Effect of Cassava Flour Variety and Concentration on Bread Loaf Quality

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ABSTRACT

Cassava flour from 12 clones was baked into bread loaves at 10, 20, 30, and 40% substitution. Loaves were rated according to volume, color and character of crust, texture and grain, crumb color, and taste. Total scores of all quality parameters measured for each clone decreased as the amount of cassava flour was increased. Total scores at each concentration also varied depending on the cassava variety used ($P = 0.001$). Variations in volume, taste, crust color and character, and crumb color at each concentration of the clones were also very significant ($P \leq 0.001$). There was no correlation among various physicochemical properties of the cassava flour and bread quality. Cyanide concentration in the bread depended on the cassava variety and on the percentage substituted.

Partial substitution of cassava flour for wheat flour in bread baking has been studied mainly at the Institute of Grain, Flour and Bread (TNO) in Wageningen, the Netherlands, at the Tropical Products Institute (presently called the Overseas Development Natural Resources Institute), London, England (Dendy et al 1970, Grace 1977), and at North Dakota State University (Ciaco and D'Appolonia 1978). The Food and Agriculture Organization of the United Nations also initiated the use of cassava flour in its Composite Flour Program in Sao Paulo, Brazil and in Colombia (Gallien 1967). In Nigeria, similar work has been done at the University of Ife (Adeyemi 1984, *personal communication*) and at the Federal Institute of Industrial Research, Oshodi (Bamiro et al 1978).

In these studies, the variety of the cassava used for flour was not considered. This work was conducted to determine whether cassava clone or variety has an effect on bread quality especially at high cassava flour concentrations.

MATERIALS AND METHODS

Flours were prepared from 12 clones from the International Institute of Tropical Agriculture, Ibadan, Nigeria: TMS 518, TMS 30001, TMS 30040, TMS 30555, TMS 30572, TMS 50395, TMS 60142, TMS 60447, TMS 63397, TMS 91142, TMS 4(2)1425 and TMS 8042. Tubers from 12-month old plants were washed, peeled, washed, cut into thin chips, dried at 55°C to less than 10% moisture, and ground in a Wiley mill (0.5-mm sieve).

Soluble sugars in the flour were extracted with 80% ethanol, and the starch was extracted with perchloric acid from the residue (McCready et al 1950), then determined using the phenol sulfuric acid method of Dubois et al (1956). Total cyanide in the flour and in the bread were analyzed using an automated enzymic method (Rao and Hahn 1984). Kjeldahl nitrogen was multiplied by 6.25 to obtain protein. Crude fiber was determined by digestion with H_2SO_4, then with NaOH and ashing (AOAC 1970). The viscosity of the cassava flour paste was measured with a Brabender viscograph (Brabender 1962, Almazan 1988a). Gel consistency of the flour in water and in KOH and amylose content were determined by modifying the procedures for milled rice (Juliano 1971, Cagampang et al 1973, Almazan 1988b).

The straight dough formula and procedure for baking bread were based on those used by Nout (1977) and Bamiro et al (1978) and similar to those used in most Nigerian bakeries. Loaves at 10, 20, 30, and 40% cassava (flour weight basis) were prepared from 200 g of flour (cassava-wheat), 4 g of dry yeast (Engedura), 12 g of sucrose (table sugar), 2 g of table salt, 4 g of fat, and 105–120 ml of water. Wheat flour used was the locally available "Golden Penny." A yeast suspension was initially prepared by mixing 4 g of yeast, 2 g of sucrose, and 50 ml of water (37°C), and setting this aside for 20 min. The remaining sugar, salt, fat, yeast suspension, and water were mixed in a Hobart mixer (model A120) at setting 2. The amount of water varied from 55 ml at 10% to 70 ml at 40% cassava flour at an increment of 5 ml for each 10% increase of cassava. Flour was added to the suspension and the dough was mixed for 10 min. The dough was shaped into a ball, placed in a bowl, and fermented at 35–37°C. After 30 min, the dough was remixed for 5 min, rolled on a slightly oiled surface, folded, and placed into a nonstick baking pan (17.0 × 7.5 × 5.5 cm). The dough was proofed for 30 min at the same temperature, then baked at 175°C for 20 min. The loaves were removed from the pan immediately after baking and cooled on a rack. After 2 hr, the loaves were weighed and their volumes measured by displacement with sorghum.

The bread loaves were rated for external and internal characteristics using a method of evaluation based on the American Institute of Baking scoring system (Matz 1960) with some modifications to suit the cassava bread. Parameters scored were assigned the following maximum number of points: volume = 20, crust color = 10, character of crust = 15, grain and texture = 25, crumb color = 10, and taste = 20, giving a total score of 100 points. Crust and crumb colors were compared with standard samples. The scale for scoring crust character was as follows: 15 = thin and smooth top, 12 = thin and slightly rough top, 9 = slightly thick and rough top, 6 = thick and slightly cracked top, 3 = thick and deeply cracked top. Taste was rated: 20 = similar to pure wheat bread and no cassava taste, 16 = slight sweet cassava taste, 12 = bland cassava taste, 8 = slight wet or dry mouthfeel and slight bitter cassava taste, 4 = wet or dry mouthfeel and slight bitter cassava taste. For volume, the scale was based on specific volume (cm^3/g): 20 = 4.1–4.5, 17 = 3.6–4.0, 14 = 3.1–3.5, 11 = 2.6–3.0, 8 = 2.1–2.5, 5 = 1.6–2.0, 2 = 1.0–1.5. Texture and grain was rated: 25 = fine crumb or cell structure, 20 = coarse cell structure, 15 = slightly crumbs during slicing, 10 = slightly wet or dry and crumbs slightly when sliced, 5 = wet or dry especially at center and crumbs when sliced.

RESULTS AND DISCUSSION

Cassava flour concentration in the bread was varied from 10 to 40%. As more wheat flour was substituted with cassava flour, the total score for each clone decreased (Table I). Total score is the sum of the ratings for volume, crust color and character, grain and texture, crumb color, and taste. Variation in total scores among the clones was highly significant ($P = 0.001$). Total score for wheat bread was 92, higher than any of the breads from composite flours. This is because the rating score was defined according to wheat bread characteristics. The score for each

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TABLE I
Total Scores of Bread Loaves at Different Cassava Flour Concentrations[a]

Cassava Clones	Replacement Level 10%	20%	30%	40%	Mean[b]
TMS 518	80	66	44	35	56.2 g
TMS 30001	89	79	71	45	71.0 a
TMS 60447	87	78	72	41	69.5 a
TMS 30555	87	79	47	33	61.5 de
TMS 30572	87	75	44	30	59.0 f
TMS 50395	87	75	50	38	62.5 d
TMS 60142	84	77	58	39	64.5 c
TMS 63397	85	66	46	28	56.2 g
TMS 4(2)1425	87	77	59	35	64.5 c
TMS 30040	88	73	59	46	66.5 b
TMS 8042	82	76	52	29	59.8 ef
TMS 91142	79	75	58	41	63.2 cd

[a] Average of sensory and baking quality scores for at least two loaves; maximum possible = 100.
[b] Mean total scores for four cassava flour concentrations. CV = 7.7%. Values with the same letters are not significantly different at the 0.1% level.

quality parameter decreased with concentration for each clone ($P < 0.001$). Based on the analysis of variance, the differences in the ratings for each characteristic were also highly significant among the 12 cassava clones tested. Only the variation in the texture and grain for the different clones was not significant. Changes in the volume and in the texture and grain of the loaves with TMS 30572 can be noted in Figure 1.

Based on the mean total scores for each clone, TMS 30001 and TMS 60447 appeared to be the best cassava clones for baking bread. The other clones ranked in decreasing order of mean total scores were TMS 30040, TMS 4(2)1425 and TMS 60142, TMS 91142, TMS 50395, TMS 30555, TMS 8042, TMS 30572, TMS 518, and TMS 63397.

Total soluble sugars, starch, amylose, crude fiber, protein, paste viscosity, and gel consistency in water and in KOH of the different cassava flours were determined. There was no correlation among the physicochemical properties of the flour and the quality parameters of the bread. Quality of bread made of pure cassava flour with pentosan as a bread improver also depends on the variety used for preparing flour. Only flour with maximum paste viscosity of at least 800 Brabender units produced bread with the normal crumb structure, whereas those with low values produced wet loaves resembling pudding (IITA 1985). Apparently, although varietal differences in the bread with composite flour were observed, each quality characteristic was affected not only by the cassava flour but also by the wheat flour and the other components in the formula. The baking procedure was similar for all clones.

The cassava tuber contains the cyanoglucosides linamarin and lotaustralin at different concentrations depending on the variety. These can be reduced to levels safe for human consumption by proper processing (Mahungu et al 1987). Sun-drying of cassava chips could lower cyanide concentration by 95%. Oven-drying was not as effective, but a reduction of at least 50% could be obtained. Fermentation prior to drying eliminated most of the toxic factor. Because the flours used were from unfermented tubers, cyanide in the bread was analyzed. The cyanide contents of the breads from seven clones are shown in Figure 2. A reduction in HCN concentration due to flour dilution and the baking process was observed in all clones.

In the raw peeled tuber, a concentration greater than 5 mg HCN/100 g is considered moderately poisonous (Bolhuis 1954). Lower maximum levels are recommended for some cassava products: 2 mg HCN/100 g (Ingram 1975) and 3 mg HCN/100 g (Akinrele et al 1962) for *gari*, and 1 mg HCN/ 100 g for flour (Codex Alimentarius Commission 1985). There is no recommended cyanide level for bread, but a maximum value of 1 mg HCN/100g is probably safe for human consumption.

Flours containing low cyanide levels produced breads with very

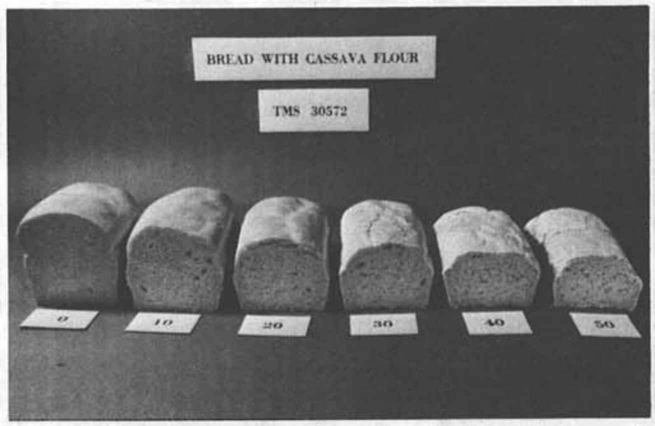

Fig. 1. Change in the volume, grain, and texture of bread loaves with increasing cassava flour (TMS 30572) concentration.

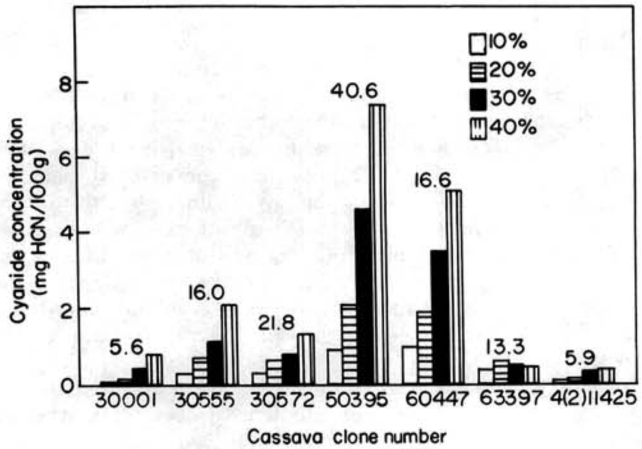

Fig. 2. Cyanide concentrations in bread loaves with different cassava flour concentrations. At least two loaves were analyzed per concentration for each cassava clone. The cyanide contents of pure cassava flour are indicated above the bars.

low cyanide content. The lowest concentrations were obtained from TMS 30001 and TMS 4(2)1425; below 1 mg HCN/100 g even at 40% substitution. Besides producing the best bread among the clones examined, TMS 30001 had this additional advantage. Highest HCN concentrations were found in TMS 50395 breads. Pure flour of this clone also had the highest cyanide concentration.

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