

Original Research Article**BLENDING OF ACETYLATED CASSAVA STARCH, CASSAVA FLOUR AND WHEAT FLOUR FOR COMPOSITE IN BREAD MAKING****ABSTRACT**

Chemical modification of cassava starch was carried out by acetylation and the resultant modified cassava starch was blended with high quality cassava flour and wheat flour as composites for bread production. High quality cassava flour (HQCF) and cassava starch were produced from TMS 30575 variety. The starch was treated chemically with acetic anhydride. Wheat flour, cassava flour and acetylated cassava starch were blended at varying ratios of 90:7:3, 80:11:9, 70:18:12, 60:25:15, 50:32:18 respectively and 100% wheat flour served as the control. The various composites were subjected to proximate and functional analyses; and thereafter used in bread production, following the straight dough method. The composite breads produced were subjected to physical analysis and sensory evaluation. The data were analyzed statistically and the means compared at 5% probability. Values obtained from the functional analysis ranged from 1.09-1.99ml/g; 0.61-0.73g/ml; 7.90-8.60ml/g; 7.99-8.60ml/g and 46.67-51.67°C for the swelling index, bulk density, oil absorption capacity, water absorption capacity and gelling temperature respectively. The proximate values ranged from 9.5-12.00%; 9.62-11.09% and 68.99-84.45% for protein, moisture content and carbohydrate respectively. Also the bread volume ranged from 725.3–1060.5cm³. The bread from, 70:18:12 composite did not differ from the 100% wheat flour at p>0.05 in the bread volume. Also, the blend of 70:18:12 did not differ significantly (p>0.05) from the control in the crumb colour, aroma and taste respectively.

27 Introduction

28 Bread is an important staple food word over because it furnishes superior nutritional,
 29 sensorial and textural characteristics, ready-to-eat convenience as well as cost
 30 competitiveness (Ade-omowaye *et al.*, 2008). In most countries of the world bread has
 31 become an increasingly important food- it provides more nutrients than any single food
 32 source. (Rychnovsky,1980). All breads are nutritious, contributing valuable quantities of
 33 proteins, iron, calcium, and some of the B-vitamins to our diet and therefore daily food
 34 requirement (Amendola, 1972). Eddy *et al.* (2007) indicated that fibre in bread increases
 35 intestinal transit time for bile salt derivatives such as deoxycholate, which are effective
 36 chemical carcinogen, hence reducing incidence of carcinoma of the colon. The idea of
 37 substituting part of wheat flour with other starchy crops, during bread making in non wheat
 38 producing countries is not new (Ade-omowaye *et al.*, 2008). The reason is because wheat
 39 bread is relatively expensive due to cost of importation and cannot be grown locally as a
 40 result of climatic limitation (Olaoye *et al.*, 2008). Organizations like Food and Agriculture
 41 Organization (FAO, 2004), has acknowledged the need for strategic development and use of
 42 popular foods like bread to meet nutritional needs of malnourished people. This led to the
 43 initiation of the composite flour program (Edema *et al.*, 2005). Previous works have shown
 44 that tropical root and tuber crops: cocoyam, cassava, taro and others can serve as alternative
 45 sources of major raw material for bread making (Edward, 1974). The use of composite flour
 46 (CF) (partial substitute to wheat flour) has currently received the support of policy makers
 47 and for example: the Federal Government of Nigeria has mandated the flour mills to add a
 48 minimum of 10% high quality cassava flour (HQCF) to wheat flour for making composite
 49 flour meant for baking purposes (Shittu *et al.*, 2008).

51 Although, there is now a substantial amount of available composite bread technology, such
 52 breads still require at least 70% wheat flour to be able to rise (Eggleston *et al.*, 1992).
 53 Cassava flour is deficient in gluten (gliadin and glutenin) which contributes to the elasticity
 54 and cohesiveness of the dough; as such Cassava flour and some other non-wheat flours
 55 cannot alone be used for bread making. Gluten essentially forms a network that traps the CO₂
 56 produced during fermentation from escaping, thus bringing about rising of the dough.
 57 Application of functional but expensive emulsifiers, mono and diglycerides are known to
 58 strengthen the dough and enhance the production of non-wheat bread (Pomeranz, 1991).
 59 Acetylation, esterifies the starch molecules and improves its functional ability by increasing
 60 its viscosity and swelling power (Bentancur *et al.*, 1997). Adebowale (2002) reported that
 61 acetylation of starch retards retrogradation or recrystallization of starch in baked goods.
 62 However these attributed of modified starch have not been tried in leavening dough when non
 63 wheat flour is incorporated as composite in bread production. The present study investigates
 64 the influence of added acetylated starch in strengthening the dough when cassava flour is
 65 used as component in bread making. The study is justified by the need to increase the cassava
 66 component in composite bread making.

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68 **Materials and Methods**

69 **Procurement and production of unfermented high quality cassava flour**

70 The fresh cassava tubers used for this study were harvested purchased from the farm centre of
 71 Imo State Polytechnic, Umuagwo, Imo State Nigeria and identified as TMS 30575. Acetic
 72 anhydride (food grade) was purchased from Gatelab Laboratories, No 88 Royce Road and
 73 baking ingredients were purchased from Ekeonuwa market all in Owerri, Imo State Nigeria.
 74 The processing of cassava starch, unfermented high quality cassava flour and baking of bread

75 were carried out in the Pilot Plant of Department of Food Science and Technology, Federal
76 University of Technology Owerri, Nigeria.

77 **Production of cassava flour**

78 The method reported by IITA (2005) was followed for the production of unfermented cassava
79 flour. The cassava tubers were peeled manually using a stainless steel knife. The peeled
80 tubers were washed, grated to obtain cassava mash. The mash was dewatered, sieved, oven
81 dried, milled into fine particle size to yield unfermented cassava flour and packaged in air
82 tight bag. This process was completed within 24 h from harvesting to avoid fermentation in
83 accordance with IITA specification.

84 **Production of Cassava Starch**

85 A portion of the freshly harvested cassava tubers were peeled with stainless steel knife
86 washed with clean water and grated to obtain smooth slurry. The slurry was further mixed
87 with water to form free flowing slurry which was then filtered using a muslin cloth into a
88 plastic bucket. The filtration continued until all the starch was extracted and the woody mass
89 discarded. The filtrate was allowed to settle in the plastic bucket before the supernatant was
90 decanted leaving the starch at the base of the bucket. After decanting the supernatant, the
91 surface of the starch was washed severally with clean water to obtain a white- odourless
92 starch. The thick starch paste was scooped into a clean calico bag and pressed to dewater,
93 crumbed within the palm, sun-dried to obtain cassava starch and packaged in air tight
94 container.

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96 **Acetylation of cassava starch**

97 Acetylated starch was prepared following the method described by Van Hung and Morita
98 (2005) but with slightly modification process conditions. One kilogram of high quality
99 cassava starch was weighed in 5 L acrylic vessel equipped with baffles and mixed with 2.5 L

of distilled water. The vessel was equipped with a stirrer, which provided mechanical agitation to ensure homogenous mixing during the process. The starch slurry was mixed for 1.0 h at room temperature to fully suspend the starch granules. The pH was adjusted to 8.0 with 1 M aqueous sodium hydroxide, acetic anhydride (8%, w/w, on a starch dry basis) was added drop wise. Sodium hydroxide (1 M) was added simultaneously at a rate a 1.0mL/min. The pH of the suspension was maintained at a range of 7.8 to 8.5 during the reaction. The reaction was allowed to proceed for 60 min after final addition of acetic anhydride. Thereafter, the slurry was adjusted to pH 5.5 with 1 M hydrochloric acid to neutralize the reaction and followed by vacuum- filtration, and the resulting cake mixed with 2 L of distilled water. The vacuum -filtration was repeated and followed by washing thrice with distilled water to remove residual acid. Then the slurry was oven dried overnight at 40⁰C and packed in air proof bag. A duplicate experiment was performed.

Validation of acetylation (Determination of Acetyl Content and Degree of substitution (DS))

The titrimetrically method of Wurzburg 1964 as reported by Ayucitra (2012) was followed in determining percent acetylation (% acetyl) and degree of substitution (DS). One gram of an acetylated cassava starch sample was suspended in 50 mL of a 75% ethanol solution and was kept in a water bath at 50⁰C for 30 min with constant stirring. The slurry was then cooled to room temperature and 40 mL of 0.5 M potassium hydroxide was added. The slurry was allowed to stand for 72 h at room temperature with occasional swirling. The excess alkali was titrated with 0.5 M hydrochloric acid using phenolphthalein as an indicator. The solution was allowed to stand for another 2 h. Any additional alkali that might leach from the sample was titrated. Blanks with native cassava starch were analysed concurrently. The sample volume, the hydrochloric acid normality and the volume of hydrochloric acid required to titrate the

124 blank and sample were recorded. Duplicate measurements were performed for each starch
125 sample.

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129 **Formulation of the composite flour**

130 The composite flour was formulated from wheat, cassava flour and acetylated cassava starch
131 using the following ratios:

- 132 100% wheat flour (serving as the control)
- 133 90% wheat flour, 7% cassava flour and 3% cassava starch
- 134 80% wheat flour, 11% cassava flour and 9% cassava starch
- 135 70% wheat flour, 18% cassava flour and 12% cassava starch
- 136 60% wheat flour, 25% cassava flour and 15% cassava starch
- 137 50% wheat flour, 32% cassava flour and 18% cassava starch.

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139 **Proximate Analysis of the Composite Flour for Bread Making.**

140 The protein, moisture, crude fibre, fat, ash and carbohydrate contents were determined as
141 described by AOAC (1990).

142 **Functional Properties of the Composite Flour for Bread Making**

143 **Bulk density**

144 Five grams (5g) of the flour was weighed into a graduated cylinder and its volume was
145 recorded. Then, the cylinder was tapped against a table for 15min until there was no further
146 change in volume. Bulk density (g/mL) = weight of sample (g)/volume of the sample
147 (mL)

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150 **Water/oil absorption capacity**

151 The method described by Onwuka (2005) was used for determination of oil/ water absorption
152 capacity. One gram (1g) of the flour was weighed into 15mL centrifuge tube and 10mL
153 distilled water or the oil was added. The sample was mixed thoroughly and allowed to stand
154 for 3min at room temperature and centrifuged at 2000rpm for 30min. The volume of free
155 water or oil (the supernatant) was read directly from the graduated centrifuge tube.

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157 **Wettability**

158 The method described by Onwuka (2005) was used. One gram (1g) of flour was weighed into
159 a 25mL graduated cylinder with a diameter of 1.0 cm. A finger was placed over the open end
160 of the cylinder before it was inverted and clamped at a height of 10cm from the surface of a
161 600mL beaker containing 500mL of distilled water. The finger is removed to allow the test
162 material to be damped. The time for complete dampening of the sample was recorded.

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164 **Swelling capacity**

165 This was determined using the method of Bello and Okezie (1998). Swelling capacity was
166 determined as the ratio of swollen volume of a unit weight of the sample when left in contact
167 with excess water. One gram (1g) of the flour was dispensed into a calibrated 10mL
168 measuring cylinder. Ten millimetres (10mL) of distilled water was added to the sample and
169 the volume was recorded. The cylinder was left to stand for 1h.

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171 **Wet Gluten**

172 The gluten content of the composites was determined by weighing 20g of the flour into a
173 beaker 50mL of water added and mixed thoroughly. The dough formed was allowed to stand

at room temperature for 30min after which it was washed in running water until cloudy colour disappeared. The resultant mass was weighed in order to derive the percent wet gluten.

Bread Production

The bread loaves were produced using a modification of bread recipe and straight dough method. All the ingredients were mixed in bowl and transferred to the bowl containing composite flour, these were further mixed together for about 10min. The dough was kneaded for 5 min and subsequently shaped and transferred into previously greased pans; and allowed to proof for about 45mins. The proofed dough was baked in an oven at 200°C for 25 min. The bread was allowed to cool at room temperature, weighed and the volumes determined.

Table 1. Recipe for 100% wheat flour bread and composite bread.

<u>Ingredient</u>	<u>Weight (g)</u>
Flour	200
Yeast	2.0
Sugar	20
Fat	10
Salt	2.0
<u>Water</u>	<u>Variable</u>

Determination of bread volume

The loaf volume was measured according to seed displacement method described by Onwuka (2005). The loaf samples were weighed in a suitable weighing balance (). Soya bean seeds were used to fill the volumeter to a level marked X. bread sample was then placed in the volumeter. The level of the soya bean was then noted again and marked Y. the difference

199 between Y and X gave the volume of the loaf bread as read off from the stem of the
200 volumeter.

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202 **Sensory attributes of the bread.**

203 **Sensory evaluation** was carried out on the bread samples using 20-man semi-trained
204 panellists selected from the University Community. A 9-point Hedonic scale where: 1.0 is
205 dislike extremely, 5.0 represents neither like nor dislike and 9.0 is like extremely was used.
206 The samples were sliced and a slice was presented in a coded manner to the panellists, who
207 were required to evaluate following attributes: crust colour, crumb colour, texture, aroma,
208 taste and overall acceptability.

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210 **Statistical analysis**

211 The data obtained were analyzed using the SAS software (SAS 2000) for ANOVA and
212 separation means at 5% level of probability was tested using least significance difference
213 (LSD)

214 **Results and Discussion**

215 The percent acetyl content and degree of substitution (DS) of acetylated cassava starch
216 obtained from process validation is presented in Table 2. The values showed a gradual
217 increase in both percent acetyl content and degree of substitution as the treatment is
218 replicated. A similarity in trend was reported by Singh *et al.* (2004), who attributed the
219 variation to differences in starch structure, reaction velocity and other process conditions.

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Table 2. The % acetyl content and degree of substitution (DS) of acetylated cassava starches obtained from 1st and 2nd treatments

Starches	Acetyl Content (%)	DS
ACS-1	3.87	0.17
ACS-2	4.56	0.19
NCS	0.00	0.00

ACS-1: acetylated cassava starch (1st treatment);
ACS-2: acetylated cassava starch (2nd treatment);
NCS: native cassava starch

Proximate composition of wheat flour, cassava flour and acetylated cassava starch composite.

Table 3, shows the result of the proximate analysis of the composite flour from wheat, cassava flour and acetylated cassava starch including 100% wheat flour which served as a control. The moisture content of the composite samples ranged from 12.13 to 12.94%. The extent of substitution of wheat flour with cassava flour and acetylated starch did not influence values obtained for the moisture.

The protein content of the flours varied significantly at $P < 0.05$ with YW2 (100% wheat) having the highest of 15.50% while PL6 had the lowest of 11.46%. There appears to be gradual decrease in protein content with increasing inclusion of acetylated starch and high quality cassava starch. This could be attributed to decrease in gluten content as with portion is gradually substituted.

The ash content of the flours showed that PL6 had the highest (1.87%) while YW2 had the least 0.25%. The ash content of the various blends increased with increased level of substitution of wheat flour with cassava flour and acetylated cassava starch, which implies that the composite flours contain more inorganic nutrients than the wheat flour.

The carbohydrate content of the flour samples ranged from 72.17% in PL6 to 68.66% in the reference flour (100% wheat). It is also observed that the carbohydrate content increased with

increased inclusion of cassava flour and acetylated cassava starch. This could be as a result of

high content of carbohydrate in cassava flour and the acetylated cassava starch. According to Enwere (1998), carbohydrate is the predominant food nutrient in roots and tuber crops. It is also observed that the carbohydrate values differed significantly, with the exception of UW1 and XX9, which did not differ at $p>0.05$.

Functional properties of a composite of wheat flour, cassava flour and acetylated cassava starch.

The result in Table 4 shows that the functional properties of the composite flour differed significantly ($P < 0.05$) for the swelling index, wetability, bulk density and wet gluten. It is observed that the oil absorption and water absorption capacities did not differ significantly ($p>0.05$).

The swelling index had the least value at QII (1.49ml/ml), which gradually increased as the substitution of wheat flour increased and the highest value was obtained for PL9 (1.99ml/ml). According to Bentancur *et al*, (1997), acetylation has been reported to increase paste and gel clarity, solubility and swelling power. Similarly, a gradual and significant increase in bulk density was observed as the cassava flour and acetylated starch increased, with PL9 having the highest value of 0.73g/ml.

The highest wet gluten was reported for YW2 (100% wheat flour (28.97%), which gradually declined as the portions of cassava flour acetylated starch increased. This trend is expected since the cassava flour and treated starch are known to be poor in gluten.

The Physical Characteristics of the Bread

The physical properties of bread fabricated from wheat flour/cassava flour/acetylated cassava starch blends are represented in Table 5. The bread volumes ranged from 842.6 to 1060.5cm³, with sample Q11 (90:7:3) having the highest volume (1060.5cm³). This might be

attributed to the influence of acetyl cassava starch and gluten reaction, which networked the dough structure and trapped escaping gasses thereby increasing the loaf volume. However, sample PL6 (50: 32:18) had the lowest loaf volume (842.6cm^3). The highest loaf volume obtained for the blend of 90:7:3 (wheat flour/cassava flour/acetylated cassava starch) makes technical sense that acetyl starch inclusion gave desired result when added in small amount. Another noteworthy inference is that the loaf volume gradually decreased from the peak (1060.5cm^3) as the amount of cassava flour increased, but statistical difference ($p>0.05$) was obtained for the control(YW2,100% wheat flour) and sample 5V2 {(80:11:9); wheat flour/cassava flour/acetylated cassava starch}. The gradual decrease in loaf volume might due to the increase in amount of cassava four which is poor in gluten and does not have physical strength to retain gas during proofing.

The loaf weight also had a significant increase ($p< 0.05$) as the blends increased in the amount of cassava flour and acetylated starch. The observed increase in loaf weight corresponds to the increase in bulk density as the substitution ratio of non wheat materials increased. See Table 5.

The specific loaf volume showed similar trend with that of the loaf volume, however sample Q11 had the highest loaf volume ($4.06\text{cm}^3/\text{g}$) while PL6 had the least $3.06\text{cm}^3/\text{g}$.

In like manner, the oven spring seemed to be affected by the substitution ratio of the composite flour. Peak value of oven spring (2.35cm) was obtained for sample Q11 while UWI had the least 0.36cm .

Sensory attributes of the Breads from Wheat Flour, Cassava Flour and Acetylated Cassava Starch Composite.

The result presented in Table 6 is the sensory attributes of breads produced from various composite flour. There were no statistical difference in taste, aroma and the crumb colour of the breads, but other attributes: texture, crust colour and overall acceptability) differed

significantly at $p < 0.05$. The statistical similarity in the rating for taste, aroma and crumb colour might be attributed to the use of high quality cassava flour and acetylated starch which were odourless, colourless and tasteless. The difference in rating of the breads' texture followed a pattern of increasing substitution ratio of non wheat flour. The breads did not differ in their acceptability scores among the control sample, YW2 and samples: Q11 and 5V2. However, the poor score for the sensory attributes goes to show that inclusion of acetylated starch might not play any sensory role but contributes to improvement of the bread structure and shelf stability. Adebowale *et al.* (2002) reported that acetylation of starch retards starch retrogradation or recrystallization. Acetylation reduces syneresis in freeze-thawed gels, which principally is caused by the rearrangement of amylose molecules in starch granules at reduced temperature which acts to exclude water from the gel structure (Liu, 1999).

Conclusion

The study revealed that adding low amount of acetylated starch as component of flour for bread making at substitution ratio of { 90%:7%:3% (wheat flour: cassava flour: acetylated cassava starch) enhanced the loaf volume and the specific volume. Improvement was also obtained in the bread texture and crust colour. These findings are of technical benefit to the bread maker because they lead to high profit. Incorporation of acetylated starch at high amount in bread making does not improve the physical and sensory attributes of bread. The increasing component amount of cassava flour in the blends was found to mask expected influence the acetylated starch might have had on the functional and physical properties of bread.

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Table 3 Means of Proximate Composition of WheatFlour/Cassava Flour/Acetylated Cassava Starch for Composite Bread Making.

Sample	Moisture(%)	Protein(%)	Fat(%)	Crude fibre(%)	Ash(%)	Carbohydrate (%)
YW2	12.94±0.1 ^a	15.50±0.1 ^a	2.40±0.2 ^a	0.25±0.4 ^t	0.25±0.1 ^t	68.66±0.1 ^d
QII	12.52±0.3 ^a	13.35±0.1 ^b	1.87±0.1 ^b	1.89±0.3 ^a	0.78±0.4 ^e	69.59 ±0.4 ^c
5V2	12.22±0.3 ^{ab}	12.85±0.3 ^c	1.70±0.4 ^b	1.56±0.3 ^b	1.13±0.3 ^d	70.54 ±0.4 ^b
XX9	12.79±0.4 ^a	12.36±0.2 ^d	1.60±0.3 ^b	1.13±0.2 ^d	1.33±0.1 ^c	70.79 ±0.1 ^b
UW1	12.13±0.2 ^b	11.67±0.2 ^e	1.55±0.1 ^b	1.33±0.2 ^c	1.56±0.1 ^b	71.76 ±0.2 ^a
PL6	12.27±0.1 ^{ab}	11.46 ±0.3 ^f	1.45±0.2 ^b	0.78±0.1 ^e	1.87±0.3 ^a	72.17 ±0.2 ^a
LSD	0.562	0.194	0.175	0.097	0.050	0.729

Means are triplicate determinations. Means with different alphabets within the column differ significantly at P < 0.05.

YW2 is 100% wheat flour; Q11 is 90:7:3(wheatflour:cassava flour:acetylated cassava starch); 5V2 is 80:11:9(wheatflour:cassava flour:acetylated cassava starch).

XX9 is 70:18:12(wheatflour:cassava flour:acetylated cassava starch); UW1 is 60:25:15(wheatflour:cassava flour:acetylated cassava starch)

PL6 is 50:32:18(wheatflour:cassavaflour:acetylated cassava starch)

Table 4 Functional Properties of Wheat/Cassava flour/Acetylated Cassava starch for Bread making Sample

	Swelling Index (ml/ml)	Bulk density (g/ml)	Wetability (s)	OAC (ml/g)	WAC	Wet Gluten(%)
YW2	1.78±0.03 ^c	0.61±0.52 ^b	39.17±0.2c	7.90±0.2 ^a	8.40±0.26 ^a	28.97±0.93 ^a
QII	1.49±0.1 ^e	0.61±0.16 ^b	59.97±0.3 ^a	7.99±0.1 ^a	8.00±0.01 ^a	27.61±0.40 ^a
5V2	1.52±0.01 ^d	0.65±0.03 ^b	54.38±0.6 ^b	8.40±0.6 ^a	8.60±0.27 ^a	27.32±0.28 ^a
XX9	1.73±0.16 ^c	0.66±0.26 ^b	53.44±0.1 ^b	8.43±0.1 ^a	7.99±0.03 ^a	21.97±0.45 ^b
UW1	1.88±0.2 ^b	0.66±0.01 ^b	49.67±0.5 ^b	8.20±0.3 ^a	8.33±0.02 ^a	21.65±0.72 ^b
PL6	1.99±0.3 ^a	0.73±0.01 ^a	27.8±0.3 ^d	8.60±0.6 ^a	8.46±0.16 ^a	20.52±0.20 ^b
LSD	0.087	0.073	4.006	0.7284		1.765

Means are triplicate determinations. Means with different alphabets in the column differ significantly at P<0.05.

YW2 is 100% wheat flour; QII is 90:7:3(wheatflour:cassava flour:acetylated cassava starch); 5V2 is 80:11:9(wheatflour:cassava flour:acetylated cassava starch).

XX9 is 70:18:12(wheatflour:cassava flour:acetylated cassava starch); UW1 is 60:25:15(wheatflour:cassava flour:acetylated cassava starch)

Table 5 Mean Values of the Physical Properties of Bread from Wheat Flour/Cassava Flour/Acetylated Cassava Starch Composite Bread

Sample	Loaf volume (cm ³)	Loaf weight(g)	Specific loaf volume(cm ³ /g)	Oven spring(cm)
YW2	1045.4 ± 0.6 ^b	257 ± 2.7 ^b	4.07 ± 0.001 ^a	2.04 ± 0.003 ^b
Q11	1060.5 ± 0.6 ^a	259 ± 2.7 ^a	4.09 ± 0.004 ^a	2.35 ± 0.002 ^a
5V2	1045.5 ± 0.3 ^b	262 ± 0.7 ^b	3.99 ± 0.002 ^b	2.08 ± 0.003 ^b
XX9	881.2 ± 0.3 ^c	268 ± 7.0 ^d	3.29 ± 0.002 ^c	0.7 ± 0.025 ^d
UW1	855.3 ± 0.06 ^d	271 ± 1.7 ^c	3.16 ± 0.003 ^d	0.38 ± 0.004 ^c
PL6	842.6 ± 0.03 ^d	276 ± 1.7 ^c	3.05 ± 0.003 ^c	0.93 ± 0.001 ^c
LSD	12.8010	3.1325	0.0476	0.1650

Means are triplicate determination. Mean with same superscripts within the same columns are not significantly different ($P \leq 0.05$)

YW2 is 100% wheat flour; Q11 is 90:7:3(wheat flour: cassava flour: acetylated cassava starch); 5V2 is 80:11:9(wheat flour: cassava flour: acetylated cassava starch).

XX9 is 70:18:12(wheat flour: cassava flour: acetylated cassava starch); UW1 is 60:25:15(wheat flour: cassava flour: acetylated cassava starch)

PL6 is 50:32:18(wheat flour: cassava flour: acetylated cassava starch);

Table 6 Sensory Evaluation of Bread from Wheat Flour/Cassava Flour/Acetylated Cassava Starch Composite

Samples	Taste	Aroma	Crumb colour	Texture	Crust colour	Overall Acceptability
YW2	6.9±0.28 ^a	6.6±0.1 ^a	7.3±0.3 ^a		7.7±0.4 ^a	7.1±0.1 ^a
QII	6.5±0.14 ^a	6.7±0.3 ^a	7.0±0.1 ^a		7.4±0.28 ^a	6.9±0.28 ^a
5V2	6.3±0.14 ^a	6.1±0.3 ^a	6.9±0.28 ^a		6.7±0.28 ^a	6.7±0.3 ^a
XX9	6.8±0.11 ^a	6.5±0.1 ^a	7.0±0.2 ^a		6.8±0.1 ^{ab}	6.7±0.28 ^a
UW1	5.7±0.14 ^a	6.1±0.2 ^a	6.4±0.1 ^a		5.8±0.3 ^{bc}	5.0±0.3 ^b
PL6	5.4±0.28 ^a	5.5±0.2 ^a	6.3±0.4 ^a		5.5±0.1 ^c	5.1±0.1 ^b
LSD					1.0800	1.280
						0.990

Means are triplicate determination. Means with different letters of alphabets differ significantly at $P < 0.05$. YW2 is 100% wheat flour; Q11 is 90:7:3 (wheat flour:cassava flour:acetylated cassava starch).

5V2 is 80:11:9 (wheat flour:cassava flour:acetylated cassava starch); XX9 is 70:18:12 (wheat flour:cassava flour:acetylated cassava starch)

UW1 is 60:25:15 (wheat flour:cassava flour:acetylated cassava starch); PL6 is 50:32:18 (wheat flour:cassava flour:acetylated cassava starch)