Chemical and Sensory Characteristics of two Types of Cassava Pulp during their Processing into Bedecouman

Rose Koffi-Nevry1* • Marina Koussémon1 • Kablan Tano2 • Firmin Aboua2

1 Laboratory of Biotechnology and Food Microbiology, Department of Food Science and Technology, University of Abobo-Adjame, 02 BP 801 Abidjan 02, Côte d’Ivoire
2 Laboratory of Food Biochemistry and Tropical Products Technology, Department of Food Science and Technology, University of Abobo-Adjame, 02 BP 801 Abidjan 02, Côte d’Ivoire

Corresponding author: * rosennevry2002@yahoo.fr

ABSTRACT

This study was undertaken to analyze and compare the chemical composition and sensory characteristics of bedecouman made from two cassava pulps at various stages of its preparation. The fermented cassava dough contained 54-56.7% moisture, 2.06-1.98% proteins, 0.20% lipids, 1.15-1.1% ash, and 23.86-23.65% starch for the white and yellow pulp respectively. The investigations showed respectively 68.35-69.3% moisture, 1.04-1.01% proteins, 0.28-3.9% starch and 0.17-0.2% lipids for the white and the yellow bedecouman. The end product had a mean hydrocyanic acid content of 52.12 and 55 mg HCN/kg for the white and yellow pulp, respectively and for the fermented cassava dough 155.62 and 135 mg HCN/kg. High rating was given to the flavor for the white pulp (8.92), then homogeneity of the appearance) 8.16 and 7.50 for the white and yellow pulp, respectively. There was a significant difference between the types of pulp especially for color and flavor. Boiling was more efficient than natural fermentation in reducing the HCN.

Keywords: boiling, cyanidic acid, fermentation, proximate composition

INTRODUCTION

The present work was undertaken to characterize and compare the chemical composition and organoleptic characteristics of bedecouman made from two types of cassava, white pulp and yellow pulp, and to help understand the loss of cyanogens during cassava processing.

Cassava (Manihot esculenta Crantz) is the most important tropical root crop and in many African countries. The crop contributes significantly to the diets of over 800 million people, with per capita consumption averaging 102 kg a year. In some areas of Africa it makes up over 50 percent of the daily diets of the people (FAO 2001). Cassava is grown mainly by smallholder farmers with limited resources for its starchy roots which are a major source of dietary energy, and widely consumed in warm tropical areas (As-sanvo et al. 2006; Akely et al. 2010). Cassava ranks as the world’s fifth most important food crop after maize, rice, wheat and potato and fourth in the developing countries, after rice, maize and wheat (FAO 2009). Cassava provides income, employment and food security for more than 500 million people in Africa, Asia and South America (Pluknett et al. 2001). In 2008, around 232.95 million tons of cassava was produced. More than half of that amount was produced in Africa (54%), 30% in Asia and only 16% in Latin America and the Caribbean. About 2/3 of production is in Nigeria. Cassava is an all-season food crop in several African countries (and particularly in Côte d’Ivoire), Asia and Latin America (Assanvo et al. 2006; Abodjo Kakou et al. 2010).

Every year, Côte d’Ivoire produces about 1.9 million metric tons of cassava making it the second largest food crop after the yam which is another important root with an estimated yield of 3 million tons in 2002 (Akely et al. 2010; Djeni et al. 2011). The traditionally producing areas of cassava in Côte d’Ivoire are Abidjan (southern region), Bouaké (central region), Man (western region) and Daloa (central western region). Most of the cassava produced is used as a food product by people for whom roots are the major source of calories.

When cassava roots are not processed soon after harvesting, their use is limited because of their deterioration only a few days after harvesting. The losses are also due to the relatively high amount of compounds such as cyano- genic glycosides whose hydrolysis (Onwuka and Ogbogou 2007) leads to the release of toxic hydrocyanic acids that can cause diseases such as tropical ataxic neuropathy and endemic goiter (Koffi-Nevry et al. 2007). Over 90% of the cassava processed in Africa is used for human nutrition as fermented products (Koffi-Nevry et al. 2007; Djeni et al. 2011). Traditionally, cassava is processed before consumption. Processing is necessary for several reasons. First, it serves as a means for removing or reducing the potentially toxic cyanogenic glucosides present in fresh cassava. Second, it serves as a means of preservation. Third, processing yields products that have different characteristics, and creates a variety of cassava based food.

There are several varieties of cassava, but they can be classified into two groups: sweet and bitter varieties (Assanvo et al. 2006; Obeta et al. 2007). Cassava is processed into various end-products in Côte d’Ivoire. Some sweet or bitter varieties show two different colors: white and yellow.
pulp. Depending on the variety, cassava is either associated with banana in order to make foutou or processed into products of fermented dough. In Côte d’Ivoire, sweet white pulp cassava may be consumed directly mainly through dishes like foutou, foutou, akeksi or braised roots. The bitter white pulp varieties are traditionally processed into a wide range of foods with different local names such as attiékié, placati, attiékipou, konkonné, bédécouman (Assanvo et al. 2008). After boiling for 45-90 min, and packed one more time in a cloth or a synthetic bag (Koffi-Nevry et al. 2010; Djeni et al. 2011). Therefore, white pulp cassava is more consumed in Côte d’Ivoire than the yellow pulp cassava, which is less known to the population. One of the dishes is the bédécouman, a specialty of the southern people of Côte d’Ivoire.

In Côte d’Ivoire, many studies have been conducted on cassava-based products such as attiékié using the white varieties (Coïn et al. 1991; Yao et al. 2006; Akely et al. 2010; Djeni et al. 2011). Bédécouman (also called bessike) is obtained through cooking, pounding and shaping a pre-fermented cassava dough. The bédécouman comes in the shape of a loaf about 10 to 15 cm long, packed in Tomatococcus danielli leaves are commonly called leaves of attiékié. People eat it together with a stew. It can also be kept at room temperature for 4 days and consumed within those days. Further preparation is obtained through cooking, pounding and shaping a pre-fermented cassava dough. The bédécouman made from a variety of white cassava pulp from Bonoua. Very few studies have incorporated the yellow pulp in the production of cassava-based food. To our knowledge, there is no publication in Côte d’Ivoire about the use of the yellow pulp cassava.

**MATERIALS AND METHODS**

**Collection of cassava tubers**

Freshly harvested roots from two local varieties of sweet cassava called Bonoua (white pulp and yellow pulp) were collected from a farm in Adua, a village located in the vicinity of Abobo (South Eastern region of Côte d’Ivoire). All cassava roots, about 30 cm long and 10 cm in diameter, were processed in the laboratory of Food Biochemistry and Tropical Products Technology, at the University of Abobo-Adjame, Abidjan, Côte d’Ivoire. The traditional inoculum (leaves) used is made from fermented cassava; the cassava was previously boiled, kept in a synthetic fiber bag and left to ferment at room temperature (30 ± 2°C) for 4 days.

**Processing of bédécouman**

In the production of bédécouman, 20 kg of the two types of Bonoua cassava roots were processed according to the method described by Koffi-Nevry et al. (2008). The whole roots were peeled, cut into pieces, washed in clean water and ground in a cassava grinder. The ground pulp represents the unfermented (fresh) dough. Fermentation is not spontaneous but initiated by the addition of 8% (w/w) of a traditional inoculum as previously described. The inoculum was carefully added to the fresh dough in addition of 8% (w/w) of a traditional inoculum as previously described. The inoculum was carefully added to the fresh dough in 2006; Djeni 2008; Koffi-Nevry et al. 2010). During this period, the pH during fermentation was due to the production of organic acids by lactic acid bacteria (Abodjo Kakou et al. 2000). Hydrocyanic acid content was determined using silver nitrate volumetric analyses (AOAC 1990; Oboh et al. 2002) for cooked, fermented and raw cassava dough, and the starch content was obtained through the difference in absorbance at 450 nm according to the method of B.I.P.E.A (1976). All determinations were made in triplicate, the results expressed on dry weight basis, and mean values calculated.

**Sensory evaluation**

The sensory evaluation panel was composed of 15 people who were not familiar with bédécouman. They rated the flavor, aroma, color, consistency (texture) and homogeneity on a scale of 1 through 10 where 1 = extremely bad and 10 = extremely good. The evaluation was performed in two sessions.

**Statistical analysis**

The experiments were carried out twice. Since there was no significant difference between the two experiments, the results were pooled and averaged. The experiments were laid out in a completely randomized block design. Regarding the sensory evaluation experiments, mean values of organoleptic characteristics were compared. In order to determine which means (for flavor, aroma, color, consistency and homogeneity) for dry mass and percentage of extraction were significantly different from others, differences between means were assessed by Duncan’s multiple range test at α = 0.05 (Musyimi et al. 2008).

**RESULTS AND DISCUSSION**

Fig. 1 shows an image of the 2 types of bédécouman obtained from the white and yellow pulp. The final product is creamy white or yellow. The results from the chemical analysis are shown in Tables 1 and 2. From these tables, it appears that the proximate composition of the cassava dough was affected during processing into bédécouman. The chemical composition was different between and within the types of pulp, except for the ash, the lipid and moisture contents. The titratable acidity of the fermented dough increased from 90-95 to 115-110 meq/100 g rapidly, lowering the pH to below 5.0. The acidity decreased during cooking and in the final product to 77.5 meq/100 g in the 2 types of cassava pulp studied. However, there was no discernable trend in the pH values (about 4.5) of the fermented cassava dough during processing into bédécouman. The decrease in pH during fermentation was due to the production of organic acids by lactic acid bacteria (Abodjo Kakou et al. 2010; Oguntoyinbo and Dodd 2010).

The result of the analysis of the fresh and the fermented
Cassava pulp revealed that there was an increase in dry matter content of the fermented cassava dough (46%; 43.3%) when compared to the unfermented one (32.7%; 34.3%) for the white and yellow cassava pulp, respectively (Table 1), and a decrease during the cooking process (31.65%, 30.7%) (Table 2). The values of dry matter obtained in the two cassava pulps analyzed agreed with those of FAO (2001), which indicated that cassava roots contain 30-40% dry matter. The values recorded for the dry matter indicate that bedecouman contains a high percentage of water, making it a perishable product. The cooking process increased the moisture content to about 69%. This value is higher than a perishable product. The cooking process increased the moisture content to about 69%. This value is higher than a perishable product.

The high hydrocyanic acid (HCN) contents in the fresh roots is from 15-400 mg HCN/kg fresh weight (Obeta et al. 2002). Ampe et al. (2001) showed that reducing sugars are widely used during fermentation as a source of carbon by lactic acid bacteria. There was no discernable trend of the ash content between the unfermented dough (1.1-0.9%) and the fermented one (1.2%, 1.1%) from the two types of cassava pulp studied. A decrease was observed after the two boiling steps (0.6 and 0.3%) for the white and the yellow Bonoua cassava pulp, respectively. The values for bebecouman in this study (0.6 and 0.3%) were similar to that obtained by Yao et al. (2006), which was 0.4% for attieke.

Cassava roots usually have a high concentration of cyanogenic glucosides. The white pulp contains more cyanide (253.12 mg/kg) than the yellow pulp (236.37 mg/kg). The fresh cassava dough contains more cyanide than the fermented one and the bebecouman. Cassava is often classified as "bitter or sweet" according to the amount of cyanide present. The normal range of cyanoglucoside content in fresh roots is from 15-400 mg HCN/kg fresh weight (Obeta et al. 2007) but occasionally varieties with very low HCN content of 10 mg/kg or very high HCN content of 2000 mg/kg.

The high hydrocyanic acid (HCN) contents in the fresh and the fermented cassava dough make them unsafe and unsuitable for human consumption (Ebuehi et al. 2005). Cooking the fermented cassava dough during processing into bebecouman reduced the cyanide content down to 52.12-55 mg/kg from 253.12-236.37 mg/kg for the unfermented and 155.62-135 mg/kg for the fermented dough for the white and the yellow cassava pulp, respectively. The highest reduction occurred during the second cooking step. The HCN values obtained in the bebecouman are above the recommended FAO/WHO (1992) safe limit set at 10 mg HCN/kg and still slightly above the threshold of tolerance, which is 50 mg/kg. The toxicity is not eliminated probably because the fermentation process was too short and the product was

**Table 1** Proximate composition and hydrogen cyanide of the unfermented and fermented dough from 2 varieties of cassava (White and Yellow Bonoua).

<table>
<thead>
<tr>
<th>Composition (g/100 g dw)</th>
<th>Fresh dough</th>
<th>White pulp</th>
<th>Yellow pulp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td>32.7 ± 0.3</td>
<td>46 ± 0.02</td>
<td>34.3 ± 0.1</td>
</tr>
<tr>
<td>Moisture</td>
<td>57.3 ± 0.03</td>
<td>54 ± 0.02</td>
<td>65.7 ± 0.01</td>
</tr>
<tr>
<td>Protein</td>
<td>0.95 ± 0.02</td>
<td>2.06 ± 0.05</td>
<td>0.96 ± 0.03</td>
</tr>
<tr>
<td>Lipid</td>
<td>0.20 ± 0.10</td>
<td>0.20 ± 0.08</td>
<td>0.23 ± 0.10</td>
</tr>
<tr>
<td>Starch</td>
<td>25.60 ± 0.7</td>
<td>23.86 ± 0.62</td>
<td>25.45 ± 0.8</td>
</tr>
<tr>
<td>Reducing sugar</td>
<td>2.70 ± 0.06</td>
<td>1.88 ± 0.03</td>
<td>3.01 ± 0.05</td>
</tr>
<tr>
<td>Ash</td>
<td>1.1 ± 0.005</td>
<td>1.2 ± 0.03</td>
<td>0.90 ± 0.005</td>
</tr>
<tr>
<td>pH</td>
<td>6.17 ± 0.5</td>
<td>4.38 ± 0.7</td>
<td>6.24 ± 0.5</td>
</tr>
<tr>
<td>Acidity (meq/100 g)</td>
<td>90 ± 5</td>
<td>115 ± 5.59</td>
<td>95 ± 3.53</td>
</tr>
<tr>
<td>HCN (mg/kg)</td>
<td>253.12 ± 27</td>
<td>155. ± 22.01</td>
<td>236.37 ± 18.9</td>
</tr>
</tbody>
</table>

**Table 2** Proximate composition of white and yellow Bonoua fermented cassava dough during the processing into bebecouman.

<table>
<thead>
<tr>
<th>Composition (g/100 g dw)</th>
<th>White pulp</th>
<th>Yellow pulp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td>46.8 ± 0.02</td>
<td>31.65 ± 0.03</td>
</tr>
<tr>
<td>Moisture</td>
<td>59.2 ± 0.002</td>
<td>68.35 ± 0.005</td>
</tr>
<tr>
<td>Protein</td>
<td>1.26 ± 0.08</td>
<td>1.04 ± 0.07</td>
</tr>
<tr>
<td>Lipid</td>
<td>0.18 ± 0.10</td>
<td>0.17 ± 0.10</td>
</tr>
<tr>
<td>Starch</td>
<td>13.09 ± 0.71</td>
<td>0.28 ± 0.02</td>
</tr>
<tr>
<td>Reducing sugar</td>
<td>1.5 ± 0.03</td>
<td>1.38 ± 0.03</td>
</tr>
<tr>
<td>Ash</td>
<td>0.60 ± 0.005</td>
<td>0.60 ± 0.005</td>
</tr>
<tr>
<td>pH</td>
<td>4.52 ± 0.1</td>
<td>4.56 ± 0.5</td>
</tr>
<tr>
<td>Acidity (meq/100 g)</td>
<td>105 ± 3.53</td>
<td>77.5 ± 2.5</td>
</tr>
<tr>
<td>HCN (mg/kg)</td>
<td>95.62 ± 3.11</td>
<td>52.12 ± 3.53</td>
</tr>
</tbody>
</table>

Means ± standard deviation.
wrapped in *T. danielli* leaves before cooking.

Therefore, *bedecouman* from the 2 types of cassava pulp could be considered unsafe in terms of cyanide poisoning.

The high values of HCN recorded in this study could be explained by the duration of the fermentation which was only 1 day, too short to release a large amount of HCN. About 38-42% percent of the cyanogens in fresh cassava dough were lost after fermentation, but a substantial proportion remained in the dough. In addition, more HCN was eliminated during the cooking steps. At the end of those cooking steps, a substantial proportion (76-79%) of the cyanogens was again eliminated. Therefore, cooking was more efficient than natural fermentation in reducing cyanide. The level of HCN in the *bedecouman* could probably be lower if the fermentation and cooking steps were longer. Onwuka and Ogbovu (2007) reported that fermenting cassava for 2 or more days is sufficient to detoxify the HCN. Koffi-Nevry et al. (2007) reported values of 11.7 mg HCN/kg for *attoukoup* after 3 days of fermentation. Muchnik and Vinck (1984) showed that HCN which is volatile and soluble in water, could be removed during washing, fermentation, drying and cooking. Indeed, Muchnik and Vinck (1984) indicated that after the hydrolysis of starch, the decrease in pH due to the presence of lactic acid bacteria facilitates the breakdown of cyanoecenic glucoside in the presence of the limanarase enzyme in cyanide which drains out during cooking. In this study, the pH of the fermented dough (pH 4.5) facilitates the release of the HCN during cooking.

The sensory test results are shown in Table 3. This sets out the rating given by testers using the scale described earlier. A high rating was given to flavor of the white pulp (8.92) than homogeneity, 8.16 and 7.50 for the white and the yellow pulp, respectively. The highest color rating was given to the white pulp (6.42 vs 3.91) while the highest aroma rating was given to the yellow cassava pulp. There was, however, no significant difference (p<0.05) in the aroma, color, flavor, and overall acceptability within the white *bedecouman*, but there was a significant difference (p<0.05) between the types of pulp, especially for color and flavor. Fermentation is responsible for product stability, better flavor and aroma, and for the reduction of HCN (Nout and Sarkar 1999). The organic acids produced during fermentation include lactic, acetic, propanoic, and butanoic acids, among others. These are believed to contribute to the characteristic flavor of fermented cassava products.

### CONCLUSION

The processing of cassava into *bedecouman* significantly affected the chemical properties of the 2 types of cassava pulp samples analysed. Fermentation is an important process in the preparation of many cassava products in Africa, although a limited number of techniques are used. Cooking was more efficient than the natural fermentation in reducing the cyanide. The study of the traditional production of *bedecouman* was intended to help understand the loss of cyanogens during cassava processing.

### ACKNOWLEDGEMENTS

We acknowledge the Department of Food Science and Technology, University of Abobo-Adjame, Abidjan, Côte d’Ivoire for providing us with the necessary facilities for effective execution of this research work.

### REFERENCES


FAO (2001) Production annuaire. Collection FAO Statistique, 55, 70

AOAC (1990) Official Methods of Analysis (15th Edn), AOAC Inc, Arlington, VA, USA


Djeni NT, N’guessan FF, Taka DM, Kouame KA, Dje KM (2011) Quality of attieke (a fermented cassava product) from the three main processing zones in Côte d’Ivoire. Food Research International 44 (1), 410-416


FAO (2001) Production annuaire (Vol 5), Statistique N°170, Rome


Ketiku AO, Akineye IO, Keshiiruo AO, Akinnawo OO (2003) Changes in the hydrocyanic acid concentration during traditional processing of cassava into ‘gari’ and ‘lfain’. Food Chemistry 3 (3), 221-228


Koffi-Nevry R, Koussoumen M, Aboua F (2007) Chemical and organoleptic properties of *attoukoup* made from two cassava varieties (Manihot esculenta Crantz) varieties, Bonoua and IAC. Journal of Food Technology 5 (4), 300-304


Oboh G, Akindahunsi AA (2003) Biochemical changes in cassava products (flour and gari) subjected to Saccharomyces cerevisiae solid media fermentation. Food Chemistry 82 (4), 599-605


