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Public Health Dimensions of Cassava Processing in Eastern Nigeria

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ABSTRACT - Cassava is a staple food in Eastern Nigeria. Cassava processing is popular and has become a risk factor to human health in the area. The attitudes of the people to cassava processing seem to promote arthropod-vector activities and could result in public health problems. The study revealed that *Culex quinquefasciatus* bred in pots of fermenting cassava. This mosquito species could become a potential vector of bancroftian filariasis in the area. Cassava fermentation that is also carried out in streams and riverbanks prolong water contact hours thereby increasing opportunity for schistosomiasis infection. Mechanization of cassava processing, and trade on cassava staple, *fufu*, have provided short cuts in cassava processing, which are known to result in high remaining cyanogens levels in the product consumed, which is harmful. The general epidemiological implications of the use of cassava and its processing in Eastern Nigeria was discussed.

Key words: Cassava processing, vector breeding, public health

INTRODUCTION

Cassava (*Manihot esculenta* Crantz:) is an important tropical root crop belonging to the family Euphorbiaceae. Its synonyms include *Manihot ultissima* Phol with high cyanogenic concentration and *M. aipi* Phol with low cyanogenic concentration. In terms of chromosome number, cassava uniformly is $2n = 36$. Out of about 98 species in the family, only cassava is widely cultivated for food production. The starchy root of the cassava plant

~~Abstract~~

is one of the most important staple foods in the world (Rosling, 1997; Onwueme, 1978). It serves as a major source of dietary energy for ~~approximately~~ 500 million people around the world. It is regarded as the highest producer of carbohydrates among staple crops. The United Nations Food and Agriculture Organization (FAO), ranks cassava as fourth of food crops in the developing countries after rice, maize and wheat. In some parts of Africa and in the Americas, the leaves, which are relatively rich on protein, are consumed. Cassava is also used as animal feed and in making some industrial products. Cassava consists of 30 to 40 percent dry matter, the root contains mostly carbohydrates, but it is also rich in vitamin C, carotenes, calcium, and potassium, though poor in protein. Cassava leaves, in contrast, contain high levels of protein, in addition to being rich in vitamins (CIAT, 2001).

The cassava production is about 165 million metric tonnes /year, of which about 50% is produced in five countries namely, Nigeria, Brazil, Thailand, Zaire and Thailand. In those countries the average yield is 11-15 tonnes/hectare. About 58% of the world's production is used in the producing countries for food; 28% as animal feed; 15% for industrial purposes in Europe and Japan; and 14% for industry and wastage. Some of the industrial uses of cassava include papermaking, textiles, adhesives, high fructose syrup and alcohol.

Cassava is one of the very few tropical crops where cyanide content has not restricted its use as an important food for human consumption. This is because a large variety of processing techniques have been developed in different parts of the world resulting in a wide variety of products. According to O'Hair (1995), all plant parts contain cyanogenic glucosides the highest concentrations of which are in the leaves. In addition, the , concentration of cyanogenic glucosides is higher in the peels of the roots than in the interior. Cyanogenetic glucosides are poisonous plant compounds that often cause headaches in humans. In Africa, cassava could be divided into two types namely, the sweet and the bitter types depending on the toxic levels of cyanogenic glucosides. The bitter type contains higher concentrations of cyanogenetic glucosides than the sweet type.

Eating of insufficiently processed cassava has been reported to be injurious to health (Rosling, 1997). The present work was aimed at studying the attitudes of households to cassava processing and their importance public health in a rural community of eastern Nigeria, and to ascertain whether the use of cassava fermentation containers were viable as vector breeding sites.

MATERIALS AND METHODS

Description of the Study Area

The study was carried out in Umulolo community, which is located

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about 10 km northwest of Okigwe. The population consists mostly of the indigenous Igbo-speaking people. The only immigrants in the area are civil servants, especially teachers, who are there because of job postings.

Familial settlement pattern was evident in the study community with houses arranged in family clusters. Each cluster is separated from another by arable farmlands of varying sizes. The area is hilly with characteristic undulating plains. The principal lotic water bodies there are the Imo River and the Ngwara Stream. There are also numerous pockets of natural, and man-made stagnant water pools at the banks of the river and stream, which are used by the villagers for processing cassava. The vegetation is a mixture of typical equatorial forest at the riverbanks and the derived savannah background of the hilly undulating plains.

Farming is the main occupation, with every villager being a farmer in one way or the other. Even those who are employed in other occupations, engage in subsistence farming. The soil consists predominantly of shale, which provides good agricultural land for intense farming activities for crops like yam, cassava, maize, groundnut, vegetables, cocoayam, three-leaf yam, banana, and pineapple.

Survey on Household Attitudes to Cassava Processing in the Area

A structured questionnaire (see Table 1) was used by two well-trained Village Assistants to conduct a house-to-house interview of each household in the area. They moved from one family to another, and only consenting households were interviewed. Information was obtained on methods, frequency, purpose and attitudes to cassava processing among others. The consent of the Village Chief and leaders of the Town Development Union were obtained well in advance of the survey, while the villagers themselves were briefed.

Study on Cassava Fermentation Pots as Breeding Sites

Three Exit traps, constructed to match a commonly used fermentation container, were employed to ascertain whether mosquitoes bred in the water used in fermenting cassava. The exit traps were set immediately after the fermented cassava tubers have been removed for grating. The exit traps were left for some days under close monitoring. Newly emerging mosquitoes caught by the trap were identified based on external morphology using Edwards (1941), Gillies and de Meillon (1968), Gilles and Coetze (1987), and Uttah

Table 1 Survey on cassava processing by families at Umulole, Okigwe Nigeria

Variable	Number (%) n=328
Do you practice cassava processing by fermentation?	
Yes	293 (89.3)
No	35 (10.7)
Where do you ferment your cassava?	
In pots & containers only	172 (52.4)
In riverbanks/streams only	0 (0.0)
In both pots & containers and riverbanks/streams	121 (36.9)
Other ways	0 (0.0)
For how long do you ferment your cassava?	
4 days	246 (75.0)
More than 4 days	13 (4.0)
Less than 4 days	8 (2.4)
Varies depending on circumstances	26 (7.9)
How often do you ferment cassava?	
Up to once every week	21 (7.3)
Up to once every month	97 (29.6)
Up to once every quarter	137 (41.8)
Only occasionally	38 (11.6)
For what purpose do you ferment cassava?	
Family eating	273 (93.2)
Commercial purposes	20 (6.8)
Not applicable	35 (10.7)
Do you cover the pot during the fermentation process?	
Yes	46 (14.0)
No	247 (75.3)
Not applicable	35 (10.7)
When do you discard the water used in the fermentation process?	
Immediately processing completed	57 (17.4)
Whenever container needed	81 (24.7)
Time for another fermentation process	53 (16.2)
Not definite	102 (31.1)

(1998).

DATA ANALYSIS

The SPSS for Windows package (1995 version) was used for both entering of data and for data analysis. P-values < 0.05 were considered statistically significant.

Results

The survey coverage was high as 328 (97.6%) out of 336 households were successfully interviewed.

Table 1 shows that cassava processing was very common in the area. There is a significant difference between those who practiced cassava processing by fermentation (89.3%) and those who did not get involved in cassava processing (10.7%) (χ^2 -test; $p < 0.001$). The cassava fermentation was an age long cultural practice by the people to get rid of poisonous cyanide. Majority of the households (52.4%) fermented their cassava at home using

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pots or other containers, while others (36.9%) in addition to using these containers at home, also fermented theirs by the riverbanks and streams. Fermentation by the riverbank was only a complementary method by those whose farms and/or homes were close to the river. Furthermore, there was a trend in mechanizing cassava processing in the area; and the finished products could have relatively higher levels of cyanide, because only the grating was mechanized while the fermentation aspect was neglected.

Majority of the households (85.7%) completed their fermentation process in four days, while few households (2.4%) completed their processing in less than four days. About 8% of the households do not have definite duration for the processing. Analysis of the frequency of cassava fermentation process shows that 7.8% of households processed once per week, 29.6% once per month; 41.8% once per quarter, while 11.6% of households processed only occasionally. Cassava processed in the area by 83.2% of the households was for subsistence. Only 6.1% of households processed cassava for commercial purposes. Selling of already-cooked cassava flour dish (*fufu*) by food vendors enjoyed wide patronage by the population. Seventy-five percent of households did not cover the containers during the fermentation process, only 14% of households did, and this was statistically significant (χ^2 -test; $p < 0.001$). The water used in the fermentation process was discarded immediately after the processing was completed by only 17.4% of the households, others did not. The attitudes of other households included discarding the water whenever the container was needed (24.7% of the households); and whenever it was time for another fermentation process (16.2% of the households). The remaining 31.1% of the households discarded the water impulsively and whenever they felt like doing so. There was a statistical difference between the number of households, which discarded the water immediately after the fermentation, and the number of households, which did not (χ^2 -test; $p < 0.001$).

The relationship between purpose of cassava fermentation and duration of the processing in the study area is shown in Table 2. All families that were completing their fermentation process in less than 4 days were those with commercial interest, while those completing theirs in more than four days were those processing for their subsistence. Furthermore all families processing cassava for commerce were doing so at least once every week, while majority of families processing for subsistence were doing so either monthly or quarterly (see Table 3).

Table 4 shows that majority of families (51.4%) who did not cover their containers during cassava fermentation process were those, which had less frequency of fermentation process over time. There was statistical

Table 2: Relationship between Purpose of, and Duration of Cassava Fermentation Process in the Study Area.

Duration of fermentation	Purpose		
	Eating (%)	Commercial (%)	Total
4 days	239 (87.5)	7 (35.0)	246
> 4 days	0 (0.0)	13 (65.0)	13
< 4 days	8 (2.9)	0 (0.0)	8
Circumstantial	26 (9.5)	0 (0.0)	26
Total	273 (100)	20 (100)	293

Table 3: Relationship between family purpose for cassava fermentation and the frequency of the process in the study area.

Frequency of cassava fermentation	Purpose		
	Eating (%)	Commercial (%)	Total
Up to once every week	1 (0.4)	20 (100)	21
Up to once every month	97 (35.5)	0 (0.0)	97
Up to once every quarter	137 (50.2)	0 (0.0)	137
Only occasionally	38 (13.9)	0 (0.0)	38
Total	273 (100)	20 (100)	293

Table 4: Relationship between frequency of cassava fermentation process by families and their covering of containers used during the fermentation process.

Frequency of cassava fermentation	Purpose		
	Eating (%)	Commercial (%)	Total
Up to once every week	2 (4.3)	19 (7.7)	21
Up to once every month	5 (10.9)	92 (37.2)	97
Up to once every quarter	10 (21.7)	127 (51.4)	137
Only occasionally	29 (63.0)	9 (3.6)	38
Total	46 (100)	247 (100)	293

Table 5: Matrix of association between vectors and vector-borne diseases linked with cassava processing in Eastern Nigeria.

	Culicine Mosquitoes	Bulinus snails	Biomphalaria snails
Filariasis	●		
Schistosomiasis (<i>mansoni</i>)			●
Schistosomiasis (<i>haematobium</i>)		●	
Arboviruses	●		

Table 6: Relative time scale of manifestation of human medical problems and diseases associated with cassava processing in Eastern Nigeria.

Fast	Slow	Slower
Aboviruses	Schistosomiasis	Filariasis
Acute poisoning		
Aggravation of iodine deficiency disorders		
Konzo?		
Topical ataxic neuropathy		
Damages to pancrease		
Diminution of visual acuity.		

difference between those who covered the fermentation containers and those who did not in all given categories of frequency of processing (χ^2 -test; $p < 0.05$ for all tests).

Fermentation Containers as Breeding Sites

All the mosquitoes caught by the exit traps over cassava fermentation containers were identified to be *Culex* species. No anopheline species were caught.

Health Impact Assessment of Cassava Processing in the Area

Health Impact Assessment of cassava processing in the area was attempted. Figure 1 summarizes the pathway through which cassava processing could affect human health. The pathway shows two principal factors: firstly, fermentation activity in cassava processing, which could provide breeding sites for culicine vectors of filariasis thereby aggravating the disease epidemiology in the area. The polluted water, which resulted from fermenting, grating and washing cassava during processing could favor the emergence of other culicine mosquitoes such as *Aedes aegypti*, the vector of arbovirus such as yellow fever (see Table 5). The Eastern Nigeria falls within the areas endemic for schistosomiasis and this means that cassava processing activities in infested rivers and streams would increase water contact time enhancing the possibilities for an infection.

A theoretical relative timeframe for a possible on-set of these human medical problems and diseases that could result from cassava processing activities was attempted, and divided into three categorized, which are Soon, Later, and Much Later (see Table 6). The vector-borne diseases would be relatively slower to manifest than the non vector-borne medical problems.

DISCUSSION

The study shows that cassava processing was very common in the

area. The cassava fermentation was an age long cultural practice by the people to get rid of poisonous cyanide. Those who did not involve in the processing were settlers who neither had farms of their own nor any produce to process, and civil servants such as teachers. In Africa, cassava is processed in several different ways. Populations that eat cassava employ processing methods that result in the disintegration of the plant cells thereby removing the barriers between the cyanoglucosides and enzymes, allowing the enzymes to break down the poison. The extent of the elimination or reduction of cyanide in the final product varies greatly with the type of processing technique used. Cassava contains free and bound cyanogenic glucosides, linamarin and lotaustralin. They are converted to hydrogen cyanide (HCN) in the presence of linamarase (Banea-Mayambu, *et al.*, 1997; WHO, 1996; Bourdoux *et al.*, 1982). The enzyme linamarase occurs naturally in cassava, and acts on glucosides when the cells are ruptured. In some places the cassava may be first fermented in water and then either sun-dried for storage or grated and made into dough thus making cassava a safe commodity for consumption (Tylleskär *et al.*, 1992). Alcoholic beverages can be made from the roots. In traditional settings of the Americas, roots are grated and the sap is extracted through squeezing or pressing. The cassava is then further dried over a fire to make a meal or fermented and cooked. This subsequent process of drying, heating or frying further breaks down cyanohydrins to yield hydrogen cyanide. The highly volatile hydrogen cyanide evaporates into the air at 27 degrees Celsius (CIAT, 2001). Furthermore, fermentation of grated root pulp in sacks followed by drying is also an effective method of cyanogen removal.

In the study area only the cassava tubers are eaten. There are three main forms into which cassava tubers are prepared namely, *fufu*, *garri*, and *tapioca*. The mode of processing depends on the form intended. For *fufu*, the mode of processing was firstly fermentation by soaking in water pots or in local freshwater riverbanks and streams. This fermentation process took about four days to be completed. The fermented tubers now softened enough, were grated by crushing with fingers under water and then filtered (Uttah, 1998; Iwuala, 1979). This method is common among the traditional peoples of Eastern Nigeria. For preparation of *garri*, the tubers were peeled, grated, allowed to ferment, and then fried, while for *tapioca*, the tubers were sliced to small sizes cooked then left in water for days, then sun-baked.

It was observed in this study that the use of containers, especially the traditional clayey pots for the fermentation was quite popular, while majority neither discarded the water used in the fermentation after the processing, nor covered such containers thus enabling the culicine mosquitoes to breed in them. This result is consistent with an earlier observation by Iwuala (1979)

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that *Culex quinquefasciatus* bred in pots of fermenting cassava in the Nsukka area. Similarly, Udonsi (1988) reported of great abundance of *Culex sp.* in the Igwun River Basin, where also the cassava processing method is popular. Indeed human activities are altering the pattern of disease transmission in the tropics (Southgate, 1984; Edungbola, 1980). Culicine mosquitoes exploited the food processing habit of the local people. The viability of the cassava processing method as provider of breeding habitat for *Cx quinquefasciatus* could explain my earlier observation in a neighboring Umuowaibu and Ogbakiri (Uttah, 1998) of sustained satisfactory relative abundance of this species in these areas. The frequency of cassava processing in the area was high and took place all year round. This development has many epidemiological implications. Firstly, it means that this cassava processing method is providing this mosquito species, referred to as an index of urbanization (Kuklow and Zielke, 1978), with the opportunity to conquer the rural habitat. According to Subra (1980), *Cx quinquefasciatus*, which occurs mainly in the urban areas, may spread to rural areas of West and Central Africa, which will precede the transmission of *Wuchereria bancrofti*. Secondly, *Cx quinquefasciatus* has been described as a potential vector of filariasis in the West African region (Taylor, 1930; Brengues, 1975; Kuhlow, 1987; Anosike and Onwuliri, 1992). They may become epidemiological important in the transmission of both the urban and rural filariases in Nigeria and West Africa. A successful experimental infection of *C. quinquefasciatus* was reported in Jos, Nigeria in which 76.6% of this mosquito species harbored infective L₃ larvae of *W. bancrofti* that led to a conclusion that compatibility existed between the local strain of the filarial parasite and this species of mosquito (Anosike and Onwuliri, 1992). In another West African area, *W. bancrofti* larvae were found in *Cx. antennatus* (Brengues, 1975). Thirdly, the movement of infected people from rural West Africa into the large West African urban centres where *Cx. quinquefasciatus* is well established, could lead to *W. bancrofti* becoming adapted to *Cx. quinquefasciatus* (Subra, 1975; Maasch, 1973).

Furthermore, when people carry out fermentation activities by the riverbanks and streams, they grate and wash the cassava *in situ*. This prolonged water contact time they spent in infested rivers enhancing the transmission of schistosomiasis in endemic areas (Dalton and Pole, 1978).

All the households processing for commercial purposes admitted completing processing below the mean fermentation duration (which was four days), which was also the traditional fermentation duration in the area. It is arguable that the *fufu* sold by food vendors were insufficiently processed. This potentially dangerous trend has been reported in the savannah area of

Zaire where during period of intensive cassava trade, the population frequently used short-cuts in cassava processing resulting in high remaining cyanogens levels in the product consumed (Banea *et al.*, 1992a). This could aggravate medical conditions of the population (Banea-Mayambu, *et al*, 1997; Rosling and Tylleskar, 1995; Tylleskar *et al*, 1995; Banea *et al*, 1992b), especially in a population where there is low sulphur intake, which seems to be a permissive factor for neurotoxicity as it reduces or modifies cyanide detoxification (Banea-Mayambu *et al*, 1997). It has been observed that reduced detoxification rate increases the biological effect of a given intake of cyanide (Swenne *et al*, 1996). Eating of insufficiently processed cassava could expose the population to health problems such as acute poisonings, aggravation of iodine deficiency disorders, neurological disease known as tropical ataxic neuropathy, damaged pancreas (Rosling, 1997), and diminution in visual acuity. There is a risk of either acute poisoning with severe sudden illness and death, or a later onset of a suddenly appearing paralysis that is non-progressive, which is called konzo. The name konzo is the local designation among the first affected population, the southern Bandundu region in Zaire, the Democratic Republic of Congo (Rosling, 1995, Tylleskar and Rosling, 1995). In the Yaka language *konzo* means tied legs" which is spastic gait abnormality (Rosling, 1997). Konzo is an upper motor-neuron disease, characterized by an abrupt onset of a permanent but non- progressive spastic paraparesis. Initial symptoms are described as heaviness or trembling of the legs and difficulty, or tendency to fall when walking. The most severely affected become unable to stand immediately at onset and may present difficulties in talking and diminution of visual acuity. The paraparesis varies in severity but always mostly affects the distal part of legs. It is symmetrical and the damage to upper motor neurone is permanent but non-progressive. Konzo is clinically and epidemiologically very different from tropical ataxic neuropathy that has been attributed to low level of dietary cyanide exposure during many years (Rosling, 1997). Konzo affects mainly children and women in childbearing age. Konzo occurs among populations that rely almost exclusively on bitter cassava as staple or cash crop. The outbreaks of konzo have been identified in certain areas of Africa including Central Africa Republic, Mozambique, Tanzania, and Democratic Republic of Congo (Zaire). Although the cassava variant eaten in Eastern Nigeria seems to be less toxic to the ones eaten in these countries where konzo has been reported, but there is no guarantee that eating the Nigerian variant unprocessed would not be dangerous to health. The present evidence from these neighbouring countries should be strong enough to serve as a deterrent to the Eastern Nigerian population. Eating of improperly processed cassava poses more

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immediate danger to human health in Eastern Nigeria than the threat of vector-borne diseases, which takes many years to be established. Finally, it has become necessary that Public Health Officers educate the population on safe processing

CONCLUSION

Cassava is an important source of food in Eastern Nigeria. Its processing before consumption has become a paradox: its dangerous to human health when not processed properly, yet some processing activities provide breeding sites for vectors of human diseases. Care should be exercised to adequately process cassava before consumption. Pot for cassava fermentation should be covered to deny mosquitoes access. Cassava fermentation in streams and riverbanks should be avoided. In this way medical problems associated with cassava would be eliminated.

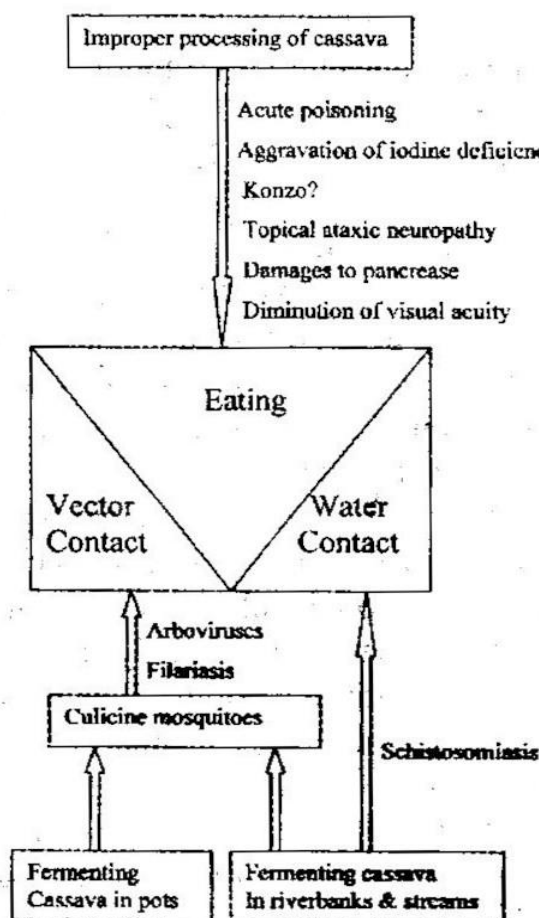


Figure 1. Pathway by which cassava processing could affect human in Eastern Nigeria.

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