

Nutritive Value, Toxicological and Hygienic Quality of Some Cassava Based Products Consumed in Cameroon

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Abstract: Some cassava based products (cassava chips, gari and cooked fermented cassava paste “Batons de manioc”) were bought from local markets in Cameroon and analyzed for protein, cyanide content and their microbiological quality evaluated. Results showed a high level of total cyanide in gari (114.16±25 ppm), cassava chips (73.85±11 ppm) and a little less in fermented cassava paste (“Batons de manioc”) (63.1±5 ppm). The average total protein content was very low (2.9±0.5% in cassava chips, 1.9±0.3% in fermented cassava paste and 4.13±0.4% in gari). Microbiological quality was non-acceptable with an average high level of fungi in gari and cassava chips, and total mesophil aerobic microorganisms (56 x 10⁵cfu/g of dry weight) in fermented cassava paste. This study suggests amelioration in the production process and post-retting practices with the scope of improving on the toxicological, nutritive and hygienic quality of these products.

Key words: Cassava, microorganisms, proteins, cyanide compounds, gari

Introduction

Cyanide toxicity from cassava is mostly occurred after ingestion of fresh cassava roots of the bitter variety (Conn, 1969). Usually, manifestations of toxicity are chronic and are linked to ingestion of poorly detoxified derivatives of cyanogenic cassava containing cyanogens (Mlingi *et al.*, 1993). This also shows that the cassava roots likely contain residual quantities of cyanogenic glucosides (Conn, 1969). Accumulation of these cyanide compounds in humans is responsible for disorders such as goiter, cretinism, neuropathy ataxia, etc (Esser *et al.*, 1992; Baena *et al.*, 1997).

Available technologies for the preparation of different cassava products on the market requires hard work and is time consuming (Oyewole, 1995). Most of the procedures varies and are manual. This does not always guarantee the nutritional, toxicological and hygienic quality of the final product.

The present study is thus aimed at contributing to the toxicological and microbiological study of some cassava based products, mainly; gari (cassava that has been mash, tied up in bags, pressed and allowed a dry fermentation for 2 days after which it is fried without or with a little quantity of palm oil), cassava chips (roots cut into cubes, fermented sun dried and further ground into a flour) and cooked fermented cassava paste “Batons de manioc” (cassava roots submerged in water, fermented, ground and molded into a paste form, tied in leaves and boiled). Those cassava based products are mostly consumed in Cameroon (Ambe and Foaguegue, 1988).

Materials and Methods

Sampling: Sampling was carried out in 25 local markets, for seven of the ten provinces of Cameroon (Table 1 and 2). Samples were collected 4 times to give a total of 60 samples of fermented cassava paste and chips and 22 samples of gari from the different regions sampled over the national territory. Samples of 250g were taken out, sealed in plastic bags, stored in cooler boxes and transported, within the shortest possible time, to the microbiological laboratory of National Advanced School of Agro process Industries (ENSAI), Ngaoundéré, Cameroon, for biochemical and microbiological analyses.

Analytical methods

Biochemical analyses

Total cyanide measurement: Total cyanide which represents the sum of free and bound cyanid (cyanohydrins and glucoside) cyanide. This was carried out on 20g of crushed samples homogenized in 50ml of 0.1M HCl for 3mins and filtered. The filtrate was adjusted to pH 6.8 with 2M NaOH and centrifuged at 500g for 3mins. The supernatant was then used for analyses following the titration method described by Sylvestre and Arreaudeau (1983).

Total protein measurement: This measurement was carried out following the modified method of Hantzsch on the mineralization of Kjeldhal (Devani *et al.*, 1989).

Microbiological analyses: Total aerobic mesophile flora, coliforms (enterobacteria), *Staphylococcus*

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Table 1: Total residual cyanide (ppm) in cassava derivatives produce in Cameroon

Origin	Fermented cassava paste	Cassava chips	Gari
Meiganga	76±26	64±16	-
Ngoundéré	69±23	74±11	-
Tibati	53±10	60±10	-
Ngoundal	95±22	70±12	-
Banyo	43±14	68±08	-
Garoua-Mbolai	78±16	72±09	77±12
Batouri	68±13	89±12	89±17
Bertoua	96±09	102±13	-
Belabo	95±15	93±16	-
Betaré-Oya	53±18	78±08	-
Yaoundé	43±16	68±11	-
Obala	35±12	71±08	79±09
Mbalmayo	26±10	74±11	-
Ambam	76±16	72±14	-
Ebolowa	49±14	66±22	-
Douala	36±11	68±10	140±17
Nkongsamba	29±10	59±08	-
Muyuka	-	-	167±14
Mamfe	-	-	136±10
Mundemba	-	-	169±09
Bamenda	-	-	136±12
Mbengwi	-	-	125±09
Bafoussam	110±18	76±19	82±15
Foumbot	76±13	89±15	96±09
Foumban	56±07	64±09	74±07

replication= 4

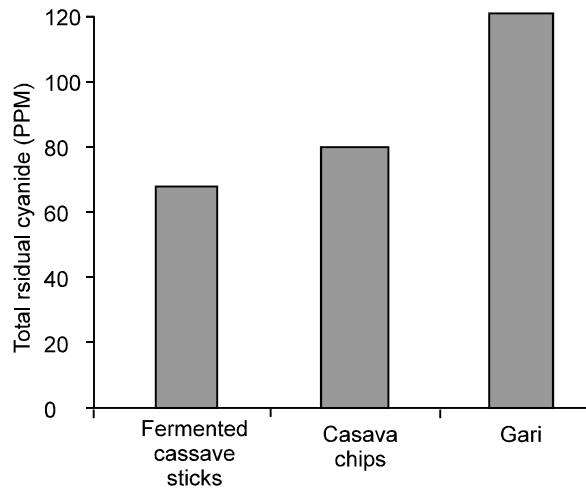


Fig.1: Average total residual cyanide in some cassava derivatives.

NB: "Cassava sticks"= "Cassava paste"

aereus, *Clostridium spp* and the fungi flora was evaluated. Counting was done according to the classical decimal dilution method using a 1/4 ringer solution as diluents. By adding 180ml of diluent to 20g and neutralizing afterwards with 2M NaOH, a 10⁻¹ dilution was obtained. Choice of media was according to the methods described by Buttiaux *et al.* (1974).

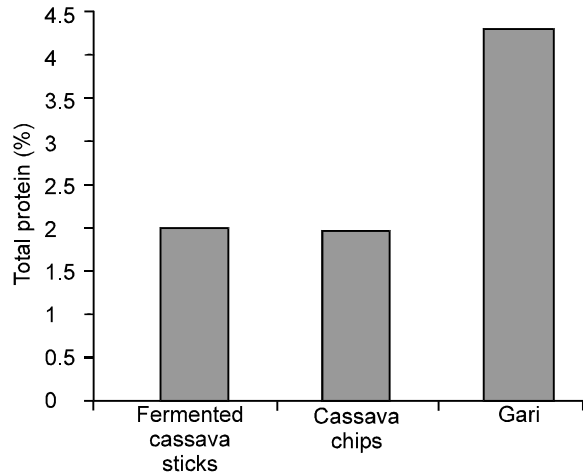


Fig.2: Average total protein in some cassava derivatives

NB: "Cassava sticks"= "Cassava paste"

Results

Total residual cyanide: Fig.1 shows the average total residual cyanide content in various derivatives. The highest (114.16±16 ppm) was recorded in gari and the lowest (63.1±15 ppm) in cooked fermented cassava paste (Bobolo). We also noticed a high total residual cyanide content in gari, with a content varying from 74±7 ppm (gari from Foumban) to 169±19 ppm (gari from Mundemba) (Table 1). Cassava chips had higher residual rates, with values varying from 59±8ppm (sample from Nkongsamba) to 102±13 ppm (sample from Bertoua). Fermented cassava paste present values from 26±10 (sample from Mbalmayo) to 110±25 ppm (sample from Bafoussam). It is important to note that these rates are significant as they are above the acceptable limits of less than 50 ppm (Brauman *et al.*, 1992).

Total residual protein: Residual protein in derivatives was found to be low irrespective of the product or region of origin (Table 2). The lowest (0.5±0.1%) and highest (3.84±0.3%) were recorded in gari from Garoua Mboulai (East Province of Cameroon) and Bafoussam (West Province of Cameroon) respectively. Averages of total protein in the products are shown in Fig.2 with the lowest (1.79%) observed in cassava chips and the highest (2.25%) in gari with the value of fermented cassava paste falling between them.

Microbial profile: There was a predominant fungal flora in all samples, irrespective of product or region (Fig. 3). Fermented cassava paste samples from Bertoua (East Province) were the most contaminated with a total flora of aerobic mesophiles of 96×10⁵cfu/g, than gari and gari from Douala (Littoral Province) the least contaminated sample by this group of microorganisms

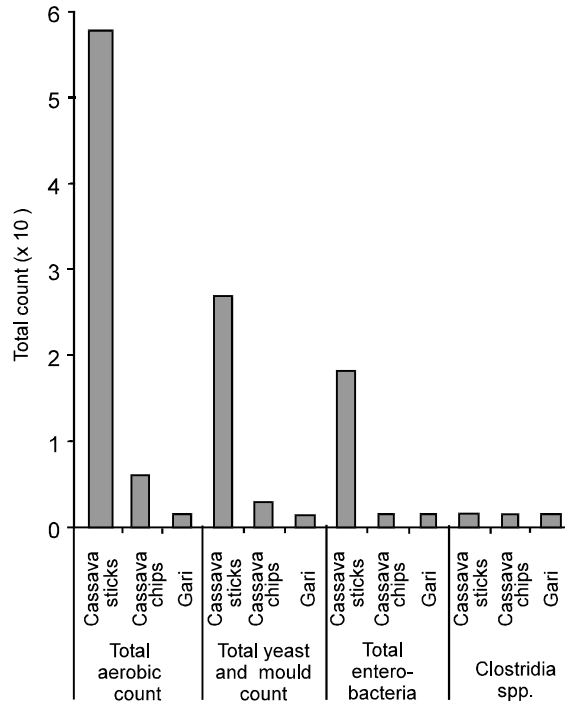


Fig. 3: Average total microbial count in some cassava derivatives.

(14×10^6 cfu/g dry weight). Fig. 3 shows average contamination of cassava products with fermented cassava paste being the most contaminated for each class of Microorganisms, followed by chips and then gari.

Discussion

Residual cyanide rates which are above acceptable limits of < 50 ppm according to Brauman *et al.* (1992) could explain the prevalence of some neurological diseases (ataxic neuropathy, cretinism, xerophthalmia) noticed in these regions and could be linked to intoxication by cyanide compounds (Esser *et al.*, 1992). This high content of cyanide compounds in cassava products as gari, can be linked to factors which include; the type of fermentation, use of short-cut techniques (Mlingi *et al.*, 1993) and a cut down in the fermentation time. Dry fermentation, allow difficultly the appropriate contact of the detoxification enzyme, linamarase, which penetrate difficultly to the pulp in order to meet the substrate (Mpong *et al.*, 1990). Retting, increases this process in a humid fermentation where the roots are completely submerged in water (Ayernor, 1985), the the process is used for cassava chips and fermented cassava roots (Bobolo) production. (Agbor-Egbe *et al.*, 1995). The shortened of fermentation time to a few hours is linked to the increasing demand of these products in the local market. These producers shorten

Table 2: Total residual proteins (% dry weight) in cassava derivatives according to their origin

Origin	Fermented cassava paste	Cassava chips	Gari
Meiganga	1.6±0.6	0.95±0.6	-
Ngoundéré	2.3±0.5	1.26±0.3	-
Tibati	1.7±0.6	1.19±0.5	-
Ngaoundal	3.4±0.7	0.84±0.5	-
Banyo	1.18±0.7	0.95±0.2	-
Garoua-Mbolāi	1.3±0.8	1.29±0.6	0.5±0.1
Batouri	2±0.8	1.06±0.7	1.2±0.7
Bertoua	2.15±0.9	0.65±0.2	-
Belabo	3.15±0.7	1.12±0.4	-
Betaré-Oya	1.52±0.7	1.23±0.3	-
Yaoundé	1.26±0.6	0.73±0.3	-
Obala	1.45±0.4	0.89±0.5	1.90±0.4
Mbalmayo	1.98±0.5	0.84±0.6	-
Ambam	1.91±0.3	1.18±0.7	-
Ebolowa	2.1±0.3	1.06±0.1	-
Douala	1.33±0.3	0.70±0.1	2.54±0.9
Nkongsamba	1.22±0.4	0.95±0.5	-
Muyuka	-	-	3.79±0.2
Mamfe	-	-	2.20±0.6
Mundemba	-	-	2.35±0.5
Bamenda	-	-	1.26±0.5
Mbengwi	-	-	3.25±0.8
Bafoussam	2.4±0.9	1.12±0.1	3.84±0.3
Foumbot	1.18±0.7	1.01±0.4	2.30±0.5
Foumban	1.25±0.5	0.84±0.1	2.02±0.1

n= 4

some steps in the production process in order to gain time in the transformation of roots. This also confirms why some authors indicate that fermentation has little influence in cassava detoxification (Westby and Twiddy, 1992) and encourage producers to neglect this step, which is consider as wasting of time. This short-cut technique is replacing fermentation step by a simple grinding and thickening steps process before cooking. Mainly, this method is harmful as we noticed a blockage in the natural detoxication process of glucosides at the level of cyanohydrin (Coon, 1969). One of the principal characteristics of cassava and cassava derivatives is their low protein content. The high protein content observed in gari could be attributed to the dry fermentation method use to produce gari, which could favours the proliferation of yeast and moulds whose cells are excellent protein sources. The low protein content observed globally in the derivatives can be linked to the multiple steps necessary to obtain most of these products, which could lead to leaching, by washing and proteins losses by roasting as in gari. In addition, studies on the factors which could influence the quality of cassava derivatives have shown that the duration of drying has a significant effect on the crude protein as well as the ecological area were the root is harvest (Trèche *et al.*, 1995). The presence here of a less important fungal flora could be a harmful factor for food conservation as well as for potential consumers. Previous reports shown the presence of toxigenic

moulds especially of the genus *Aspergillus* (Ngaba and Lee, 1979; Yandju, 1989). Aflatoxin production by some *Aspergillus* spp. such as *Aspergillus flavus* LINK, *A. niger* and *A. fumigatus* (Moreau, 1974; Mongi, 1979; Cock and Wheatley, 1984) has also been reported in the course of cassava fermentation, and should therefore not be surprise if this toxin is found in cassava derivatives. The low presence of pathogenic bacteria in the derivatives could be explained by the presence of an important concentration of lactate in these products and the acidity of the medium, which is linked to the presence of the principal organic acids (acetic and lactic) and ethanol liberated during fermentation by the natural microflora (Brauman *et al.*, 1995). However, the aerobic microflora detected here, which comprises principally *Bacillus* spp and *Klebsiella* spp (Okafor, 1977) indicate that they are not entirely eliminated by the activity of the fermentative microflora and the lactic acid producers. The presence of enterobacteria and coliforms in the cassava bases products in general and particularly in fermented cassava paste indicates that post retting processes or packaging of the products could re-contaminate these derivatives. This flora could be dominated by amylolytic bacteria (Oyewole and Odunfa, 1992). Gari, were less contaminated than the other products. This therefore explains the high level of contamination of fermented cassava roots which is humid, the water activity of the medium being a favourable factor for the proliferation of micro organisms. This can also be due to the fact that starch from fermented cassava paste is cooked and raw starch is less biodegradable than cooked starch, which is likely easier to be use by amylolytic flora (Mercier, 1985). This could explain the low contamination by bacteria like coliforms and clostridia species noticed in chips and gari.

Conclusion: Most cassava derivatives sold in our local markets still contain high levels of residual glucosides, low levels of total protein and the hygienic quality is poor and non-acceptable.

This therefore suggest an amelioration of the post retting and handling processes and improvement of the traditional technologies use for cassava based product processing. This could lead to the selection of starter culture for detoxification, which could by their cells increase the protein content of the derivatives and at the same time being safe for consumers. These can lead to the amelioration of the help ameliorate the nutritive, toxicological and hygienic quality of consumed cassava derivatives.

References

Agbor Egbe, T., M.I. Lape, L. oubi and S. Trèche, 1995. The effectiveness of cyanogen reduction during cassava processing into miondo. In E. Agbor, A. Brauman, D.Griffon, S.Trèche. Transformation Alimentaire du Manioc. ORSTOM. Paris, pp:306-318.

- Ambe, J.T. and A. Foaguegue, 1988. The place of cassava in Cameroon. In Collaborative Study of Cassava in Africa. Working Paper nE3, IITA, Ibadan, Nigeria, pp: 1-6.
- Ayernor, G.S., 1985. Effects of the retting of cassava on product yield and cyanide detoxification. J. Food Tec., 20: 89-96.
- Baena, M., T. Tylleskar and H. Rosling, 1997. Konzo and Ebola in Bandundu region of Zaïre. J. Fruits Vegetables and Nuts., 349: 621- 625.
- Brauman, A., S. Kéléké, O. Mavoungou, F. Ampe and E. Miambi, 1995. Kinetic studies of cassava retting in Central Africa (Congo). In E.Agbor, A. Brauman, D. Griffon, S. Trèche Transformation Alimentaire du Manioc. ORSTOM. Paris, pp: 287-305.
- Brauman, A., S. Trèche and O. Legros, 1992. Amélioration de la qualité des aliments fermentés à base de manioc. Opération Congo. Rapport de fin d'études dans le cadre du programme CEE-STD2 (Contrat nE TS2A-O226), pp: 54.
- Buttiaux, R., H. Beerens and A. Taquet, 1974. Manuel de techniques bactériologiques, 4^{ème} éd. Flammarion, Paris, pp: 700.
- Cock, J.H. and C. Wheatley, 1984. Aflatoxin in cassava...is it a real problem? Cassava Newsletter, 8: 14.
- Coon, E.E., 1969. Cyanogenic glucosides. J. Agri.,17: 519-526.
- Devani, M.B., Shishoo, S.A. Shah and B.N. Suhagia, 1989. Spectrophotometric for the micro-determination of nitrogen in Kjeldahl digest. J. the Association of Official Analatic Chem., 72: 953-956.
- Esser, A.J.A., P. Alsen and H. Rosling, 1992. Insufficient processing of cassava, induced acute intoxications and the paralytic disease konzo in rural areas of Mozambique. Ecol. Food Nutr., 27: 17-27.
- Mercier, C., 1985. Les enzymes amylolytiques. In Mouranche A., Costes C., eds., Hydrolases et dépolymérasés, collection Biochimie Appliquée dirigée par Costes. Gauthier-Villars, pp: 109-142.
- Mlingi, N.V., V.D. Assey, A.B.M. Swai, D.G. McLarty, H. Karlen and H. Rosling, 1993. Determinants of cyanide exposure from cassava in a konzo-affected population in northern Tanzania. Int. J. Food Sci Nutr., 44: 137-144.
- Mongi, J., 1979. Les moisissures et leurs toxines. La recherche, 102: 732-742.
- Moreau, C.I., 1974. Moisissures toxiques dans l'alimentation. In Masson et Cie eds. Paris, pp: 263.
- Mpong, O.E., H. Yan, G. Chism and R.T. et Sayre, 1990. Purification, characterization and localisation of linamarase in cassava. Plant Physiol., 93: 176-181.
- Ngaba, P.R. and J.S. et Lee, 1979. Fermentation of Cassava (*Manihot esculenta* Crantz) J. Food Sci., 44: 1570-1571.

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- Okafor, N., 1977. Microorganisms associated with cassava fermentation for "gari" production. *J. Appl. Bacteriol.*, 42: 279-284.
- Oyewole, O.B., 1995. The application of biotechnology to cassava processing in Africa. In E. Agbor, A. Brauman, D. Griffon, S. Trèche *Transformation Alimentaire du Manioc ORSTM*. Paris, pp: 277-286.
- Oyewole, O.B. and S.A. Odunfa, 1992. Extracellular enzyme activities during cassava fermentation for *fufu+ production. *World J. Microbiol. Biotec.*, 8: 71-72.
- Sylvestre et Arreaudeau, 1983. *Le Manioc*, éd ORSTM, pp: 159.
- Trèche, S., O. Legros and F. Tchibindat, 1995. Vitafort: un atelier pilote de fabrication farine de sevrage à base de manioc au Congo In E. Agbor, A. Brauman, D. Griffon, S. Trèche *Transformation Alimentaire du Manioc ORSTM*. Paris, pp: 667-682.
- Westby, A. and D. Twiddy, 1992. Role of microorganisms in the reduction of cyanide during transformation of African cassava products. In Westby and Neilly, IFS proceeding workshop. *Trad. Afr. Foods, Quality and Nutr.*, pp: 127-131.
- Yandju, D.L., 1989. L'importance des moisissures dans le ramolissement du manioc en fermentation sèche. *Mémoire de D.E.S. Fac. Sc. UNIKIS, Kisangani, Zaïre*.