

Effect of Rice Bran Substitution on the Physicochemical Properties of Water Yam Flour

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ABSTRACT---- *This work was performed to investigate the effect of rice bran substitution on the nutritive value of water yam flour. The chemical, functional, phytochemical and pasting properties of the flour were determined. The result indicated that 60WYF:40RB% had the highest protein (26.60%), fat (14.00%) and energy (380.84 kcal), ash (4.03%), while 60WYF:40RB% had the highest moisture content (13.99%). Sample 60WYF:40RB% had the highest alkaloid (7.50%), oxalate (3.82 mg/100g) and saponin (38.50%). The result showed that 60WYF:40RB% flour had the highest water absorption capacity (220%), oil absorption capacity (300%), bulk density (0.67g/ml) and low in foaming capacity (4.00%). There was a significant difference ($P < 0.05$) among the samples. Furthermore, it is worthy to note that as level of substitution of water yam with rice bran increased, nutritive value of composite flour blends was improved.*

Keywords: Rice bran, water yam flour, proximate, functional, phytochemical, pasting properties

1. INTRODUCTION

Yam which is popular in Nigeria serves as food for both adults and children is also an essential source of carbohydrate for the inhabitant of yam producing area of West Africa (Akissoe *et al.*, 2003). There are different types of yam varieties and they are *Dioscorea esculenta* (lesser yam), *Dioscorea rotundata* (white yam), *Dioscorea alata* (water yam) and *Dioscorea cayensis* (yellow yam). Water yam (*Dioscorea alata*) is known to contain bioactive compounds such as dioscorine, diosgenin and water soluble polysaccharide (Harijono *et al.*, 2013). These protein and polysaccharides are essential in controlling and management of hypertension, cholesterol metabolism, obesity has and anti-tumor activity (Moalic *et al.*, 2001; Kwon *et al.*, 2003; Liu *et al.*, 2007; Li *et al.*, 2012). The application of water yam as composite flour with wheat in production of bakery products such as cookies, bread and cakes has been documented by Adeleke and Odedeji (2010). In Nigeria water yam species is applied in herbal medicine for the treatment of infertility in man (Okwu and Ndu, 2006). The water yam tuber from which flour is produced consist mainly of carbohydrate, and contains small amount of protein contents, which has become source of worry in relation to its consumption alone. Using rice bran in production of products such as biscuit is a way of adding value to rice bran which is regarded as waste. In addition, substituting yam flour with rice bran should provide a product that may be more suitable for persons suffering from diabetes and cardiovascular disorder since previous studies has shown that rice bran is beneficial for human health. These health benefits includes prevention of cancer, asthma, arthritis high blood pressure (Vogt *et al.*, 2003; Babu *et al.*, 2009). It is high in protein, contains reasonable quantity of antioxidants such as tocopherols, tocotrienol, gamma-oryzanol (Godber and Wells, 1994; Godber and Juliano, 2004; Orthoesfer and Eastman, 2004).

Therefore, fortification of water yam flour with rice bran will improve the nutritional quality and render health benefits to consumers. However, fortification could possibly influence the physical and chemical, functional and pasting properties of flour oriented foods (Adebowale *et al.*, 2008). Such knowledge will be beneficial to food processors and nutritionists to formulate a commercial product based on water yam-rice bran blends.

Developing new flour for producing snacks such as biscuit from indigenous plant will create new uses for underutilized plants. In addition, it will give consumers new alternative uses of water yam and rice bran. Furthermore, the study will bring to light the possibility of using this underutilized plant for food product development. The objective of this study is to investigate the effect of rice bran on the physicochemical properties of water yam flour.

2. MATERIALS AND METHOD

2.1 Sources of raw materials

Fresh rice bran was collected from Ebony Agro Mill, in Ikwo Local government area of Ebonyi State while water yam was purchased from Nkwegu market in Abakaliki local government area of Ebonyi State, Nigeria.

2.2 Stabilization of rice bran

Fresh mill bran was placed in a well ventilated oven (Griffin and Gero made in Britain), maintained at a temperature of 120 °C for 10 minutes to inactivate lipase enzyme. The stabilized rice bran was allowed to cool to room temperature and was packaged in jute bags and stored in a laboratory cupboard for further analysis as described by Iqbal (2005).

2.3 Preparation of water yam flour

The method of Binta *et al.* (2010) was used to prepare the water yam flour. Ten kilograms of water yam was washed, peeled, sliced into cubes and sundried. The dry yam chips were milled using a local attrition mill to obtain fine flour and packaged in an airtight high density polyethylene bag until needed for further analysis. Production of water yam and rice bran flour blends is described using the table below.

Table 1: Treatment use in the study

Treatments:	Water yam flour (%)	Rice bran (%)
WYF	100	0.00
T ₁	60	40
T ₂	80	20
T ₃	70	30
T ₄	90	10

Where T₁ = 60:40 water yam/rice bran flour, T₂ = 70:30 water yam / rice bran flour,
T₃ = 80:20 water yam / rice bran flour, T₄ = 90:10 water yam / rice bran flour,
WYF = 100% water yam flour, wheat flour = control.

2.4 Proximate determination

The proximate analysis for moisture content, protein content, ash, dietary fibre, carbohydrate, energy and fat content were carried out on the flour samples using standard methods (AOAC, 2000).

2.5 Functional properties determination

The water absorption capacity, oil absorption capacity, bulk density, foaming capacity and emulsion capacity were determined using the methods described (Onwuka, 2005).

2.6 Phytochemical determination

The oxalate was determined using the method described by (Onwuka, 2005), while the phytate, saponin, alkaloid, tannin and phenol were determined using the method of (Obadoni and Ochukwu, 2001).

2.7 Pasting Properties

The pasting characteristic was determined with a Rapid visco-analyzer (RVA), (Model RVA 30⁺, Newport Scientific, and Australia). (Newport Scientific, 1998).

2.8 Statistical Analysis

Complete randomized design was conducted on each of the data by means of one way analysis of variance (ANOVA) procedure on statistical package for the social science (v 20.0 SPSS Inc., Chicago, Illinois, USA). The values were separated using Turkey test to determine whether significant variations occurred among means in each of the sample. Significance was established at 5 % probability levels ($p < 0.05$).

3. RESULT AND DISCUSSION

3.1: Chemical Composition of Water Yam/ Rice Bran Flour Blends

The result of the chemical composition of water yam/ rice bran flour blends is presented in Table 1 below.

Table 1: Chemical Composition of Flour from Water Yam and Rice Bran Blends

Code	Protein (%)	Ash (%)	Moisture (%)	Fat (%)	Soluble Fibre	Insoluble Fibre	Total Dietary Fibre	Carbohydrate	Energy (K Cal)
T ₁	26.60±0.12 ^a	4.03±0.05 ^a	13.99±0.04 ^a	14.00±0.04 ^a	1.09±0.06 ^d	2.86±0.01 ^e	4.00±0.00 ^f	37.11±0.08 ^e	380.84±0.52 ^a
T ₂	23.97±0.02 ^b	3.56±0.02 ^b	13.99±0.05 ^a	13.50±0.43 ^a	1.12±0.07 ^c	2.98±0.11 ^d	4.07±0.07	40.98±0.38 ^d	381.30±2.27 ^b
T ₃	22.75±0.02 ^c	3.50±0.03 ^c	13.00±0.02 ^b	12.49±0.02 ^b	1.12±0.00 ^c	3.03±0.00 ^c	4.16±0.00 ^c	44.60±0.02 ^c	381.81±0.18 ^c
T ₄	18.20±0.04 ^d	2.50±0.02 ^d	12.99±0.01 ^b	11.20±0.06 ^c	1.17±0.00 ^b	3.09±0.00 ^b	4.27±0.00 ^b	51.03±0.44 ^b	377.73±0.18 ^d
WYF	5.99±0.11 ^f	2.00±0.04 ^e	8.83±0.02 ^d	3.98±0.01 ^d	1.21±0.01 ^a	3.13±0.01 ^a	4.34±0.0 ^a	66.83±0.20 ^a	359.24±0.12 ^e
Wheat	13.14±0.05 ^e	2.00±0.06 ^e	10.00±0.04 ^c	4.00±0.05 ^d	1.06±0.01 ^d	2.96±0.00 ^d	4.02±0.01 ^e	34.23±0.13 ^f	355.88±0.23 ^f

Means are values of triplicate determinations

Values with the same superscript within a column are significantly the same (P < 0.05) level.

Where T₁ = 60:40 Water yam/ rice bran flour, T₂ = 70:30 Water yam/rice bran, T₃ = 80:20 Water yam/ rice bran

T₄ = 90:10 Water yam/rice bran, WYF = Water yam flour

The protein content of the flour is presented in Table 1. The results shows that the substituted blended flour had higher protein content ranging from (18.20 – 26.60 %) followed by wheat (13.14 %) while water yam had the least protein content (5.99 %). There was a substantial raise in protein content of flour with increase in level of supplementation. The values indicate that significant difference ($P < 0.05$) exists among the samples. High protein content has been reported by (AbdEl-Galeel and EL-Bana, 2012; Rosniyana *et al.*, 2007; Hu *et al.*, 2009) rice bran. The protein value is very high when compared with other formulated flour (7.28 %) when yam flour was replaced with 40 % cowpea flour (Ashwel, 2001). Therefore, the increase in incorporation of rice bran flour into water yam flour will improve the protein value of a product produced from the flour. Its high protein will be an advantage in the preparation of weaning food formulation.

The fat content presented in Table 2. Fat content ranged from (11.20 – 12.49 %), followed by wheat flour (4.00 %) while water yam had the least (3.99 %). Fat content of the formulated flour increased with increment in substitution levels. The value gotten for composite flour is in good harmony with those obtained by (Idouraine *et al.*, 1996; Rosniyana *et al.*, 2007; Rosniyana *et al.*, 2009) who attributed the elevated lipid to the presence of clustered aleurone layers in the rice bran which are separated mostly at the first stage of milling.

The moisture content is as shown in Table 2. Moisture content ranged from 12.99 % - 13.00 %, followed by wheat flour (10.00 %), while water yam flour had least moisture content (8.83 %). There was significant difference ($P < 0.05$) among the sample. The range of moisture content implies that the flour had good storage potential, since it is a known fact that moisture and water activity of a product determine greatly the keeping quality of the food.

The ash content is as seen in Table 2 above. Ash ranged from 4.03 – 2.00 % in the samples. The sample differ significantly ($P < 0.05$). The value reported is similar to report by Abd-EL-Galeel and EL-Bana, (2012) and Rosniyana *et al.* (2009). The ash content increased with the incorporation of rice bran flour. This is in agreement with the reports of Adebayo *et al.* (2012) who stated that ash content increases with increase in substitution. High value of the flour blends suggests that the composite flour is high in minerals.

The carbohydrate content of the blends is as seen in Table 2, ranged from 66.83 – 34.23 %. There was a significant difference ($P < 0.05$) among the sample. It could be observed that the carbohydrate present in rice bran is from the starch endosperm, ridges and broken pieces resulting from the final milling operation to remove the final traces of bran layers as well as kernel endosperm (Lloyd *et al.*, 2000). However, carbohydrate reduced with incorporation of rice bran flour. These results is in harmony with the report of Jimoh and Olatidoye (2009), who stated that there was a reduction in carbohydrate content when soybean flour level was increased. Energy content of the flour is presented in Table 3 above. The energy value of blended flour ranged from 380.84 – 355.88 kcal. The energy differ significantly ($P < 0.05$) among the samples. Energy was observed to be elevated in the entire formulation and increased with increased level of substitution.

Table 1 showed the dietary fibre content of rice bran and water yam flour blended at various level of substitution. It was shown that there was variation of soluble and insoluble dietary fibre content between the samples and there was significance difference ($P < 0.05$). The content of soluble dietary fibre did not differ by increasing the substitution level of the bran, while on the contrary, the content of insoluble dietary fibre increased by increasing the level of substitution. Soluble dietary fibre ranged from 1.09 to 1.17 % in the formulated flour, followed by water yam flour (1.28 %) while wheat flour had the least content (1.06 %). The results are lower than that reported by (Damayanthi, 2001). Insoluble dietary fibre content ranged from (2.87 – 3.09 %) for blended flour, followed by water yam flour (3.13 %) and wheat flour (2.96 %). The values are lower than that reported by (Damayanthi, 2001). The high value recorded for insoluble fibre may be due to the fact that rice bran contains mostly cellulose, hemicelluloses and pentosan which are all insoluble dietary fibre and that it contains about 2 % soluble dietary fibre. Other factors that affect dietary fibre include processing methods and degree of milling (Rosniyana *et al.*, 2009).

The total dietary fibre ranged from (4 – 4.34 %). Essential health profits linked with optimal ingestion of dietary fibre comprises decreased coronary heart diseases, decreased risk of developing type 2 diabetes, better satiety and stool bulking (Buttriss and Stokes, 2008; Kendall *et al.*, 2010).

3.2 Functional Properties

3.2.1 Functional Properties of Water Yam/ Rice Bran Flour Blends.

The result of functional properties of water yam/ rice bran flour blends is presented in Table 2 below.

Table 2: Functional Properties of Water Yam and Rice Bran and Wheat Flour Blends

Code	Water absorption capacity (%)	Oil absorption capacity (%)	Emulsion Capacity (%)	Bulk Density g/mL	Foaming Capacity (%)
T ₁	220.00±10.00 ^a	300.00±0.90 ^a	82.26±0.36 ^b	0.67±0.06 ^a	4.00±0.02 ^c
T ₂	210.00±15.00 ^a	250.00±0.50 ^b	81.60±0.09 ^b	0.62±0.05 ^b	4.00±0.03 ^c
T ₃	200.00±10.00 ^a	220.00±0.30 ^c	76.94±0.02 ^c	0.62±0.00 ^b	8.00±0.05 ^d
T ₄	180.00±0.70 ^b	200.00±0.70 ^c	72.74±0.02 ^d	0.60±0.00 ^b	9.93±0.04 ^c
WYF	140.00±0.50 ^b	200.00±0.40 ^c	65.62±0.03 ^e	0.58±0.00 ^c	11.93±0.05 ^b
Wheat	120.00±0.30 ^b	210.00±0.30 ^c	86.57±0.04 ^a	0.50±0.00 ^d	14.00±0.04 ^a

Values are means of triplicate determinations

Values with the same superscript within a column are significantly the same (P<0.05) level

Where T₁ = 60:40 water yam/rice bran flour
 T₂ = 70:30 water yam/rice bran flour
 T₃ = 80:20 water yam/rice bran flour
 T₄ = 90:10 water yam/rice bran flour
 WYF = 100% water yam flour
 Wheat = 100% control

Water absorption capacity of the samples is presented in Table 2. The result indicates that 60 WYF: 40 RB had the highest value (220 %) while least value was recorded in 100 % water yam flour (140 %). Significant differences ($P < 0.05$) exist among samples. Water absorption capacity increased with addition of rice bran flour. The increase may be due to the proportion of hydrophilic amino acid present in the protein. The result obtained is higher than those reported by Singh *et al.*, (1991). Adepeju *et al.* (2014) reported that elevated water hydration ability is advantageous in food structure to get better yield and uniformity of food product. This is in agreement with the finding of Satina *et al.* (2011).

Oil absorption capacity of the samples is presented in Table 2. The oil absorption capacity ranged from 300 to 200 %. The highest value was observed in 60 WYF: 40 RB (300 %) and 100 % water yam flour had the least (200 %). The oil absorption capacity increased with addition of rice bran flour. This means that rice bran can be used to improve oil absorption of a material. Hutton and Campbell (1981) reported that the ability of food to absorb oil may help to enhance flavor retention and mouthfeel.

The result of the bulk density is presented in Table 2. The bulk density ranged from 0.67 to 0.50 g/ml. The result revealed that the bulk density was increased upon addition of rice bran flour where higher values were recorded. The bulk density differ significantly ($P < 0.05$) among the samples. The values are higher than that reported by Satinar *et al.* (2011) for defatted rice bran.

Result of the foaming capacity is presented in Table 2. The foaming capacity ranged between 14 and 4 %. The result showed that there was a decrease in the foaming capacity with increase in rice bran flour. The sample was significantly different ($P < 0.05$). The foaming capacities were less compared with result reported by (Oshodi *et al.*, 1999). Ekasit *et al.* (2010) associated good foaming capacity with flexible protein molecules which is easily denatured and reduces surface tension. This implies that protein in rice bran flour is a highly ordered globular protein which is not easily denatured. Formulated sample cannot be use in aerating products such as cake, chipped toppings.

The result of emulsion capacity is presented in Table 2. The values ranged from 86.57 to 65.62 %. The result revealed that there was an increase in emulsion capacity with addition of rice bran. There was a significant difference ($P < 0.05$) among samples. Due to high emulsion Properties of formulated flour from rice bran and water yam, it can be used as additives for the stabilization of emulsions.

3.3 Phytochemical Properties

3.3.1 Phytochemical Composition of Water Yam/ Rice Bran Flour Blends.

The result of the phytochemical composition of water yam/ rice bran flour blends is presented in Table 3 below.

Table 3: Phytochemical Composition of Water Yam and Rice Bran and Wheat Flour Blends

Code	Alkaloid (%)	Oxalate(mg/100g)	Phytate (mg/100g)	Saponin (%)	Tannin (%)	Phenol (mg/100g)
T ₁	7.50±0.02 ^a	3.82±0.05 ^a	2.18±0.02 ^c	38.30±0.20 ^a	2.44±0.02 ^f	0.001±0.00 ^a
T ₂	6.25±0.06 ^b	3.81±0.02 ^a	2.31±0.09 ^c	28.50±0.02 ^b	4.17±0.01 ^e	0.002±0.00 ^a
T ₃	4.98±0.03 ^c	0.94±0.02 ^c	2.41±0.16 ^c	20.50±0.20 ^c	5.79±0.02 ^c	0.002±0.00 ^a
T ₄	4.95±0.14 ^c	0.94±0.04 ^c	3.28±0.49 ^b	15.50±0.30 ^d	6.06±0.03 ^b	0.002±0.00 ^a
WYF	3.50±0.02 ^d	0.23±0.16 ^d	3.43±0.02 ^a	6.00±0.02 ^e	5.36±0.04 ^d	0.003±0.00 ^a
Wheat	3.00±0.02 ^e	2.89±0.00 ^b	3.00±0.01 ^d	5.00±0.52 ^f	7.77±0.02 ^a	0.004±0.00 ^a

Means are values of triplicate determinations

Values with the same superscript within a column are significantly the same (P < 0.05) level

Where T₁ = 60:40 water yam/rice bran flour
 T₂ = 70:30 water yam/rice bran flour
 T₃ = 80:20 water yam/rice bran flour
 T₄ = 90:10 water yam/rice bran flour
 WYF = 100% water yam flour Wheat = 100% control

The oxalate content of the sample is presented in Table 3. The result shows that blended flour had elevated oxalate value which ranged from 3.82 – 0.23 mg/100g, followed by wheat flour (2.8 mg/100g) while water yam flour had the least (0.94 mg/100g). There was a significant difference ($P < 0.05$) among the samples. The result indicates that supplementing water yam flour with rice bran increased the oxalate content. High oxalate has been reported by Satinder *et al.* (2011) for rice bran, followed by wheat bran and oat bran. The result suggests that water yam flour fortified with rice bran would supply a constant intake of oxalate. The elevated oxalate content in formulated flour than in polished cereal grain implies that oxalic acid is mostly situated in the surface covering of grains cereal (Satinder *et al.*, 2011). However, the study reveals that all the flours can be consumed even by patients suffering from kidney stone. This is because the value is far below the daily recommended intake not to go above 50 – 60 mg/day (Chicago Dietetic Association, 2000).

Table 3 shows the phytate content of the flour in different concentrations. The phytate content ranges from 3.43 to 2.18 mg/100g in the formulated flour. Statistically, significant variations were observed.

Table 3 revealed that blends of flour from water yam and rice bran exhibited higher level of saponin (38.50-15.50 %), followed by water yam flour (6.00 %) and wheat flour (5.00 %). There was significant difference ($P < 0.05$) among the sample. Satinder *et al.* (2011) reported high saponin content for rice bran, followed by wheat bran and barley bran. Therefore, the high content of saponin observed is contributed by rice bran flour. The high level of saponin is nutritionally advantageous since saponin exercise several biological gains like anti-atherosclerotic, hepatoprotective and hypolipidemic, anti-HIV, anti-inflammatory and anti-diabetic and serve as gastro-protective, (Lee *et al.*, 1996; Banno *et al.*, 2004). Saponins are helpful in preventing osteoporosis, peptic ulcer, lowering blood cholesterol and enhance liver function (Kao *et al.*, 2008).

The alkaloid content of the sample is presented in Table 3. The results show that blended flour sample had higher alkaloid, followed by wheat while water yam flour had the least alkaloid content. The sample differ significantly ($P < 0.05$). Alkaloid has been categorized as the major component that is therapeutically important substance in plant. Wholesome alkaloid extracted from plant and their artificial derivations are applied as essential medicinal ingredients for their bactericidal, antispasmodic and analgesic effects (Stray, 1998).

The tannin content of flour is presented in Table 3. The result shows that formulated flour had lower tannin content compared to wheat and water yam flour. However, there was significant difference ($P < 0.05$) among the samples. Satinder *et al.* (2011), reported lower value of tannin for wheat bran, rice bran, oat bran and the value reported by Okwu and Ndu (2006) is lower than the value reported for this work. Tannins have been reported to speed up the rate of healing in enlarged mucous membrane, to be quick in curing of wounds and to possess astringent properties. The presence of tannin in the flour will support their use in treating haemorrhoid, varicose ulcers, frostbite, burns in herbal medicine and wound (Okwu and Okwu, 2004).

The phenol content of flour is presented in Table 3. The result revealed that wheat had the highest phenol content, followed by water yam flour while the formulated flour had the least phenol content. Statistically, significant difference ($P > 0.05$) did not exist between the samples. The value are lower than the value reported by Satinder *et al.* (2011) for rice bran and value reported by Okwu and Ndu, (2006) for water yam flour is higher than value reported for this work. The trace quantities of phenolic compounds indicate that the sample could act as immune enhancers, hormone modulators, antioxidant, anti-clothing and anti-inflammatory (Okwu and Omodamoro, 2005).

3.4 Pasting Properties

3.4.1 Pasting Properties of Flour from Water Yam/ Rice Bran Blends.

Pasting properties of flour from water yam/ rice bran blends is as shown in Table 4 below.

Table 4: Pasting Properties of Wheat and Water Yam/Rice Bran Flour Blends

Sample	PV	TV	BD	FV	P. Time	Setback	Pasting Temp
T ₁	66.67±0.02 ^c	62.42±0.02 ^a	4.25±0.02 ^a	256.75±0.02 ^b	5.75±0.02 ^d	194.33±0.02 ^a	92.25±0.00 ^b
T ₂	66.08±0.04 ^d	62.08±0.01 ^a	4.00±0.02 ^b	235.42±0.02 ^d	6.62±0.02 ^c	173.33±0.04 ^d	91.75±0.00 ^e
T ₃	68.67±0.02 ^b	66.00±0.02 ^a	2.67±0.02 ^c	257.33±0.04 ^a	6.95±0.09 ^a	191.33±0.03 ^b	92.55±0.00 ^c
T ₄	62.75±0.02 ^e	60.58±0.02 ^a	2.17±0.02 ^d	230.83±0.02 ^e	6.88±0.02 ^b	170.25±0.02 ^e	94.45±0.00 ^a
WYF	50.33±0.01 ^f	46.83±0.03 ^b	3.50±0.03 ^c	120.25±0.02 ^f	6.70±0.00 ^c	73.42±0.03 ^{fs}	92.29±0.00 ^b
Wheat	69.92±0.02 ^a	67.25±0.02 ^a	2.67±0.02 ^e	250.00±0.03 ^c	5.58±0.02 ^e	182.75±0.02 ^c	90.24±0.00 ^d

Means are values of duplicate determinations

Values with the same superscript within a column are significantly same (P < 0.05) level.

Where FV = Final viscosity, BD = Breakdown viscosity TV = Trough viscosity, PV = Peak viscosity

Where T₁ = 60:40 water yam/rice bran flour
 T₂ = 70:30 water yam/rice bran flour
 T₃ = 80:20 water yam/rice bran flour
 T₄ = 90:10 water yam/rice bran flour
 WYF = 100% water yam flour
 Wheat = 100% control

The peak viscosity value ranged between 66.67 and 50.33 RVU. The maximum value was observed in wheat flour (100 %) while the least value was observed in 100 % water yam flour (Table 4). Peak viscosity is the highest thickness reached during or after the cooking of the sample. The sample differed significantly ($P < 0.05$). Peak viscosity is the capacity of the starch to rise up prior to its physical breakdown (Sanni *et al.*, 2004). The results indicate that the addition of rice bran to water yam flour increased the maximum thickness. High peak viscosity gives the water holding power of a material and takes place at stable point during swelling, thereby leading to rise in thickness break and arrangement causing it to reduce.

The trough viscosity value ranged from 67.27 to 46.83. The maximum value was observed in wheat flour (100 %) while the least value was observed in 100 % water yam flour. There was no significant difference ($P > 0.05$) among the samples. Trough thickness measures the smallest capacity of the paste to resist collapse during the period of cooling (Adegunwa *et al.*, 2011). The value is greater than the value reported by (Appiah *et al.*, 2011).

The breakdown value ranged from 4.25 to 2.17RVU. The highest value was recorded in 60 WYF: 40 RB % while the least value was recorded in 90 WYF: 10 RB %. Significant difference ($P < 0.05$) was observed in all the samples. The breakdown viscosity shows the stability of cooled starch. Breakdown is a measure of susceptibility of cooled starch granules to disintegrate (Beta *et al.*, 2003). Generally, the breakdown viscosity is low which suggest that all the samples are more stable and has high resistance to retrogradation, syneresis or weeping, cooling or paste stability.

The setback value ranged from 194.33 to 73.42 RVU. Sample 60 WYF: 40 RB had the maximum setback value whereas 100 % water had the least value. The setback value differ significantly ($P < 0.05$) between the samples. Setback is a stage in pasting profile that is related to the re-association of starch after cooking (Kin *et al.*, 1995).

The pasting time is presented in Table 6. The values ranged from 6.95 to 5.58 minutes. The highest value was observed in 80 WYF: 20 RB flour while wheat flour had the least value. The sample differ significantly ($P < 0.05$).

Pasting temperature ranged from 94.45 to 92.24^oC. Significant difference ($P < 0.05$) existed among the samples. Pasting temperature gives the lowest temperature needed to cooking a sample, cost of energy involved and other component firmness.

The final viscosity ranged from 257.35 to 120 RVU. The maximum value was observed in 60 WYF: 40 RB flour whereas the least value was observed in 100 % water yam flour. Significant was difference ($P < 0.05$) among samples. Final viscosity shows the capacity of a sample to yield a gel or thick paste upon cooling or cooking in opposition to the paste due to shear stress during mixing (Adebowale *et al.*, 2005).

4. CONCLUSION

This study was undertaken to evaluate the effect of rice bran substitution on water yam flour and its effects on the quality characteristics of the flour. The following were observed at the end of the study. Inclusion of rice bran into water yam flour resulted in significant increase in the chemical composition of the flour blends. The inclusion of rice bran into water yam flour led to better functional properties, phytochemical and pasting of the developed flour blends.

5. REFERENCES

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