ISSN:
Print - 2277 - 0593
Online - 2315 - 7461

Journal of Natural Science, Engineering and Technology

QUALITY ATTRIBUTES OF PANCAKES FROM PEELED AND UNPEELED SWEETPOTATO FLOURS WITH CASSAVA STARCH

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ABSTRACT

This study evaluated some quality attributes of pancakes from peeled and unpeeled sweetpotato flours and cassava starch. Cassava starch was substituted up to 30% of the total composite flour. The proximate composition, colour, carotenoid and functional properties of the different flour blends were determined. The flour blends were processed into pancakes and the proximate composition and sensory acceptability of the pancakes were determined. Data obtained were subjected to analysis of variance. The result showed that they were significant differences ($p<0.05$) in the functional properties of the flour blends. Bulk density, Water absorption capacity, Oil absorption capacity, swelling capacity ranged from 0.70 to 0.78 g/ml, 1.87 to 2.30 g/ml, 1.02 to 1.40 g/ml and 5.18% to 6.66% respectively. There were significant differences ($p<0.05$) in the proximate composition of the pancake samples. The values ranged from 42.76 to 45.53%, 2.13 to 3.98%, 9.06 to 10.34%, 5.01 to 7.18%, 3.75 to 6.01% and 29.19 to 35.33% for moisture, ash, fat, protein, crude fibre and carbohydrate contents, respectively. Pancake produced from 100:0 peeled and unpeeled sweetpotato flour had the highest score for overall acceptability which can compare favorably, with pancakes from wheat flour which is the control sample. In conclusion, sweetpotato flour blended with cassava starch at different ratio gave good proximate and functional properties which resulted in pancakes of good quality attributes.

Keywords: Sweetpotato flour, cassava starch, frying, pancake, proximate composition

INTRODUCTION

Gluten is a major protein component of wheat flour which is responsible for dough forming characteristics in baking industry. It affects elastic properties of dough and contributes to the overall appearance and crumb structure of many baked products (Torbica *et al.,* 2012). Pancake is a flat cake, often thin, and round, prepared from a starch-based batter and cooked on a hot surface such as a griddle or frying pan. They can be served for breakfast, lunch, dinner or dessert, and even as an appetizer. They may be served at any time with a variety of toppings or fillings including jam, fruit, syrup, chocolate chips, or meat (Dalby and Andrew, 1996).

The prevalence of celiac disease (CD), an intolerance of gluten, has been reported to be as high as one in 200 of the world population (Fasano and Catassi, 2001).

Pancakes are another popular wheat-based product that can be reformulated to be nonwheat and gluten-free. Conventional wheat pancakes have been studied extensively on processing conditions for the improvement of texture and flavour (Seguchi *et al*. 1998). Sweetpotato is an economical and healthy food crop, gluten-free and particularly rich in beta-carotene (pro-vitamin A). Beta-carotene is a powerful antioxidant known to give orange vegetables and fruits their vibrant colour, which is converted to vitamin A in the body, potassium, dietary fiber and many other healthy nutrients such as Choline. Choline helps with sleep, muscle movement, learning and memory and that makes it an important and versatile nutrient in sweetpotato. Consuming foods rich in beta-carotene may reduce the risk of developing certain types of cancer, offer protection against asthma and heart disease and delay aging and body degeneration. Sweetpotato can be processed into flour, flakes, purees, canned products, beverages and various snack foods. Sweetpotato flour and flakes can partly substitute wheat and other cereals flours, and enrich beta-carotene content in bakery products and pancakes (Woolfe, 1992). Cassava is a versatile crop and can be processed into a wide range of products such as starch, flour, tapioca, beverages and cassava chips for animal feed. Starch is one of the most important but flexible food ingredients possessing value added attributes for innumerable industrial applications. The most common sources of food starch are corn, potato, wheat, cassava/tapioca and rice. Cassava is the chief source of dietary food energy for the majority of the people living in the lowland tropics, and much of the sub-humid tropics of West and Central Africa (Tsegia and Kormawa, 2002). Cassava starch is equitable to other tuber and cereal starches on top of being easily extracted (FAO, 2000). The advantages of cassava for starch production over other grains or root crop includes: high purity level, excellent thickening characteristics, a neutral (bland) taste, desirable textural characteristics, is relatively cheap and it contains a high concentration of starch (dry-matter basis) (Masamba *et al*., 2001). The main objective of this research was to evaluate some quality attributes of gluten-free pancakes from sweetpotato flour and cassava starch blends.

MATERIALS AND METHODS

Sources of raw material

Yellow fleshed sweetpotatoes were purchased from a farm and cassava starch was obtained from Kuto market in Abeokuta, Ogun State. Ingredients for frying of pancakes were also obtained.

Sample Preparation

Sweetpotato flour was produced using the method of Ukpabi *et al*., (2008). The sweetpotato tubers were thoroughly sorted to remove bad ones from the lot. The sorted tubers were then washed to remove adhering soil, dirts and extraneous materials. A portion of the tubers were peeled and washed, while the other portion of the tubers were not peeled, followed by slicing using a hand slicer to facilitate fast rate of drying and to ease milling operations. The sliced tubers were soaked in a clean potable water in order to inactivate enzymes that may cause browning reaction. These were then drained followed by drying in a cabinet drier at 60°C for 24 h. After which the dried sweetpotato slices were milled into flour. The flour was then screened through a 0.25 mm sieve and packed in high density polyethylene (HDPE) bag until use.

Preparation of pancake

In the preparation of the pancake, the sweetpotato flour (peeled and unpeeled) were mixed with cassava starch powder in the ratio of 100:0, 90:10, 80:20, 70:30 as presented in Table 1. Wheat flour-based pancakes were used as a control. Peeled sweetpotato flour:cassava starch powder and unpeeled sweetpotato flour:cassava starch powder were labeled as P_{100}, P_{90}, P_{80}, P_{70} and UNP_{100}, UNP_{90}, UNP_{80}, UNP_{70} and the control wheat flour was labeled as Wh. Other ingredients such as sugar (20 g), salt (2 g), milk (20 g), baking powder (5 g), and 1 raw egg were mixed with the composite flour (100 g) with 250 ml of water to reach a smooth batter consistency. The batter was kept for 10 min (resting time) and pure vegetable oil was measured into a frying pan using a 15 ml measuring spoon. The oil temperature was adjusted to 120°C, then the batter was poured into the oil and the pancake was cooked for 1min until the upper surface bubbled and it was turned to cook the other side, which turned brown in another 1 min.

Table 1: Sample Formulation of Sweetpotato Flour and Cassava Starch Blends

Sample	Peeled Sweetpotato Flour (%)	Unpeeled Sweetpotato Flour (%)	Cassava Starch (%)	Wheat (%)
Wh 100	0	0	0	100
Unp100:0	0	100	0	0
Unp90:10	0	90	10	0
Unp80:20	0	80	20	0
Unp70:30	0	70	30	0
P100:0	100	0	0	0
P90:10	90	0	10	0
P80:20	80	0	20	0
P70:30	70	0	30	0

Wh: wheat flour; Unp: unpeeled sweetpotato flour; P: peeled sweetpotato flour

Determination of Proximate Composition

The composite flour blends (Sweetpotato-cassava starch) and pancakes from it were analyzed for moisture, ash, crude fibre and oil according to AOAC (2003). Protein was determined using Kjeldahl method (AACC, 46-12.01). The carbohydrate content was obtained by difference.

Determination of Functional Properties of Sweetpotato Flour and Cassava Starch Blends

Pasting Property of the Blends

Pasting characteristics was determined with a Rapid Visco Analyser (RVA) by TECMASTER. Three grams of flour was mixed in 25 ml of water in a sample canister using the formula below. The sample was thoroughly mixed and fitted into the RVA, with the use of the 12-min profile, the slurry was heated from 50 ºC to 95 ºC with a holding time of 2 min followed by cooling to 50 ºC with another 2 min holding time. Both the heating and cooling was at a constant rate of 11.25 ºC/min with constant shear at 160 rpm. Corresponding values for peak viscosity, trough, breakdown, final viscosity, setback, peak time, and pasting temperature from the pasting profile will be read on a computer connected to the RVA.

$$S = \frac{86 \times A}{100 - M}$$

$$W = 25 + (A - S)$$

Where S = corrected sample mass
A = sample weight at 14% moisture basis (depending on the type of sample, this is taken from the general guide on weight of sample from RVA manual)
M = actual moisture of the sample (% as is)
W = corrected water mass

Swelling index

The swelling capacity was determined using the method of Okezie and Bello (1988). It was determined as the ratio of swollen volume of a unit weight of the sample when left in contact with exess water. One gram of flour sample was dispensed in 10 ml measuring cylinder. Ten ml of distilled water was added to the sample and the volume was noted. The cylinder was left to stand undisturbed for 1 h. The volume which the sample occupied was then recorded and swelling capacity was calculated as

$$\text{Swelling capacity} = \frac{\text{Volume occupied after swelling}}{\text{Initial volume occupied by sample}}$$

Water and oil absorption capacities

The water and oil absorption capacities were carried out according to the method described by Sosulski *et al* (1976). Ten ml distilled water or oil was mixed with 1 g of the flour sample, the mixture was allowed to rest at 30 ±2 º C for 30 min and then centrifuged at 2000rpm for 30 min and finally the water and oil absorption capacities of the flour were expressed as grams of water or oil absorbed by I g of the flour sample.

Dispersibility

The dispersibility of the flour sample was assessed by vigorously shaking 10 g of each samples in 100 ml distilled water in a measuring cylinder for 2 min before allowing it to rest and settle for 3 h. The volume of the settled particles gave an index of dispersibility as described by Kulkani *et al.* (1991).

% Dispersibility = 100 – volume of settled particle

Bulk density

Bulk density was determined using the method of Akpapunam and Markakis (1981). Ten grams (10 g) of sample was weighed into 50 ml graduated measuring cylinder. The sample was packed gently by tapping the cylinder on the bench top. The volume of the sample was recorded.

Determination of beta- carotene (pro vitamin A)

Total carotene content was determined using the modified method of Park (1987). Dehydrated sweetpotato flour (0.5 g) was extracted with a mixture of hexane and acetone (7:3, 25 ml).
The extracts were filtered through a Buchner funnel with Whatman No. 1 filter paper. The

residue was re-extracted until it became colourless. The filtrates were combined in a separatory funnel and washed with 50 ml of distilled water. The water phase was discarded and a pinch (0.5 g) of Na_2SO_4 was added as desiccant. The hexane phase was transferred to a volumetric flask. The concentration of carotene in the solution was determined from the absorbance at 450 nm. The beta-carotene content was determined from the standard curve for prepared beta-carotene.

Determination of browning index

Browning index was determined using the method described by Youn and Choi (1996). One gram of dehydrated sweetpotato flour was extracted with 40 ml of distilled water and 10 ml of 10% Trichloroacetic acid solution in a beaker. The extract was filtered through a Bunchner funnel with Whatman No. 2 filter paper. After the solution stood for 2 h at room temperature, its concentration was determined from absorbance reading at 420 nm.

Determination of colour Parameters

The colour parameters (Hunter L*, a* and b* values) were measured with a Chromameter (CR-400/410 Konica Minolta. Japan). Colour change was calculated as:

$$DE = [(DL^*)^2 + (Da^*)^2 + (Db^*)^2]^{1/2}$$

Sensory evaluation of pancakes

Preferences among pancakes were assessed. Thirty untrained panelists from the Federal University of Agriculture, Abeokuta, were selected according to their willingness, availability, motivation and capability to work as a member of a sensory panel. Five sensory properties – aroma, taste, colour, hardness, structure and overall acceptability were analyzed using a 9-point hedonic scale (9= Like extremely and 1= Dislike extremely) (Iwe, 2002).

Statistical Analysis

The data were subjected to analysis of variance (ANOVA). The means were then separated with the use of Duncan's multiple range test at 5% probability using the statistical package for the social sciences, SPSS 16.0 software.

RESULTS AND DISCUSSION

Proximate Composition of Sweetpotato flour and Cassava Starch Blends

Table 2 shows the results of the proximate composition of wheat, sweetpotato and cassava starch flour blends. The moisture content of the composite flour blends ranged significantly from 8.87 to 11.24%, Unp70:30 had the highest value while P100 had the lowest value. The level of moisture content in the composite flour was within the recommended moisture level of 14% for safe storage as reported by Shahzadi *et al.,* (2005) to prevent microbial growth and chemical changes during storage. The value of moisture content would enhance the storability and keeping quality of the products. The ash content of composite sweetpotato flour ranged from 1.07 to 3.26%, which is similar to those reported by Van Hal (2000). Ash content is indicative of the amount of mineral in any food sample. The Unp100 had the highest value (3.26%) while the control sample (Wh 100) had the lowest (1.07%).

Table 2: Proximate Composition of SweetPotato flour and Cassava Starch Blends

Sample	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Fibre (%)	Carbohydrate (%)
Wh 100	10.81±0.01[d]	1.07±0.01[i]	1.21±0.01[a]	6.68±0.03[a]	2.11±0.01[i]	78.13±0.02[a]
Unp100:0	9.01±0.01[h]	3.26±0.01[a]	1.02±0.01[b]	4.80±0.01[b]	5.01±0.01[a]	76.91±0.02[d]
Unp90:10	10.67±0.01[e]	3.10±0.00[b]	0.95±0.00[d]	4.67±0.01[c]	4.84±0.01[b]	75.77±0.01[g]
Unp80:20	10.86±0.03[c]	2.88±0.01[d]	0.86±0.01[f]	4.56±0.01[d]	4.42±0.03[e]	76.42±0.07[f]
Unp70:30	11.24±0.01[a]	2.61±0.01[f]	0.77±0.01[g]	4.44±0.03[e]	4.11±0.01[g]	76.84±0.00[e]
P100:0	8.87±0.01[i]	3.02±0.02[c]	0.99±0.01[c]	4.53±0.01[d]	4.78±0.01[c]	77.82±0.00[c]
P90:10	9.15±0.01 [g]	2.78±0.02[e]	0.90±0.00[e]	4.47±0.01[e]	4.60±0.00[d]	78.11±0.04[a]
P80:20	9.98±0.01[f]	2.46±0.01[g]	0.75±0.01[g]	4.39±0.01[f]	4.36±0.01[f]	78.10±0.00[a]
P70:30	11.02±0.03[b]	2.0±0.00[h]	0.70±0.01[h]	4.31±0.02[g]	4.01±0.01[h]	77.96±0.00[b]

Values are means of duplicates. Mean values having different superscripts shows significant differences ($p< 0.05$) across the columns.

The high value in ash contents of Unp100 and P100 of the flours is indicative of the high mineral content of sweetpotatoes (Van Hal, 2000). The fat content also ranged from 0.70 to 1.21% which was similar to those reported by Van Hal (2000). There were significant ($p<0.05$) differences in fat content. The control samples (Wh100) had the highest values (1.21%) while P70:30 had the lowest (0.70%). The fat content decreased with increased cassava starch for all composite flour blends. The crude fibre ranged from 2.11 to 5.01%, the control sample (Wh100) had the least fibre content (2.11%). The decrease was significant at 70-30% level of substitution after which there was no significant decrease. The Unp100 had the highest fibre content (5.01%). This is due to the fibre content in the skin of the sweetpotato. The flour blends showed significant decrease in protein and the values ranged from 4.31 to 6.68%, the control sample (Wh100) had the highest. The protein content in sweetpotato is generally low ranging from 1.00% to 8.50% (Van Hal 2000). The control sample had the highest value (8.50%) and P70:30 had the lowest (1.00%). There were significant ($p<0.05$) differences in protein content of the flour blends. Similar result was reported by Okoye *et al.* (2010), Yusuf *et al. (*2013). The carbohydrate content of sweetpotato flour ranged from 75.77 to 78.13% which are consistent with the values reported by Van Hal (2000).

Functional Properties of Composite Flour From Sweetpotato Flour and Cassava Starch Blends

Table 3 shows the functional properties of composite sweetpotato flour and the control sample (wheat flour). Values of water absorption capacity, oil absorption capacity and bulk density ranged from 1.87 to 2.30g/m, 1.16 to 1.40g/m and 0.70 to 0.78g/m, respectively which were within the range of previous values reported by Etudaiye *et al.* (2008). Also values of water absorption capacity were in line with that of Ojinaka *et al* (2009) in cocoyam starch modification effects on functional, sensory and cookies qualities which ranged from 0.83-200 g/ml. Bulk density of composite sweetpotato flour and wheat flour gave higher value than the previous report made by Etudaiye *et al* (2008) but was within the range of values of 0.62-0.75g/ml of Ojinaka *et al* (2009). Bulk density is an indication of porosity of a product which influences package design. It is affected by moisture content and particle size distribution of the flour (Onimawo and Egbekun, 1998). High bulk density of the flour and starches indicated that they would serve as good thickeners in food products (Adebowale *et al.,* 2005), while the low bulk density of flour and starch samples will be suitable for the formulation of high nutrient density weaning food (Mepba *et al.,* 2007). Swelling capacity decreased as the level of cassava starch increased in unpeeled sweetpotato flour but increased as the level of cassava starch increased in peeled sweetpotato flour.

Swelling power of flour is often related to their protein and starch content (Woolfe, 1992). Solubility followed an increasing order as the level of cassava starch increased from 12.84 to 18.61%. Dispersibility of this study ranged from 50.10 to 60.15%. Dispersibility measures the degree of reconstitution of flour blends in water (Kulkarni *et al.,* 1991). High dispersibility indicates that there is stability in reconstituted food product (Sanni *et al.,* 2006).

Table 3: Functional Properties of SweetPotato Flour and Cassava Starch Blends

Sample	BD (g/ml)	WAC (g/ml)	OAC (g/ml)	SC (%)	SLB (%)	DPS (%)
Wh 100	0.72±0.00^{g}	1.87±0.00^{i}	1.16±0.00^{h}	6.66±0.02^{a}	12.84±0.07^{i}	60.15±0.14^{a}
Unp100:0	0.73±0.00^{e}	2.30±0.00^{a}	1.26±0.00^{b}	5.64±0.04^{f}	14.26±0.07^{h}	55.85±0.01^{c}
Unp90:10	0.74±0.00^{d}	2.25±0.00^{b}	1.21±0.00^{d}	5.55±0.01^{g}	15.26±0.01^{g}	54.30±0.14^{d}
Unp80:20	0.75±0.00^{b}	2.14±0.00^{e}	1.17±0.00^{g}	5.45±0.01^{h}	15.98±0.10^{f}	51.00±0.01^{f}
Unp70:30	0.78±0.00^{a}	2.03±0.00^{g}	1.02±0.00^{i}	5.18±0.13^{i}	16.38±0.00^{e}	50.10±0.01^{g}
P100:0	0.70±0.00^{i}	2.21±0.00^{c}	1.40±0.00^{a}	5.71±0.01^{e}	16.75±0.02^{d}	57.05±0.21^{b}
P90:10	0.71±0.00^{h}	2.17±0.00^{d}	1.23±0.00^{c}	5.81±0.02^{d}	17.54±0.11^{c}	55.85±0.01^{c}
P80:20	0.73±0.00^{f}	2.04±0.00^{f}	1.18±0.00^{e}	5.86±0.02^{c}	17.94±0.10^{b}	52.15±0.01^{a}
P70:30	0.74±0.00^{c}	2.00±0.00^{h}	1.17±0.00^{f}	6.02±0.02^{b}	18.61±0.01^{a}	51.05±0.01^{f}

Values are means of duplicate. Mean values having different superscripts shows significant differences ($p < 0.05$) across the columns.

Wh: wheat flour; Unp: unpeeled sweetpotato flour P: peeled sweetpotato flour

BD: bulk density, WAC: water absorption capacity, OAC: oil absorption capacity
SC: swelling capacity, SLB: solubility, DPS: dispersibility

Pasting Properties of Sweetpotato Flour and cassava starch blends

The pasting characteristics of composite sweetpotato flour are shown in Table 4. 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).

Peak viscosity ranged from 43.29 to 265 RVU. High peak viscosity is an indication of high starch content which also relate to water binding capacity of starch (Oikku and Rha, 1978; Osungbaro, 1990). The minimum viscosity at constant temperature phase of the RVA profile and the ability of paste to withstand breakdown during cooling is referred to as the trough. The trough ranged from24.46 to 184 RVU. There were no significant ($p<0.05$) differences in the trough for sample Unp80:20, Unp70:30, P100:0 and sample P90:10, P80:20, P70:30. The break down viscosity is an index of the stability of starch (Fernandez de tonella and Berry, 1989). Sample P90:10 had the lowest break down (14.00RVU) while the control sample had the highest breakdown viscosity (80.13 RVU).

Table 4: Pasting Properties of SweetPotato Flour and Cassava Starch Blends

Sample	PV (RVU)	TR (RVU)	BD (RVU)	FV (RVU)	SB (RVU)	PT (Min)	PST (^{O}C)
Wh 100	265.01±4.48^{a}	184.00±1.36^{a}	80.13±3.12^{a}	307.00±5.07^{a}	123.01±1.01^{a}	6.53±0.05^{a}	70.20±0.08^{d}
Unp100:0	60.63±0.64^{bc}	55.63±0.53^{b}	5.00±0.11^{d}	72.67±1.06^{c}	17.21±1.40^{cde}	5.00±0.00^{b}	84.08±0.03^{a}
Unp90:10	85.42±1.65^{b}	68.09±1.65^{b}	17.33±0.00^{bcd}	97.25±1.88^{b}	29.17±0.04^{b}	4.93±1.01^{bc}	83.10±0.05^{abc}
Unp80:20	63.08±7.42^{bc}	46.29±5.95^{c}	16.79±1.47^{bcd}	68.04±8.19^{c}	21.75±2.07^{c}	4.74±0.11^{de}	82.70±1.01^{bc}
Unp70:30	69.50±0.11^{bc}	49.92±1.77^{c}	19.59±1.65^{bc}	69.17±1.41^{c}	19.25±0.03^{cd}	4.84±0.01^{cd}	82.70±0.02^{bc}
P100:0	69.21±33.29^{bc}	44.63±18.09^{c}	24.58±15.20^{bc}	59.50±24.99^{cd}	14.88±16.00^{de}	4.74±2.09^{de}	84.00±4.04^{a}
P90:10	43.29±4.29^{c}	29.30±3.01^{d}	14.00±1.30^{cd}	41.63±3.95^{d}	12.34±1.11^{e}	4.64±0.00^{e}	83.60±0.03^{ab}
P80:20	44.09±0.47^{c}	24.46±0.18^{d}	19.63±0.29^{bc}	38.42±0.59^{d}	13.96±0.08^{de}	4.64±0.00^{e}	83.20±0.03^{abc}
P70:30	54.13±5.13c	25.67±2.24^{d}	28.46±2.89^{b}	41.84±3.42^{d}	16.17±1.14^{cde}	4.67±0.02^{e}	81.93±0.04^{c}

Values are means of duplicate. Mean values having different superscripts shows significant differences ($p < 0.05$) across the columns.

Wh: wheat flour; Unp: unpeeled sweetpotato flour P: peeled sweetpotato flour

PV: peak viscosity, TR: trough, BD: breakdown, FV: final viscosity, SB: setback, PT: peak time, PST: pasting temperature

The final viscosity is the change in the viscosity after holding cooked starch at 50°C and it is one of the most common parameter used to define 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 (Adeyemi and Idowu, 1990; Adebowale, 2008). The control sample had the highest set back value (123 RVU) followed by Unp90:10 (29.17 RVU). Lower setback was observed for P90:10 (12.34 RVU) 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 weight of products made from the flour (Adeyemi and Idowu, 1990). The peak time which is a measure of the cooking time, ranged from 4.64 min for sample P90:10 and P80:20 to 6.53 min for control sample. The pasting temperature gives an indication of the gelatinization temperature during processing. It is the temperature at which the first detectable increase in viscosity is measured and it is an index characterized by the initial change due to the swelling (Emiola and Delarosa, 1981). As the percentage of cassava starch was increased, the pasting temperature decreased gradually but there were similarities in the sample Unp100:0, P100:0, and sample Unp80:20, Unp70:30 and sample Unp90:10, P80:20.

pH, beta-carotene, and browning index of Sweetpotato Flour and Cassava Starch Blends

Table 5 shows the result of pH, beta-carotene and browning index of wheat, sweetpotato and cassava starch flour blends. The pH of flour samples decreased significantly from 6.64 to 6.01 with Unp70:30 had the lowest and P100:0 had the highest value. The beta-carotene value ranged from 3.46 to 10.80µ/g, the result showed that they were significant differences in the values. It was noted that the value decreased as the level of sweetpotato flour reduced. This is due to the high level of beta-carotene in yellow fleshed sweetpotato. The browning index of composite sweetpotato flour blends ranged from 0.35 to 0.44 which were similar to those reported by Maruf *et al.,* (2010). Browning appears to be a complex process involving several factors including substrate levels, enzyme activity, presence of ascorbic acid and other inhibitors or promoters influencing the browning reactions, in addition to tissue damage (Zhang *et al.,* 2005).

Table 5: The pH, Beta-Carotene and Browning Index of SweetPotato Flour and Cassava Starch Blends

Sample	pH	Beta-carotene (μ/g)	Browning index
Wh 100	6.06±0.01[g]	3.46±0.01[i]	0.35±0.01[f]
Unp100:0	6.23±0.02[e]	10.80±0.01[a]	0.44±0.01[a]
Unp90:10	6.14±0.01[f]	10.54±0.02[c]	0.42±0.01[b]
Unp80:20	6.06±0.00[g]	10.11±0.01[e]	0.39±0.01[d]
Unp70:30	6.01±0.01[h]	9.44±0.02[g]	0.38±0.00[d]
P100:0	6.64±0.01[a]	10.71±0.01[b]	0.42±0.01[b]
P90:10	6.55±0.01[b]	10.44±0.01[d]	0.40±0.00[c]
P80:20	6.49±0.01[c]	10.00±0.00[f]	0.37±0.01[e]
P70:30	6.37±0.01[d]	9.37±0.01[h]	0.36±0.01[ef]

Values are means of duplicate. Mean values having different superscripts shows significant differences ($p < 0.05$) across the columns.
Wh: wheat flour; Unp: unpeeled sweetpotato flour; P: peeled sweetpotato flour

Colour characteristics of sweetpotato flour and Cassava starch blends

The mean values of colour of the blends is presented in Table 6. The highest L* value was found in P100, P80:20 and P70:30 while the lowest was found in Unp100 and Unp90:10. The result showed that as the level of substitution of cassava starch increased, the L* value also increased. The result for a* value ranged from -2.03 to -0.34. All the blends showed negative value of a*, but in the case of b* value, it ranged from 1.69 to 5.35. The highest value of b* were found in Unp100 and P100 while the lowest were found in P70:30 and the control sample. The result here showed that as the level of sweetpotato decreased, b* value decreased.

Table 6: Color Characteristics of SweetPotato Flour and Cassava Starch Blends

Sample	**L***(lightness)	**a*** (redness)	**b***(yellowness)
Wh 100	97.58±0.35[b]	-0.99±0.04[b]	1.81±0.08[e]
Unp100:0	92.21±0.19[d]	-0.34±0.39[a]	5.35±0.23[a]
Unp90:10	92.17±0.33[d]	-0.52±0.03[a]	4.47±0.05[b]
Unp80:20	93.68±0.48[c]	-0.58±0.01[a]	3.59±0.03[c]
Unp70:30	93.84±0.34[c]	-0.47±0.06[a]	2.66±0.16[d]
P100:0	99.29±0.98[a]	-2.21±0.02[d]	5.05±0.06[a]
P90:10	97.50±0.47[b]	-2.03±0.06[d]	4.49±0.21[b]
P80:20	99.09±0.16[a]	-1.62±0.06[c]	2.99±0.16[d]
P70:30	99.82±0.09[a]	-1.43±0.00[c]	1.69±0.16[e]

Values are means of duplicate. Mean values having different superscripts shows significant differences ($p < 0.05$) across the columns.
Wh: wheat flour; Unp: unpeeled sweetpotato flour; P: peeled sweetpotato flour

Proximate composition of pancake from sweetpotato flour and cassava starch blends

The results of proximate composition of pancakes from composite sweetpotato flour blends and the control sample are presented in Table 7. The moisture content value for pancake ranged from 42.76 to 45.53%, the control sample (Wh100) had the highest and P70:30 had the lowest value. The moisture content in this study decreased with increase in cassava starch for both peeled and unpeeled sweetpotato flour. Sweetpotato flour has a lower moisture content but high starch and fibre content where as wheat flour is rich in moisture, protein and carbohydrate.

The ash and fibre content value ranged from 2.13 to 3.98% and 3.75 to 6.01%. The Unp100 had the highest value in ash and fibre while the control sample (Wh100) had the lowest. For fat and protein, increase in the level of cassava starch resulted in decrease in the protein and fat content progressively from 9.06 to 10.34% and 5.01 to 7.18%, in pancake with 30% cassava starch. This must have been due to the low protein and fat content of the cassava starch which must have diluted the protein and fat content of the sweetpotato flour thus reducing it with increase in the level of cassava starch. Also, crust formation which acts as a barrier to reduce the oil uptake, prevents the inside water from escaping to the outside and consequently preventing further oil uptake as reported by Omidiran *et al.* (2016).

This is similar to the earlier finding where protein content of biscuit reduced with supplementation with starch based product (Olaoye *et al.*, 2007). For carbohydrate, the composite sweetpotato flour showed significant differences. The P70:30 had the highest while the Unp100 had the lowest. The pancake from unpeeled flour blends was observed to be high in fibre compared to the peeled flour blends.

Table 7: Proximate Composition of Pancake from Sweetpotato Flour and Cassava Starch Blends

Sample	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Fibre (%)	Carbohydrate (%)
Wh 100	45.53 ± 0.05^{a}	2.13 ± 0.01^{i}	10.34 ± 0.02^{a}	7.18 ± 0.01^{a}	3.75 ± 0.00^{h}	31.03 ± 0.07^{c}
Unp100:0	45.00 ± 0.00^{b}	3.98 ± 0.00^{a}	9.79 ± 0.01^{b}	6.03 ± 0.01^{b}	6.01 ± 0.01^{a}	29.19 ± 0.01^{g}
Unp90:10	44.21 ± 0.01^{d}	3.64 ± 0.01^{c}	9.63 ± 0.01^{c}	5.92 ± 0.02^{c}	5.61 ± 0.02^{c}	30.99 ± 0.01^{e}
Unp80:20	44.00 ± 0.00^{e}	3.14 ± 0.01^{e}	9.36 ± 0.01^{e}	5.72 ± 0.01^{d}	5.26 ± 0.02^{d}	32.52 ± 0.06^{d}
Unp70:30	43.22 ± 0.01^{g}	3.00 ± 0.00^{g}	9.11 ± 0.00^{g}	5.36 ± 0.01^{e}	5.02 ± 0.02^{f}	34.30 ± 0.01^{b}
P100:0	44.72 ± 0.02^{c}	3.75 ± 0.01^{b}	9.42 ± 0.01^{d}	5.90 ± 0.01^{c}	5.88 ± 0.01^{b}	30.34 ± 0.03^{f}
P90:10	43.76 ± 0.01^{f}	3.44 ± 0.01^{d}	9.31 ± 0.01^{f}	5.73 ± 0.01^{d}	5.26 ± 0.01^{d}	32.50 ± 0.01^{d}
P80:20	43.13 ± 0.01^{h}	3.11 ± 0.01^{f}	9.13 ± 0.01^{g}	5.38 ± 0.01^{e}	5.08 ± 0.01^{e}	34.17 ± 0.02^{c}
P70:30	42.76 ± 0.01^{i}	2.97 ± 0.01^{h}	9.06 ± 0.01^{h}	5.01 ± 0.01^{f}	4.88 ± 0.02^{g}	35.33 ± 0.01^{a}

Values are means of duplicate. Mean values having different superscripts shows significant differences ($p < 0.05$) across the columns.

Wh: wheat flour; Unp: unpeeled sweetpotato flour; P: peeled sweetpotato flour

Sensory Acceptability of Pancake from Sweetpotato Flour and Cassava Starch Blends

Pancake made from all the blends were evaluated and compared with the control (100% wheat flour). The results are shown in Table 8. The data indicated that there were significant ($p<0.05$) differences in colour, aroma, structure and overall acceptability. Values for colour, taste, aroma, hardness, structure and overall acceptability ranged from 5.59-8.16, 5.74-8.06, 5.68-7.36, 5.62-7.21, 5.59-8.86 and 5.50-8.86, respectively. The 100% peeled and unpeeled sweetpotato flour were found to be the most preferred sample, because all attributes scored highest value (7.53 and 7.10) for overall acceptability which is very much similar to the control sample. Other blends also showed good result in terms of sensory attributes such as colour, structure and hardness.

Table 8: Sensory Evaluation of Pancake from Sweetpotato Flour and Cassava Starch Blends

Sample	Color	Taste	Aroma	Hardness	Structure	Overall acceptability
Wh 100	8.16 ± 0.01^{a}	8.06 ± 0.01^{a}	7.36 ± 0.01^{a}	7.21 ± 0.00^{a}	8.86 ± 0.01^{a}	8.86 ± 0.01^{a}
Unp100:0	7.24 ± 0.01^{c}	6.46 ± 0.00^{cd}	7.02 ± 0.01^{c}	6.81 ± 0.01^{c}	7.80 ± 0.01^{d}	7.10 ± 0.02^{c}
Unp90:10	6.95 ± 0.00^{d}	5.92 ± 0.02^{e}	6.16 ± 0.01^{e}	5.98 ± 0.01^{e}	7.04 ± 0.01^{g}	6.01 ± 0.00^{f}
Unp80:20	6.05 ± 0.01^{f}	6.29 ± 0.02^{d}	5.96 ± 0.00^{f}	5.93 ± 0.02^{e}	8.12 ± 0.01^{c}	6.04 ± 0.01^{f}
Unp70:30	5.59 ± 0.02^{g}	5.92 ± 0.02^{e}	5.68 ± 0.01^{g}	5.62 ± 0.02^{f}	7.16 ± 0.01^{f}	5.50 ± 0.01^{h}
P100:0	7.80 ± 0.00^{b}	7.59 ± 0.03^{b}	7.28 ± 0.01^{b}	7.03 ± 0.01^{b}	8.75 ± 0.00^{b}	7.53 ± 0.01^{b}
P90:10	7.17 ± 0.03^{c}	6.56 ± 0.01^{c}	6.72 ± 0.01^{d}	6.20 ± 0.01^{d}	7.36 ± 0.01^{e}	6.25 ± 0.02^{d}
P80:20	6.48 ± 0.01^{f}	6.56 ± 0.01^{c}	6.18 ± 0.01^{e}	6.16 ± 0.00^{d}	6.52 ± 0.01^{i}	6.13 ± 0.00^{e}
P70:30	5.68 ± 0.01^{g}	5.74 ± 0.01^{e}	5.93 ± 0.01^{f}	6.18 ± 0.01^{d}	5.59 ± 0.01^{h}	5.63 ± 0.01^{g}

Values are means of duplicate. Mean values having different superscripts shows significant differences ($p < 0.05$) across the columns.

Wh: wheat flour; Unp: unpeeled sweetpotato flour P: peeled sweetpotato flour

CONCLUSION

This study showed that an sensory acceptable pancake of good proximate composition can be produced from blends of sweetpotato flour and cassava starch. They also showed appealing, desirable and acceptable sensory attributes (colour, taste, aroma, hardness, structure). Sweetpotato flour and cassava starch blends differ significantly ($p<0.05$) in their proximate and functional properties, which enhanced their utilization potentials. The moisture contents of the flour blends enhanced the storability and keeping quality of the pancake while the high value of ash content indicated high mineral content of sweetpotato. Pancakes produced from 100% peeled and unpeeled sweetpotato flour possesed similar sensory attributes with whole wheat pancakes, hence be encouraged for use in the development of high fibre gluten free pancakes.

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(Manuscript received: 8th February 2019; accepted: 24th June 2020).