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Chemical and Organoleptic Properties of *Attoukpou* Made from Two Cassava (*Manihot esculenta* Crantz) Varieties, Bonoua and IAC

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Abstract: Chemical and organoleptic properties of *attoukpou* made from two cassava, (*Manihot esculenta* Crantz) varieties, *Bonoua* and *IAC* were studied. *Attoukpou* is the product obtained when cassava mashed is fermented or not and steam cooked. There are no significant differences in proteins, lipids and the mineral contents of *Attoukpou* made from the two different varieties of cassava. Results showed that the moisture content, protein and lipids of the attoukpou samples ranged between 48 and 50 %, 1.2 and 1.3 g 100 g^{-1}, 0.2 and 0.3 g 100 g^{-1}, respectively. The pH value is around 3.9. The cyanide value was reduced from 123 to 9.4 mg Kg^{-1} for variety Bonoua and from 217-11.7 mg Kg^{-1} for IAC variety. Both products are slightly mineralized but phosphorus content is higher, about 35 mg g^{-1}. *Attoukpou* made from both cassava varieties has almost the same colour (yellowish), texture, flavour and homogeneity. It could be concluded from this experiment that processing cassava into attoukpou optimally did not reduce the cyanide enough. Value found for IAC variety is above the 10 mg Kg^{-1} HCN preconized by FAO.

Key words: Steam cooked, *attoupkou*, *attieke*, cassava, cyanide, chemical and organoleptic properties

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is a root tuber produced in the tropical region of the world between latitudes 30° North and 30° South of the equator. It ranks 7th among food consumed in the world (Anonymous, 2001). Cassava is a food consumed in Côte d'Ivoire and other parts of Africa. Per year, Côte d'Ivoire produced about 1.9 million metric tones of cassava which ranked second after Yam among food-producing cultures (Anonymous, 2001). Most of cassava produced in Côte d'Ivoire is used as foods for human for whom roots are the major sources of dietary calories. Utilization of unprocessed cassava roots is limited by post harvest losses due to rapid deterioration of roots few days after harvesting and also by the relatively high amounts of compounds such as cyanogenic glycosides whose hydrolyses result in the release of toxic hydrocyanic acids (Onwuk and Ogbogou, 2007) which can lead to diseases such as tropical ataxic neuropathy, endemic goiter... (Onimawwo and Egbekun, 1988).

To limit post harvest losses and the toxic effect of hydrocyanic acid, cassava roots must be processed into cassava-base products such as *attieke, gari, fufu, foutou, lafun, placali, attoukpou, bêdêcouman*... Several works have been carried out on the potential of cassava varieties in food technology (Chuzel and Griffon, 1987; Favier *et al*., 1971; Oyewole and Odunfa, 1992; Onwuk and Ogbogou, 2007). Many of cassava processes require a step of fermentation. Fermentation is important in the development of organoleptic properties, reducing toxicity and in the hygienic quality of the fermented product (Almazan, 1992).

Attoukpou is a disc (15-20 cm in diameter) obtained when cassava is fermented and steam cooked as *attiéké* (semolina fermented cassava product) which is known in other parts of West Africa and the most important item in the diet of millions in Côte d'Ivoire. *Attoukpou* differs from *attiéké* because the processing final is different. *Attoukpou* was chosen to meet the requirement for valorisation of tropical cultures; it should be known as another cassava based product closed to *attiéké*. Cassava could be processed into *attoukpou* to reduce post harvest lost of cassava. The marketing of *attoukpou* at retail level is more hygienic than attieke because it is less handled and *attoukpou* processing is less time consuming. However, little is known of *attoupkou* which is only well known in the south area of Côte d'Ivoire.

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Attoukpou is the third cassava base product consumed in Côte d'Ivoire after *attieke* and *placali*. Its physisco-chemical and organoleptic properties should be known for better use at industrial level. In Côte d'Ivoire, many studies have been conducted on attieke (Aboua *et al*., 1989; Aboua, 1998; Kouadio *et al*., 1991; Yao *et al*., 2006) but no study has been published on *attoukpou*. Thus, this study was undertaken to characterize the proximate composition of *attoukpou* made from two commonly used cassava varieties in Côte d'Ivoire, Bonoua and IAC compared to *Attieke*.

MATERIALS AND METHODS

Freshly harvested cassava roots of two commonly used varieties, local variety Bonoua (Sweet variety) and IAC (Improved African Cassava) (bitter variety) were obtained from Koumassi and Port'Bouet markets in Abidjan, Côte d'Ivoire and processed in the Food Technology laboratory, at the University of Abobo-Adjamé, Abidjan.

***Attoukpou* and *attieke* processing:** *Attoupkou* was processed from cassava roots of both varieties and *attieke* from only IAC variety. In the processing, about 20 kg of cassava roots, all about 30 cm long and 10 cm in diameter were peeled, cut into pieces, washed in clean water and ground in a cassava grinder. Then the mashed was put in a big (metallic or plastic) pan and inoculated with 5% boiled cassava leaven.

The ground meal is then packed into corn bag and allowed to ferment about 2-3 days at air temperature. At the end of fermentation (pH rich 4.0-4.5), the fermented product is pressed to squeeze out the water and eliminate starch. During this process, the hydrocyanic acid is also eliminated due to its solubility into water (Coursey and Richard, 1981). The solid residue obtained is then sieved to eliminate hard fibres (Aboua, 1998). The sieved product is slightly sun dried (30-60 min) or directly steam-cooked with a cooker, using circular moulds of 15-20 cm in diameter (Fig. 1). After 10-15 min heating, the starch grains conglomerated on surface. The product being cooked is returned to allow grains on the other face to bind and be cooked to give the particular rounded cake shape product called *attoukpou*. It should be mentioned that *attoukpou* could be processed without fermentation but the product obtains is crumbly and would probably contain high amount of HCN.

To obtain *attieke*, after fermentation and dewatering, the solid residue is always granulated after sieving to separate the medium and the fine grains. The medium size grains are sun dried (4-6 H) and steam cooked, about

Fig. 1: Flow diagram of the processing technique for making *attoukpou*

30-45 min. During cooking, the granulated material is mixed several times with a wooden spatula (Aboua, 1989), (Fig. 1). The medium size grains are the form in which *attiéké* is usually consumed. The smaller size grains (powder) are a by-product (Yao *et al*., 2006).

Chemical analysis: Analysis such as moisture content, cyanide content, pH were carried out to determine the quality of the processed cassava products and the effect of the process treatment on the cyanide content of fresh and fermented mash and the two cassava products, *attoukpou* and *attieke*.

The whole *attoupkou* and *attieke* was analysed by the following methods. Dried weigh was determined by drying 5 g sample to constant weigh (AOAC, 1990) in an infrared dessicater (Mettler Lp16). The pH of was measured using a calibrated glass electrode pH meter (Hanna instruments); 10 g of each sample were dispersed in 100 mL distilled water. The dispersion was allowed to stand for 30 min. This was repeated to get duplicated reading. Protein (Kjeldahl) was determined by multiplying the total nitrogen by 6.25 (AOAC, 1990), fat (soxhlet) and Hydrocyanic acid by titration against 0.01$AgNO_3$ (FAO, 1956). Phosphorus was estimated colorimetrically (Taussky and Shorr, 1959), while the other minerals (Ca, Fe) were determined using the atomic spectrophotometer.

Sensory evaluation: The sensory evaluation panel was composed of 15 peoples familiar with *attoukpou*, who rated taste, colour, flavour, texture, grain homogeneity on a scale of 10 = extremely good to 1 = extremely bad, evaluation was performed in two sessions.

Statistical analysis: Since there was no significant difference between the two experiments, the results were pooled and averaged. Data on sensory evaluation were submitted to an analysis of variance, following by Neuwman-Keul's multiple comparison test ($\alpha = 0.05$).

RESULTS AND DISCUSSION

***Attoukpou*:** Figure 2 shows an image of *attoukpou*, the final product which is a disc of a creamy white to yellowish colour of about 1-1.5 cm thick and 15-20 cm in diameter. *Attieke* is semolina like product with either coarse, medium or smaller size grains.

Chemical analysis: The pH and Cyanogenic content are shown in Table 1 and 2. The pH values of *attoukpou* samples range between 3.8-3.9, respectively for varieties Bonoua and IAC. pH is low (pH 3.8) similar to that found for *attieké*, 4.0.

The cyanogenic content of raw cassava roots and fresh mashed from the two varieties are given in Table 1. Local variety Bonoua has approximately 123 mg Kg^{-1} while IAC had 217 mg Kg^{-1} hydrogen cyanide. The cyanogenic content was significantly reduced in *attoukpou* and *attieke* from about 123-9.4 mg Kg^{-1} for Bonoua variety (92.35%) and from 217-11.7 mg Kg^{-1} (for IAC) which represent 94.6 % lost. Lost in cyanide content for *attieke* was about 98.1%. The cyanogenic content was already highly reduced in the fermented cassava mash, about 67.8% for variety Bonoua (123-39.6 mg Kg^{-1}) and 75.39% for IAC.(217-53.4 mg Kg^{-1}) (Table 1).

Table 2 shows the results of the chemical analysis of *attoukpou* from the two varieties (Bonoua and IAC) of cassava compared to those of *attieke*. When comparing proximate composition of *attoukpou* from the two varieties of cassava, only slight differences of components were noticed. There are no significant differences in proteins, lipids and the mineral contents (Ca, Fe and P) between *attoukpou* made from cassava varieties Bonoua and IAC. Both products are characterized by their low content of protein: 1.31 g $100g^{-1}$ for *Bonoua* and 1.28 g $100g^{-1}$ for IAC. *Attoukpou* is also poor in other essential nutriments such as lipids; both are poor in fat (0.2 and 0.3 g $100g^{-1}$, respectively) as reported by FAO (1992) which is 0.2%. Both products are slightly mineralized; the mineral content such as Fe is very low (traces); values for calcium are 22 and 24 mg 100^{-1} g and phosphorus 35.7 and 36.1 mg $100g^{-1}$, respectively for *Bonoua* and IAC varieties.

Sensory evaluation: The organoleptic test panel results are shown in Table 3. This sets out the marks accorded by the testers using the scale given above. It will be seen that high rating was given to the colour (between 8 and 9) and the flavour which ranged from 7.6-8.78. Regarding the acidity evaluation, the highest rating was given to

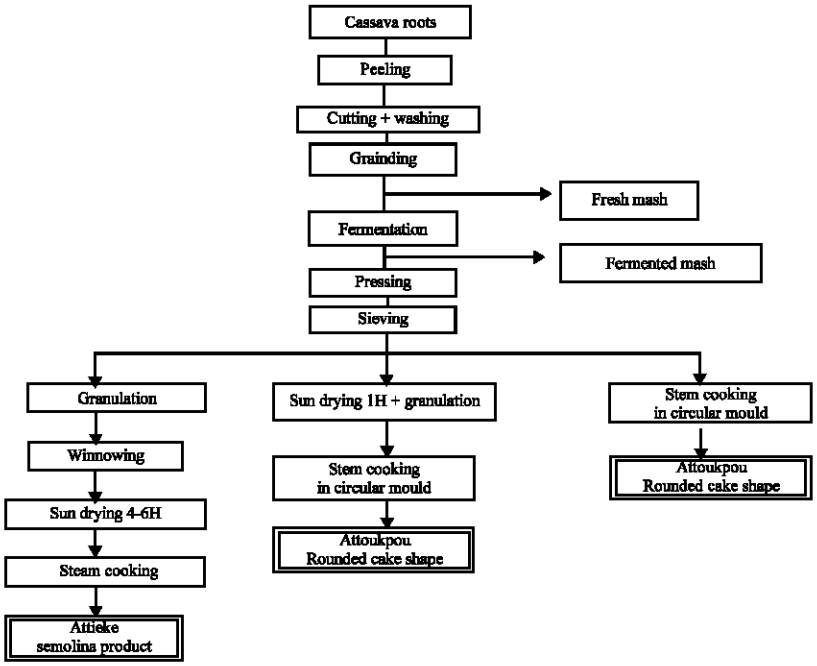

Fig. 2: Image of *attoukpou*

Table 1: Hydrogen cyanide content (mg Kg^{-1}) and pH of raw and fermented cassava, *Attoukpou* and *attieke*

	Cassava varieties	Raw cassava roots	Fresh mash	Fermented mash	*Attoukpou*	*Attieke*
HCN	Bonoua	123 ±3.1	76 ±1.15	39.6±1.02	9.4± 0.25	-
	IAC	217±2.73	108±1.5	53.4±0.87	11.7± 0.31	4.2±0.1
pH	Bonoua	-	6.3 ± 0.3	4.0±0.1	3.8± 0.2	-
	IAC	-	15.9± 2	3.7±0.15	3.9± 0.3	4.0±0.3

- Not determined

Table 2: Mean values of composition of *attoukpou* from two local cassava varieties, Bonoua and IAC

Composition (dwb)	*Attoukpou* (Bonoua)	*Attoukpou* (IAC)	*Attieke*
Dry matter (g $100g^{-1}$)	49.6 ± 1.93	51.8 ± 3.32	65.1±2.4
Moisture (%)	50.4 ± 1.93	48.2 ± 3.32	34.9±2.4
pH	3.8 ± 0.2	3.9 ± 0.3	4.0± 0.3
Protein (g $100g^{-1}$)	1.31 ± 0.0	1.28 ± 0.2	1.41±0.1
Fat (g $100g^{-1}$)	0.2 ± 0.1	0.3 ± 0.25	0.4±0.18
HCN (mg Kg^{-1})	9.4 ± 0.25	11.7 ± 0.31	4.2 ± 0.1
Fe (mg $100g^{-1}$)	Traces	Traces	Traces
Ca (mg 10 g^{-1})	22	24	55
P (mg $100g^{-1}$)	35.7	36.1	60

HCN = Hydrogen Cyanide

Table 3: Mean values of organoleptic properties of *attoukpou* from two local cassava varieties, Bonoua and IAC

Characteristic evaluated	*Attoukpou* Bonoua	*Attoukpou* IAC
Colour	8.42±1.32	8.21±1.35
Texture	7.32±2.48	7.20±3
Taste	7.26±2.8	7.92±3.01
Flavour	7.64±2.28	8.78±1.03
Grain homogeneity	7.15±2.81	7.46±2.71

attoukpou made from IAC variety (7.92).for flavour, most of the tasters' marks went to the mild cassava flavoured material and the grains are quite well bound (7) and uniforms.

The low pH is due to generation of organic acid during fermentation (Akingbala *et al*., 1991).

The values are quite high and if taken in their native state will definitely cause harm as save level is as low as 10 mg Kg^{-1} (FAO/WHO, 1992). The HCN results attest that during cassava processing, most of the hydrocyanic acid is eliminated during fermentation due to its solubility into water (Coursey and Richard, 1981). The HCN values of 9.4 mg kg^{-1} for *attoukpou* obtained from *Bonoua*, a sweeter variety, is below the FAO recommended standard level of 10 mg kg^{-1} but above the safe limit for *attoukpou* made from IAC, a bitter variety (11.7 mg kg^{-1}). The cyanogen content of *attoukpou* is above values for *attieke* (4.2 mg HCN kg^{-1}). This could be explained by the fact that attieke is more manipulated that attoukpou during processing. Beside elimination of cyanide during fermentation, more HCN is removed during the steps of granulation, winnowing and drying during *attieke* processing. Onwuka and Ogbogu (2007) reported that fermenting cassava for 2 or more days is sufficient to detoxify the cyanide level of cassava in the production of *fufu*, similar to results found in this study.

It should be mentioned that although the HCN value for *attoukpou* made from variety IAC is above the threshold of 10 mg kg^{-1}, this cassava variety offers the highest lost in HCN during cassava processing into *attoukpou* (94,6%) and even into *attieke* (98,1%). The HCN level in attoukpou would be probably lower if the fermentation, drying and cooking steps were longer.

An average dried matter of 49-52% was recorded which indicated that *attoukpou* contains enough water to be a perishable product. The moisture content (about 50%) is higher than that of *attieke* (35% moisture) similar to values found by Aboua *et al*. (1989) for *attieke*. Therefore mould, yeast and bacteria can grow readily on *attoukpou* when left at room temperature. The higher moisture content of *attoukpou* compared to that of *attieke* can be explained by the final process of cassava transformation. The drying step in *attieke* processing is longer (4-6 h) compared to that of *Attoukpou* which lasts only 30-60 min. Water is important for starch grains binding during steam cooking to give the densely built-up disc called *Attoukpou*.

However, during *attieke* processing, granulation is an important step to avoid starch grains binding and drying reduced more water since starchy grains must remain separated after cooking to give semolina (*attieke*).

The protein values are above those found by Meuser and Smolnik (1980) for *gari* another fermented cassava product (0.4 g $100g^{-1}$), but below values reported by Oluwamukomi *et al*. (2007) for *gari* (2.6 g $100g^{-1}$) and below values for *attieke* found in this study (1.41 g 100 g^{-1}) and others (Aboua *et al*., 1989; Yao *et al*., 2006). These authors found respectively, 1.95 and 1.5 g 100 g^{-1} protein. The mineral values are similar to those found by Aboua *et al*. (1989) for *attieke* and match with the 0.8 % found by Meuser and Smolnik (1980) for cassava roots.

The sensory evaluation in Table 3 shows that *Attoukpou* from cassava varieties Bonoua and IAC are similar since there is no significant differences (α <0.05) in the two products. Both have almost the same colour (yellowish), texture (consistent). Both products have slight acid taste; the flavour is light and the grains are homogenised. The creamy-yellowish colour like that traditional attieke and *attoukpou* was very well appreciated. This represents a good acceptance of *attoukpou*.

CONCLUSION

Only slight difference in components is observed between *attoukpou* made from cassava varieties Bonoua and IAC. The cyanogenic acid is still above the threshold for *attoukpou* made from IAC variety and *attoukpou* is still poor in nutriments such as protein and lipid.

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