NOTE

# Impact of Milling Procedure on Breadmaking Potential of Cassava Flour in Wheatless Breads

I. DEFLOOR and J. A. DELCOUR[1]

Several problems are associated with the partial or total substitution of wheat by cassava flour for the production of bread. It is clear that a gradual loss of gluten in the recipes leads to lower breadmaking potential. In earlier work at this laboratory (Defloor et al 1991), we investigated the role of emulsifiers and extruded starch as bread improvers in cassava bread. The flour used was from a homogeneous lot. Breads of acceptable quality were obtained using glyceryl monostearate or extruded starch as improving agents.

A review of the literature showed that, in papers describing the production of cassava wheatless (Kim and de Ruiter 1968, 1969; Kim 1971; Satin 1988) or composite flour breads (Olatunji and Akinrele 1978, Almazan 1990), processing dried cassava chip into flour was never considered. Apparently it was taken for granted that dried cassava would yield a constant quality flour for bread production.

The present undertaking was to study the impact of the milling procedure on the breadmaking potential of cassava flour in wheatless bread recipes. Indeed, cassava starch and cassava flour have different breadmaking potential (Kim and de Ruiter 1968). Thus, it could be argued that fractionation of cassava in different milling streams could yield a starch-enriched cassava flour particularly suitable for baking. Furthermore, the impact of the milling procedure on starch damage of the resulting flour and, subsequently, the baking performance is unclear.

Therefore, fractions obtained by milling cassava chips at two moisture levels with a Buhler mill were analyzed and tested in wheatless bread recipes. Also evaluated was cassava flour obtained from chips that were ball- and hammer-milled.

## MATERIALS AND METHODS

### Materials

Materials used were described earlier (Defloor et al 1991). Cassava chips were obtained from the International Institute of Tropical Agriculture (Ibadan, Nigeria), courtesy of Y. Jeon. Cassava roots, harvested 13 months after planting, were peeled, washed, chipped, and sun-dried. The final moisture content of the chips was 11.5%.

### Milling of Cassava Chips

Chips were milled at 11.5 and 15.9% moisture level. Conditioning was carried out at room temperature by continuous mixing overnight to allow for a uniform distribution. Enough water was added to 20 kg of chips to obtain a final moisture content of 15.9%.

*Roller mill.* The chips were milled with a Buhler MLU-202 laboratory roller mill (Uzwil, Switzerland) adjusted for soft wheat milling (method 26-31, AACC 1983). The milling flow sheet and flour sieves were as given in Delcour et al (1989).

*Ball mill.* Chips were ball-milled (30 g batches, 5 min) in a Heidelberger Colloidmühle (Hormuth-Vetter, Heidelberg, Germany). The flour obtained (15.9% mc) was sieved (aperture 1.5 mm) before use to remove remaining lumps.

[1]Research Unit Food Chemistry, Katholieke Universiteit Leuven, Kardinaal Mercierlaan 92, B-3001 Heverlee, Belgium. Fax: 32-16-293805



*Hammer mill.* We used a President 4K (Ieper, Belgium) with a 1.5-mm sieve to hammer mill only chips of low moisture content.

### Analyses of Flour Composition

Ash content (in duplicate) of the respective flours was determined according to method 08-01 (AACC 1983). The samples were incinerated at 560°C. Soluble and insoluble dietary fiber content were determined (in triplicate) according to the procedure described by Asp et al (1983). Starch was determined enzymatically (in quadruplicate) according to the procedure described by Boehringer-Mannheim (1986). Percent damaged starch was determined according to method 76-30A (AACC 1983). Protein content was determined by a semimicro Kjeldahl method.

*α-Amylase activity.* The Phadebas colorimetric method (Analytica 1987) was used to determine the α-amylase activities of the flour samples. Six replicates were taken.

*Pasting properties of flour.* The Brabender visco-amylograph was used to study the pasting properties of the flour samples obtained under different conditions. Flour (50 g, 14% mc) was suspended in 450 ml of disodium phosphate-citric acid buffer solution, pH 5.30–5.35 (method 22-10, AACC 1983). The suspension was heated uniformly from 30 to 95°C, held at 95°C for 20 min, cooled to 50°C, and held for 20 min.

*Gelatinization properties of flour.* A Seiko DSC 120 instrument (Kawasaki, Kanagawa, Japan) was used to record the gelatinization properties of the flour samples. Samples were weighed in aluminum pans (Seiko, P/N 50-023) and heated at 2°C/min. The dry matter-buffer ratio was 0.47. Samples were run with the same buffer solution as in the Brabender visco-amylograph.

*Wheatless bread.* Wheatless bread was prepared according to the procedures by Defloor et al (1991). Loaves were baked with 80 g of cassava flour and 20 g of defatted soy flour. Glyceryl monostearate (3%) or extruded corn starch (12%) were incorporated in the formula to improve the gas retention capacity of the dough and the quality of the baked product.

## RESULTS AND DISCUSSION

### Analysis of Different Flours

The yields for the different milling streams of the roller mill are given in Table I.

B2 and B3 flour samples, as well as C2 and C3 flour samples, were mixed because the yields for these milling streams were low. In addition to break roll and reduction roll flours, we obtained two milling streams with fibrous material (Fl and F2) that corresponded to the traditional wheat terminology of bran and short fractions.

TABLE I
Yields and Moisture Levels for Different Milling Streams of the Roller Mill for Cassava Chips

| Milling Stream | Milled at 11.5% mc | | Milled at 15.9% mc | |
|---|---|---|---|---|
| | Yield | Moisture | Yield | Moisture |
| B1 | 27.5 | 11.6 | 34.5 | 13.6 |
| B2 | 5.5 | 11.4 | 9.0 | 11.8 |
| B3 | 1.5 | 11.4 | 2.0 | 11.8 |
| C1 | 40.0 | 11.2 | 32.5 | 12.0 |
| C2 | 11.5 | 11.1 | 6.0 | 11.5 |
| C3 | 4.5 | 11.1 | 3.0 | 11.5 |
| F1 | 8.0 | 11.4 | 10.5 | 11.1 |
| F2 | 0.5 | 10.4 | 2.5 | 11.7 |

**TABLE II**
**Ash, Fiber, Starch, Damaged Starch, and Protein Contents[a] of the Flour Samples Obtained by Milling Cassava Chips Using Different Milling Techniques at 11.5% mc**

| Flour | Ash | Fiber | | Starch | Damaged Starch | Protein (N × 6.25) |
|---|---|---|---|---|---|---|
| | | Soluble | Insoluble | | | |
| Roller mill | | | | | | |
| B1 | 2.13 | 1.79 ± 0.48 | 2.73 ± 0.01 | 85.9 ± 0.7 | 13.5 ± 0.7 | 1.15 ± 0.01 |
| B2+B3 | 2.15 | 1.42 ± 0.21 | 2.19 ± 0.04 | 88.6 ± 2.6 | 14.5 ± 0.5 | 1.23 ± 0.02 |
| C1 | 2.43 | 2.65 ± 0.20 | 3.18 ± 0.17 | 85.9 ± 1.5 | 15.6 ± 0.3 | 1.39 ± 0.02 |
| C2+C3 | 2.34 | 2.77 ± 0.14 | 4.19 ± 0.16 | 83.1 ± 1.1 | 14.8 ± 0.3 | 1.41 ± 0.01 |
| F1 | 2.76 | 4.15 ± 0.04 | 11.80 ± 0.34 | 72.3 ± 0.7 | nd[b] | nd |
| F2 | 3.25 | 3.11 ± 0.16 | 28.34 ± 2.37 | 61.6 ± 0.5 | nd | nd |
| Ball mill | 2.30 | 2.96 ± 0.31 | 4.16 ± 0.55 | 84.4 ± 1.5 | 13.9 ± 0.2 | 1.33 ± 0.02 |
| Hammer mill | 2.38 | 2.40 ± 0.55 | 4.69 ± 0.34 | nd | 13.6 ± 0.3 | 1.60 ± 0.01 |

[a] Results expressed as % dry matter.
[b] Not determined.

Milling of cassava chips at 11.5% mc resulted in lower yields of break roll flours (B1, B2, and B3) but higher yields of reduction roll flours than did milling carried out at 15.9% mc. The yields of F1 and F2 were also lower when the chips were milled at 11.5% mc.

The extraction yields (sum of break and reduction flours) for the milling at 11.5 and 15.9% mc were 91 and 87%, respectively.

Softer material (higher moisture content) was liberated more readily in the breaking stage and less in the reduction stage. These actions apparently compensated for each other, resulting in extraction yields that differed only to a small extent.

Ash, fiber, starch, damaged starch, and protein content of the flour obtained by milling cassava chips of 11.5% mc with different mills are listed in Table II. Similar results were obtained at the 15.9% mc milling experiment.

The insoluble fiber content of the Cl, C2 + C3, ball mill, and hammer mill flour samples was higher than that in the break flour samples (B1 and B2 + B3). Differences in soluble fiber content between the flour samples were less pronounced. However, the C1, C2 + C3, ball mill, and hammer mill flour samples had slightly higher soluble fiber content than the B1 and B2 + B3 flour samples. This was true at both chip moisture levels investigated. The soluble fiber content of the B1, B2 + B3, and C1 flours was slightly lower than the insoluble fiber content. This effect was more pronounced for the C2 + C3, ball mill, and hammer mill flour samples.

**Gelatinization and Pasting Properties of the Flour Samples**

Gelatinization enthalpies and peak temperatures, as measured by differential scanning calorimetry, did not vary with milling procedure.

The viscosity of flour suspensions at different steps of the heating and cooling cycle described above showed no significant differences attributable to the milling procedure applied. $\alpha$-Amylase activity averaged between 2.0 and 5.4 units per 100 g of dry matter. It was slightly lower for the flour samples obtained from chips milled at 15.9% mc. This was more pronounced for the C1, C2 + C3, and ball mill flour samples.

We suspect that the $\alpha$-amylase data did not correlate with the peak viscosity results because the levels of $\alpha$-amylase were not significantly different; they were too low to be expected to have a relevant effect on the starch pasting properties.

**Wheatless Bread**

The breadmaking capacity was not significantly altered by milling conditions. No real differences in crumb structure were observed for either the 3% glyceryl monostearate or the 12% extruded corn starch formulas. Loaves were comparable to those obtained earlier (Defloor et al 1991). Loaves obtained with hammer-milled flour showed a slightly greyish crumb color in contrast to the yellowish crumb color of loaves from flour obtained by other milling procedures.

Even with some noticeable differences in loaf volumes, no clearly important improvement in crumb structure was observed for the different flour samples.

## CONCLUSION

The differences in milling procedures of cassava chips affected analytical data (ash, fiber, starch, and protein content), $\alpha$-amylase activity, starch damage, pasting and gelatinization properties, and breadmaking potential to only a limited extent.

### LITERATURE CITED


ALMAZAN, A. M. 1990. Effect of cassava flour variety and concentration on bread loaf quality. Cereal Chem. 67:97-99.

AMERICAN ASSOCIATION OF CEREAL CHEMISTS. 1983. Approved Methods of the AACC, 8th ed. Method 08-01, approved April 1961, revised October 1981; Method 22-10, approved May 1960, revised October 1982; Method 26-31, first approval April 1961, final approval October 1988; Method 76-30A, approved May 1969, revised November 1972, October 1982, October 1984. The Association: St. Paul, MN.

ANALYTICA. 1987. Approved Methods of the European Brewery Convention. Schweizer Brauerei- und Getraënke-Rundschau: Zurich.

ASP, N. G., JOHANSSON, C. G., HALLMER, H., and SILJESTROM, M. 1983. Rapid enzymatic assay of insoluble and soluble dietary fiber. J. Agric. Food Chem. 31: 476-482.

BOEHRINGER-MANNHEIM 1986. Starch UV-method. Pages 108-110 In: Methods of Biochemical Analysis and Food Analysis. Boehringer Mannheim GmbH, Biochemica: Germany.

DEFLOOR, I., DE GEEST, C., SCHELLEKENS, M., MARTENS, A., and DELCOUR, J. A. 1991. Emulsifiers and/or extruded starch in the production of breads from cassava. Cereal Chem. 68:323-327.

DELCOUR, J. A, VANHAMEL, S., and DE GEEST, C. 1989. Physicochemical and functional properties of rye nonstarch polysaccharides. I. Colorimetric analysis of pentosans and their relative monosaccharide compositions in fractionated (milled) rye products. Cereal Chem. 66:107-111.

KIM, J. C. 1971. Bakprodukten uit meel van tropische landbouwgewassen. Voedingsmiddelentechnologie 2:1-5.

KIM, J. C., and DE RUITER, D. 1968. Bread from non-wheat flours. Food Technol. 22:867-878.

KIM, J. C., and DE RUITER, D. 1969. Bakery products with non-wheat flours. Baker's Dig. 43:58-63.

OLATUNJI, O., and AKINRELE, I. A. 1978. Comparative rheological properties and bread qualities of wheat flour diluted with tropical tuber and breadfruit flours. Cereal Chem. 55:1-6.

SATIN, M. 1988. Bread without wheat. New Sci. April 28, pp 56-59.


[Received July 16, 1992. Accepted June 23, 1993.]