SELECTING CASSAVA VARIETIES FOR COMPOSITE BREAD

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ABSTRACT: Five cassava varieties, TMS, TMS 419, TMS 98/05050, TMS 4 (2) 1425 and native variety (black stem), were selected for flour production and baking of composite bread. Wheat flour (100%), was the reference flour for the study. Flour yield for these cassava varieties were 26.4%, 25.08%, 16.77%, 16.71% and 15.37% for TMS 419, TMS 98/0505, TMS 4(2) 1425, NR8082 and native variety (Obubit Ikpo), respectively. The bulk density, which determines the fines of the flour (particulate matter) were 0.69g/ml, 0.69 g/ml, 0.54 g/ml, 0.68 g/ml and 0.51 g/ml in that order as against 0.74 g/ml for wheat flour. The flour moisture content of TMS 419 and TMS 98/0505 were 8.00% and 8.33% as against 9.00%, 9.30% and 10.75% for NR8082, TMS 4(2) 1425 and native variety, respectively. The smaller the moisture content, the greater the affinity for water, an index for good mixing during dough making. Hydrogen cyanide in TMS 419 and TMS 98/05/05 flour were 0.5ppm and 1.00 ppm as against 12.00 ppm in native variety. TMS 419 composite bread at levels of 5% to 20% cassava flour inclusion had higher mass than all others, including 100% wheat bread, the reference loaf. TMS 419 composite bread also had the highest leaf volume yield at 5-15%, cassava flour substitution, among other cassava varieties composite bread. Sensory analysis showed that TMS 419 composite bread at 5% cassava flour inclusion was most preferred composite bread. This bread had little or no difference from the 100% wheat bread. However, cassava flour inclusion up to 15% level gave very good bread. Two varieties, TMS 419 an TMS 98/0505 were very good for composite bread.

INTRODUCTION

About 46% of world's cassava production is in Africa (FAO, 1991a). Nigeria is currently the largest producer in the world with an estimated production of 35 to 40 million metric tons of fresh cassava roots annually (FIIRO, 2006). The production rate is still rising and with this trend, it is likely that the traditional food market will be oversupplied. Consequently farm gate prices for cassava roots can fall drastically leading to low farmers' income and reduced cassava production. This can be avoided if cassava utilization is diversified. The diversification has already taken place in Latin American countries such as Brazil where cassava is processed into many industrial products as well as bioethanol, an important renewable fuel for spark ignition engines (Bokanga and Tewe, 1995; Oyewole, 2002).

In Africa, there is also particular interest for partial or total substitution of cassava into products typically made with cereals such as maize and wheat. Substituting cassava into accepted products will create new markets for farmers and it will help sustain the demand for cassava.

Bread is a well-established and popular convenience food in Africa for both urban and rural communities. The major problem with bread consumption in Africa is that most countries, including Nigeria, depend almost entirely on imported wheat for the bread market. FAO (1991b) stated that these prominent cassava producing African countries import about 2 million tones of wheat yearly for the baking industry. A lot of foreign exchange is expended in this exercise.

Wheat substitution with flour from other starchy crops is not new. Composite flour programme initiated by the Food and Agriculture Organization (FAO) of the United nations (1964) was conceived mainly to develop bakery products from locally available raw materials, particularly in those countries which could not meet their wheat requirement.

In 2006, the Federal government of Nigeria issued a directive that flour mills in the country should replace 10% of their wheat flour with cassava flour (FIRRO, 2006). This measure was to encourage the use of local products and also to save some foreign exchange.

Research works at the Federal Institute for Industrial Research, Oshodi (FIRRO) in Lagos, Nigeria, show that cassava flour can be incorporated into wheat flour for bread making at different levels of substitution, 10-15% being most acceptable, while 15-20% is acceptable for confectionaries and other baked products (FIRRO, 2006). According to Bokanga (2004), Akubundu (2005), up to 20 substitution of cassava flour has no adverse sensory and organoleptic effect on bread while more development was still being expected. International Institute of Tropical Agriculture (IITA), Ibadan, has also developed a range of baked products including bread, cakes and biscuits, using cassava and soybean flour and cassava starch. (Bokanga and Tewe, 1995).

In the proposed work, flour would be produced from selected varieties of improved cassava found in the Uyo environment. At least one popular local variety would be included. The flour produced will pass through physical assessment such as flour yield, water absorption capacity, bulk density and compared with wheat flour to determine its quality. The flour quality will also be determined chemically through proximate analysis. The flour would be used with wheat flour to produce composite bread at different levels of cassava flour inclusion. The bread produced would be examined for quality physically and chemically. It will pass through sensory evaluation to test the level of acceptability, 100% wheat flour bread would serve as reference bread.

The success of cassava composite bread and confectioneries would create favourable market for cassava farmers and would bring more income to them.

MATERIALS AND METHOD

Flour Production

Five varieties of cassava, NR8082, TMS 419, TMS 98/0505, TMS 4(2) 1425 and a local variety called Obubit Okpo (black stem), were selected for the study. The roots were washed to remove the soil and reduce contamination during processing. They were then peeled and washed again. The washed, clean roots of each variety were weighed to have a quantity of 3.82kg. They were sliced very thinly and sun-dried on clean woven mats for about 11 hours. The woven mats assisted in draining the water during drying, resulting in effective drying. The dried chips which became brittle, were ground in a corn mill grinder. The ground cassava powder was sieved through 212μm (micron) sieve, using standard mechanical sieve shaker. The flour obtained was packed in sealed plastic container to avoid absorption of moisture from the atmosphere. The different cassava flours were subjected to the following tests:

(i) **Flour yield :** This is the weight of flour obtained, expressed as a percentage of the weight of washed fresh tubers before slicing.

(ii) **Hydrogen Cyanide (HCN) content:** This was determined using the method of Association Of Analytical Chemists (AOAC, 2002).

(iii) **Moisture Content (MC):** This was determined using wet basis method, loss in weight due to drying expressed as a percent of initial weight before drying.

(iv) **Proximate Analysis:** Using OAOC method, the crude fibre, ash content, lipid contents, crude protein, carbohydrate or starch content, etc, were determined, (AOAC, 2002).

(v) **Bulk density (BD):** Some quantity of the flour was weighed into a graduated cylinder. The graduated cylinder was tapped several times until the flour settled to a constant volume and the volume was recorded. The bulk density was calculated as

$$\frac{\text{Mass of the flour}}{\text{Volume of the flour (settled volume)}} \quad \text{(g/ml)}$$

(vi) **Water absorption capacity (WAC):** 5g of the sample was added to 40ml of distilled water in a centrifuge tube and mixed thoroughly, the resultant slurry was allowed to stand for 1 minute at room temperature before centrifuged at 2000rpm for 5 minutes. The mixture was then allowed to settle and the clean water on top decanted to the last lower graduation point. The amount of water absorbed by the flour was found from the difference in volume between the initial volume of water and the volume remaining after being decanted.

(vii) **ph Measurement:** Digital ph meter was used for the measurement of the ph of the solution of the sample in distilled water.

BAKING

Baking of composite bread was carried out at 5%, 10%, 15% and 20% cassava flour inclusion. There was 100% wheat flour bread serving as control. The required ingredients such as water, salt, yeast, sugar, baking fat and flavour were added to the composite flour in the recommended proportions and mixed properly to form a dough. The dough was fermented for about I hour before loading them into the oven in bread pans for baking. Baking at about 250^{o}C lasted for about 30 minutes. The baked product (bread) was cooled to ambient temperature before it became ready for packaging and consumption.

Loaf quality was assessed by some physical, chemical and sensory evaluations such as mass of loaf, loaf volume, loaf volume index, loaf volume yield, proximate analysis and sensory evaluation. They were obtained as follows:

(i) **Mass of loaf**

The loaf after cooking, was weighed in electronic balance.

(ii) **Loaf Volume:**

The volume of the loaf was obtained by seed displacement method as described by Etudaiye and Aniedu (2008). An empty steel box which accommodates the loaf was filled with seed and shaken to level off. The seeds were poured into a graduated cylinder and the volume recorded. The loaf was then placed in the steel box and the remaining spaces filled with the same seed and leveled to the brim. The loaf was removed and the seeds which filled the spaces were also poured into the measuring cylinder and the volume recorded. The difference in volume between when the steel box was filled with seeds alone and when it was filled with both the loaf and seeds, gave the volume of the loaf.

(iii) Loaf volume index $= \frac{\text{Volume of loaf}}{\text{Mass of loaf}}$ ml/g

(iv) Loaf volume yield = $\frac{\text{volume of loaf}}{\text{Mass of flour used}}$ x 100%

The quality of loaf was also assessed chemically by proximate analysis, to have their nutritional contents, such as moisture content, ash content, fibre content, protein contents, lipids, etc.

Sensory Evaluations

Three samples of the composite bread at 5 to 20% level of cassava flour substitution, besides the reference bread (wheat bread), were served 19 persons who were familiar with the sensory attributes of taste, aroma, texture and colour of the samples. The samples were presented in identical containers coded with 3-digits random numbers such as 459, 667, 619 and 347, representing samples 1, 2, 3 and 4, respectively and served simultaneously to reduce the possibility of re-evaluation. The persons were asked to score their likes and dislikes on a nine-point Hedonic scale with 1 = like extremely, 5 = neither like nor dislike and 9 = dislike extremely (Etudaiye and Aniedu (2008); (Iwe, 2002). The data obtained after ratings were converted to numerical scores and analysed using analysis of variance (ANOVA) at $P < 0.05$.

RESULTS AND DISCUSSION

Table 1: Physical properties of flour of selected cassava varieties

Physical properties	**Cassava varieties**					
	NR 8082	**TMS 419**	**TMS 98/05/05**	**TMS 4(2) 1425**	**Local variety (black stem)**	**Reference (Wheat flour)**
Weight of tuber (g)	3820	3820	3820	3820	3820	-
Weight of flour obtained (g)	638.49	1002.60	958.10	602.34	586.97	-
Flour yield (%)	16.71	26.40	25.08	16.77	15.37	-
Starch yield (%)	67.00	70.10	69.00	65.70	65.02	
Water Absorption capacity of flour (%)	70.00	80.00	76.00	64.00	60.00	56.00
Bulk Density (g/ml) of flour	0.67	0.69	0.69	0.54	0.51	0.74

Table 1 show that TMS 419 has the highest flour content of 1002.6g from cassava tube of 3820g, which is 26.4% flour yield. It was followed by TMS 98/0505, with a flour content of 958.10g from tuber of 3820kg, and flour yield of 25.08%. The lowest was the native variety (black stem) with a flour content of 586.97g and flour yield of 15.37%. Starch yield was also highest for TMS 419 and lowest in native variety. Water Absorption Capacity (WAC) of the flour, indication of the retention of water by the flour, was highest for TMS 419 too. It was followed by TMS 98/0505. The wheat flour, the reference flour had the least WAC, lower than those of cassava flour.

The bulk density, was highest for wheat flour, about 0.74g/ml. Among cassava flour, TMS 419 and TMS 98/0505 had the highest value of 0.69g/ml. The smaller the particles of the particulate matter, the higher the bulk density. It helps in the design of packaging and storage materials.

Table 2: Chemical properties of flour of selected cassava varieties (AOAC, 2002)

Chemical Properties	**Cassava varieties**					
	NR 8082	**TMS 419**	**TMS 98/05/05**	**TMS 4(2) 1425**	**Local variety (Obubit Okpo)**	**Reference (Wheat flour)**
Moisture content (%)	9.00	8.00	8.33	9.30	10.75	12.33
HCN (ppm)	1.02	0.50	1.00	7.00	12.00	-
Crude fibre (%)	1.30	1.12	1.14	2.50	3.00	2.00
Protein content (%)	1.25	1.66	1.37	0.94	0.88	10.00
Ash content (%)	0.94	0.67	0.91	1.42	1.00	0.48
Lipid (%)	0.76	0.38	1.49	0.36	0.36	0.74
ph	6.60	6.80	6.70	6.90	6.70	6.50

Those of wheat flour are also shown. The flour from the two varieties of cassava from International Institute of Tropical Agriculture (11TA), TMS 419 and TMS 98/0505 had the least moisture content of 8.00% and 8.33% respectively. They are drier than the wheat flour which had moisture content of 12.33%. That is why they readily absorb water, hence they have high WAC, when exposed to water.

The Hydrogen cyanide (HCN) content in TMS 419 was the lowest, with 0.5ppm. TMS 98/0505 had 1.00ppm, next to the lowest. The native variety had the highest value of 12.00ppm. TMS 419 flour had the highest crude protein content with a value of 1.66%. All cassava flours had protein content of below 1.7% as compared with that of wheat flour, 10.00%. The ph values for all the flour, including wheat flour, were almost the same, about 6.6.

The high lipid content in NR8082 and TMS 98/0505 will contribute to high diastatic activity of the flour (Eggleston, et al, 1993) and will not allow for good specific loaf volume of the bread. Therefore, TMS 419, TMS 4(2) 1425 and native variety will give good specific loaf volume.

Table 3: Proximate analysis of cassava composite bread at 10% cassava flour substitution.

Food Properties	**Cassava variety composite bread.**			
	NR 8082	**TMS 419**	**TMS 98/05/05**	**Control (Wheat bread)**
Moisture content (%)	17.82	17.50	17.70	18.02
Hydrogen cyanide (ppm)	-	-	-	-
Crude fibre (%)	2.6	1.1	1.1	2.1
Protein content (%)	11.50	10.02	9.58	13.00
Ash content (%)	1.70	1.50	1.68	1.39
Fat/lipid (%)	1.70	1.19	2.11	1.56
Carbohydrate (%)	64.68	68.65	57.78	63.94
Energy content (Kcal/100g)	320.02	325.39	328.43	321.88

They were the best 3 selected for baking. 100% wheat flour bread is also included as reference bread.

Moisture content is lowest, about 17.50%, in TMS 419 composite bread. It has the capacity for longer shelf life, than others. The wheat bread had the highest moisture content. The unique thing about bread is that it still has sufficient moisture content at that high temperature of baking, 250°C. This sufficient moisture content does not allow nutrients to be destroyed in the bread at the baking temperature. There were no traces of Hydrogen Cyanide (HCN) in all the composite bread, on account of the high temperature of baking. Protein content was raised from about 1.6% in cassava flour to about 10% in composite bread (10% cassava flour inclusion). It is close to 13.00%, the protein content of 100% wheat bread. However, that of NR8082 is about 12%, almost as that of wheat bread. Carbohydrate content of TMS 419 composite bread was 68.65%, about the highest among the bread made, including wheat bread. Energy content of all the composite bread were about the same value of wheat bread. Some of them, TMS 98/0505 and TMS 419, had higher energy content than wheat bread. Therefore TMS 419 and TMS 98/0505 performed very well in composite bread.

Table 4: Loaf quality as described by some physical criteria

Composite bread (Cassava/wheat flour composition)	Mass of flour (g) (composite)	Mass of Bread (g)	Loaf volume (Cm^3)	Loaf volume index (cm^3)/ g, bread	Loaf volume yield (%)
Sample 1 (NR 8082)					
5.95%	200	281.05	182	0.65	91
10.90%	200	265.04	178	0.67	89
15.85%	200	270.15	172	0.64	86
20.80%	200	280.91	112	0.40	56
100% (control)	200	290.87	190	0.65	95
Sample 2 (TMS 419)					
5.95%	200	299.44	187	0.62	93.5
10.90%	200	296.74	185	0.62	92.5
15.85%	200	300.90	172	0.57	86.0
20.80%	200	296.64	117	0.39	58.5
100% (control)	200	290.87	190	0.65	95
Sample 3 (TMS 98/0505)					
5.95%	200	288.46	177	0.61	88.5
10.90%	200	270.19	173	0.64	86.5
15.85%	200	275.00	171	0.62	85.5
20.80%	200	267.23	167	0.62	83.5
100% (control)	200	290.87	190	0.65	95.0

Table 4 shows quality of cassava/wheat flour composite bread at different levels of cassava flour substitution (5 to 20%) for 3 varieties of cassava namely, NR8082, TMS 419 and TMS 98/0505. Different physical parameters are used for the quality assessment. A constant weight of 200g of the composite flour, including the reference flour, 100% wheat flour was used for baking all the samples.

It is observed that TMS 419 had the highest mass of loaf (bread) and at all the levels of substitution (5 to 20%), the mass was higher than the 100% wheat loaf. The other 2 samples, NR 8082 and TMS 419, had their mass of loaf at all levels of cassava flour substitution less than the wheat loaf. Loaf volume index was highest in sample 1 (NR 8082) and lowest in samples (TMS 419)

However, in loaf volume yield, wheat bread had the highest value (95%). It was followed by TMS 419 at 5 to 15% level of cassava flour substitution. Secondly, it was observed in Table 4 that 5 to 15% cassava composite bread in all the three samples of cassava varieties competed favourably with wheat flour bread. The cassava variety TMS 419 was the best performer.

Table 5: Mean scores for Hedonic Sensory Evaluation of the Bread Samples

Sample – 1 (NR8082)

Cassava/wheat flour composition	Colour	Taste	Aroma	Texture	Prefe-rence	Accepta-bility
5.95%	17.80	17.80	17.80	17.80	17.80	17.80
10.90%	17.58	16.91	16.96	16.78	16.99	16.94
15.85%	17.84	15.73	15.42	15.80	15.93	15.81
20.80%	17.16	13.08	15.98	13.61	13.17	13.17
100% (control)	18.50	18.50	18.40	18.60	18.40	17.90
Sample 2 (TMS 419)						
5.95%	17.80	17.80	17.80	18.42	18.10	18.00
10.90%	17.85	16.91	16.96	18.26	18.09	17.88
15.85%	17.84	15.73	15.42	17.56	17.27	17.51
20.80%	17.16	13.08	15.98	15.83	15.13	15.13
100% (control)	18.50	18.50	18.40	18.60	18.40	17.90
Sample 3 (TMS 98/0505)						
5.95%	17.92	17.40	17.00	15.40	17.90	17.90
10.90%	17.91	16.84	16.75	16.96	16.80	16.59
15.85%	17.11	16.19	16.75	16.34	16.28	16.14
20.80%	12.90	12.92	16.63	16.27	16.15	16.13
100% (control)	18.50	18.50	18.40	18.60	18.60	17.90

The observed scores shows that the level of substitution of cassava flour in the composite bread did not reduce caramelizan process which forms the brown colour during baking. The rating for the taste of the composite breads varied indirectly with the percentage substitution of cassava flour, with the highest score shown in 5%, close to 100% wheat bread. This gave a mean score of 18.50. This attribute showed a high level of correlation (r = 0.776; = α 0.01) with taste. The texture increased with the reduction in cassava flour substitution level, the highest score obtained in wheat bread, closely followed by TMS 419 at 5% and 10% levels of cassava flour substitution. The lowest was at 20% level of substitution especially with sample NR 8082.

The results shows that bread at 5%, 10% and 15% cassava flour substitution compared favourably in colour, taste, aroma and texture, with that of 100% wheat flour bread. The acceptability of the products might have been encouraging mainly by good taste, aroma of the samples and the absence of cyanogenic toxicity. TMS 419 at 5% cassava flour inclusion was more acceptable than 100% wheat bread.

CONCLUSION

Five varieties of cassava, NR 8082, TMS 419, TMS 98/0505, TMS 4(2) 1425 and the local variety, black stem, were chosen for the production of composite bread. TMS 419 had the highest flour yield of 26.4%. It was followed by TMS 98/0505 with flour yield of 25.08%. Others had lower flour yield, ranging from 16.77 to the least, the local variety with 15.37%. TMS 419 and TMS 98/0505 also had highest starch yield than others.

The higher flour and starch yields showed they have great potentials for composite bread and confectionery. These two cassava flours also had higher water absorption capacity, much higher than the reference wheat flour. Their bulk density were high too, only being superseded by the wheat flour. The high bulk density is associated with the degree of fines of the flour particles. TMS 419 flour also had the lowest moisture content. It was followed by TMS 98/0505. The low moisture content indicates affinity for water and mixing is easier when making dough. It has the lowest hydrogen cyanide. TMS 98/0505 had the second lowest. These flours are safe for consumption. These IITA varieties had highest protein content in their flour too.

Composite bread baked from a constant mass of 200g of composite flour showed that TMS 419 had the highest mass and the highest loaf volume yield among the 3 varieties of cassava flour used. Again, it had the lowest moisture content and this may give the bread longer shelf life, since the rate of microbial decay may be reduced. The carbohydrate content of TMS 419 composite bread was the highest even higher than that of wheat bread the energy content of 98/0505 composite bread was the highest. TMS 419 followed it. In sensory evaluation, TMS 419 composite bread at 5-10% level of cassava flour inclusion was most acceptable especially at 5% composite bread. However other cassava composite bread in order of preference are those of TMS 98/0505, NR8082. For effective composite bread performance, it is recommended that the percent cassava flour inclusion should be from 5 to 15%.

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