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Composition and microbiological and physical attributes of mawè, a fermented maize dough from Benin

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Summary

Home-scale and commercial mawè samples produced in urban Benin were very similar in composition, particle size, dough viscosity, and microbial loads, with titratable acidity 1.2–1.4% w/w (as lactic acid); home-produced mawè had a slightly higher pH (4.2), protein, fat, fibre, and ash than commercial mawè. Lactobacilli and yeasts predominated in both.

Keywords

Colour, dough viscosity, Lactobacilli, particle size, sourdough, yeasts.

Introduction

Fermented cereal foods are produced for daily consumption in most African countries. In Benin they are obtained from two types of intermediate fermented products:

(1) *ogi*, a gruel obtained by fermentation of a suspension of maize in water (Oke, 1967; Akinrele, 1970) is consumed as gels, as a semi-solid product, or as a liquid porridge, and (2) *mawè*, a fermented dough, also known in Togo (Doh, 1970), is used for cooked dishes including gels (*ogi*-like products), steam-cooked bread (*ablo*), or porridge (*koko*, *aklui*, *akluiyonu*). Although less *mawè* is produced than *ogi*, it is sold both as ready-to-serve and as domestic ready-to-cook products in urban areas.

The 'home-' and 'commercial-' processes for *mawè* production are outlined below. The main difference is that commercially fines are separated, grits washed to remove more hulls and germ, and fines added back before soaking.

Winnowed maize is washed, crushed in a plate disc mill (Premier 1A type), and screened by metal or nylon sieve with 0.5 × 0.5 mm apertures (commercial process), or through a palm-fibre sieve ('*sassado*') with 2 × 2 mm or 2 × 4 mm apertures (home

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production method). Grits and hulls are separated by gravity on the sieve and the fine endosperm fraction collected in a bowl. In the commercial process (entirely in the milling shop), the grits are washed by rubbing in water, the germs and remaining hulls floated off and discarded, water decanted, and the sedimented endosperm grits blended with the fine endosperm fraction. In the home production method, the grits are not washed, but home-dehulled. The resulting grits and fine fraction are moistened, held for 2–4 h, and milled to a dough. The kneaded dough is then covered with polyethylene sheet and allowed to naturally ferment to a sour dough and held in the fermentation bowl or wrapped in paper or polyethylene.

These methods of mawè production show some similarity to the dry-milling approach for ogi manufacture (Banigo *et al.*, 1974).

The present study was of the chemical, microbiological, and physical characteristics of home-produced and commercial mawè as a basis for product quality improvement.

Materials and methods

Samples (2 kg) of home-produced mawè collected from 20 homes, 15 samples of commercial mawè collected at markets, and 15 samples obtained directly from producing mills were immediately brought to the laboratory in their original packaging (bowl, paper or polyethylene bag), where sub-samples were taken for microbial culture and the remainder packed in freezer bags and held at -50°C for analysis.

The following measurements were made immediately: titratable acidity and pH (Nout *et al.*, 1989); moisture (method 44–15A; AACC, 1984); and colour (Minolta CR 210b portable chromameter, illuminant D65; CIE, 1976, standardized with a standard white tile; $Y = 94.8$, $x = 0.315$ and $y = 0.3324$). Thawed mawè (50 g) was dried (60°C , 48 h), ground, dried to constant weight at 103°C and vacuum-sealed in laminated aluminium bags for proximate analysis (methods 46–11A, 30–25 and 08–01; AACC, 1984) and for crude fibre analysis (Osborne & Voogt, 1978). Carbohydrate was calculated by difference.

Viscosity of mawè thawed overnight at $+5^{\circ}\text{C}$ was measured with a viscograph (Pt 100, 700 cmg sensitivity cartridge, Brabender OHG Duisburg, Germany) on 8% dry matter slurries (450 g) during heating and cooling ($1.5^{\circ}\text{C min}^{-1}$ from 30 to 90°C , held at 92°C for 15 min and then cooled at $1.5^{\circ}\text{C min}^{-1}$ to 50°C ; Adeyemi, 1983). The viscograms were evaluated as described by Banigo *et al.*, 1974).

Particle size was determined by wet sieving for 30 min through 355, 250, 125, 90, and $45\text{ }\mu\text{m}$ sieves (Endecotts, London, UK), followed by dry matter measurement (Sefah-Dedeh, 1989).

For microbiological analyses, duplicate sub-samples (10 g) were homogenized with 90 ml sterile peptone-physiological salt solution (5 g peptone, 8.5 g NaCl, 1 l distilled water, pH 7.0 ± 0.2) and decimal diluted. All cultures were on pour-plates. Total aerobic mesophilic counts (3 days, 30°C) were on Plate Count Agar (PCA; 5 g tryptone, 2.5 g yeast extract, 1 g dextrose, 15 g agar No 1, 1 l distilled water, pH 7.0 ± 0.2) with a PCA overlay to avoid surface spreading. Lactic acid bacteria counts (3–5 days, 30°C) were on MRS medium (Oxoid CM361) containing 0.1% (w/v) natamycin (Delvocid, Gist-Brocades, Delft, The Netherlands), with an overlay of the same medium. Lactobacillus spp. counts (3 days, 30°C) were on Rogosa Agar (Oxoid CM627) with overlay. Yeasts and filamentous fungi (moulds; 3–5 days, 25°C) were on Yeast Extract Glucose Agar (Oxoid CM545) to which 0.01% (w/v) sterile oxytetracycline (Oxoid SR73) was added after autoclaving. Enterobacteriaceae

(20–24 h, 37°C) were on Violet Red Bile Glucose Agar (VRBG, Oxoid CM485) with overlay.

Results and discussion

Titratable acidities of both home-made and commercial mawè samples were similar (1.2–1.4% w/w as lactic acid), but home-made mawè had a slightly higher pH (Table 1); both values were similar to that found in highly acceptable ogi (Steinkraus *et al.*, 1983) and Ghanaian maize dough (Plahar & Leung, 1983). As expected, crude protein, crude fat, crude fibre, and ash contents of home-produced mawè were slightly higher, since more hull and germ is retained during home production; process conditions influence ogi composition in a similar way (Banigo *et al.*, 1974; Adeyemi *et al.*, 1987).

The dominating micro-organisms in mawè (Table 1) are lactic acid bacteria and yeasts, with Enterobacteriaceae counts less than 400 and 3600 c.f.u. g⁻¹ in commercial and home-produced mawè, respectively. Commercial market mawè had a slightly higher yeast count, with no real differences in counts of total aerobic mesophilic and lactic acid bacteria.

In general, mawè is a white dough produced from white maize varieties. Most

Table 1. Chemical composition (dry weight basis, dwb), microbial load (log₁₀ c.f.u. g⁻¹) and colour attributes of mawè samples

	Home produced mawè (collected from homes) <i>n</i> = 20	Commercially produced mawè (fresh from the mill) <i>n</i> = 15	Commercially produced mawè (sold at the market) <i>n</i> = 15
pH	4.2 ± 0.4	3.9 ± 0.3	3.8 ± 0.3
Titratable acidity (% w/w, as lactic acid)	1.2 ± 0.2	1.1 ± 0.3	1.4 ± 0.5
Moisture content (%)	46.8 ± 2.7	45.9 ± 1.5	45.1 ± 1.2
Crude protein (N × 6.2, % dwb)	9.2 ± 0.9	8.3 ± 0.8	8.2 ± 1.0
Crude fat (% dwb)	2.3 ± 0.9a*	0.9 ± 0.4b	1.0 ± 0.6b
Crude fibre (% dwb)	0.7 ± 0.1a	0.4 ± 0.1b	0.4 ± 0.1b
Ash (% dwb)	1.1 ± 0.2a	0.6 ± 0.1b	0.6 ± 0.1b
Soluble carbohydrate (% dwb)	86.7	89.8	89.8
Total aerobic mesophilic count	9.0 ± 0.4	8.8 ± 0.4	8.8 ± 0.3
Lactic acid bacteria	9.0 ± 0.6	8.9 ± 0.4	8.9 ± 0.3
<i>Lactobacillus</i> spp.	9.0 ± 0.4	8.9 ± 0.4	8.9 ± 0.3
Yeasts†	5.8 ± 0.8	6.4 ± 0.9	6.9 ± 0.5
<i>Enterobacteriaceae</i>	≤3.6	≤2.5	≤2.3
L*	78.7 ± 2.1	78.0 ± 2.5	79.7 ± 1.3
a*	-1.0 ± 0.4	-1.0 ± 0.4	-1.1 ± 0.3
b*	9.8 ± 0.9	9.3 ± 0.9	9.2 ± 1.8
ΔE	20.8 ± 2.1	22.0 ± 3.2	19.0 ± 1.4

* Averages with different letters within rows are significantly different (Student's *t*-test; *P* < 0.05).

† Moulds were not detected.

Table 2. Particle size distribution of mawè (weight %)

Particle size (μm) (range)	Home produced mawè $n = 20$	Commercial mawè $n = 30$
$x \geq 355$	5.5 ± 3.1^1	2.8 ± 1.4
250–355	4.9 ± 1.6	4.2 ± 1.5
125–250	13.3 ± 3.0	12.9 ± 3.0
90–125	6.7 ± 3.3	6.1 ± 1.5
45–90	7.7 ± 3.1	10.2 ± 3.5
$x < 45$	62.0 ± 6.3	62.8 ± 6.5

¹ Averages and standard deviations.

commercial mawè is visually whiter than home-produced mawè, although all the measured values were very similar (Table 1). Brabender viscosity profiles of mawè are similar to those for sorghum ogi (Adeyemi, 1983) and ogi from different varieties of maize (Adeyemi *et al.*, 1987). The average temperature of gelatinization was about 73°C for the commercial market mawè and 75°C for home-produced mawè. Viscosity during heating and cooling, stability and gelatinization index were all slightly higher in commercial than in home-produced mawè. According to Banigo *et al.*, 1974, this should make commercial mawè more suitable than home-produced mawè for the preparation of gel-type products (e.g. agidi).

Particle size analysis showed major fractions as $<45 \mu\text{m}$ in all samples (Table 2).

Conclusion

Colour, fineness, and acidity are the major quality criteria in mawè production. Commercial mawè is thought to be whiter and finer than home-produced mawè, but no real differences were found. As significantly more hulls and germ are retained in the home-made mawè, it has slightly more protein, crude fat, crude fibre, and ash. The microflora of both products is fairly similar and consists mainly of *Lactobacillus* spp. and yeasts. Traditional mawè varies widely, and is not of uniform composition; factors responsible include the maize cultivars used, actual process conditions and environmental conditions during the fermentation; all of which affect the nature and activity of dominating micro-organisms and the biochemical transformations taking place.

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