International Institute of Tropical Agriculture (IITA)

Traditional processing and utilization of cassava in Africa

Sang Ki Hahn

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International Institute of Tropical Agriculture (IITA)
Training Program
PMB 5320
Ibadan
Nigeria
Fax: (234 2) 241 2221
Telephone: (234 2) 241 2626
Telex: 31417 or 31159 TROPIB NG
E-mail (Internet): IITA@CGNET.COM

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Text processing	Kehinde Jaiyeoba
Artwork	Chiweta Onianwa
Layout	Nancy Ibikunle
Coordination	Rainer Zachmann

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Traditional processing and utilization of cassava in Africa

Objectives. This guide is intended to enable you to:

- explain why cassava needs processing
- describe traditional methods of processing cassava
- discuss constraints in traditional processing
- analyze implications of cyanide and tannin
- describe processing equipment
- describe storage and utilization of processed products
- discuss the use of cassava leaves as vegetable
- discuss the future of cassava

Study materials

- Cassava roots and leaves of different varieties.
- Processing tools and equipment.
- Processed products.
- Storage materials and facilities.

Practicals

- Interview farmers on cassava processing and utilization (informal survey).
- Demonstrate and practice methods of cassava processing and utilization.

Questions

1 Why is cassava playing a major role in efforts to alleviate the African food crisis?
2 What are the advantages of cassava processing?
3 Why can fresh cassava roots not be stored?
4 How can the nutritional value of cassava be fortified?
5 Where did traditional cassava processing originate?
6 What are the major products of cassava processing?
7 What is the procedure for *gari* processing?
8 What are local names for fermented and dried cassava pulp?
9 Where is *chickwangue* group popular?
10 What is the disadvantage of dried cassava?
11 What are the constraints to traditional cassava processing?
12 What is the labor efficiency of cassava processing?
13 What are the aims of improved processing methods?
14 What are the effects of cyanide?
15 What are the possibilities to reduce cyanide content of products?
16 What are the effects of tannins?
17 What equipment does cassava processing require?
18 What are the storage requirements of cassava products with respect to temperature and humidity?
19 What is *fufu*?
20 What local products does the *fufu* group include?
21 What is the nature of the 'soup' consumed with cassava root based foods?
22 Where are cassava leaves consumed as a most preferred green vegetable?
23 How are cassava leaves prepared?
24 What is the nutritional value of cassava leaves?

Traditional processing and utilization of cassava in Africa

Abstract. Cassava is playing a major role in African food systems. Processing of cassava has several objectives and advantages. Traditionally, cassava is processed into many products. However, several constraints affect cassava processing. Cyanide content in the roots is a major limitation to cassava utilization, but can be reduced by appropriate processing.

Traditional processing does not require sophisticated equipment, but storage requirements of the processed products are critical. At many locations, cassava leaves are used as a preferred green vegetable. Future research on improved cassava processing and utilization techniques would greatly increase labour efficiency, productivity and nutrition.

1 Why cassava needs processing

Cassava is one of the most important staple food crops grown in tropical Africa. Because of its efficient production of food energy, year-round availability, tolerance to extreme stress conditions, and suitability for present farming and food systems in Africa, cassava is playing a major role in efforts to alleviate the African food crisis.

Traditionally, cassava roots are processed by a variety of methods into many different products and used in diverse ways according to local custom and preference, to provide the carbohydrate part of the diet. Processing cassava roots into flour in Latin America dates back to as early as 2000 B.C.

Improvement of cassava processing and utilization techniques would greatly increase labor efficiency, productivity, incomes, and lives of cassava farmers and the urban poor, as well as enhance the shelf life of products, make transportation easier, raise marketing opportunities, and upgrade nutrition. This Research Guide reviews traditional cassava processing and utilization as used at the present time by small-scale farmers and processors in Africa and examines the opportunities for improving postharvest activities in Africa.

Fresh cassava roots cannot be stored for long because they rot within 3–4 days after harvest. Being bulky, with about 70% moisture content, transportation of the roots from rural to urban areas for marketing is difficult and expensive. Both root and leaf contain varying amounts of cyanide which is toxic to human and animals. The raw cassava root and leaf are not palatable. Thus, there is a need to process cassava into various products that have increased shelf life, are easier to transport and market, cost less to transport, contain less cyanide, and have improved palatability.

Nutritional value can also be increased through food composites and by fortification with other protein-rich crops. Processing can increase the efficiency of land use by releasing land after harvest for other crops or for fallow to sustain soil productivity. Processing reduces food losses and stabilizes seasonal fluctuation in supply of the crop. Thus, cassava requires more processing than any other food crop in Africa. On the other hand, its processing is simple, not requiring sophisticated tools and equipment or much capital input.

2 Traditional methods of processing cassava

The various traditional cassava processing methods used in Africa probably originated in tropical America, particularly northeastern Brazil, and/or have been adapted from indigenous techniques for processing yams.

The processing methods comprise combinations of activities such as peeling, boiling, steaming, slicing, grating, soaking or steeping, fermenting, pounding, roasting, pressing, drying and milling (Figure 1).

Cassava is processed into many different products of which several major ones are described below, including how they are processed:

- *gari*
- fermented and dried cassava pulp
- wet pulp
- smoked cassava balls *(kumkum)*
- *chickwangue*
- starch
- dried cassava

Gari. Fresh roots are peeled and grated (Figure 2). The grated pulp is put in sacks (jute or polypropylene) and the sacks are placed under heavy stones or pressed with a hydraulic jack between wooden platforms for 3–4 days to express excess liquid from the pulp while it is fermenting (Figures 3 and 4). Fermentation imparts an acidic taste to the final product.

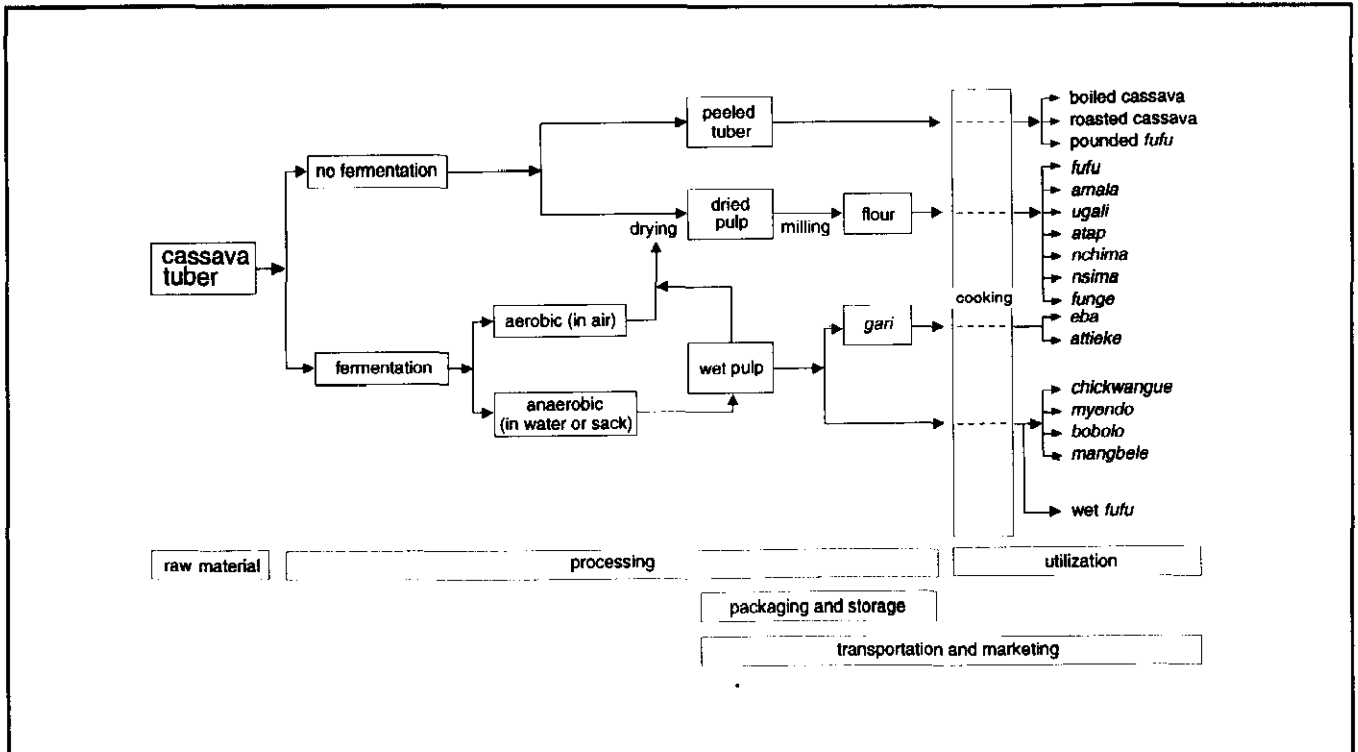


Figure 1. Traditional cassava processing and utilization in Africa.

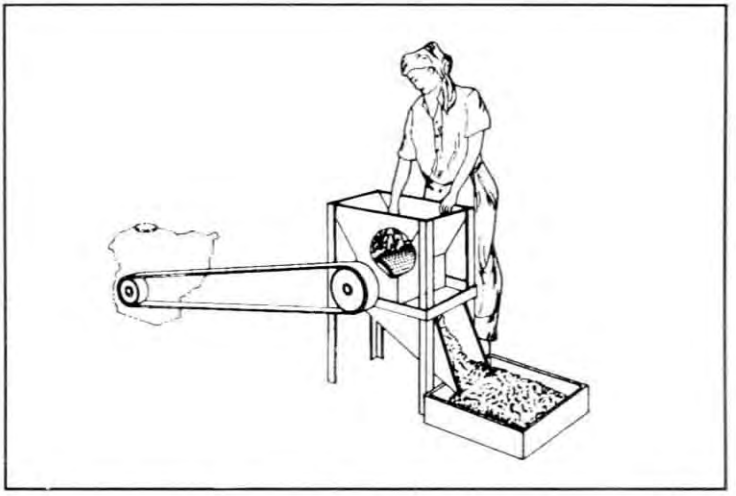
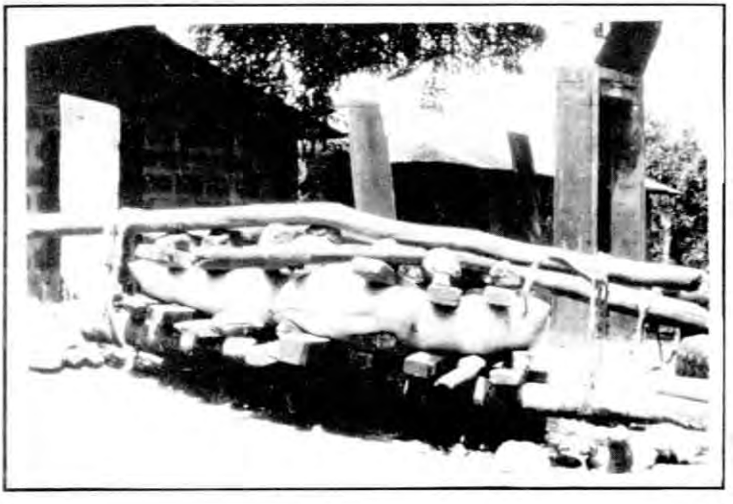


Figure 2. Peeled cassava tubers grated with a power-driven grater.

Figure 3. Grated cassava pulp sacks pressed with a hydraulic press for 2–4 days.

The dewatered and fermented lumps of pulp are crumbled by hand and some fibrous material picked out. The remaining mass is passed through a traditional sieve, made by weaving pieces of split cane, or through the iron or polyethylene mesh that is now in common use. After the fibres have been sifted out, the fine pulp is roasted in a pan made of iron or in an earthenware pot over a fire.

Figure 4. Grated cassava pulp is put into sacks and placed between wooden plates. Excess liquid is expressed by tightening ropes around the platforms.



The garification or conversion rate of fresh roots to *gari* is 19% with a range of 14–26% (Table 1). This value varies with variety, time of harvesting, age of plant and other environmental factors. A similar method is used to produce farinha de mandioca in Brazil.

Table 1. Losses during the processing of 10 kg fresh cassava tubers into *gari*.

Year	Varieties	Losses (kg) resulting from: peeling	grating dewatering fermenting	sifting	roasting	Residual *(gari)*
1980	12	3.10	3.67	0.40	1.27	1.56
1981	12	2.20	3.15	0.70	1.70	2.25
1982	12	2.30	4.10	0.40	1.30	1.90
1983	18	1.50	4.10	0.23	2.70	1.47
1984	18	1.46	4.45	0.37	2.28	1.44
1985	15	1.78	3.93	0.23	1.49	2.57
Average	15	2.06	3.90	0.39	1.79	1.87

If the sieved pulp is too wet, it takes a longer time to roast, resulting in a finished product that is lumpy and of a dull color. Palm oil (extracted from the husk of the fruits of the palm *Elaei guineensis* Jacq.) is often added during roasting in order to prevent burning of the pulp and also to impart a light yellow color, thus yielding two types of *gari*: white and yellow. Palm oil contains a substantial quantity of vitamin A and is expensive. Therefore, yellow *gari* is more nutritious and costs 10–30% more than white *gari*.

Peeling is done mainly by women and children. The peeled roots are grated by women, if a simple traditional grater is used, but is done by men if a power driven grater is used. Pressing is done by women if it is in the traditional way, but done by men when a hydraulic press is used.

Roasting of the sieved pulp is done almost exclusively by women. When they are roasting the fermented pulp in a pan or pot over a fire, with fuelwood as an energy source, they are constantly in contact with smoke and heat, and probably with cyanide, although the quantity is probably small (no experimental data are available).

A large quantity of fuelwood is needed for roasting the pulp into *gari*, so *gari* is normally produced in the forest or savanna areas where fuelwood is available. *Gari* is very popular in Nigeria and to a lesser degree in Cameroon, Bénin, Togo, Ghana, Liberia and Sierra Leone.

Fermented and dried cassava pulp. *Lafun* in Nigeria, *cossettes* in Zaire and Rwanda, *kanyanga* and *mapanga* in Malawi, and *makopa* in Tanzania belong to this category.

The processing method is very simple and does not require much labor and is thus widely used for processing high cyanide cassava varieties in many parts of Africa where water is available for soaking.

The whole or peeled roots are immersed in a stream, in stationary water (near a stream) or in an earthenware vessel for 3–4 days and fermented until they become soft. The fermented roots are then taken out, and the peel and central fibres of the fermented roots are normally removed and the pulp broken into small crumbs and sun-dried on mats, racks, flat rocks, cement floors, roofs of houses, and so on (Figure 5).

Figure 5. Fermented cassava pulp is mashed by hand and dried on a rock in the sun.

Drying takes 1–3 days, depending on the weather. The dried crumbs are milled into flour. Although the processing method is simple, fermented and dried cassava is losing ground to *gari* among consumers in West Africa, primarily because of the poor hygiene practiced during its production.

Wet pulp. The procedures for wet pulp production are similar to those for production of fermented and dried pulp, except that the fermented pulp is not dried. The wet pulp may be moulded into balls (3–5 cm diameter), put in boiling water and stirred thoroughly to obtain a stiff paste. Wet pulp, with fibres removed, is packed in bags (plastic or polypropylene) in 0.5-1 kg lots and marketed in urban areas in Nigeria, Cameroon and Ghana. Thus, urban women do not need to buy fresh roots to prepare wet *fufu*. This is a good example of how farmers or small-scale processors near urban areas are meeting the rapidly changing needs of urban dwellers.

Smoked cassava balls *(kumkum)*. Processing for smoked cassava balls is the same as for fermented and dried pulp production, except that the fermented wet pulp is pounded and moulded into round balls of about 4–7 cm diameter, which are smoked and dried on the platform above a fireplace in a special structure hung above the hearth. The dark coating due to smoke is removed and the cleaned balls are milled into flour before reconstitution into *fufu*.

Chickwangue. *Chickwangue* is the most popular processed food form of cassava in Zaire. *Myondo* and *bobolo* in Cameroon, *mboung* in Gabon, *mangbele* in Central African Republic belong to this *chickwangue* group. Similar products are produced in Congo, Sudan and Angola.

Cassava roots are peeled, steeped in water and left for 3–5 days to ferment until they become soft. Fibres are removed from the pulp, which is heaped on a rack for further fermentation or covered with leaves and pressed with heavy objects to drain off excessive liquid. The pulp is then ground on a stone or pounded in a mortar.

The fine pulp is wrapped in leaves of plantain or species belonging to the family *Zingiberaceae*, tied firmly with fibres from banana and steamed in pots.

Chickwangue has a diameter of about 10 cm and a length of 20 cm (Figure 6). *Myondo* has a diameter of 1.5–2 cm and a length of 15–20 cm. *Bobolo* has a diameter of 2–4 cm and is 30–40 cm long. *Mboung* in Gabon is smaller than *chickwangue* in Zaire but is basically the same.

Figure 6. *Chickwangue* on sale in Zaire.

Starch. Cassava roots are peeled, washed and grated. The grated pulp is steeped for 2–3 days in a large quantity of water, stirred, and filtered through a piece of cloth. The filtrate is allowed to stand overnight and is then decanted. The starch sediment is air-dried in the shade. Its average starch content is within the range of 20–25%. The starch percentage (Y) can be estimated from the dry matter percentage (X) using the equation $Y = -2.8082 + 0.8679\,X$.

Dried cassava. Roots are peeled, sliced into small pieces and sun-dried on racks, roofs, and so on from 4 days to 3 weeks, depending on weather and the size of the pieces. The pieces are then milled into flour. This process is very simple but the products contain considerable amounts of cyanide. This method is widely practiced in many areas of Africa, particularly where water for fermentation is scarce.

Environmental factors. During the rainy season, there is less sunshine and temperatures are relatively low for processing cassava, particularly in lowland humid areas where much cassava is grown and utilized. In certain localities, particularly in savanna areas, water which is essential for processing cassava into certain products is not easily available. In the early part of the rainy season, the dry matter content of the roots is usually lower than in the dry season, which can result in lower yields of products. In the dry season, when the soil is hard, harvesting roots and peeling them for processing are more difficult, resulting in more losses.

Varietal factors. Root shape varies among cultivars of cassava. Roots with irregular shapes are difficult to harvest and peel by hand. This leads to great losses of usable root material. Root size also varies with cultivar, although it depends much on environmental factors such as soil. Smaller roots require more labour for peeling. Ease of peeling (separating the periderm from the root cortex) depends very much on cultivar. Varietal differences in dry matter content and in both content and quality of starch influence the output and quality of the processed products. Cyanide content varies with variety, but is also affected by the environment in which the crop is grown.

Agronomic and socioeconomic factors. Time of planting and harvesting, and age of plant (from planting to harvesting) affect size and shape of tubers, starch content, yield and quality of processed products. Other agronomic practices such as fertilizer application, spacing, and so on can also affect them.

Harvesting and transportation of roots from farm to homestead and subsequent processing are mainly done by women. Most of the steps in processing are carried out manually, using simple and inexpensive tools and equipment that are available to small-scale farmers. The labor requirement for processing is very high and labor productivity in processing is very low.

The bad condition of rural roads makes transport of fresh cassava and processed products to market difficult. These are the major factors limiting cassava production, apart from the disincentive of low prices. The drudgery associated with traditional processing is enormous. The products from traditional processing methods are contaminated with undesirable organisms and extraneous matter. Some of the products are therefore not hygienic and so of poor market quality.

Better processing methods can improve life-styles by ensuring higher processing efficiency, saving labor, reducing drudgery and improving the quality of products. It can make more spare time available to women for other family duties and caring for their children, thus improving their health.

Traditional subsistence farmers harvest cassava as need arises. By leaving cassava in the ground for a long period, the farmers believe that cassava is safer and the roots undergo less damage than if they had been harvested. This system has certain merits but the delay in harvest can result in more root losses due to root rots, damage by animals and a decrease in the starch content of the roots. Besides, this results in very inefficient land use.

Fuelwood for processing has become scarce as deforestation occurs and environmental degradation becomes acute due to population pressure on the land.

Cassava contains the cyanogenic glucosides, linamarin and lotaustralin. After tissue damage, they are hydrolyzed by the endogenous enzyme linamarase to the corresponding cyanohydrins and further to hydrogen cyanide (HCH) which is responsible for chronic toxicosis when inadequately processed cassava products are consumed by humans or animals for prolonged periods. Therefore, processing procedures must reduce cyanide as well as improve storability, convenience and palatability.

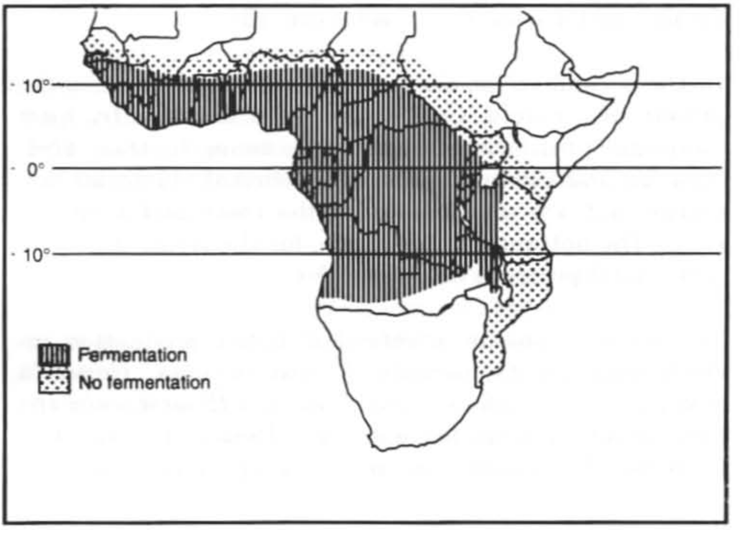
Traditional processing methods range from simple procedures such as peeling and boiling for immediate consumption to complicated procedures such as conversion into *gari* which entails many more steps: peeling, grating, pressing/fermenting, sifting and roasting. Some of these steps are more effective than others in reducing cyanide.

Procedures vary between countries and between localities within a country, depending on food culture, environmental factors such as availability of water, cassava varieties used, and types of processing equipment and technologies available.

The most important traditional culinary preparations of cassava in Africa are boiled/roasted roots, *fufu* (cassava flour stirred with boiled water over a low-heat fire to give a stiff dough), *eba (gari* soaked in hot water to give thick porridge) and *chickwangue* (steamed fermented pulp wrapped in leaves). Some of the important processing activities associated with these and their effects on HCN content are described.

Fermentation and tissue disintegration. Fermentation (Figure 7) may be either aerobic or anaerobic. Anaerobic fermentation is carried out mainly in areas where water is readily available. For aerobic fermentation, the peeled and sliced cassava roots are first surface-dried for 1–2 hours, then heaped together and covered with straw or leaves and left to ferment in air for 3–4 days till the pieces get mouldy.

Figure 7. Geographical areas where fermentation of cassava roots is or is not generally practised by farmers.



The fermented pieces are placed in the sun to dry after scraping off the mould. The dried pieces (called *mokopa* in Uganda) are milled into flour. The flour is converted into a *fufu* called *kowon* in Uganda to which the fermented cassava imparts a flavor that appeals to some consumers. This method increases the nutrition because of the mould growth, which increases the protein content of the final product by three to eight times. This fermentation method is very popular in parts of East Africa such as Uganda, Tanzania, Rwanda and Zaire.

Grated cassava are put in sacks and pressed between wooden platforms with stones or a jack for processing into *gari*. Whole roots or pieces of peeled roots placed in water for 3–5 days for processing into *fufu* undergo an anaerobic and exothermic fermentation.

In the first stage of *gari* production, *Corynebacteria manihot* attacks the starch of the root leading to the production of various organic acids (such as lactic and formic) and a lowering of substrate pH.

In the second stage, the acidic condition stimulates the growth of a mould, *Geotrichum candida*. *Geotrichum candida* proliferates rapidly, causing further acidification and the production of a series of aldehydes and esters that are responsible for the taste and aroma of *gari*. The optimum temperature for the fermentation is 35°C and it proceeds well up to 45°C.

The microorganisms involved in *lafun* production include four yeasts, namely, *Pichia onychis, Candida tropicalis, Geotrichum candidum,* and *Rhodotorula* sp.; two moulds *Aspergillus niger* and *Penicillium* sp.; two bacteria: *Leuconostoc* sp. and *Corynebacterium* sp.

Moisture, pH and temperature conditions are critical for the growth of these microorganisms in roots and thus for fermentation of roots.

Tissue disintegration in the presence of excess moisture during grating or fermenting in water permits the rapid hydrolysis of glucosides, effectively reducing both free and residual cyanide in the products. Fermentation in air is not as effective as that in water. Soaking roots in water for three days reduced cyanide by 70–85%.

Gari production, involving grating, fermentation, and roasting resulted in an 80–95% reduction in total cyanide content relative to fresh peeled roots. When *gari* is converted to *eba*, HCN is further reduced to even safer levels. Cyanide reduction of 100% was achieved by processing roots into *chickwangue*.

Oke (1968) reported HCN contents of 1.9 mg/100 g for *gari* (Nigeria); 2.5 mg/100 g for *fufu* (Nigeria) and 1.0 mg/100 g for *fufu* (Zaire) or *lafun* (Nigeria). The HCN concentration in 202 *gari* samples collected across the cassava growing areas of Nigeria was 0–3.2 mg HCN/100 g with a mean of 0.6 mg/100 g. Akinrele and others (1962) considered 3.0 mg HCN/100 g to be an acceptable level in *gari*. Therefore, adequately processed *gari* in Nigeria would contain acceptable levels of HCN.

Dewatering fermented cassava. During or after fermentation of roots for *gari* production, the grated pulp is put in sacks (jute or polypropylene) on which stones are placed or jack-wood platforms are set to drain or press off excess liquid from the pulp. In Zaire, the cassava pulp resulting from fermentation in water is taken out and heaped on racks in the sun for further fermentation and draining off of excess moisture. In this way, much cyanide is also lost along with the liquid. Thus dewatering is an effective means of reducing cyanide.

Drying. Drying is the simplest method of processing cassava. It reduces both moisture and cyanide contents of roots, thereby prolonging product shelf life. This processing method is used mainly for low cyanide varieties and in areas with restricted water supplies. Drying is done in the sun or by placing root pieces over a fire. The former is more common because it is simple and does not require fuelwood.

Fast air-drying decreased the total cyanide content of chips of peeled cassava roots by only 10–30%. Slow sun-drying, however, produced a greater loss of cyanide. Mahungu and others (1987) reported that sun-drying peeled cut pieces of roots gave an HCN concentration lower than 10 mg/100 g but that oven-drying was less effective.

Boiling. Boiling the peeled roots does not remove HCN efficiently and pounding of the boiled roots into 'pounded fufu' decreased HCN concentration by only 10% more. Therefore, this method of preparation is recommended for only low cyanide cultivars.

Milling. The dried root pieces and fermented/dried pulp are milled into flour by pounding in a mortar or using a hammer mill, if available. Hammer milling is done at the village level. Milling may reduce cyanide. Dried cassava roots (both fermented and unfermented) are often mixed with sorghum, millet and maize, in a ratio of two or three to one, and milled into composite flour. The proportions vary, depending on availability of the components and regional tastes.

Mixing cereals with cassava increases and balances food protein, enhances palatability by improving consistency and, more importantly, ekes out the cereals which are often scarce and expensive at certain times of the year.

Tannins. Cassava contains tannic acid, ranging from 0.05–0.20 mg/100 g in the peel and 0.04–0.05 mg/100 g in the tuber itself. This imparts a dull color to the processed products, which affects their market value. Tannins may, however, play an important role in protecting the cassava plant from diseases, pests and large animals. However, it acts as a growth depressing factor by decreasing protein digestibility.

Traditional cassava processing does not need sophisticated equipment. Processing cassava into *gari* requires equipment such as a grater, presser and fryer, but for production of other cassava food products, not much equipment is needed. The traditional cassava grater is made of a flattened kerosine tin or iron sheet perforated with nails and fastened onto a wooden board with handles. Grating is done by rubbing the peeled roots against the rough perforated surface of the iron sheet which tears off the peeled cassava root flesh into a mash.

In recent years, various attempts have been made to improve graters. A grater that is belt-driven from a static diesel engine (5 hp Lister type) has been developed and is being used extensively in Nigeria. Its capacity is about one ton of fresh peeled roots per hour.

The peeled cassava roots are grated by keeping them in contact with the perforated surface of the mashing roller. Such a grater is often placed on a cart to provide a mobile service moving among households and between villages.

This type of power driven grater is, however, not suitable for women in a small household because, firstly, it is expensive and, secondly, it cannot be operated by most farm women. Therefore, low cost and low energy demanding graters, which can be operated easily by women and fabricated locally, need to be developed.

For draining excess liquid from the grated pulp, the sacks containing the grated pulp are slowly pressed, using a 30-ton hydraulic jack press with wooden platforms before sieving and roasting into *gari*.

Stones, where available, are used traditionally to press out the excess moisture from the grated pulp. Tied wooden frames are used for this purpose in places where stones are not available. A pan made of iron or an earthenware pot is used for roasting the fermented pulp. Fuelwood has been used as a major source of energy for boiling, roasting, steaming and frying. However, fuelwood may not be easily and cheaply obtained in the future due to rapid deforestation.

Slight changes in equipment can help save fuel and lessen the discomfort, health hazard, and drudgery for the women operating it. The economic success of any future commercial development of cassava processing will depend upon the adaptability of each processing stage to mechanization. However, the first step should be to improve or modify the presently used simple processing equipment or systems, rather than changing to entirely new, sophisticated and expensive equipment.

Processing, particularly drying and roasting, increases the shelf life of cassava products. Cassava products are very hygroscopic and their storage life depends on their moisture content and on the temperature and relative humidity of the storage environment. The moisture content of *gari* needs to be below 13% for safe storage.

When temperature and relative humidity are above 27°C and 70% respectively, *gari* goes bad. The type of bag used for packing also affects shelf life due to varying ability to maintain product moisture levels.

Jute bags are recommended in a dry, cool environment because they allow good ventilation; in a humid, hot environment, hessian bags would be better. When *gari*, dried pulp and flour are well dried and packed properly to prevent moisture absorption, they can be stored for more than a year without loss of quality.

Dried cassava balls *kumkum* can be stored for well up to two years. *Chickwangue, myondo* and *bobolo* can only be stored for up to one week but they can be kept for several more days if re-cooked.

Cassava may be cooked by boiling, steaming, or roasting. Peeled fresh cassava roots may be eaten raw or boiled or roasted (Figures 1 and 8). This method of preparation is common throughout Africa. Fresh roots may also be boiled and pounded to obtain *pounded fufu*, which is popular in Ghana, and to some extent, Nigeria and Cameroon.

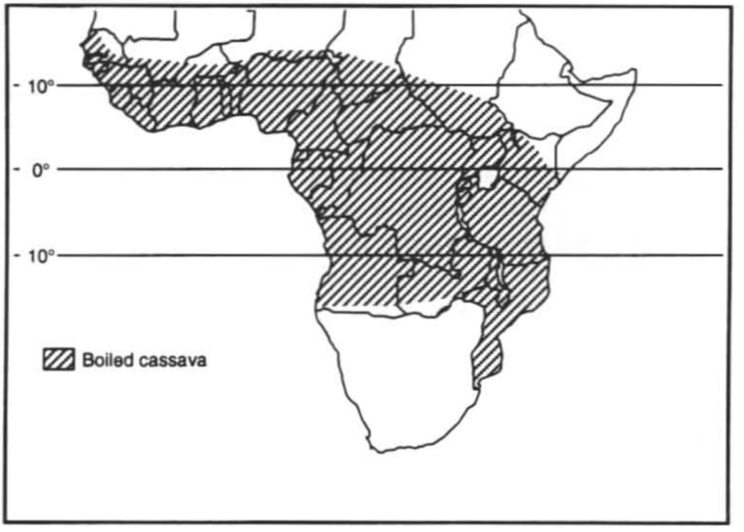
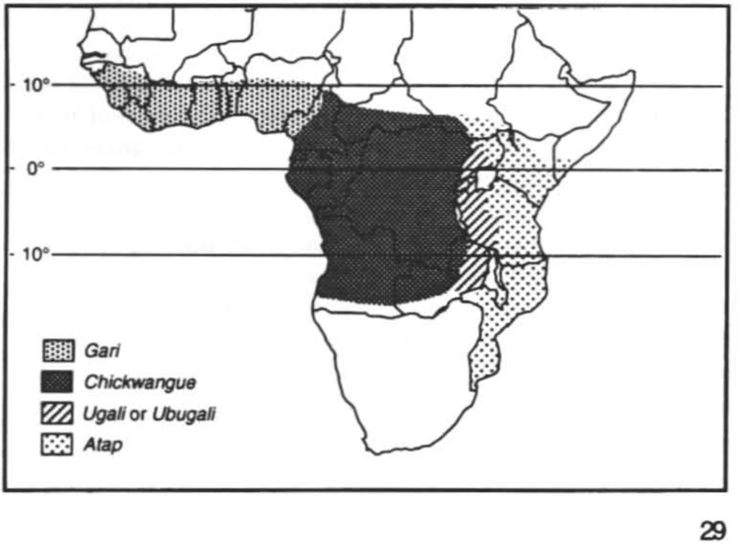


Figure 8. Geographical areas where cassava roots are eaten boiled.

Figure 9. Geographical areas where four major cassava products are produced from cassava roots.



In Africa, processed cassava, in the form of flour, wet pulp or *gari*, is cooked and eaten in three main forms: *fufu, eba* and *chickwangue* (Figures 1 and 9).

Fufu is a kind of porridge or strong paste or sticky dough made from cassava flour derived either directly from sun-dried root pieces or from fermented and dried pulp. *Fufu* is the most common cassava product consumed in Africa (Figure 1).

The *fufu* group include *amala* in Nigeria, *toh* in Guinea, *fufu* in Zaire, Congo, Cameroon and Gabon, *ugali* and *kowon* or *atap* in Uganda and Tanzania, *nchima* in Mozambique, *nsima* in Malawi, *ubugali* in Rwanda and *funge* in Angola.

Eba is a stiff paste prepared by soaking *gari* in hot water. *Gari* may also be eaten dry or it may be soaked in cold water to which sugar is added and drunk. *Gari* is steamed to prepare food called *attieke* in Côte d'Ivoire and Togo.

Eba is a very popular form of food in Nigeria and is gaining popularity in Cameroon, Bénin, Ghana, Liberia and Sierra Leone because of fast and easy reconstitution into a convenient food. These qualities will be of even greater importance as urbanization advances and life becomes busier in Africa.

Chickwangue is a very stiff paste or porridge, much stiffer than *fufu* and *eba*. The size, shape and texture of the *chickwangue* food group vary among countries. *Myondo* and *bobolo* in Cameroon are prepared in essentially the same way as *chickwangue*, although shapes and sizes are different, and thus belong to the *chickwangue* food group.

Chickwangue and its analogues are produced under more hygienic conditions and contain the least cyanide but they require more labor for processing and preparation than do the other foods prepared from cassava in Africa.

Cassava root based foods listed earlier are consumed with soup or stew without exception. The soup is essential in the food system in Africa because the carbohydrate from the cassava root is supplemented with protein when consumed with soups or stews. Soup made of cassava leaves is often eaten with cassava root based foods.

Urban growth is rapid in coastal Africa where more non-farm opportunities exist. Convenience and fast foods are increasingly being demanded by busy urban people.

Eba and *fufu* can be prepared quickly by stirring *gari* or cassava flour into hot water. However, a soup or stew is needed to eat *eba* or *fufu*. It takes more time to prepare a soup than to prepare *eba* or *fufu*. Therefore, a soup that can be prepared quickly and eaten with food such as *eba* or *fufu* needs to be developed for urban Africans.

Gari is the best form of cassava food in Africa. It has excellent shelf life, and is a relatively cheap carbohydrate, very convenient and fast to reconstitute and very hygienic. These characteristics are attractive to urban people.

7 Cassava leaves as vegetable

In some cultures, cassava leaves are also consumed as a most preferred green vegetable in most of cassava growing countries, particularly Zaire, Congo, Gabon, Central African Republic, Angola, Sierra Leone and Liberia. Thus, many traditional foods processed from cassava (both roots and leaves) may constitute the major part of the daily food needs of the family.

Cassava leaves prepared as a vegetable are called *sakasaka* or *pondu* in Zaire, Congo, Central African Republic and Sudan, *kizaka* in Angola, *mathapa* in Mozambique, *chigwada* in Malawi, *chombo* or *ngwada* in Zambia, *gwen* in Cameroon, *kisanbu* in Tanzania, *cassada leaves* in Sierra Leone, *banankou boulou nan* in Mali, *mafe haako bantare* in Guinea, and *isombe* in Rwanda. They are mostly served as a sauce which is eaten with *chickwangue*, *fufu* or boiled cassava. People in Zaire call manioc 'all sufficient' because "we get bread from the root and meat from the leaves".

Cassava shoots approximately 30 cm in length are harvested, the hard petioles removed, and the blades and young petioles pounded with a mortar and pestle. A variation of this process involves blanching the leaves before pounding. The resulting pulp is then boiled for about 30–60 minutes. In some countries, the water from the first boiling is decanted and replaced. Pepper, palm-oil and other aromatic ingredients are added. The mixture is boiled again for 30 minutes.

Unlike the roots which are essentially a source of carbohydrate, the leaves are a good source of protein and vitamins, which can provide a valuable supplement to predominantly starchy diets. Cassava leaves are rich in protein (26% on a dry weight basis), calcium, iron and vitamins, comparing favorably with other green vegetables generally regarded as good protein sources. The amino acid composition of cassava leaves shows that with the exception of methionine, the essential amino acid values in cassava leaves exceed those of the FAO reference protein.

The total essential amino acid content for cassava leaf protein is similar to that found in hen egg and greater than that of oat and rice grain, soybean seed and spinach leaf. While the vitamin content of the leaves is high, the preparation of the leaves for consumption can lead to large losses. Boiling, especially when prolonged, as is the case in the preparation of typical African soups or stews, results in considerable loss of vitamin C.

Residual cyanide in pounded cassava leaves *pondu* or *sakasaka* was found to be still high (8.6 mg/100 g) although 96% of the total cyanide in leaves was removed in the course of processing.

Research in national and international research institutes has focussed mostly on preharvest activities. It is expected that higher productivity will come from improved production technology. As a result, surpluses are anticipated that could lower farm prices of cassava products, with a consequent depressive effect on production.

To prevent this, production strategies need to include not only preharvest activities but also the postharvest aspects of processing, packaging, storage and utilization. Interest is growing among government functionaries and researchers in Africa in improvement of processing and utilization of cassava and development of new or alternative uses and products.

Rapid urbanization in tropical Africa, about twice the world average, increasing mobility in both rural and urban areas, and the changing roles and status of women have resulted in an unprecedented demand for convenience foods. It is therefore necessary to address the issues related to the needs of both producer and consumer (particularly future urban needs), to economic factors, and to nutritional values.

Improvement of the nutritional value of processed products will have to receive special attention by both policy makers and researchers in the future. Cassava is frequently denigrated because its roots are not high in protein. However, protein may be supplied from other sources, particularly legumes and cereals.

Fortification of cassava flour or *gari* with protein rich soyflour and cereals is feasible. Although such fortified products would be nutritionally better, the question is whether such products would be economic and acceptable to consumers.

Although cassava is regarded as a subsistence crop of low-income families or as a 'famine-reserve' crop, about 60% of the cassava output of households in the Oyo area of Nigeria (where yams and cereals have been the dominant staples and urban markets are located closely) is sold for processing (mostly into *gari)*, the rest being consumed at home.

A high proportion (50%) of cassava is also sold to food processors in the western region of Cameroon. This suggests that the role of cassava in these places is rapidly changing. This trend may extend to other parts of Africa in future. Also, where increasing population pressure and more intensive use of land has resulted in environmental degradation, cassava still assures a reasonable yield of high and cheap energy food.

The future of cassava depends much upon development of improved processing technologies that can increase labor productivity and of improved products that can meet the changing needs of urban people and on its suitability for alternative uses such as animal feeds and industrial raw material.

Also important are the overall ratings of different products to meet the expectations of producers, transporters and consumers (Table 2). While the future is bright, more quantitative information on post-harvest aspects of cassava culture in tropical Africa will help scientists focus their efforts to satisfy the many needs of both rural and urban dwellers.

Table 2. Subjective ratings of traditionally processed cassava products and final food in Africa based on selected features.

Cassava product	Shelf life	Transport-ability	HCN content	Ease of processing	Ease of preparation	Ease of utilization	Hygiene of processing	Overall rating
Peeled root boiled cassava	1.1	1.5	2.8	4.5	4.5	3.7	4.0	3.2
Flour/*fufu* (unfermented)	2.0	2.3	3.9	3.3	3.2	3.4	2.8	3.0
Flour/*fufu* (fermented)	2.9	3.2	3.9	2.9	3.0	3.5	2.8	3.6
Gari/eba	4.8	4.2	3.7	2.5	4.0	4.9	4.4	4.1
Wet pulp/ *chickwangue*	2.7	3.0	4.3	1.2	4.5	4.3	4.5	3.5

Subjective rating based on a scale of 1–5; 1 = lowest, 5 = highest. Figures are average ratings of 10 scientists working on cassava in Africa, except those for *chickwangue* which are average ratings of only six scientists.

The principal market in the future for increased cassava production is as livestock feed. Cassava has long been recognized by researchers in Africa as a suitable animal feed and it has been used as an important and cheap feed in many European countries. Both roots and leaves can be used as feed (Figure 10).

Cassava is one of the most drought tolerant crops and can be successfully grown on marginal soils, giving reasonable yields where many other crops cannot. Cassava production technologies have long been available and in use in Africa since the crop was introduced to the continent in the 16th century and it has attained the status of a traditional crop.

Figure 10. Cassava peelings need not be wasted; they can be fed to goats.

The African environment is very suitable for successful cassava production. Therefore, cassava offers tremendous potential as a cheap source of food energy for animals, provided it is well balanced with other nutrients. Currently, there is a great-deal of interest in supplementing feeding of animals with cassava in Africa.

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10 Suggestions for trainers

If you use this Research Guide in training:

Generally:

- Distribute handouts (including this Research Guide) to trainees one or several days before your presentation, or distribute them at the end of the presentation.

- Do not distribute handouts at the beginning of a presentation, otherwise trainees will read instead of listening to you.

- Ask trainees not to take notes, but to pay full attention to the training activity. Assure them that your handouts (and this Research Guide) contain all relevant information.

- Keep your training activities practical. Reduce theory to the minimum that is necessary to understand the practical exercises.

- Use the questions on page 4 (or a selection of questions) for examinations (quizzes, periodical tests, and so on). Allow consultation of handouts and books during examinations.

- Promote interaction of trainees. Allow questions, but do not deviate from the subject.

- Respect the time allotted.

Specifically:

- Discuss with trainees about the importance of cassava and cassava products at trainees' locations.

Ask trainees about their experiences and perceptions with regard to the content of this Research Guide as listed on page 5 (10 minutes).

- Present, discuss and demonstrate the content of this Research Guide, considering the study materials listed on page 3 (45 minutes).

  You may photocopy the diagrams and tables of the Research Guide on transparencies for projection with an overhead projector.

  Have real samples of cassava, cassava products, tools and equipment available so that each trainee can see, feel and taste. Show color slides of material and equipment that you cannot have available.

- Conduct demonstrations/practicals on the different processing methods in groups of 3–4 trainees per group (2 hours). Make sure that each trainee has the opportunity to practice. Have resource persons available for each group and practical. Keep trainees busy.

- Organize a lunch or dinner offering different cassava dishes.

- Conduct an informal survey with farmers, at markets, processing plants and so on to determine opportunities and constraints in cassava processing (½ day). You may assign different locations to different groups. Have resource persons available for each group. Ask groups to prepare, present, and discuss their findings.

International Institute of Tropical Agriculture (IITA)
Institut international d'agriculture tropicale (IITA)
Instituto Internacional de Agricultura Tropical (IITA)

The International Institute of Tropical Agriculture (IITA) is an international agricultural research center in the Consultative Group on International Agricultural Research (CGIAR), which is an association of about 50 countries, international and regional organizations, and private foundations. IITA seeks to increase agricultural production in a sustainable way, in order to improve the nutritional status and well-being of people in tropical sub-Saharan Africa. To achieve this goal, IITA conducts research and training, provides information, collects and exchanges germplasm, and encourages transfer of technology, in partnership with African national agricultural research and development programs.

L'Institut international d'agriculture tropicale (IITA) est un centre international de recherche agricole, membre du Groupe consultatif pour la recherche agricole internationale (GCRAI), une association regroupant quelque 50 pays, organisations internationales et régionales et fondations privées. L'IITA a pour objectif d'accroître durablement la production agricole, afin d'améliorer l'alimentation et le bien-être des populations de l'Afrique tropicale subsaharienne. Pour atteindre cet objectif, l'IITA mène des activités de recherche et de formation, divulgue des informations, réunit et échange du matériel génétique et encourage le transfert de technologies en collaboration avec les programmes nationaux africains de recherche et développement.

O Instituto Internacional de Agricultura Tropical (IITA) é um centro internacional de investigação agrícola pertencendo ao Grupo Consultivo para Investigação Agrícola Internacional (GCIAI), uma associação de cerca de 50 paises, organizações internacionais e regionais e fundações privadas. O IITA procura aumentar duravelmente a produção agrícola para melhorar a alimentação e o bem-estar das populações da Africa tropical ao sul do Sahara. Para alcançar esse objetivo, o IITA conduz actividades de investigação e treinamento, fornece informações, reúne e troca material genético e favorece a transferência de tecnologias en colaboração com os programas nacionais africanos de investigação e desenvolvimiento.

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