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Training Manual on Cassava Postharvest Processing and Equipment

Contributors

Okechukwu R, Tarawali G, Asumugha G, Dixon A, Dashiell K,
Udensi U, Rogers S, Adewale K, Oyebanji O, and Izuakor F.



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International address:
IITA, Grosvenor House,
125 High Street
Croydon CR0 9XP, UK

Headquarters:
PMB 5320, Oyo Road
Ibadan, Oyo State

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Cassava Processing

This manual is a guide on both small and large-scale processing of cassava into highly valuable products. As a food, cassava is consumed by more than 90% of people in Nigeria as a cheap source of dietary carbohydrates and energy in both fresh and processed food forms as well as a veritable source of cash income for both rural and urban dwellers. Cassava can be processed into livestock feed, industrial raw materials, and a wide range of food products.

Why cassava is processed

Cassava is processed for many reasons. These include:

- To increase shelf life of roots and prevent spoilage or food loss.
- To reduce bulkiness, ease transportation, and reduce transportation costs.
- To remove the toxic compounds in cassava.
- To create a variety of foods with acceptable taste, aroma, and texture.
- To improve palatability.
- To convert it into a readily utilizable industrial raw material.

Current research efforts on cassava in Nigeria aim at improving the nutritional and sensory qualities of cassava, reducing the time and labor involved in processing it, diversifying the utilization of the crop, minimizing the cost of processing, and enhancing the storage stability of the fresh roots.

Challenges to cassava processing in Nigeria

Manual operations

Some of the arduous and time consuming unit operations in cassava processing are currently done manually and, in some instances, mechanically. These include chipping, grating, dewatering, drying, sieving, toasting (as in gari production), and milling. Considerable progress has been made in mechanizing cassava processing in Nigeria and efficient cassava processing machines are readily available. Engineers/fabricators in the country's research institutes, universities, polytechnics, non-governmental agencies, other processing equipment fabricating establishments, and IITA are working very hard to achieve full mechanization of cassava processing.

Mechanical peeling & drying

Peeling and drying constitute challenges in cassava processing with the latter being a very serious problem, especially in the rainy season. Efficient cassava peeling machines are being produced in Nigeria.

High cost of energy

The high cost of diesel and the erratic and inadequate supply of electricity discourage processors from employing mechanical dryers for drying. The cost of operating the flash dryer is also high with the cost of diesel contributing very significantly. However, a substitute for diesel namely, black oil, has been developed and is being produced at IITA and NRCRI.

Shelf-life

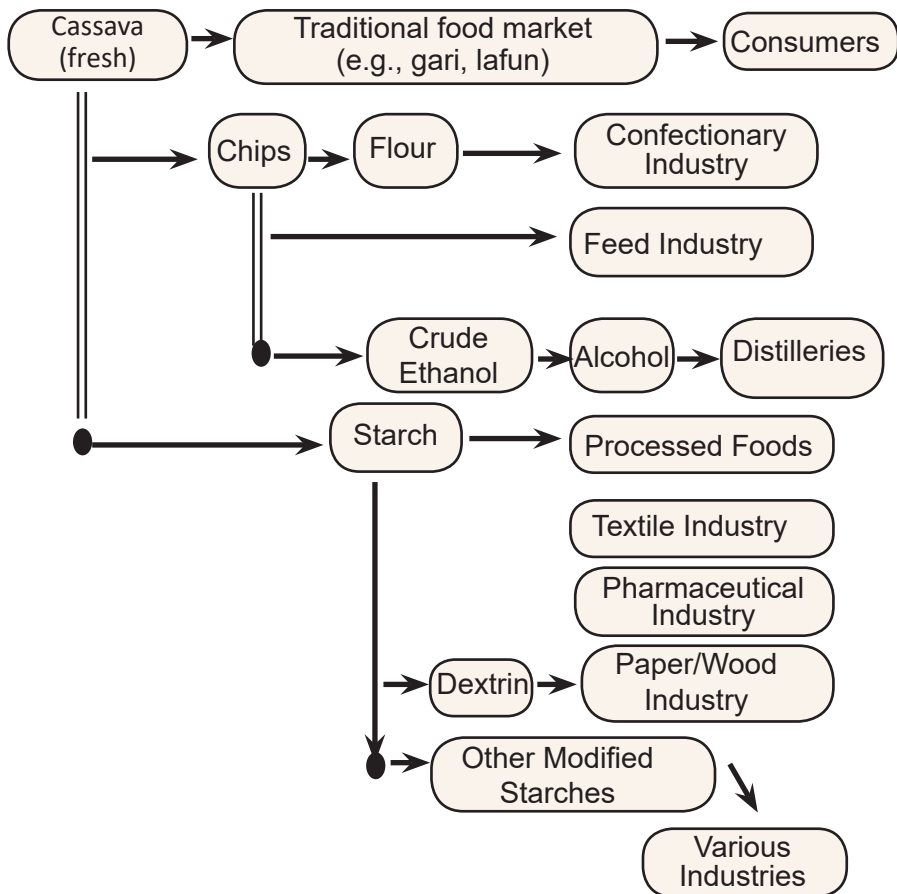
Fresh cassava roots cannot be stored for more than three days under ambient conditions. A technology has been developed for keeping

cassava roots fresh for three months after harvest by using moist sawdust. Also, efforts are being made to develop cassava varieties with delayed postharvest physiology deterioration (PPD).

Cassava Products

Cassava is used fresh and processed as food, and as an income generating enterprise. The most important food into which cassava is converted is a granular free-flowing product called *gari*. Traditional processes of producing *gari* from cassava roots are well documented. Other food forms processed from cassava roots include odorless cassava *fufu*, flour, *lafun*, *abacha*, *nsisa*, *akpu*, *fufu*, *starch* and *tapioca* (produced from starch), and high quality cassava flour (HQCF). HQCF has been produced for composite cassava products in the proportion of 20% cassava: 80% wheat for making bread and other confectionery (chin-chin, bread, meat/fish pies/rolls, strips; sausage rolls queen cakes, biscuits, doughnuts, buns, fritters, and croquettes). Salad cream has also been produced from cassava starch.

Very few entrepreneurs are currently producing odorless *fufu* flour, *lafun*, and starch at a commercial scale using semi-mechanized processes. Cassava root is also processed into cassava root meal (CRM) containing more than 65% starch and safe levels of cyanide (less than 50 mg/kg). CRM has been used as a substitute for maize at 50% to produce layers and 70% for broilers. This product is pelletized to reduce insect infestation and mold for export. Cassava chips are also being produced for export. Appropriate technologies are being developed for processing cassava peel, leaves, and stems into forms they can be used in livestock feeds. The most important secondary product into which cassava roots are processed in Nigeria is starch. The starch is further processed into ethanol, but this activity is at a very low level presently. Cassava flour is also used for ethanol production.



Market Chain for Industrial Cassava Products (Knipscheer et al. 2007).

Intensive and extensive research in processing of cassava is currently taking place in Nigeria. Food scientists are diversifying utilization of cassava, Animal scientists are exploiting cassava waste/residue for livestock feed formulation, and Engineers are designing and fabricating processing equipment (low-cost and manually operated) suitable for use at farm gate level. Appropriate packaging is being developed for extension of shelf-life and marketing of processed cassava products. Recipes have been developed for various cassava products.

Operations in cassava processing

There are many operations involved in processing cassava. These operations include peeling, washing, size reduction, drying, fermenting, cooking by steaming, roasting, frying, etc. These processing operations are combined in different sequences to make different products such as granules, dried chips/flour, pastes, fermented starch, etc.

Peeling

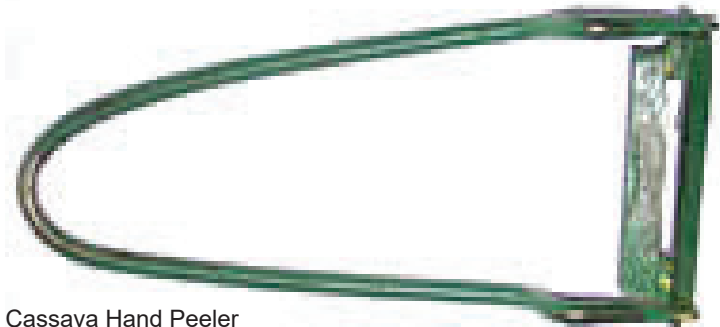
Cassava is peeled to improve the quality and safety of cassava foods. Nearly all cassava products are made by first peeling the roots, and this can be done manually or mechanically

Challenges of peeling

Peeling is labor intensive, slow, and is done manually mostly by women. A woman may peel 20–25 kg roots in one hour and peeling loss could be between 22 and 30%. Mechanical peelers are now available in countries such as Brazil, DRC, and Nigeria. Peelers that both peel and wash cassava are also available. Mechanical peelers in Nigeria, although they are still being improved, can peel between 600 and 800 kg roots per hour, removing 60–90% of the peel. Efforts are ongoing to reduce the high (up to 30%) peeling loss for some of the designs. Some mechanical peelers (and graters) in Nigeria are mobile. The machines are transported with power tillers or tricycles to the farm or remote villages to carry out two or three processing operations—peeling, grating, and pressing—at the farm gate. This approach can eliminate transportation of bulky, fresh roots over long distances before processing and can reduce the cost of the processing operation by nearly 50%. It can significantly increase access of farmers in remote villages to mechanical processing machines and increase the amount of processed products produced by such farmers.



Mechanical Cassava peeler



Cassava Hand Peeler



Cassava Factory Peeler

Size reduction

Size reduction facilitates detoxification and drying of cassava and is mostly by chipping, slicing, and grating. Grating is widely used for making gari, starch, flour, and some other products. Manual grating is labor intensive and exposes the women processors to injuries. Grating is very efficient in hydrolyzing more than 95% of the toxic compounds within 3 h after which the compounds can be almost entirely removed by dewatering. Chipping, although a new technique compared to grating, is used for making dried chips that could be milled to flour if a low cyanide cassava variety is processed or for making animal feed from any cassava variety. Commercial mechanical chippers and graters could process 2–3 tons of fresh roots per hour, significantly reducing labor inputs and saving time for women.



Grating machines



Mobile grater in Niger Delta states via IITA-CEDP.

Dewatering

Dewatering or removal of water facilitates drying of fermented or fresh cassava mash.

Processed cassava is dewatered during making of gari, high quality flour, starch, fufu, etc. Traditional methods of dewatering cassava with heavy stones and logs are dangerous, labor intensive, and slow. Mechanized single-screw, double-screw, hydraulic, and double basket presses have replaced traditional methods.

There are ongoing research efforts at IITA and some Nigerian research institutions and universities to develop machines that will grate and dewater cassava in a single operation.



Automatic Cassava Hydraulic Press.

Drying

Cassava is traditionally dried to increase storability. Roots are dried to 12–14% moisture before storage. The most common traditional method of drying cassava is sun-drying

(sun-heat and wind) on the ground in the farm, road-side, around the homestead, on roof tops, etc. Sometimes the roots are dried on-top of cooking places in the homes.

These methods are prone to microbial contamination, infestation by insects, and are slow, especially during the rainy season when drying could take 2–3 weeks. These promote

poor quality and insect infestation. The poor quality of the product (discolored, changed taste, offensive smell, etc.) lead to poor market acceptability and low prices. An improvement to this is the drying of cassava on raised platforms on black polyethylene sheets.

For large-scale processing, mechanical drying of cassava is the most suitable. It hastens the drying operation, saving time, preventing insect infestation, and preserving color, taste, and smell. Many types of mechanical cassava dryer are now available, including cabinet, rotary, tunnel, solar, and flash dryers. Sources of heat energy for dryers are electricity, sun, wood charcoal, gas, diesel, etc. Some of the factors that increase the profitability of cassava drying operations are: Use of dryers with the appropriate drying capacity, high drying efficiency through low energy-use, low fuel consumption, or low heat loss. Cabinet and rotary dryers using charcoal, wood, or agricultural waste are being tested in Nigeria, Ghana, Madagascar, Tanzania, and Zambia. Flash dryers are used for large-volume, rapid drying of cassava starch, fermented pulp (fufu), grated and pressed cassava into flour, etc. The amount of roots that can be sourced should be considered when choosing a dryer. Drying capacity excessively higher than available cassava roots would be wasteful and might make the drying operation too expensive, reducing profitability.



Flash Dryer.



Cabinet Dryer.



Milling

Milling involves dried cassava chips, chunks, or *mashare* mostly being made into flour for home or industrial use. The traditional method of milling dried cassava for home use is pounding and sieving. The method is labor intensive and slow. Milling machines for grain and other crops are very common and are used for milling cassava. The appropriate fineness of milled cassava depends on its final use. Cassava for animal feed should be roughly milled, flour for home use needs to be fine, while the flour for bread baking and starch must be very fine.



Hammer Mill.



Milling Machine.

Gari frying

Gari is made by roasting or frying cassava granules until cooked and dried. The traditional frying method exposes women to heat, smoke, and possible inhalation of free cyanide. Mechanical fryers such as the Automatic Gari Fryer reduce these risks and increase gari output. Both frying and toasting enhance the flavor of the root crop and, most importantly, its shelf life.



Traditional gari frying method.



Improved gari frying (Courtesy CEDP).



Automatic Gari Fryer.



White & Yellow Gari.

Packaging and storage

Cassava products, fermented or unfermented chips, flour, starch, etc. are hygroscopic. The moisture absorbed from the atmosphere promotes mold growth and spoilage. The growth of mycotoxigenic fungi such as *Aspergillus flavus* may increase the risk of mycotoxin contamination of moldy cassava products. The traditional methods of storing dried cassava exposed it to the moisture in the atmosphere in porous bags, on the floor, or in the attic. The methods are not effective against moisture absorption, mold growth, and insect damage. *Prostephanus truncatus* (Horn), *Dinoderus minutus*, and *Tribolium* sp. are the common insects that damage dried cassava. Proper packaging and appropriate storage conditions will preserve quality characteristics and shelf life of cassava products. Packaging materials and storage conditions to be used for cassava products must prevent the products from reabsorbing moisture, and should avoid infestation by pest insects. Polyethylene bags, paper, or polypropylene bags lined with polyethylene are suitable for packaging of cassava products.



Highlights

Traditional processing techniques are laborious, time wasting, and may result in poor products. Mechanization of cassava processing can solve these constraints of cassava processing. The choice of machines for making a cassava product depends on the unit operations involved in its production process. Machine capacity should be selected based on quantity of roots available or that can be sourced, while packaging and storage systems should aim at preventing processed cassava products from reabsorbing moisture, mold growth, and infestation by spoilage insects.

Conclusion

For processing of cassava, improved mechanized processing methods are preferred to the traditional processing techniques, which are labor and time wasting, and may not guarantee quality and safety. The use of efficient and low-cost machinery and packaging systems can guarantee the demand for the products high profitability for the processor.

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