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Influence of Pressing Force on Physicochemical and Sensory Qualities of Fermented Cassava Mash and Attieke Semolina

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ABSTRACT

The quality of attieke semolina is highly dependent on traditional processing technologies, of which certain effects, such as pressing force, are unknown. The aim of this study was to improve and consolidate attieke semolina processing by controlling the fermented cassava mash pressing process. The effect of pressing force was studied with a traditional press. The application of three forces (0.91, 1.55 and 2.58 kN) on 1100 g fermented cassava dough with 66% moisture content over 10, 15 and 20 minutes showed that 1.55 ± 0.3 kN could produce attieke semolina of good texture with better physicochemical qualities and residual cyanide not exceeding 10 mg/ml.

Keywords: starchy couscous, texture, traditional process

INTRODUCTION

Attieke is commonly called sour cassava semolina, a starchy couscous-like staple food made from fermented cassava mash. Cassava is transformed by washing, peeling adding palm oil and grating the roots then placing the paste under press to release water. The mash obtained is granulated into semolina then separate from fibers and undesired components after drying in the sun. Its traditional small scale production requires the use of an inoculum of 3-day-old cassava tubers on which spontaneous microflora have developed (Assanvo *et al*. 2006). The process uses a traditional starter which is added at around 8-12% after peeling and grating of the roots. The inocula studies on 81 starter samples from several villages showed that the dominant microflora consists of lactic acid bacteria (5.7 x 10^7 cfu/g), yeasts (5.5 x 10^7 cfu/g), *Bacillus* (3.8 x 107 cfu/g), *Enterococcus* (3.0 x 106 cfu/g), total coliforms (3.0 x 10^6 cfu/g), thermotolerant coliforms (8.0 x 10^3 cfu/g) and mould (2.0 x 10^6 cfu/g). Lactic acid bacteria, *Bacillus* spp., yeasts, faecal *Enterococci* and moulds are organisms which could play a role in the cassava fermentation (Coulin *et al*. 2006). This foodstuff is made in an alternative process by fermentation and steam-cooking cassava roots (Amani 1993).

Due to its popularity it is widely used for accompanying grilled meat and fish in urban dishes. Attieke semolina is now increasingly produced and consumed outside its origin in the Ivory Coast (Côte d'Ivoire) and now in other African countries. The most available and appreciated by many consumers is made from a bitter cassava variety namely "Improved Africa Cassava" or IAC. Attieke processing technologies have been described by several authors (Aboua *et al*. 1989; Mosso *et al*. 1991, 1998). However attieke processing technology is characterized by an empiric control and is very difficult to control (Sotomey *et al*. 2001). Therefore its pressing can vary from 1 to 10 hours depending on the cassava variety, fermentation used and kind of press. The latter step is relevant in this study because of its potential to influence semolina texture quality. To ensure food safety by enhancing reproducibility, performance and profitability of semolina production on a household, cottage-industry and industrial scale, a standardised procedure of semolina production needs to be established. The present study provides for optimisation of the production process by controlling the pressing step, which influences attieke physicochemical and sensory qualities.

MATERIALS AND METHODS

Origin of materials

Local cassava variety IAC (Improved Africa Cassava) was used for this experiment. Mature roots from experimental station of University of Abobo-Adjame were harvested in the rainy season (age ranging from 12-18 months) after reaching (80-90%) the maximum starch level. The cassava roots weighted between to 100-1000 g.

Pressing process

The roots, after collected, were peeled, cut into pieces and washed with cold water in bowls. These pieces were inoculated (10%) with a spontaneous traditional inoculum of palm oil (4 ml) and grated to a pulp. The pulp was fermented in bowls for 12 h. The mash was then filled into jute sacks and pressed. Pressing was done with a traditional manual press. Fermented cassava mash (3300 g) was divided into three lots of 1100 (±100 g) each. Each lot was pressed respectively by two extreme forces i.e. 0.91 ± 0.05 and 2.58 ± 0.09 kN and also an intermediate force i.e. 1.55 ± 0.30 for 10, 15 or 20 min. These forces and times were selected after preliminary experiments as the most ideal for this experimental quantity (1100 g) of mash, influencing the texture of cake mash. Force was measured by a universal press (Wolpert Tyz kN, Germany) from the Centre National Agronomique de Côte d'Ivoire (CNRA-Côte D'Ivoire).

Determination of granulation

Granulation was determined using the laboratory plansichter method 66-20 of the AACC (2000). Semolina of fermented mash

Received: 5 February, 2008. Accepted: 2 April, 2008.

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(100 g) was sifted by a granulometer summit (model 1500, Peter Instruments, Hudding, Sweden).

Moisture content

Moisture content was determined by the AOAC (1999) method with a moisture meter (Scaltec Instruments, Germany).

Cyanide content

The procedure for enzymatic hydrolysis developed by Cooke (1978) and which allows HCN content to be determined was employed. The method was further improved by O'Brian et *al*. (1991) by introducing an ethanol/acid extraction step, which simplifies the extraction of cyanide from cooked cassava products with gelatinised starch. The photometric procedure used in this work was developed by Essers *et al*. (1993) who replaced the toxic pyridine/pyrazolone colour reagent used by a less toxic isonicotinic/chloramin T reagent (Fluka 58930).

About 10 g of pressed mash was diluted and homogenised in 30 ml of acid extraction medium (Polytron). The homogenate was then left to stand for 10 min and then centrifuged at 10,000 × *g* for 10 min (Beckman, J-25i, Fullerton, USA). The supernatant was stored at 4°C until assayed for cyanogenic compounds. For the extraction of cyanogenic compounds, the following solutions were prepared: acid extraction medium: 0.1 M phosphoric acid in distilled water ethanol/acid extraction medium: 75% (v/v) of acid extraction medium and 25% (v/v) ethanol.

Test procedure: Phosphate buffer pH 7.0, 6.0 and 4.0 was prepared from 0.1 M H_3PO_4 and 0.1 M Na_3PO_4. Linamarase was dissolved in phosphate buffer pH 6.0 to give an activity of 5 enzyme units (EU)/ml (hydrolysis of 5 µmol of linamarin per min at 30°C in phosphate buffer pH 6.0). Chloramin T reagent was prepared by dissolving 0.5 g of chloramin T in 100 ml water. The isonicotinic acid/barbituric acid reagent was prepared by dissolving 3.5 g barbituric acid and 2.85 g isonicotinic acid in 0.5 M NaOH solution. About 0.45 ml of Phosphate buffer pH 7.0, 0.1 ml sample, 0.05 ml linamarase (VWR International AG, Dietikon, Switzerland, BDHA 391172R) solution were mixed in a 1.5 ml tube and then incubated at 37°C for 30 min before transferring to a 15 ml tube. 0.6 ml of a 0.2 M NaOH solution was added after 5 min. 2.8 ml pH 6.0 Phosphate buffer was then added. 0.1 ml of colouring agent was added and 0.6 ml isonicotinic/barbituric acid reagent was mixed in. The absorbance was measured photometrically after 20 min at 600 nm with a Photolab S12 WTW photometer (Photolab, Weilheim, Germany).

Calibration standard: About 0.4 ml buffer pH 7.0, 0.1 ml standard solution, 0.6 ml 0.2 M NaOH solution was mixed and after 5 min 2.9 ml buffer pH 6.0 was added.

Total sugar content

Total sugar content was determined by a colorimetric test (Dubois *et al*. 1956). 0.1 ml sample was added to 0.9 ml distilled water and then 1 ml phenol [5% (p/v)] and 1 ml H_2SO_4 extract was added then vigorously mixed. After being softly homogenized the mixture was boiled at 100°C for 5 min then cooled for 30 min. Absorbance was measured at 480 nm.

Starch content

Starch content was determined by the anthrone method (Hassid and Nuefeld 1964). Starch extraction was carried out by adding 3 ml of 66% perchloric acid to 0.2 g cassava mash for 20 min and then diluted into 100 ml. Two millimeters of solution obtained were placed in test tubes and mixed with 5 ml of anthrone reagent. The test tubes were placed in a boiling water bath and left for 12 min, cooled, then measured at 630 nm.

Sensory quality

Sensory evaluation was done by the triangular test method (Helm and Trolle 1946), which consisted of sensory identification of attieke semolina samples. The evaluation allowed the confirmation of similarities or differences between semolina coming from different pressing forces.

Statistical analysis

Differences between means from three replications of each sample were performed using significant F-ratios at $p < 0.05$ (Minitab 1998).

Table 1 Influence of pressing force on fresh mash semolina.

Force (KN)	**0**		**0.91 ± 0.05**			**1.55 ± 0.3**			**2.58 ± 0.09**	
Time (min)	**0**	**10**	**15**	**20**	**10**	**15**	**20**	**10**	**15**	**20**
Moisture (%)	66±1.13a	62.5±1.36b	62.3±1.02b	62.1±1.57b	52.4±1.20c	52.5±1.02c	51.8±1.57c	45.3±0.97d	44.1±0.91d	46.6±2.27d
Starch (%)	83.9±1.32a	80.0±1.35b	80.4±2.09b	80.7±2.57b	71.1±3.31c	71.5±2.51c	71.8±3.42c	55.5±2.40d	56.5±2.33d	57.7±2.42d
Cyanide (%)	63.7±2.33a	54.8±1.75b	54.5±2.11b	55.0±2.78b	35.1±1.89c	35.5±3.04c	35.0±2.78c	19.6±2.02d	19.8±1.47d	19.5±1.80d
Sugar (%)	5.73±0.43a	4.68±0.10b	4.73±0.12b	4.64±0.19b	3.21±0.18c	3.13±0.09c	3.36±0.06c	1.86±0.07d	1.66±0.05d	1.86±0.07d

Mean values ± standard deviations from triplicate analysis. Values followed by the same letter in a row are not significantly different as measured by significant F-ratios at $p < 0.05$.

Table 2 Influence of pressing force on semolina cooked into attieke.

Force (KN)	**0**		**0.91±0.05**			**1.55±0.3**			**2.58±0.09**	
Time (min)	**0**	**10**	**15**	**20**	**10**	**15**	**20**	**10**	**15**	**20**
Moisture (%)	66±1.13a	58.8±0.97b	58.7±0.98b	57.2±1.43b	48.0±1.55c	47.6±1.38c	46.4±2.18c	38.8±1.56d	41.2±1.89d	41.0±1.77d
Starch (%)	83.9±1.32a	79.2±1.03b	79.6±2.05b	78.7±2.19b	71.7±3.91c	70.3±3.07c	70.2±1.93c	54.2±2.44d	54.0±1.00d	55.7±1.29d
Cyanide (%)	63.7±2.33a	26.8±1.54b	26.6±1.44b	28.0±1.00b	11.2±1.11c	11.5±1.41c	10.8±1.24c	5.36±1.13d	5.16±1.04d	5.16±1.15d
Sugar (%)	5.73±0.43a	4.47±0.06b	4.39±0.21b	4.53±0.04b	3.05±0.02c	3.06±0.05c	3.08±0.01c	1.13±0.01d	1.13±0.02d	1.17±0.01d

Mean values ± standard deviations from triplicate analysis. Values followed by the same letter in a row are not significantly different as measured by significant F-ratios at $p < 0.05$.

Table 3 Influence of pressing force on attieke semolina texture.

Time (min)	**0**			**10**			**15**			**20**		
Attieke texture compared (kN)	D/A	D/C	D/B	A/B	A/C	B/C	A/B	A/C	B/C	A/ B	A/C	B/C
Panel Evaluation with different	100±0.01a	100±0.01b	100±0.01c	93±0.01a	97±0.01b	90±0.01c	90±0.01a	97±0.01b	93±0.01c	97±0.01a	93±0.01b	93±0.01c

Mean values ± standard deviations from triplicate analysis. A, B, C and D: attieke from 0.91, 1.55, 2.58 and 0 kN, respectively. Values in a row followed by different letters are significantly different at $p < 0.05$ as measured by the triangular test.

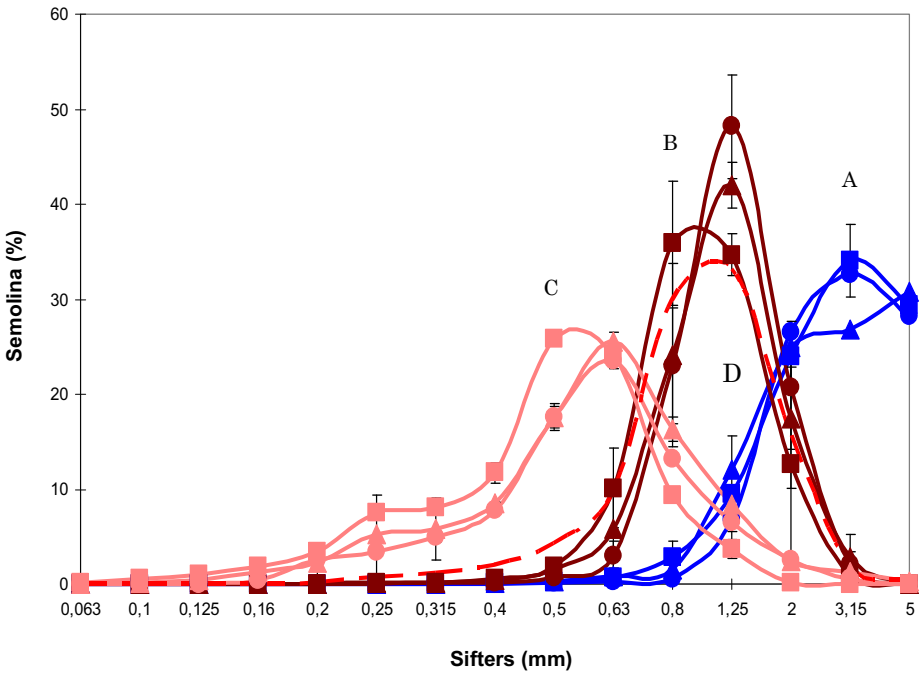

Fig. 1 Attieke semolina's distribution when 0.91 (A), 1.55 (B) and 2.58 (C) kN pressing force, respectively were applied; (D) Attieke current texture.

RESULTS AND DISCUSSION

Increasing the pressing force from 0.91 to 2.58 kN lowered the physicochemical components respectively from fresh mash (**Table 1**) and fresh attieke semolina (**Table 2**) independent of the pressing time used (10, 15 or 20 min) at $P<0.05$. The statistical analyses showed that there was a meaningful difference within each component (starch, cyanide and sugar content) for the same pressing force. Separately, the triangular sensory evaluation test (**Table 3**) confirmed significant differences between different textures or granulating distribution and pressing forces independent of the pressing period (**Figs. 1, 2**).

At 1.55 KN, i.e. intermediate pressing between 0.91 and 2.58, provided attieke of consistent texture. At 0.91 KN, the freshly mashed texture was rough because much water was present. In similar results by Aboua *et al*. (1989) this led to a bad texture of semolina attieke which was compact. At 2.58 KN the mash was dehydrated, dried and crumbly. The effect of dehydration on fermented cassava mash was previously observed in several studies (Aboua *et al.* 1989; Amani 1993; Aboua 1998). They found out that cassava mash with different humidity levels lead to differences in attieke humidity and quality. The optimal pressing force to providing atttiéké semolina with consistent texture is in this case the intermediate force of 1.55 KN with a well-dried, crumbly and good density texture. Similar results were observed for cassava total sugar content, thus related to starch (Aboua *et al.* 1989). Finally, the cyanide content was positively influenced by a pressing force between 1.55 and 2.58 KN. Therefore the cyanide content is lower than the level (10 mg/Kg) recommended by FAO (1956, 1991) and other authors (Ouegnin 1988; Aboua *et al.* 1990; Mosso *et al*. 1991; Essers *et al*. 1993; Zoumenou 1994).

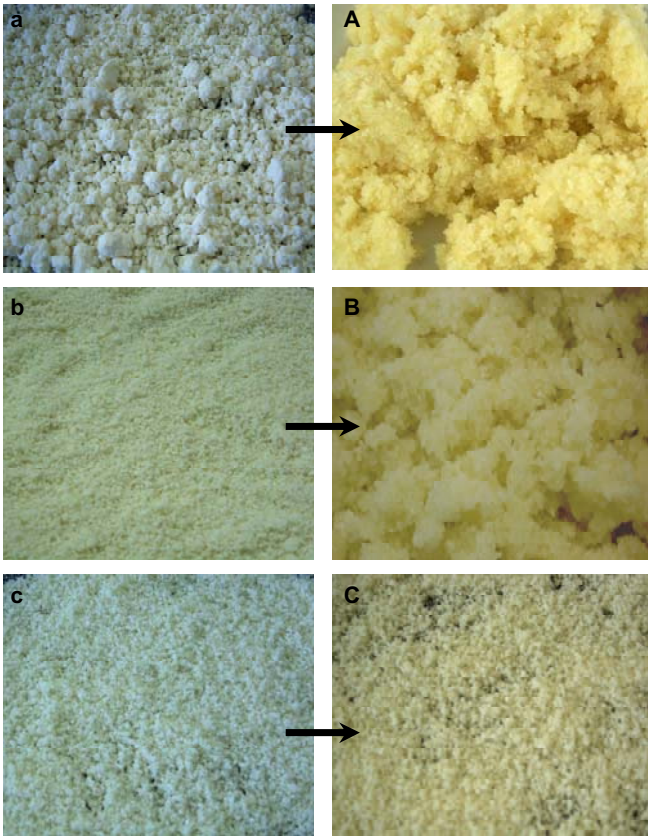

Fig. 2 Photography of fresh mash semolina granulating (a, b, c) and attieke semolina (A, B, C).

In brief, this study shows that attieke semolina (i.e. fermented cassava mash) texture is influenced by pressing force, influencing texture and sensory qualities.

ACKNOWLEDGEMENTS

We thank Mrs Gnagne François Nomel, Tagro Guehi, Fabrice A. Tetchi, Abouatier Coulibaly for valuable comments, advice and financial support. This study was carried out with the technical support of Université d'Abobo Adjamé Centre Suisse de Recherche Scientifique and Centre National de Recherche Agronomique.

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