of diabetic patients. Meanwhile it is also rich in fiber [17], antioxidants and flavonoids such as beta carotene, lutein and zeaxanthin. It is also an excellent source of iron, copper, calcium, vitamin A and B<sub>2</sub> [14, 15]. Date palm fruit has been found to contain carbohydrates (total sugars 44%-88%), fat (0.2%-0.4%), proteins (2.3%-5.6%), dietary fibre (6.4%-11.5%), minerals and vitamins [18]. Carbohydrates in date palm fruit are mostly in the form of digestible sugars (70%) mostly fructose, glucose and sucrose which are easily absorbed by the human body and therefore a ready source of energy [19, 20]. Hence it can be used to replace sugar in bakery and confectionery products. Sugar is a major ingredient used in the production of cookies [9], cakes, and other pasta products. But it has its own associated problems of inducing metabolic disorders such as Type 2 diabetes, obesity etc. and it is known to contain a whole lot of calories with no essential nutrient [21].

The main objective of this research is to develop composite flour that can be used in baking with little or no sugar and fat addition and yet the characteristic qualities of baked products will be achieved, while maintaining/boosting the nutritional qualities. The specific objective is to evaluate the proximate composition and functional properties of the formulated flour blends. Hence, this work, if successful, will ensure that flours for production of baked food products that meet both the obsessed and the diabetics needs are produced. Therefore, fortifying flours with toasted water melon seed and date palm pulp will not only be an ideal for people suffering

from diabetes and other coronary heart disease but will also improve the nutritional qualities of the flours.

## Materials and Methods

### Sample collection

The dried date palm fruits and watermelon fruits were purchased at Douglas Road (Ama Hausa) and Relief market Owerri, Imo State respectively. Golden Penny wheat flour was also obtained from Owerri Main market, Imo State, Nigeria.

### Preparation of toasted water melon seed flour

The modified method of Ubhor and Akobundu [22] was used. Toasted watermelon seed flour was prepared at ambient temperature (28-30 °C) by deseeding water melon pods, the seeds were then washed with portable water, drained and sun dried. With the help of a regulated oven, the seeds were toasted at a temperature of 130 °C for 20 minutes. The seeds were then milled using an attrition mill (Atlas Exclusive, Alzico Ltd mill) and sieved through a 250 mm mesh of US standard sieve to obtain fine flour.

### Preparation of date palm fruit pulp (DPFP)

The date palm fruit pulp four was produced at ambient temperature (28-30 °C) by first washing the date palm fruit with water to remove adhering dirt followed by deseeding of the fruit manually. The fleshy pulp was cut into small pieces with the aid of a knife. The pulp with pericarp was then oven dried at 75 °C for 6 hours and subsequently milled using an attrition mill (Atlas Exclusive, Alzico Ltd mill). It was sieved through a 250 mm mesh of US standard sieve to obtain fine flour and packaged for use [9].

### Flour formulation ratios

The composite flours for the cookies were formulated at ambient temperature (28-30 °C) using the modified method by Olapade and Adeyemo [23] with wheat flour, date palm fruit pulp meal (DPFP) and toasted watermelon seed meal in the following ratios 90:5:5, 80:10:10, 70:15:15, 60:20:20, 50:25:25 as shown in table 1. The control was 100% flour [9].

### Determination of proximate composition of flour blends

#### Determination of moisture content

The AOAC [24] method was used. Two gramme-portions of each flour blend samples were weighed into previously weighed dry crucibles. The crucibles with samples were dried in an oven at 105 °C, cooled in desiccators for ten minutes, reweighed and returned into the oven until a constant weight was attained [25-27]. The moisture content of the flour samples was calculated with the equation 1:

$$\% \text{ Moisture content} = \frac{W_1 - W_2}{W_1} \times \frac{100}{1} \quad (1)$$

Where:

$W_1$  = the weight of sample before drying

$W_2$  = the weight of sample after drying

**Table 1:** Composite flour formulation ratios.

Blends (Flour)	Wheat Flour	Toasted water-melon seed	Date palm fruit flour
CHUY <sub>1</sub>	90	5	5
CHUY <sub>2</sub>	80	10	10
CHUY <sub>3</sub>	70	15	15
CHUY <sub>4</sub>	60	20	20
CHUY <sub>5</sub>	50	25	25
CHU	100	-	-

CHU = 100% wheat flour serves as the control.

### Determination of ash content

The Ash content was determined following the AOAC [24] method as modified by Uzoukwu *et al.* [27]. Two grams of the samples were weighed in triplicate into previously weighed silica crucibles. The samples inside the crucibles were charred on a heater inside a fume cupboard to drive off most of the smoke. The crucibles with the contents were transferred into a muffle furnace and heated for about four hours at 550 °C. They were cooled in a desiccator and weighed. The heating was repeated until the samples turned grayish white and attained constant weight. The ash content was then calculated as in equation 2:

$$\% \text{ Ash} = \frac{\text{weight of ash}}{\text{weight of sample taken}} \times \frac{100}{1} \quad (2)$$

### Determination of crude lipid (ether-extract)

The total lipid content of the samples was determined using the AOAC [24]. Soxhlet fat extraction method. Five grams of the sample were weighed into a pre-weighed fat free extraction thimble which was plugged tightly with cotton wool. The thimble was placed in the Soxhlet extractor fitted up with reflux condenser, all connected to a boiling flask containing 200 ml of petroleum ether (boiling point 60 °C) on a heating mantle. As the flask and petroleum ether were heated, the solvent evaporated and condensed into the thimble extracting oil from the sample and refluxed into the boiling flask with the extracted oil. This was done for 4 hours. At the end of extraction, the solvent (petroleum ether) was evaporated by heating at 70 °C on a hot plate leaving the lipid extract in the flask. The flask with its contents were placed in an oven and dried at 110 °C for one hour, cooled in a desiccator and re-weighed [25-27]. The percentage lipid was calculated as in equation 3:

$$\% \text{ Ether extract} = \frac{\text{weight of oil}}{\text{weight of sample}} \times \frac{100}{1} \quad (3)$$

### Determination of crude protein

The crude protein contents of the samples were determined using the micro-Kjeldahl apparatus as described by AOAC [24]. Two grams of each of the samples was placed in a Kjeldahl flask and 30 ml concentrated sulphuric acid were added, followed by the addition of 10 g potassium sulphate and 1 g copper sulphate. The mixture was gently heated for few minutes until frothing ceased; the heat was increased and the sample allowed digesting for three hours. The digest

was allowed to cool and diluted with distilled water (washing the digestion flask) up to 100 ml. Ten milliliters (10 ml) of the dilute digest was pipetted into a distillation flask and 10 ml of 40% (w/v) sodium hydroxide added. The mixture was distilled and the liberated ammonia collected in 10 ml of 2% boric acid containing indicator. This was titrated with 0.01 N hydrochloric acid to grey colored end point. A blank was also prepared without a sample and treated as above [26, 27]. The amount of crude protein was then calculated by multiplying percentage nitrogen in the digest by the conversion factor (6.25) as in equation 4.

$$\%N = \frac{(a-b) \times 0.01 \times 14 \times v}{W \times C} \times \frac{100}{1} \quad (4)$$

where

a = the titre value of the digested sample

b = titre value of the blank sample

V = volume after dilution

W = weight of dried sample (mg)

C = Aliquot of sample used

14 = Atomic weight of Nitrogen

Crude protein = 6.25 x%N

### Determination of crude fibre

AOAC [24] methods were employed. Two grams of the flour samples were weighed in duplicate into a 600 ml, long Pyrex beaker and 200ml of 1.25% H<sub>2</sub>SO<sub>4</sub> solution was added. The beaker was covered with a watch glass and the content gently boiled on a hot plate for 30 minutes. The acid was removed by filtering through a muslin cloth over a Buckner funnel and the sample washed three times with 50 ml of boiling water to free it of acid, before putting it back to the beaker. Then, 200 ml of 1.25% NaOH solution was added to the residue in the beaker, which was covered with a watch glass and gently boiled on a hot plate for 30 minutes and then filtered. The residue was washed into a weighed No. 2 sintered glass crucible with 50 ml of boiling water and later washed twice with 30 ml portions of petroleum spirit. The crucible was dried in the oven at 80 °C to a constant weight and then ignited in a muffle furnace at 600 °C until a light gray coloured ash was obtained. The crucible and content were cooled to ambient temperature in a desiccator and then weighed. The crude fibre content was calculated as in equation 5.

$$\% \text{ Crude Fibre} = \frac{\text{loss in weight on ignition}}{\text{weight of sample}} \times \frac{100}{1} \quad (5)$$

### Determination of carbohydrate content

The carbohydrate content was obtained by difference [26].

%Carbohydrate = (100% - %Moisture - %Crude protein - %Fat - %Ash- %Crude fibre) (6)

### Determination of functional properties of flour blends

#### Bulk density

Using the procedure of Onwuka [26], about 5 g flour

sample was put into a 10 ml measuring cylinder gently. The bottom of the cylinder was tapped gently on the laboratory bench severally until there was no further change of the sample level to a constant volume. The bulk density was calculated using the formula below. The bulk density of the test sample was repeated three times for each sample and the average was calculated using equation 7.

$$\text{Bulk density} = \frac{\text{Mass of Flour Sample}}{\text{Volume of Flour}} \quad (7)$$

### Wettability

AOAC [24] method was used. One-gram flour was introduced into 25 ml graduated measuring cylinder with a diameter of 1 cm and a finger placed over the open of the cylinder. The cylinder was inverted and clamped at a height of 10 cm from the surface of 600 ml beaker containing 500 ml of distilled water. The finger was removed and the rest of the sample was allowed to be dumped. The wettability is the time required for the sample to become completely wet.

### Viscosity

The viscosity of the various samples was determined using the Oswald viscometer. The method described by Onwuka [26] was adopted. Each sample was added to the viscometer, pulled into the upper section, and then allowed to drain by gravity back into the lower reservoir. The time it took for the liquid to pass between two etched marks, one above and one below the upper reservoir was measured. The relative viscosity was measured using the equation 8.

$$\eta_{\text{Rev}} = \frac{\eta}{\eta_0} - \frac{\rho t}{\rho_0} \quad (8)$$

Where,

$\rho$  = the density of sample;

$t$  = the time of outflow of the sample;

$\rho_0$  = density of the outflow of the reference liquid;

$t_0$  = the time of the outflow of the reference liquid (water).

$\eta_0$  = the viscosity of the reference liquid.

$\eta$  = the viscosity of the sample to be calculated.

### Foam capacity

Foaming capacity of the flour samples was determined according to AOAC [24] method. Two grams of the flour sample were blended with 100ml of distilled water using warming blender. The suspension was whipped at 1600 rpm (revolution per minute) for 5 minutes. The mixture was then poured into a 100 ml measuring cylinder and its volume was recorded after 30 seconds. Foam capacity was expressed as percentage increase in volume using equation 9.

$$\text{Foaming Capacity} = \frac{\text{Volume after whipping} - \text{Volume before whipping}}{\text{Volume before whipping}} \times 100 \quad (9)$$

### Gelation capacity

The methods of AOAC [24] and Onwuka [26] were adopted in the determination of gelation temperature. In each case, 10 g of the sample was dispersed in 100 ml of distilled water in 250 ml beaker. A thermometer was clamped on a

retort stand with its bulb submerged in the suspension and magnetic stirrer. The heating and stirring continued until the suspension began to gel and the corresponding temperature was recorded. The temperature at boiling point was also recorded in triplicate and mean values were determined.

### Emulsification capacity (EC)

The AOAC [24] and Chukwu *et al.* [28] methods were used. From each sample, 2 g was blended with 25 ml of distilled water at room temperature for 30 seconds in a warming blender at 1600 rpm. After complete dispersion, 25 ml of vegetable oil was gradually added and the blending continued for another 30 seconds. Then the mixture was transferred into a centrifuge tube and centrifuged at 1600 rpm for 5 minutes. The volume of oil separated from the sample was read directly from the tube after centrifuging. The emulsion capacity was expressed as the amount of oil emulsified and held per gram of sample using equation 10.

$$\text{Emulsion Capacity} = \frac{\text{Height of emulsified layer}}{\text{Height of whole solution in the centrifuge tube}} \times 100 \quad (10)$$

### pH Measurement

The pH values of the samples were determined by dissolving 10 g of each sample in 100 ml of distilled water in 250 ml beaker. It was then thoroughly mixed and stirred and the pH was taken. The average of triplicate sampling used as the pH reading [29].

### Statistical analysis

Triplicate data obtained were subjected to statistical analysis using SPSS software of version 21. Mean value separations and significant differences were determined using ANOVA and Fisher's Least Significant Difference at ( $p \leq 0.05$ ) respectively [30].

## Results and Discussion

### Proximate composition of flour blends

The result of the proximate composition of the flour blends is shown in table 2.

### Ash content

Ash content of any food is a measure of the total amount of minerals within food produce [31, 32]. Ash content of the flour blends ranged from 3.44% (CHU) to 5.84% with (CHUY<sub>5</sub>). The ash contents of CHUY<sub>4</sub> and CHUY<sub>5</sub> (4.44%, 4.74% and 4.84%) were significantly ( $p \leq 0.5$ ) different from of CHUY<sub>1</sub>, CHUY<sub>2</sub> and CHUY<sub>3</sub> flour blends respectively. There was no significant difference ( $p > 0.5$ ) in ash contents of CHUY<sub>1</sub>, CHUY<sub>2</sub> and CHUY<sub>3</sub> flour blends and the control CHU. However, the ash content values in the composite flour blends were considerably greater than that of the control CHU. This shows that substitution of date palm and toasted watermelon seeds had a significant increase in the ash content of the flour blends (Table 2). Some of these minerals that make up the ash content of a food aid in the metabolism of other organic compounds such as fat and carbohydrate [33].

## Moisture content

The moisture content of the different flour blends ranged from 8.25% (CHUY<sub>5</sub>) to 11.15% (CHUY<sub>3</sub>) as shown in table 2. CHUY<sub>5</sub> had the least moisture content (8.25%) as a result of increased level of substitution of date palm pulp in the flour blends. This result agreed with Peter-Ikechukwu *et al.* [34] report that high incorporation of date palm binds water due to the high sugar content. The moisture content of the composite flours when compared with control CHU showed that higher substitution of date palm reduced the moisture content of the flour blends. High moisture content favors the development of contaminating microorganisms, whose growth and activities cause spoilage in foods [35].

( $p \leq 0.5$ ) from all the formulated flour blends. There was no significant ( $p > 0.05$ ) difference among the protein contents of CHUY<sub>1</sub> (15.45%), CHUY<sub>2</sub> (15.50%) and CHUY<sub>3</sub> (15.99%) respectively while protein content of CHU (11.30%) was the least. The highest crude protein content (20%) was obtained in CHUY<sub>5</sub> (20.00%). The high protein value in CHUY<sub>5</sub> and CHUY<sub>4</sub> were as a result of the protein content of watermelon seed [22]. It would be seen that protein content increased in the flour blends with increased substitution with watermelon seed flour; and were higher than the protein content (10.97%) of composite flour obtained by Ojinnaka and Nnorom [33]. This also shows that these composite flours would meet with the protein need of people that would consume the baked products made with these flour blends.

**Table 2:** Mean values of the proximate composition of the composite flour.

Sample	Parameter (%)					
	Ash	Moisture	Crude Fibre	Crude Protein	Crude fat	Carbohydrate
CHUY <sub>1</sub>	4.44 ± 0.00 <sup>b</sup>	10.50 ± 5.90 <sup>b</sup>	2.03 ± 0.24 <sup>bc</sup>	15.45 ± 0.14 <sup>c</sup>	11.00 ± 11.70 <sup>c</sup>	54.39 ± 0.00 <sup>c</sup>
CHUY <sub>2</sub>	4.74 ± 1.41 <sup>b</sup>	10.20 ± 7.78 <sup>b</sup>	2.11 ± 0.20 <sup>b</sup>	15.50 ± 0.35 <sup>c</sup>	11.28 ± 7.95 <sup>c</sup>	54.33 ± 0.00 <sup>c</sup>
CHUY <sub>3</sub>	4.84 ± 0.28 <sup>b</sup>	11.15 ± 13.79 <sup>a</sup>	3.55 ± 0.07 <sup>a</sup>	15.99 ± 0.44 <sup>c</sup>	11.43 ± 11.20 <sup>bc</sup>	55.25 ± 0.22 <sup>b</sup>
CHUY <sub>4</sub>	5.44 ± 0.28 <sup>a</sup>	9.25 ± 13.79 <sup>bc</sup>	3.65 ± 0.28 <sup>a</sup>	18.15 ± 0.00 <sup>b</sup>	11.92 ± 6.50 <sup>b</sup>	57.00 ± 0.71 <sup>c</sup>
CHUY <sub>5</sub>	5.84 ± 0.42 <sup>a</sup>	8.25 ± 1.06 <sup>c</sup>	3.67 ± 0.03 <sup>a</sup>	20.00 ± 0.14 <sup>a</sup>	13.38 ± 0.39 <sup>a</sup>	60.00 ± 0.21 <sup>a</sup>
CHU	3.34 ± 1.4 <sup>c</sup>	10.55 ± 1.41 <sup>b</sup>	1.53 ± 0.81 <sup>c</sup>	11.30 ± 0.00 <sup>d</sup>	9.70 ± 0.60 <sup>d</sup>	50.13 ± 0.00 <sup>d</sup>
LSD	0.56	1.64	0.81	1.54	0.5	1.42

Means of duplicate determination. Mean with the same super subscripts within a column are not significantly different ( $p \leq 0.05$ ). CHU=100% wheat flour.

CHUY<sub>1</sub>=90% wheat flour-to-5% toasted watermelon seed flour-to- 5% date palm pulp.

CHUY<sub>2</sub>= 80% wheat flour-to-10% toasted watermelon seed flour-to 10% date palm pulp.

CHUY<sub>3</sub>=70% wheat flour-to-15%-toasted watermelon seed flour-to- 15%date palm pulp.

CHUY<sub>4</sub>= 60% wheat flour-to-20%-toasted watermelon seed flour -to-20% date palm pulp.

CHUY<sub>5</sub> = 50% wheat flour-to-25%-toasted watermelon seed flour-to-25% date palm pulp

## Crude fiber

The crude fiber content (Table 2) of the flour blends ranged from 1.53% (CHU) to 3.67% (CHUY<sub>5</sub>). Though no significant difference ( $p > 0.05$ ) was observed in crude fibre contents amongst flour blends CHUY<sub>5</sub>, CHUY<sub>4</sub> and CHUY<sub>3</sub> (3.67%, 3.65% and 3.55%), however, they were significantly different ( $p \leq 0.5$ ) from CHUY<sub>1</sub>, CHUY<sub>2</sub> and CHU (2.03%, 2.1% and 1.5%) respectively. The high crude fiber values obtained in CHUY<sub>5</sub>, CHUY<sub>4</sub> and CHUY<sub>3</sub> were due to increased substitution of toasted watermelon seed and date palm fruit pulp. The incorporation of date palm pulp in flour is of nutritional importance especially to diabetic patients [17], as it adds bulk to the diet and help in bowel movement. Crude fiber also helps in lowering of blood sugar level and brings down the absorption of glucose [17]. It is pertinent to note that crude fiber increases satiety and hence helps to impact some degree of weight management [36] due to low energy and low fat flour formulated.

## Crude protein

The crude protein content of the flour blends (Table 2) increased from 15.45% (CHUY<sub>1</sub>) to 20.00% (CHUY<sub>5</sub>). CHUY<sub>5</sub> (20.00%) and CHUY<sub>4</sub> (18.1%) were significantly different

## Crude fat

The fat contents (Table 2) of the flour samples increased as substitution with watermelon seed flour increased in the formulated composite flour. When compared with CHU (the control) it could be deduced that the increase in fat content was as a result of the watermelon seed flour added. The formulated flour blends were significantly different ( $p \leq 0.05$ ) from the control (CHU) in crude fat contents. The result obtained showed that an increase in percentage of toasted watermelon seed flour substitution gave a corresponding increase in the fat content of the composite flour blends. Fats act as flavor retainers and help to improve sensory properties of baked products. However, diets high in fat predispose consumers to different illnesses such as obesity and coronary heart diseases [33]. Hence these formulated flour blends would be useful in the production of baked products for people with such condition.

## Carbohydrates

The carbohydrate content of the flour blends ranged from 50.13% (CHU) to 60.00% (CHUY<sub>5</sub>) as shown in table 2. There was no significant ( $p > 0.05$ ) difference among the carbohydrate contents of CHUY<sub>1</sub> (54.39%), CHUY<sub>2</sub> (54.33%)

and CHUY<sub>3</sub> (55.25%) composite flours. The carbohydrate content was lowest in CHU (100% wheat flour). This however shows that the increase substitution with date palm fruit in the flour blends increased the carbohydrate value of the flour blends. These composite flours could be used to manage cases of protein energy malnutrition which is prevalent in most developing countries of the world [3, 37, 38].

### Functional properties of composite flours

The result of the functional properties of the flour blends are shown in table 3.

substitution in the composite blend samples. However, 100% wheat flour dissolved fastest in water when compared to composite flour samples.

### Viscosity

The values obtained for viscosity of the different composite flour blends ranged from 2.83 Nsm<sup>-2</sup> to 3.85 Nsm<sup>-2</sup> with CHU having the highest value and CHUY<sub>4</sub> had the lowest value. There was no significant difference ( $p > 0.05$ ) between composite flour blends. Composite flour comprising of toasted watermelon and date palm fruit pulp decreased in viscosity when compared with the control (CHU). However, this may

**Table 3:** Functional properties of composite flour.

Flour Blends	Functional Properties						
	Bulk Density (g/ml)	Wettability (s)	Viscosity (Nsm <sup>-2</sup> )	Foam Capacity (%)	Gelation Temperature (°C)	pH	Emulsion Capacity (g/ml)
CHUY <sub>1</sub>	0.72 ± 0.03 <sup>b</sup>	37.00 ± 3.00 <sup>d</sup>	3.00 ± 0.05 <sup>b</sup>	11.59 ± 0.04 <sup>a</sup>	62.55 ± 2.00 <sup>d</sup>	6.47 ± 0.05 <sup>a</sup>	2.44 ± 0.05 <sup>c</sup>
CHUY <sub>2</sub>	0.76 ± 0.01 <sup>b</sup>	37.55 ± 5.00 <sup>d</sup>	3.00 ± 0.05 <sup>b</sup>	11.55 ± 0.05 <sup>ab</sup>	64.00 ± 3.00 <sup>c</sup>	6.50 ± 0.05 <sup>a</sup>	2.40 ± 0.05 <sup>c</sup>
CHUY <sub>3</sub>	0.80 ± 0.00 <sup>a</sup>	45.25 ± 2.52 <sup>c</sup>	3.01 ± 0.00 <sup>b</sup>	11.56 ± 0.06 <sup>ab</sup>	65.05 ± 1.53 <sup>b</sup>	6.58 ± 0.09 <sup>a</sup>	2.48 ± 0.04 <sup>bc</sup>
CHUY <sub>4</sub>	0.84 ± 0.05 <sup>a</sup>	46.25 ± 2.52 <sup>b</sup>	2.83 ± 0.00 <sup>b</sup>	11.60 ± 0.06 <sup>a</sup>	66.82 ± 3.00 <sup>a</sup>	6.67 ± 0.06 <sup>a</sup>	3.00 ± 0.03 <sup>ab</sup>
CHUY <sub>5</sub>	0.85 ± 0.02 <sup>a</sup>	48.55 ± 0.00 <sup>a</sup>	2.85 ± 0.05 <sup>b</sup>	11.95 ± 0.01 <sup>a</sup>	67.55 ± 3.00 <sup>a</sup>	6.71 ± 0.05 <sup>a</sup>	3.17 ± 0.04 <sup>a</sup>
CHU	0.83 ± 0.01 <sup>a</sup>	14.00 ± 0.05 <sup>e</sup>	3.85 ± 0.05 <sup>a</sup>	9.48 ± 0.06 <sup>b</sup>	60.55 ± 2.09 <sup>f</sup>	5.63 ± 0.06 <sup>b</sup>	1.52 ± 0.03 <sup>d</sup>
LSD <sub>0.05</sub>	0.08	0.85	0.81	2.11	1.01	0.73	0.54

Means of duplicate determination. Mean with the same super subscripts within a column are not significantly different ( $p \leq 0.05$ ).

Keys:

CHU=100% wheat flour.

CHUY<sub>1</sub>=90% wheat flour-to-5% toasted watermelon seed flour-to- 5%date palm pulp.

CHUY<sub>2</sub>= 80% wheat flour-to-10% toasted watermelon seed flour-to 10% date palm pulp.

CHUY<sub>3</sub>=70% wheat flour-to-15%-toasted watermelon seed flour-to- 15%date palm pulp.

CHUY<sub>4</sub>= 60% wheat flour-to-20%-toasted watermelon seed flour -to-20% date palm pulp.

CHUY<sub>5</sub>= 50% Wheat flour-25%-toasted watermelon seed flour-to-25% date palm pulp.

### Bulk density

The values obtained for bulk density ranged from 0.72 g/ml (CHUY<sub>1</sub>) to 0.85 g/ml (CHUY<sub>5</sub>). The result obtained showed that, increase in proportion of toasted water melon seed and date palm used increased the bulk density of the flour blends; and also the addition of toasted water melon seed and date fruit palm has effect on the bulk density of the flour when compared to the control (100% wheat). Bulk density is important in determining the packaging requirement, material handling, and application in processing in food industry [28]. Low bulk density is a desirable factor in food formulation especially food with less retrogradation [39]. However high bulk density is a good physical attribute when determining the mixing quality of a particular matter [28].

### Wettability

Wettability is a function of ease of dispersing flour samples in water and the sample with lowest wettability dissolves fastest in water [22]. Wettability of the samples ranged from 14.00 to 48.00 seconds, with CHUY<sub>5</sub> recording the highest value and CHU had the least wettability values. There were significant differences ( $p \leq 0.05$ ) amongst the samples and with the control CHU. The high values obtained were due to proportion of watermelon seed flour and date palm fruit

be as result of increase in protein content and fat from the toasted watermelon seed of the composite flour blends, which is in accordance with Omobolanle *et al.* [40] who stated that the existence and interaction of components like protein and fat in composite flours reduces the viscosity of the composite flour.

### Foam capacity

The foam capacity (Table 3) of the different blends ranged from 9.48% (CHU) to 11.95% (CHUY<sub>5</sub>). CHUY<sub>5</sub> (50:25:25 of wheat flour, date palm fruit pulp and toasted water melon seed respectively) had the highest foam capacity, while the lowest was CHU. The increase in the foaming capacity value of CHUY<sub>5</sub> was as result of high proportion of toasted water melon seed in this particular flour blend. However, there was no significant difference ( $p > 0.05$ ) amongst the formulated flour blends CHUY<sub>1</sub>, CHUY<sub>2</sub>, CHUY<sub>3</sub>, CHUY<sub>4</sub> and CHUY<sub>5</sub>. This showed that the protein content of toasted watermelon seed increased the foaming capacity of the flour blends. Good foam stability is a desirable attribute for flours intended for the production of variety of baked goods such as cookies, muffins etc. It also acts as functional agents in other food formulations [12, 28].

### Gelation temperature

The gelation temperature of the various flour blends ranged from 60.55 °C (CHU) to 67.55 °C (CHUY<sub>5</sub>). CHUY<sub>5</sub> had the highest gelation temperature among the various flour samples, while sample CHU had the least. This was as a result of the protein and carbohydrate content of toasted watermelon seed and date palm. Gelation primarily enhances the body and texture of a food product [22].

### pH

The pH of the flour blends (Table 3) varied from 5.63 (CHU) to 6.71 (CHUY<sub>5</sub>) with sample CHUY<sub>5</sub> having the highest value (6.83) and CHU had the least value. No significant difference ( $p > 0.05$ ) was observed amongst the formulated samples (CHUY<sub>1</sub>, CHUY<sub>2</sub>, CHUY<sub>3</sub>, CHUY<sub>4</sub> and CHUY<sub>5</sub>), but all were significantly ( $p \leq 0.05$ ) different from the control CHU. The pH values of the composite flour samples increased as the ratio of toasted watermelon seed and date fruit pulp flour increased. This is in line with Ikpeeme *et al.* [41] which stated that acidic products are more shelf stable than its non-acidic counter parts. Meanwhile, the addition of toasted watermelon seeds and date palm fruit pulp reduced the acidity of the samples.

### The emulsion capacity (EC)

The emulsion capacity of the different flour blends ranged from 1.52 g/ml (CHU) to 3.17 g/ml (CHUY<sub>5</sub>). The high emulsion capacity value obtained in CHUY<sub>5</sub> was as a result of oil and protein content of toasted water melon seeds. High emulsification is an indication that the flour sample could be an excellent emulsifier in various foods [42]. This significant increase in EC could be attributed to protein being the surface-active agents and can form and stabilize the emulsion by creating electrostatic interaction on oil droplets surface [43]. In accordance with Mwasura *et al.* [44], the result showed that blends possess a good emulsifying property that could serve as a vital source of emulsification [28, 40].

## Conclusion and Recommendations

### Conclusion

The use of date palm fruit pulp and toasted watermelon seed as sugar and fat substitutes respectively in the flour blends improved the functional properties of the flour such as the bulk density, gelation temperature, wettability, foam capacity, emulsion capacity but decreased pH and viscosity. Flour blends with date palm and toasted watermelon seeds flour gave better functional properties when compared with the control (CHU).

The proximate composition of the composite flour blends increased with increase in percentage of toasted watermelon seeds and date palm fruit pulp except for moisture content. Moisture contents decreased with increased ratio of toasted watermelon seed flour and date palm flour. Toasted watermelon seed and date palm fruit enriched the formulated flour blends when compared with CHU (100%), hence, the effect of toasted watermelon seed flour and date palm fruit pulp can be appreciated.

### Recommendation

Based on the results and discussions obtained, the following recommendations are noteworthy:

- More work should be done in the area of packaging, developing appropriate packaging material for the flour blends
- Storage stability study should be carried out to be able to establish shelf life of the flour blends for mass production.

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