Processing of sweet and bitter cassava

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Brazilian Agricultural Research Corporation
Embrapa Cassava & Fruits
Ministry of Agriculture, Livestock and Food Supply

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Foreword

Cassava production chain is of great importance within the national context, at different levels of producers. The *Recôncavo Baiano* region, where Embrapa Cassava & Fruits is located, has a large number of family farmers who grow cassava.

Sweet cassava, also known as *aipim*, is marketed as a fresh or minimally processed, chilled, frozen or precooked (in pieces or sticks) vegetable, either mashed, as chips or dumplings. Bitter cassava, named due to its high content of cyanogenic compounds in the root, is used as a raw material for producing flour, beijus, tapioca, and other products.

The knowledge and professionalization of family farmers are fundamental components in increasing the possibility of improving the income of these families. For this purpose, we present the book “Processing of sweet and bitter cassava”, which includes each stage of elaboration for the steps of making different cassava products.

Alberto Duarte Vilarinhos

General Head of Embrapa Cassava & Fruits

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Harvest and postharvest of cassava

Harvest

Determining the time for harvesting cassava can be difficult as, being a root, it does not have a defined maturation period. However, knowing the most favorable period for harvesting is important, because when the roots are harvested too early, there is a reduction in size and yield. On the other hand, when harvested late, there can be a loss of quality due to the development of fibrous roots and reduced starch content.

The beginning of cassava harvest depends on factors such as:

a) Cultivation cycle (varieties): early cultivars (which can be harvested earlier) allow harvesting from 9 to 12 months; in semi-early cultivars harvesting can be done from 14 to 16 months; and in late cultivars the harvest occurs from 18 to 20 months after planting;

b) Events observed during growth: for example, pests or diseases and level of weed infestation that anticipate or delay the harvest;

c) Planting density: studies show that planting at low densities (larger spacing) can result in early growth of commercial roots;

d) Planting method: planting in pits, ridges or mounds can result in storage roots that develop more superficially, thus facilitating harvest; which does not happen when planted in furrows;

e) Soil and climate conditions: these determine the ease or difficulty of uprooting plants. Harvesting is facilitated when the soil is moist, but not soaked. In clay soils, soaking can difficult root removal, as well as its quality.

Cassava harvest in the *Recôncavo Baiano* region is basically manual and/or aided by manual implements. The process is divided in two stages: a) Shoot pruning, at a height of 20 cm to 30 cm above ground level; and b) root removal, with the help of tools, depending on the moisture conditions and/or soil characteristics (Figure 1).

The period between pruning and uprooting should be as short as possible, since after pruning, the root starch is used as an energy source for the formation of the shoots (new sprouts), causing a reduction in the starch yield.

After uprooting or harvesting, the roots should be kept in the shade to facilitate the collection for transport. They should also be removed from the field no longer than 24 hours after, to prevent the darkening of the roots, called physiological and/or microbial deterioration. It is recommended to place the roots (especially those of commercial value) in boxes, or if they are heaped on top of each other, to make low mounds to prevent bruising and darkening. The transport of the roots from the field to their destination can be done using baskets, boxes, sacks, wooden crates, or others.

Photos: Zara Maria Fernandes da Costa

Figure 1. Manual cassava harvesting procedures. Pruning of the shoots before harvest (A) and (B), root removal (C) and root separation (D).

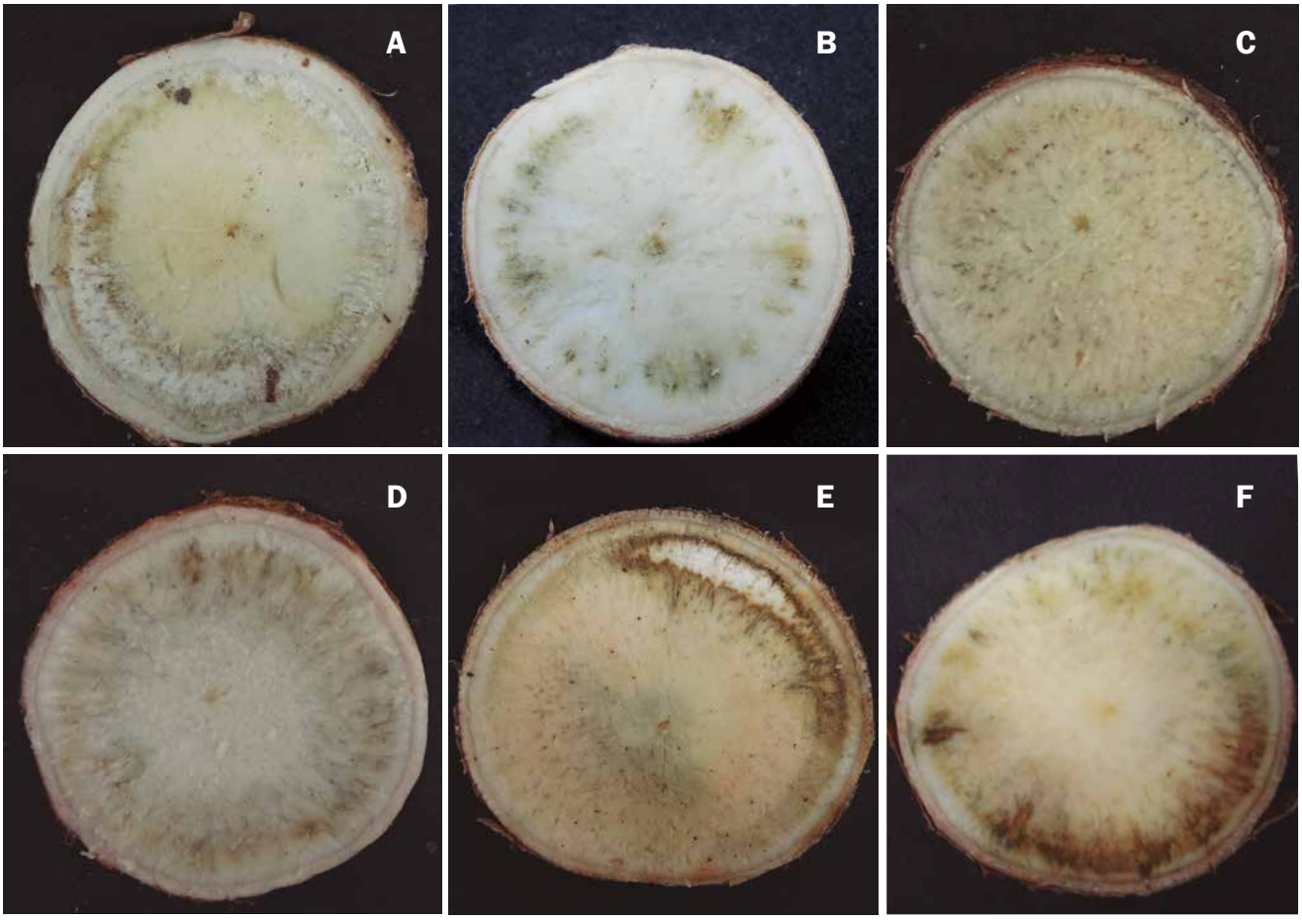
Postharvest

Postharvest deterioration

Cassava roots are very perishable and therefore have a short shelf life, which can cause high losses and difficulties to sell and use in more distant markets.

Postharvest physiological deterioration (PPD) of cassava is responsible for root fragility and is divided in physiological or primary deterioration (browning) and microbial or secondary deterioration (rotting).

Physiological deterioration occurs from 24 to 72 hours after harvest and the symptoms are dark streaks, slightly bluish along the entire root (Figure 2). When physiological deterioration becomes more severe, the roots may show symptoms of desiccation (white and dry sections).



Photos: Fabiana Sasaki

Figure 2. Symptoms of postharvest physiological (primary) deterioration in cassava roots.

Microbiological deterioration usually occurs after physiological deterioration and shows the first symptoms 5 to 7 days after harvest. These are characterized by internal browning, appearance of dark streaks, moist rot with softening of the tissues, alteration and fermentation of the roots with an unpleasant flavor and odor (Figure 3).

Several factors such as mechanical damage, temperature, humidity, atmospheric composition, stresses and preharvest factors influence physiological deterioration. Mechanical damage (bruises) caused during harvesting, handling and transport are the most important causes of physiological deterioration, in addition to facilitating the entry and development of microorganisms that can cause microbial deterioration (Figure 4). Temperatures between 20° C and 30° C and relative humidity between 65% and 80% favor the onset of physiological deterioration. Reducing the temperature to ranges around 5° C and increasing relative humidity (above 85%) may delay the appearance of deterioration symptoms.

Photos: Fabiana Sasaki

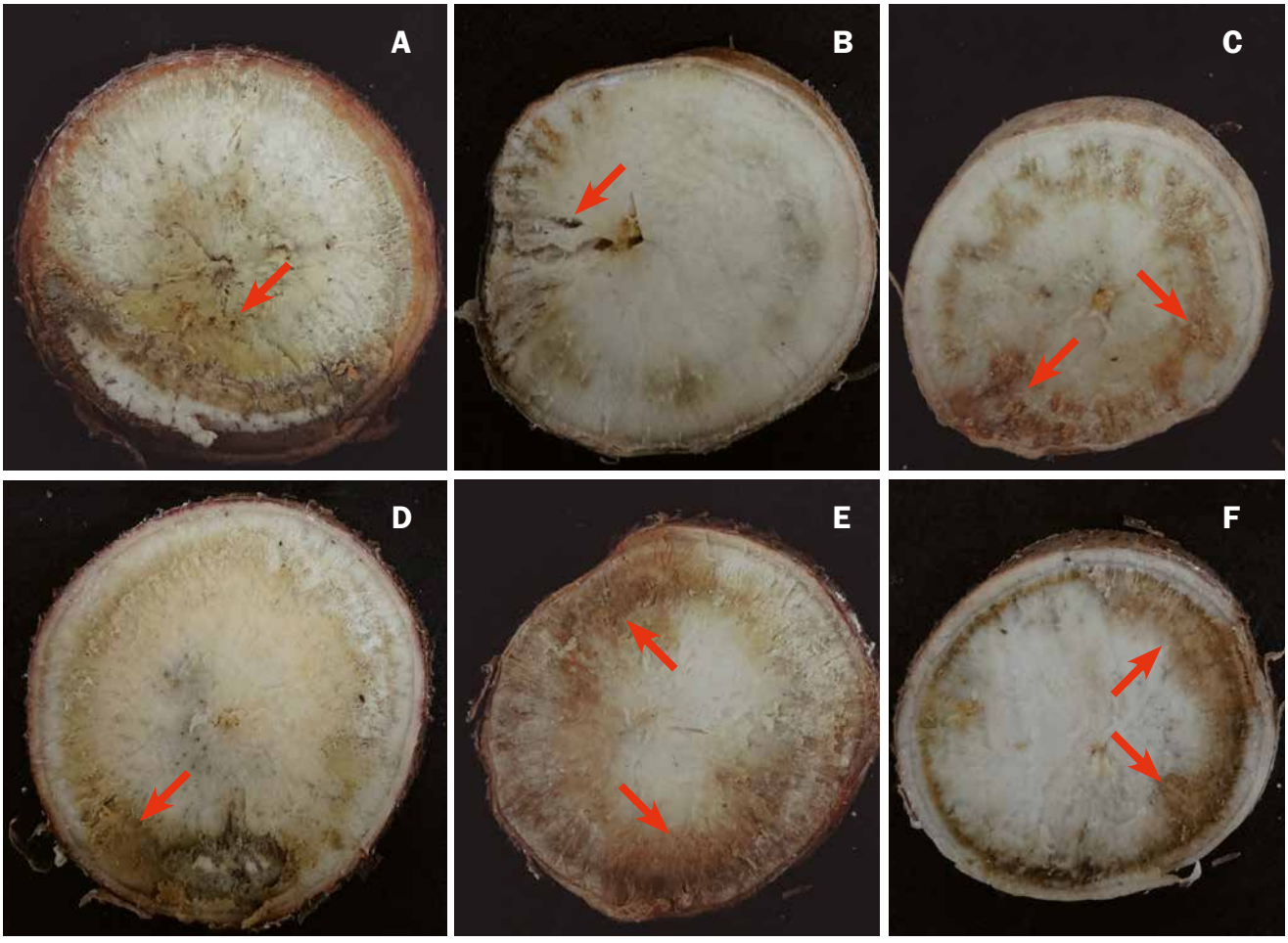


Figure 3. Symptoms of microbial (secondary) deterioration in cassava roots (red arrows).

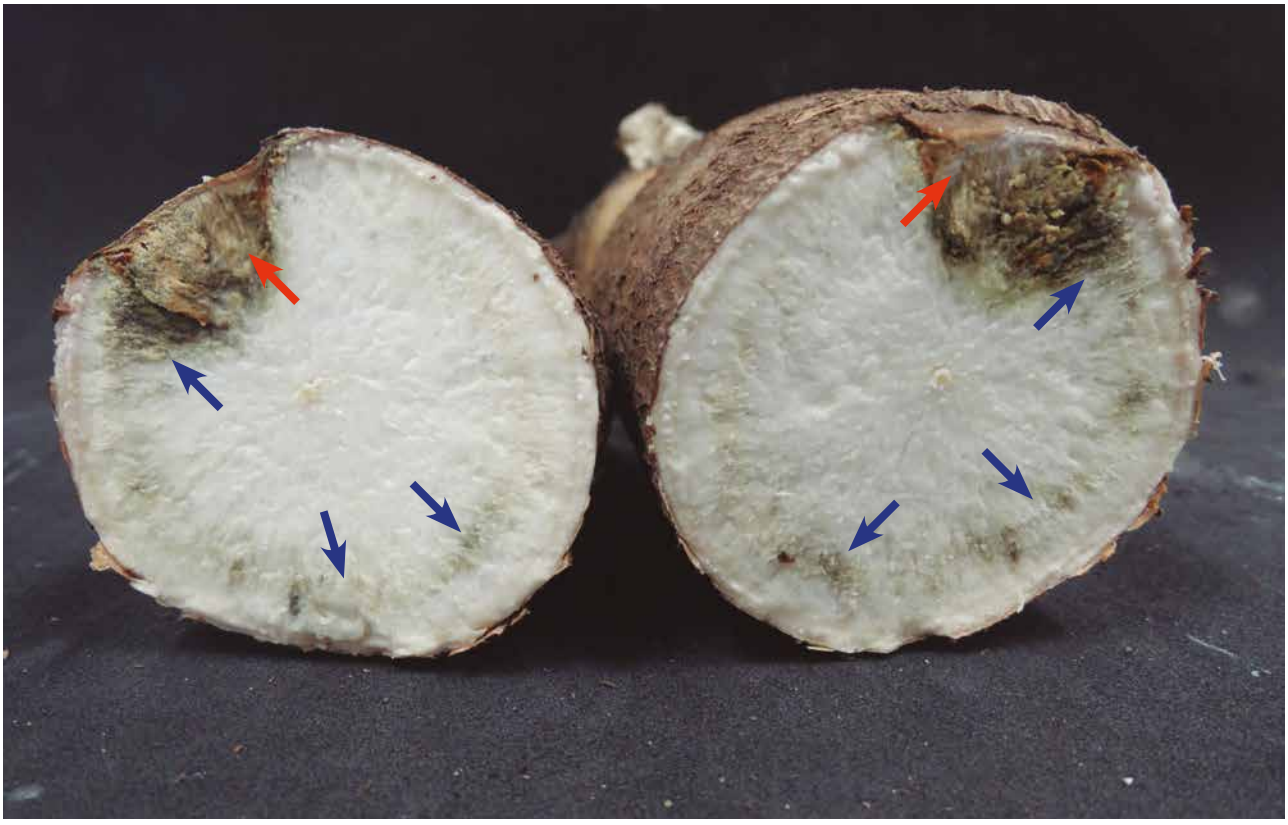


Photo: Fabiana Sasaki

Figure 4. Physiological (blue arrows) and microbial (red arrows) deterioration due to mechanical damage to the skin during harvest.

Among the preharvest factors, in practice, pruning of plants up to two days before harvest contributes to reduce physiological deterioration, as plants redirect the substances that would be used in the darkening reaction, to form hormones necessary for the development of the aerial parts. It should be noted that the shorter the period of time between pruning and uprooting, the lesser the starch loss.

The darkening caused by physiological deterioration is an important factor that should be considered in root processing. After processing and peeling, the physiological deterioration begins more intensely, but can prevented by soaking the roots in water, applying antioxidant treatments (e.g. by soaking in diluted citric or ascorbic acid) and/or bleaching (mild heat treatment).

Cassava postharvest storage

In addition to maintaining roots in the soil, another efficient postharvest method for the conservation of cassava is the application of paraffin (material used in candle production) to the roots (Figure 5). In Brazil, the Brazilian Health Regulatory Agency (Anvisa, as per its name in Portuguese) allows its use and does not limit the use of synthetic paraffin and its derivatives as an excipient, binding or coating agent (RDC Nº. 122 of June 19, 2001).

Paraffin reduces oxygen access, reducing pulp browning and the loss of root moisture. To be efficient, the use of paraffin on the roots must be done on roots harvested up to 24 hours prior to application. It is important that the roots have minimal mechanical damage and are washed, sanitized (200 mg active chlorine per liter of water) and dried. The application can be performed on the entire root or only on the extremities. Paraffinized sweet cassava roots can be stored for up to six days at room temperature.

Polyethylene plastic packages have also been used to reduce the speed of browning in sweet cassava roots due to physiological deterioration, as these packages serve as barriers to gas exchange, providing a lower concentration of oxygen and a higher concentration of carbon dioxide, and maintain a higher level of humidity. Vacuum packaging has also been used for this purpose. Due to the high humidity inside the packages, care must be taken with the proliferation of microorganisms in the roots. This type of technique is most effective when used in conjunction with refrigeration.

Photo: Fabiana Sasaki

Figure 5. Paraffin-coated sweet cassava root for postharvest storage.

Refrigeration is the most used technology for postharvest storage of vegetables, as it reduces the products metabolism and microorganisms growth, allowing for its use as an option for conservation of sweet cassava roots. Sweet cassava can be stored at 0° C to 5° C, though a temperature of 3° C has been reported as being the ideal for fresh root storage for up to 4 weeks. Roots exposed to temperatures above 4° C develop symptoms of deterioration faster.

Minimal processing of sweet cassava

One option for conserving and adding value to fresh sweet cassava roots is minimal processing. This practice has emerged due to consumer demand for easily prepared and more convenient products, and presents a solution to increase the shelf life of sweet cassava roots.

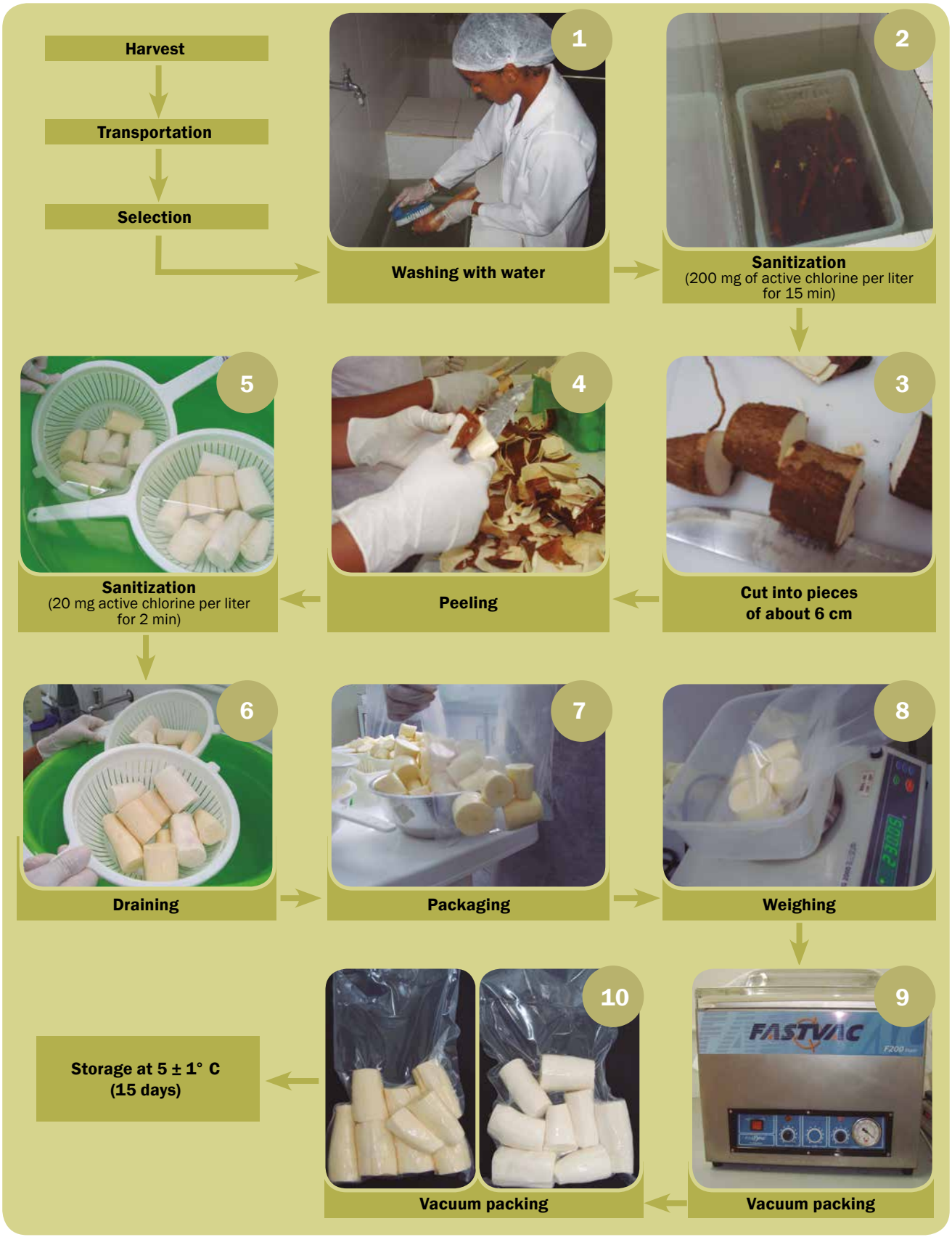
Minimal processing consists of peeling, washing, cutting, sanitizing, packaging and refrigerated storage roots (Figure 6), making them more convenient for consumption.

However, minimal processing must be undertaken with caution, as the peeling and cutting stages damage the tissues and accelerate enzymatic browning reactions, as well as increasing water loss. Taking care of the product's hygiene and sanitization are crucial factors, as the peeling of the roots results in a loss of their natural protection by exposing the pulp, which contains nutrients for the development of microorganisms, in turn causing a reduction of the product's shelf life and, in some cases, may be harmful to the consumers' health.

All processing should be performed in a cold environment (10° C to 15° C). If this is not possible, at least the water used for the processing of the sweet cassava should be around 5° C to 10° C, to reduce root metabolism.

Minimal processing should be undertaken in a clean and hygienic environment, in compliance with legislation and good manufacturing practices.

Ergarding microbiological analysis, minimally processed sweet cassava must comply with the Anvisa, RDC 12 standards published on January 2, 2001, which regulates microbiological standards for food.



Photos: Jaciene Lopes de Jesus (1) e Eliseth de Souza Viana (2 to 10)

Figure 6. Flowchart of minimal processing of sweet cassava.
Source: Viana et al. (2010).

Good manufacturing practices

The quality of cassava products depends on the quality of the raw material that must be properly cultivated, harvested, stored and transported before reaching the processing facilities. Therefore, quality control must begin in the field, continue throughout the agrobusiness, be maintained in the distribution and commercialization phases of the finished product, and end at the final consumer's table.

The Good Manufacturing Practices (GMP) cover a set of measures that must be adopted **by food processing industries** in order to **ensure the sanitary quality** and **compliance of food with the appropriate technical regulations**.

Federal sanitary legislation regulates these measures in general, and is applicable to all types of food and food service industries, and is also specifically aimed at industries that process certain types of food.

State and Municipal sanitary surveillance services are responsible for establishing complementary rules, in order to cover sanitary aspects that are more specific to their local realities, always without contradicting federal norms. Information on the main federal legislations of this topic can be seen below:

- Federal Ordinance SVS 1428/1993: precursor in the regulation of this topic. Provides guidelines for the establishment of Manufacturing and Service Good Practices in the area of food.
- Federal Ordinance SVS 326 / (30-Jul-1997) – Ministry of Health: general requirements on hygienic-sanitary conditions and Good Manufacturing Practices for food producing / industrializing establishments.
- Federal Ordinance MA 368 / (04-Sep-1997) – Ministry of Agriculture, Livestock and Food Supply - MAPA: "Sanitary Hygienic Conditions and Good Manufacturing Practices for Manufacturers and Industrializers of Food".
- Anvisa RDC Resolution Nº. 275/2002 – POPs: created to update general legislation by introducing continuous control of Good Manufacturing Practices and Standard Operating Procedures.

Hygiene of the environment, equipment and utensils

Hygiene is extremely important as it will ensure the safety and quality of the processed products. The procedure has two steps: cleaning and sanitation that must conform to the establishment's rules and frequency.

- **Cleaning:** removal of undesirable organic substances and minerals, such as food scraps, dirt, dust and grease present in the raw material, on the hands of handlers, the environment, the equipment and utensils (e.g. boards, knives, containers, etc.);

- **Sanitation or sanitization:** reducing the number of microorganisms still present on surfaces after cleaning. This step cannot be done without prior cleaning.

Cleaning can be undertaken by the combination, or not, of physical methods such as brushes and bushings with chemical agents, such as the use of detergents.

Bushings used for cleaning must be resistant and must not release debris or splinters.

Cleaning products must be stored in an organized, clean area, separate from the food products.

Cleaning and sanitizing products must be registered with the Ministry of Health, in order to be compliant with current legislation. Users of these products must pay attention to the manufacturer's recommendations to avoid misuse, waste, inactivation of active ingredients and accidents. Chemical products should not be used during food handling and must be properly identified.

There is a logical sequence to the cleaning process of facilities and equipment:

- **Step 1: Prewashing**

  At this stage, all equipment and utensils, walls and floors are pre-rinsed with potable water, preferably at temperature of approximately 40° C. This step is responsible for removing about 90% of all visible dirt.

- **Step 2: Washing with a neutral detergent**

  Scrub the countertops, detachable and non-detachable parts of the equipment and utensils with a sponge soaked in detergent solution. The dilution of detergent in potable water should be performed according to the manufacturer's instructions on the product label.

- **Step 3: Rinsing**

  Rinse, preferably with warm water, to remove residue and the detergent applied.

- **Step 4: Sanitization**

  This step can be performed with a room temperature solution of sodium hypochlorite at 100 mg per liter (for immersion) or 200 mg per liter (for spray). Example: to prepare one liter of chlorinated solution at a concentration of 200 mg per liter, use one tablespoon of sodium hypochlorite (with 2% chlorine) to one liter of water

or 100 mL of sodium hypochlorite (with 2% chlorine) to 10L of clean water. The immersed or sprayed materials should remain in contact with this solution for 15 min. After contact, rinse all parts thoroughly with water. This step aims to significantly reduce the number of deteriorating microorganisms and eliminate pathogens (disease-causing).

Agribusiness facilities

Where and how the agribusiness facility should be

Choosing the right location for the construction of a bitter and sweet cassava processing unit is step and should be taken into careful consideration. The chosen location should be within close physical proximity of the major suppliers of raw materials, as long-distance transportation increases freight cost and can compromise business.

The agribusiness facility should not be located near polluted environments such as garbage dumps or businesses with toxic soil and air activities, such as animal breeding and mining, as they pose a serious threat to food contamination. It is essential the agribusiness facilities are in locations with abundant water sources of their own, nor can they be in areas prone to flooding, pest infestations and ones that present difficulties in the removal of garbage.

Equipment layout and activity flow

The layout of equipment and flow of activities should allow for good hygiene practices within the agribusiness facility, in order to avoid cross contamination as much as possible. Cross contamination can be generated by improper contact of contaminated raw materials, surfaces, equipment, utensils, people or packaging. Contaminants are biological (eg. bacteria, fungi), chemical (eg. disinfectant residues) or physical (eg. metal fragments, nails, pieces of equipment) in their origin, and may be harmful to consumers' health.

To minimize cross contamination, there must be a proper separation of activities and the use of a continuous processing flow, from the reception of the raw material to the final product. The reception and washing areas for fresh roots must be separate from the internal processing areas.

It is recommended that the agribusiness facility have a sanitization area at its entrance, where employees can properly clean their hands and boots. There should be hand washing stations inside the processing area.

Technical specifications of the construction finishing materials

Roof

Agribusiness facility roofs should be smooth, well maintained and easy to clean. When it is not possible to build a roof slabs, the use of PVC roof is recommended, as long as they are kept in good condition, free of mold and openings. Between the walls and roofs there should be no openings that allow the entry of pests such as cockroaches, flies, birds and rats.

Lighting

Lighting, when artificial, should not have coloration that visibly alters the appearance of products or produces shadows on the work area.

The size of electrical installations must take into consideration the use of all equipment installed at the same time and must only be done by qualified professionals who comply with the existing Brazilian technical standards. Lamps must have safety systems to prevent explosions and accidental falls and must not be installed above the root processing work area.

Floor

Floors must be anti-slip, waterproof, washable, resistant to traffic and corrosion and must have a suitable sloping for water drainage.

The drains must allow for easy cleaning, be siphoned and have a closing mechanism. The grooves must be smooth and have rounded corners for easy cleaning, as well as an adequate sloping angle.

Processing area walls

Walls should be smooth, light in color, durable, waterproof and resistant to frequent cleaning. It is recommended to coat them in ceramic up to 2 meters high, with white cement grout. Uncoated walls should be painted with light, washable paint and anti-mold.

Angles between floors, walls and ceilings should be rounded.

Windows and doors

Windows and doors must be resistant to the cleaning process and allow maximum use of natural light and ventilation.

Doors in contact with the facility's external area must be very secure, as internal doors will only serve to divide sectors.

Windows must have aluminum frames. All tilting windows must be protected externally by a plastic screen to prevent flying insects and other pests, such as cockroaches and rats.

The plastic screens must be placed on a box-shaped aluminum structure, the dimensions of which must be 10 cm larger than the installed windows, and with a depth of 20 cm to allow its opening. The profiles should be installed with thumbscrews or other easily removed mechanisms to facilitate the maintenance and cleaning of windows and external eaves.

Toilets and changing rooms

Toilets and changing rooms should not have direct communication with production areas and should have self-closing external doors. They must be well ventilated, clean at all times and equipped with a foot-operated sink. They should also be equipped with hand sanitizing products and paper towels for drying. Toilets should have efficient flushing systems, toilet paper and trash can with a foot pedal and inner plastic bag.

Employees must be instructed on the obligation and correct way of washing hands after using the facilities.

Equipment

The equipment must be made of anti-corrosive material, easy to clean and inert, which does not transmit odors, flavors, or toxic substances to the food. The installation must be undertaken in a way that allows the easy maintenance and hygiene and facilitate good manufacturing practices. The equipment should be capable of disassembly, to allow maintenance, cleaning, sanitation and to verify the occurrence of a possible pest infestation. They must be kept in a good state of conservation to prevent contamination of the product by physical hazards such as metal particles, plastic chips and surface peeling.

Water supply

Production areas must have sufficient drinking water supply. To ensure water quality, it should be stored in a clean and closed container. Therefore, water deposits such as boxes, tanks and others must remain covered. Water reservoirs should be cleaned at the following times: after completion of construction or any repairs; scheduled cleaning, every six months, and whenever contamination is suspected.

Facility waste

The waste area must be isolated and exclusive for this purpose. Separate collection is advised to facilitate waste collection and possible recycling. The facility can also take advantage of the root peels for animal feed and the cassava wastewater (“manipueira”), if treated, can be used for irrigation. Waste should be removed from the facility daily, as often as needed.

External facility area

Animals and pests must not be within or in the surrounding area of the facility. Even pets such as dogs, cats and birds should be kept away. To prevent these animals from accessing the facility, a wall or fence should be installed. Backyards and areas near the flour houses should be kept clean and monitored for insects, rats, spiders and webs. It is recommended to have grass outside of the facility to reduce the amount of dust going inside.

Measures to prevent contamination

The role of people who prepare food goes far beyond the concern in offering beautiful and tasteful products. It also plays an important social role, which is to contribute to the preservation of the food quality provided to the establishment's customers. People are considered one of the main sources of contamination due to their handling of food during all of the production chain stages. Therefore, it is important to be aware of proper personal hygiene, as the simple contact of unhygienic hands with food or food processing equipment may be enough to transmit various types of microorganisms to the food. For this reason, health conditions and hygienic habits are fundamental factors that must be analyzed in order to avoid possible contamination of raw materials and equipment.

Handlers can contaminate food when:

- they are diagnosed with having foodborne diseases.
- show symptoms of gastrointestinal disease.
- have infected lesions.
- touch anywhere that may contaminate their hands.
- have poor hygiene habits.

Asymptomatic carriers are apparently healthy people who are hosts to dangerous microorganisms, but do not show any symptoms of disease. However, they can contaminate the food and the environment in which they work.

All persons who come into contact with the process, raw materials, packaging materials, products, equipment and utensils should be made aware of product hygiene and safety measures to protect food from physical, chemical and microbiological contamination.

Some basic rules to be followed:

a) Use of uniforms

All employees involved in food processing must wear fully closed and waterproof plastic boots, hat, shirt and pants without pockets and aprons, all light in color, preferably white. Bracelets, earrings, rings, wedding rings, necklaces, nail polish and lipstick must all be removed before starting work.

Uniforms should be changed daily. Pants and shirts must be made of cotton fabric, and shirts must not have pockets. They should be comfortable to facilitate the necessary movement of the arms and legs while performing activities.

- Aprons: should be made of cloth, when the activity performed does not include the use of water, or rubber, when water is used.
- Shoes or boots: shoes should be closed and boots should be white and made of rubber.
- Net or cap: has the function of keeping the hair of the handlers trapped and preventing it from falling on food. They must be disposable or of the same fabric as the uniforms. Hair should always be clean, combed and tied.

b) Hand and forearm hygiene

Hands and forearms can transfer microorganisms from the intestine, mouth, nose, skin, etc. Therefore, anyone working in the food handling area must wash their hands frequently and carefully with authorized cleaning detergents and potable water. Washing and sanitizing must be performed whenever work is started; after eating, smoking or touching any part of the body; after dealing with garbage or dirty containers; after using the toilet; after working with unclean or raw food and every time the employee returns to their work station from anywhere else.

Hand washing should follow these steps:

- Moisten hands and forearms with water (prerinse);
- Use neutral, fragrance-free liquid soap on hands and wash them against each other, focusing on the sections between fingers and the lines of the palms. Antiseptic liquid soap may be used, in which case hands and forearms should be massaged for at least one minute;
- Rinse hands and forearms well;
- Dry with non-recycled disposable paper towels or hot air;
- Apply antiseptic solution (e.g. 70% alcohol).

The use of gloves is not expressly required by federal health legislation. If employees choose to wear them, they must abide by their conditions of hygiene and cleanliness. Wearing gloves does not release the handler of the obligation of washing hands thoroughly. In addition, gloves can cause sweat and loss of touch. However, if the employee has hand injuries and cannot be replaced, wearing gloves is recommended and necessary. In this case, glove change should be monitored during every break in activity or when handling boxes, cleaning utensils, or other activities that may contaminate the product.

c) Observations

- Gloves should never replace handwashing. It is extremely important that handlers, when wearing gloves, clean their hands before wearing them and when replacing them with a new pair. Disposable gloves should never be reused.
- Frequency of change: gloves should be changed as soon as they tear; before the start of a new task; at least every 4 hours of continued use; after handling raw food and before handling cooked or ready-to-eat foods.
- Handlers should not wear wedding rings, earrings, necklaces, piercings, watches and bracelets, as these are places where microorganisms can hide and contaminate food.
- If the handler has a beard, which is not recommended, it is essential to wear a disposable mask, changing it every 30 min to avoid hair loss and contamination.
- Employees in the administrative area, auxiliary services and visitors must comply with Good Manufacturing Practice standards, i.e. all must wear appropriate clothing (apron and cap) and remove adornments before entering the processing areas. Visitor access should be controlled for contamination prevention purposes.
- It is essential that the food handler take daily baths, preferably before starting work, and that he/she also be mindful to oral hygiene.
- Employees should not wear strong-smelling perfumes and/or deodorants.
- Nails should be kept short and trimmed without nail polish or bases.
- Chewing gum, candies, or toothpicks should not be chewed on or consumed when handling roots and products, to prevent saliva from falling on them.
- Pens, badges or any other objects should not be carried, except in closed velcro pockets and below the waist.
- Talking, sneezing or coughing should be avoided during root processing and product packaging.

Processing of sweet cassava

Cassava has substances containing cyanide in its molecule and that can be released after reactions. When a cell of any part of the plant is broken (due to cutting, squashing or crushing), an enzyme present in the cassava comes into contact with these substances, forming intermediate compounds that have cyanide attached. These compounds break down spontaneously or through the action of another enzyme, releasing cyanide, a toxic compound for humans and animals.

Cassava does not contain cyanide, but can generate cyanide. This confusion occurs because the content of cyanide-containing substances in its molecule is expressed in mg of hydrocyanic acid (generated after enzyme action and decomposition of intermediate compounds) per kg of cassava root, leaf or product. Hydrocyanic acid, which evaporates at 26° C (passes from liquid to gas), is cyanide in acid form.

In Brazil, the concentration of 100 mg of hydrocyanic acid per kg of fresh root is considered the upper limit for "aipim" or sweet cassava, due to the study conducted by the Agronomic Institute of Campinas (IAC) in 1985.

Processing may diminish the concentration of cyanide-containing substances and some processing methods are better than others for this reduction.

Grinding or crushing the leaves or roots decreases particle size and thereby increases the possibility of the first enzyme coming into contact with these substances.

Drying or roasting should be performed after the first enzyme acts, because the enzyme stops acting at higher temperatures. The substances present in cassava that have cyanide in its molecule do not evaporate; the intermediate compound evaporates at 95° C and the hydrocyanic acid evaporates at 26° C.

Pressing or removing the cassava wastewater ("manipueira") allows for the removal of substances that contain cyanide by dragging it out, as they are water soluble and therefore also soluble in the wastewater. In the production of cassava starch (also known as *fécula*, *goma*, *polvilho* or *tapioca*), the water used in the extraction of the starch virtually removes all cyanide-containing substances.

Processing performed on sweet cassava is less efficient in removing cyanide-containing substances, which is why the roots must have a lower concentration of these substances. The removal of the skin and peel and the cooking of cassava are efficient ways of eliminating these substances, due to its low concentration in the pulp of cassava roots.

The roots of cassava varieties intended for commercialization for consumption in cooked form must meet consumer requirements, with elements such as a distinctive taste, soft texture and quick cooking time.

Cooking of sweet cassava can be classified into three types. In type A, cooking takes place within 30 min at boiling water temperature. In type B, the roots are cooked using a pressure cooker, as it reaches higher temperatures than boiling water at ambient pressure (100° C). In type C, cooking does not occur even under pressure.

The consumption of cassava roots is quite diverse and the roots can be marketed as a fresh vegetable, minimally processed, frozen, precooked and frozen, chips and in savory doughs.

Frozen sweet cassava

Frozen cassava is marketed in whole cylinders 5 cm to 7 cm long, in pieces or crushed for the preparation of cakes. The processing steps are the same as those for minimally processed cassava (root reception, selection, washing, sanitizing, cutting, peeling, sanitizing and packaging), except for storage at -18° C (negative 18° C) in a freezer or cold room (Figure 7). Processing frozen cassava does not need to be performed in a cold environment, as in minimal processing.

To obtain frozen cassava, first select the roots, excluding those with hard (fibrous) parts, stains, rot or other problems (Figure 8). The first root selection usually takes place in the field during harvest time. To evaluate the quality of the roots, a sample of the harvested roots must be cooked, representing the variety to be processed. Only the batch of roots that present desirable qualities, such as its cooking within 30 min after boiling water at ambient pressure, should be processed. Roots in which cooking does not occur, even under pressure, should not be processed. **Processing does not improve the quality of the processed root, so it is essential to process good quality roots only**.

Cassava must be harvested on the same day of processing. If the harvest is carried out on the day before processing, the roots must be stored in water tanks for better preservation, but should not be submerged for more than 12 hours, to prevent fermentation. To reduce the possibility of fermentation it is necessary to add chlorine to the water (10 mg active chlorine per liter) by diluting 5 mL (one teaspoon) of 2% commercial bleach in 10 liters of water. The bleach used that remains in contact with the cassava root must be suitable for use in food; this information should be present in the product's label, as well as in

its registration with the Ministry of Health. If in doubt, it is recommended to contact the manufacturer.

After washing, sanitize the roots with skin by placing them in a solution of 200 mL chlorine per liter for 15 min. To prepare this solution, add 100 mL of 2% commercial bleach (suitable for food use) in 10 liters of water or 400 mL of 2% bleach in 40 liters of water.

A solution of sodium hypochlorite at 100 mg per liter (for immersion) or 200 mg per liter (for spraying) should be prepared and used to sanitize root processing materials such as knives, table surfaces or workbenches, boards and sieves.

Peeling is carried out manually with a stainless steel knife or with adequate equipment for cassava peeling. After removing the root tips, if the peeling is done manually, the cylinders are cut to approximately 6 cm long and then peeled. If peeling is done with equipment, cutting into cylinders is performed after peeling.

The peeled cylinders are sanitized for 2 min in a solution of 20 mg chlorine per liter. To prepare the solution, add 10 mL (two teaspoons) of 2% commercial bleach (suitable for food use) in 10 liters of water or 50 mL of 2% bleach in 50 liters of water. This solution can be reused for initial root washing.

After the second sanitization, the sanitizing solution is drained and the cylinders are packed in resistant polyethylene packaging. Frozen cassava can be sold in portions of 200 g to 2 kg, depending on the consumer market. The packages are sealed and placed in a freezer at -18° C (negative 18° C), for freezing and storing. The use of vacuum packaging is not recommended, as frozen cassava can pierce the packages.

If processing is performed properly (following good manufacturing practices, freezing temperature, transport and storage at -18° C), the product will have a shelf life of at least 6 months.

The cassava must be placed for cooking while still frozen and this information must be clearly stated on the packaging.

Losses during the processing of frozen cassava, such as the skin, peel and tips, vary from 25% to 30% of the total root weight. Tips and small pieces of cassava that do not qualify for the standards of sale for consumption can be used to make other products, such as savory doughs.

Photos: Luise de Oliveira Sena

Figure 7. Stages of frozen cassava production.

Photos: Luciana Alves de Oliveira

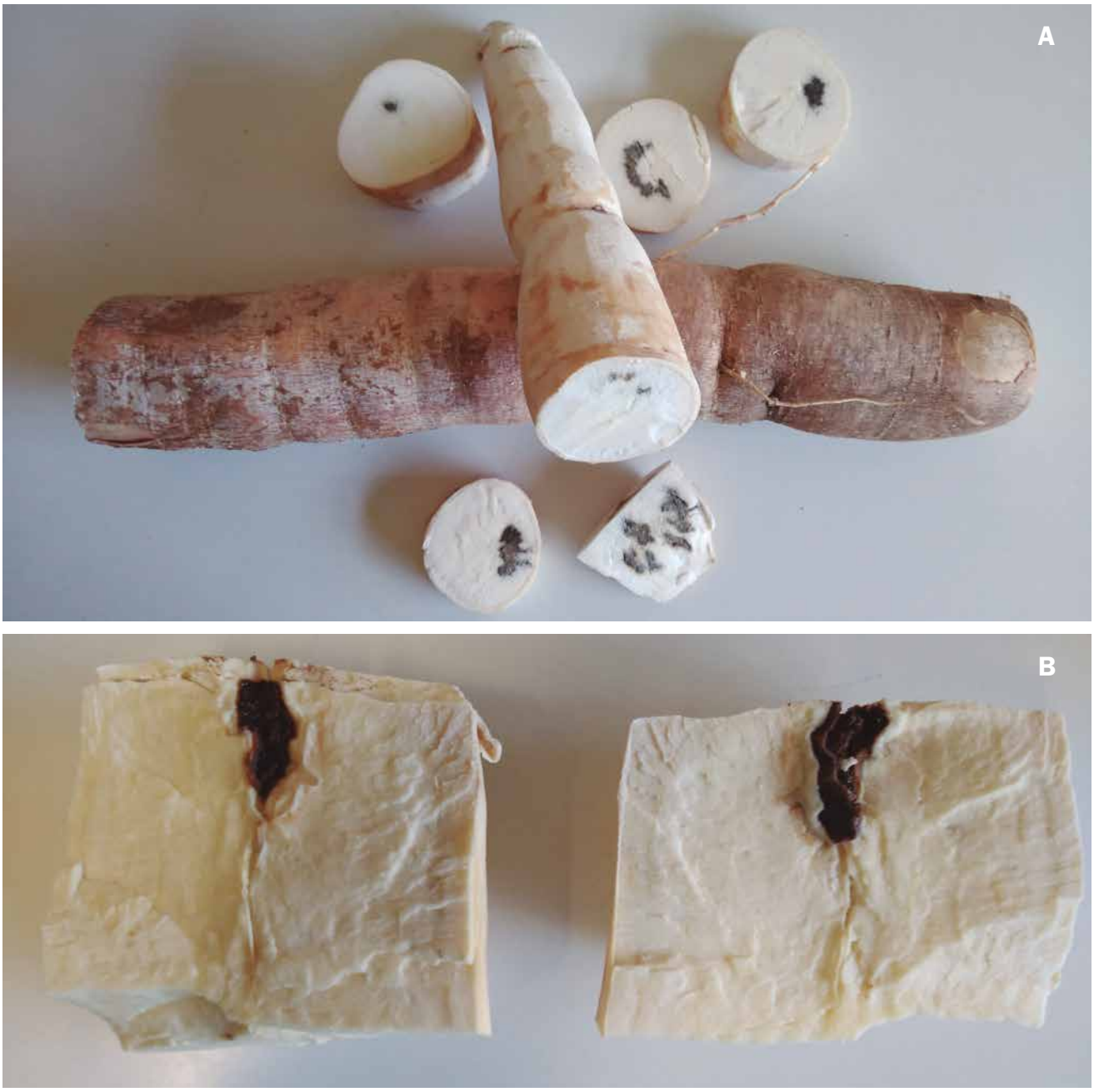
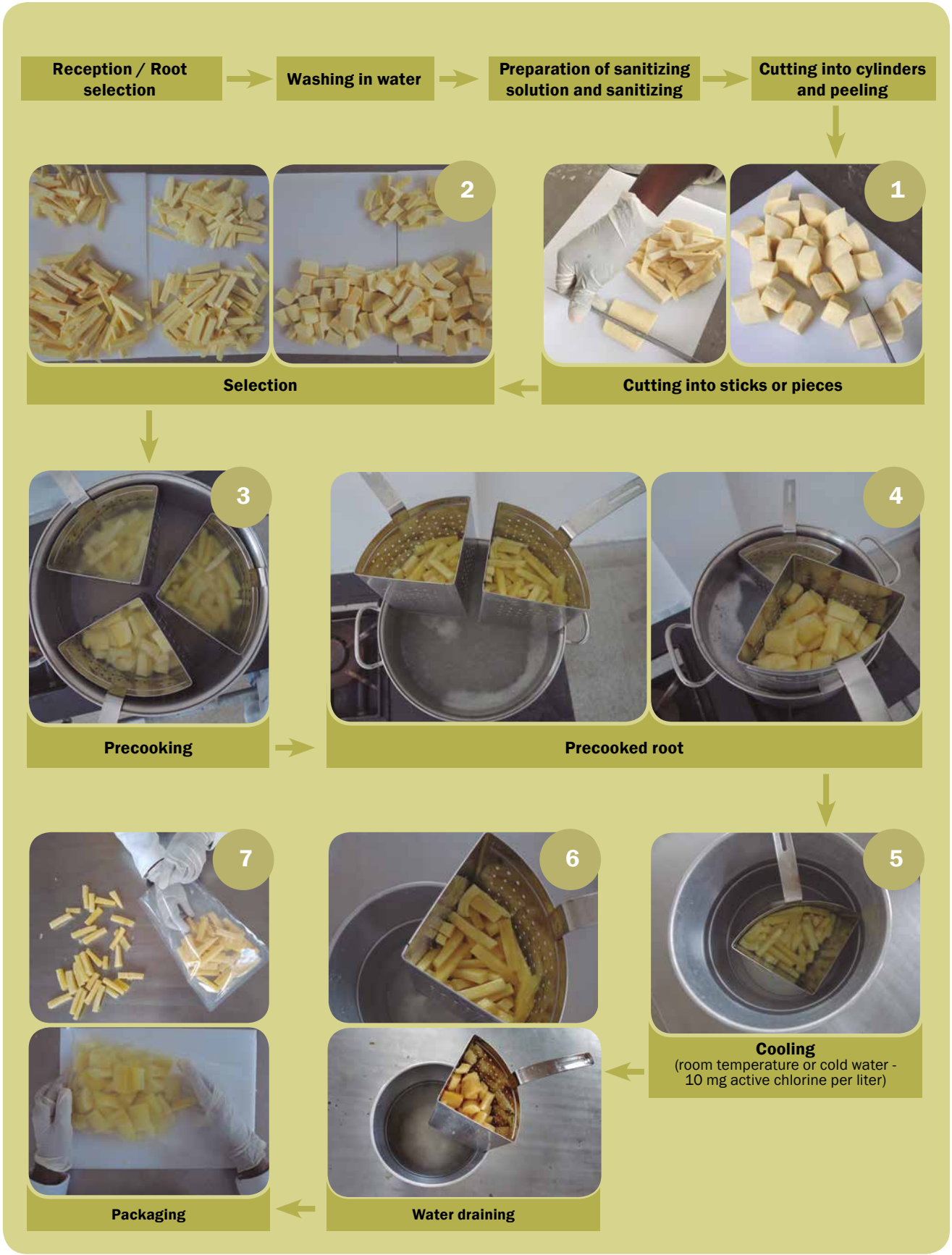


Figure 8. Inadequate cassava roots for processing.

Precooked and frozen cassava (sticks or pieces)

Precooked and frozen cassava is sold in the shape of sticks or pieces. In the processing of precooked and frozen cassava, the initial steps are the same as those for frozen cassava (root reception, selection, washing, sanitizing of roots with skin, cutting into cylinders and peeling), followed by the step of cutting the roots into sticks or pieces, selection, pre-cooking, cooling, packaging and storing at -18° C in a freezer or cold room (Figure 9).



Photos: Luise de Oliveira Sena

Figure 9. Stages of pre-cooked and frozen cassava production, in sticks or pieces.

Continue

Photos: Luise de Oliveira Sena

Figure 9. Continuation.

The cut of the cassava stick is always done so longitudinally along the root length, in the direction of the fibers. If the stick is cut transversely to the fibers, the percentage of breakage is higher and the length of the product is shorter (Figure 10). The stick is cut 1 cm wide and 5 cm to 6 cm long. For roots that are in pieces, the cylinder is cut into 4 to 8 parts. The cut is performed manually with a stainless steel knife or with suitable cassava-cutting equipment. Imperfect sticks, tips and root leftovers can be used for the production of savory pastries.

Photos: Luise de Oliveira Sena

Figure 10. Correct cut: longitudinally to the length of the root (A). Incorrect cut: transversal cut to the length of the root (B).

After cutting, the pre-cooking is done with 2 liters of water for each kg of cassava root, with the addition of 2% salt in the water (20 g of salt for each 1 kg of cassava root) to accentuate the flavor. The cooking water must be changed after 3 uses. The sticks or pieces of cassava are placed in the water once it is boiling.

The pre-cooking time should be tested for each variety used. For example, pre-cooking can be tested in 3 time periods: 2 min, 4 min and 6 min. For the test, use 250 g of the cassava sticks and 0.5 L of water with 5 g of salt for each cooking time. The precooked sticks in each time period are frozen and then fried to verify the quality of the final product. Table 1 shows the result of the test performed with two varieties of cassava, harvested on the same day and at the same age.

Table 1. Tests performed to determine the appropriate pre-cooking time for two cassava varieties processed as stick products.

Pre-cooking time	After frying	
	Variety 1	Variety 2
No pre-cooking	Taste of raw cassava	Taste of raw cassava
2 min	Taste of raw cassava	Adequate flavor and texture
4 min	Taste of raw cassava	Oil soaked
6 min	Adequate flavor and texture	Extremely oil soaked

Pre-cooking time can vary for the same variety of cassava, depending on the root age and environmental conditions (fertilization, rainfall, plant nutrition, soil, drought). The pre-cooking time for a piece of cassava is longer than that for a cassava stick product, and therefore the test to verify the best pre-cooking time must also be performed.

When peeling, all of the skin and peel must be removed, as any remaining peel on the product could impair its appearance, causing darkening (Figure 11).

Photos: Luise de Oliveira Sena

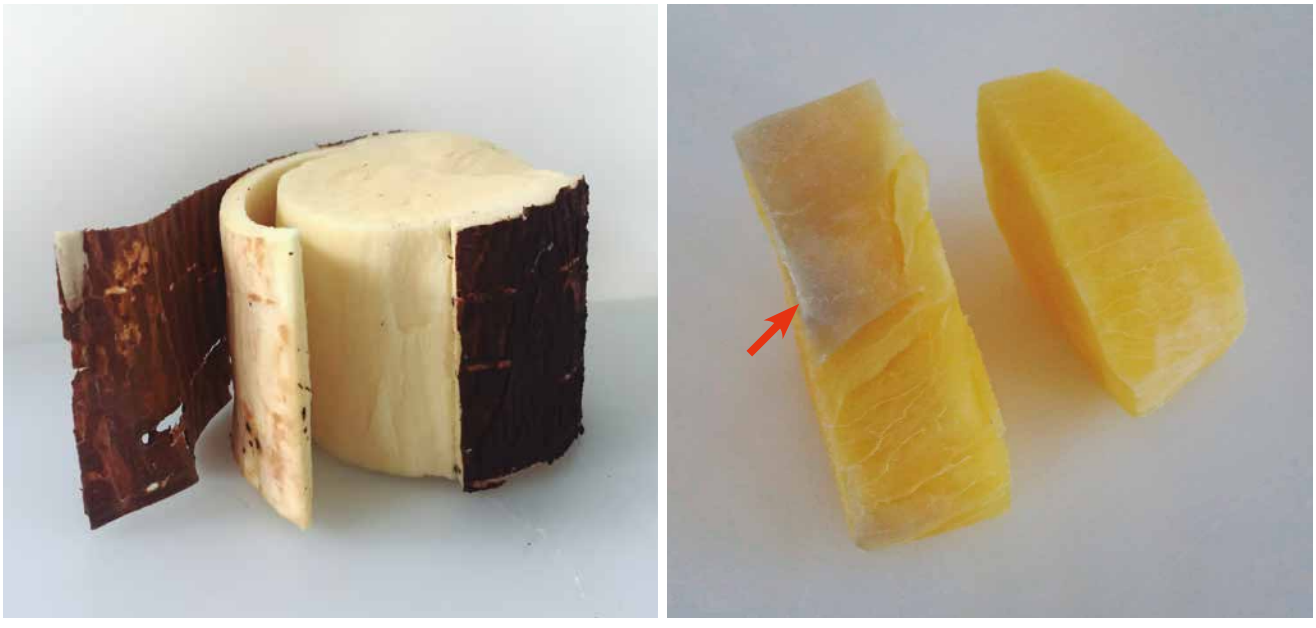


Figure 11. Cassava root peeling and presence of peel in pre-cooked cassava.

Right after pre-cooking, the sticks are submerged in slightly chlorinated room temperature or cold water (2 mg active chlorine per liter, add one teaspoon of 2% commercial bleach solution – suitable for use in food – in 50 liters of water) to stop the cooking and cool the product.

The sticks are then drained, placed in packs that can be made of resistant (thicker) polyethylene, or of another resistant material and then weighed. Cassava sticks tend to stick together; to prevent this from happening, place the sticks in a disorganized manner inside the packaging (Figure 9). The packages are then sealed and placed in a freezer at -18° C. Freezing at -18° C takes around 12 hours, though this also depends on the freezer capacity and the amount of cassava to be frozen.

Cassava chips

Another way of adding value to cassava is by producing savory snacks such as fried chips. The preparation of the chips include the reception and selection of the roots, washing in water, sanitizing the roots with skin (same steps as frozen cassava), peeling, sanitizing, slicing, soaking the slices in water, frying, salting, draining the roots of surface oil, weighing, packaging and storage (Figure 12).

Peeling of the entire root is important to reduce leftover tips. After peeling, the peeled roots are submerged in treated water to remove any adhered skin. The water used in this stage can be reused for initial root washing.

The cassava is to be cut into slices approximately 0.8 mm thick. The thickness of the slice is very important for the quality of the product (crispness). If the slice is too thick, the chips may become very hard. There is cassava slicing equipment available on the market, for this purpose. Slicing can occur directly into the fryer, or they must remain immersed in water to prevent them from sticking. After soaking, the water must be drained and the slices are then fried.

Very thick cassava roots are not suitable for chips as they crack during peeling or slicing.

Frying oil temperature should be between 170° C and 180° C. The temperature must be above 160° C to prevent the product from becoming too drenched in oil and should not exceed 190° C to avoid impairing the oil quality. The quality of the oil used for frying will influence the quality and shelf life of the finished product. Oil degradation will be greater the longer the period of its use. To monitor the quality and disposal point of the frying oil, there are quick tests and evaluation equipment on the market. Palm oil has higher oxidative stability (less degradation) than cotton, sunflower and soybean oils; therefore it is the most suitable for the production of fried products.

Photos: Luise de Oliveira Sena

Figure 12. Stages of cassava chip processing.

After frying, excess oil is drained and the chips are spread over a sheet of paper to again drain any excess oil. The product is salted with 1% salt; for every 1 kg of product add 10 g of salt. The addition of spices (oregano, chili powder, parsley, onion, among others) is performed along with the salt. If the seasoning contains salt, the amount of added salt must be decreased.

After frying, the product should be quickly packaged in order to prevent moisture absorption. The product should be packed in polypropylene bags, in portions of 40 g to 80 g, stored in a dark place and should be consumed within 15 days.

Chips may vary in quality due to factors such as the quality of the raw material and oil used, inequalities in chip thickness, temperature and frying time. The color of the final product depends on the color of the cassava variety used, which may be white, cream, yellow or pink.

To test whether a variety is suitable for chip production, a batch of chips should be made with a sample of the roots of the selected variety. If the chips become hard even when using thin slices or if the product is soft after frying (absorbs a lot of oil and is not crispy), the variety or the age of the root or the growing conditions were not suitable for the production of chips.

Preparation of cassava dough for savory pastries

For the preparation of savory dough, the first steps are the same as for frozen cassava (root reception, selection, washing in water, sanitizing of roots with skin, cutting into cylinders, peeling), followed by the steps of cutting the cassava into 4 pieces, central fiber removal, cooking, freezing, grinding, salting, shaping, packaging, freezing and storage at -18° C in a freezer or cold room (Figure 13). If processed properly (following good manufacturing practices, freezing temperature, shipping and storage at -18° C), the product will last at least 6 months.

At the Latin American and Caribbean Consortium for Support for Cassava Research and Development (Clayuca) located at the International Center for Tropical Agriculture (CIAT) in Cali, Colombia, cassava dough for savory pastries is prepared on a small scale. The central root fiber is removed (Figure 13 - stage 2) and the roots are cooked until half of all roots are fully cooked and the other half partially cooked; ideally, not all of the cassava will be well cooked. Some production facilities in Colombia use half well-cooked roots and the other half raw.

Before beginning the dough preparation, one batch of roots should be used to evaluate the cooking time of the variety used.

The cooking water is drained (Figure 13 - stage 4) and after the cooked roots have reached room temperature they are cooled at a temperature between -4° C (negative 4° C, freezer) (Figure 13 - stage 6) and -18° C (negative 18° C, freezer) (Figure 13 - stage 7) for 24 hours. The cooked root, still frozen, is ground in a meat grinder (Figure 13 - stage 9). Then the crushed dough is mixed with salt, using a ratio of 10 g salt to 1 kg dough (1% salt) in the mixer (Figure 13 - stage 12), adding the salt gradually while mixing the dough.

The savory dough is placed in a sausage maker (Figure 13 - stage 13) to make the croquettes. The machine's screw system should rotate slowly so that the texture is uniform and the dough does not present air bubbles. When the dough begins to exit the plastic section of the equipment, use hands to press the plastic section outlet (Figure 13 - stage 15 - indicated with the red arrow) while the screw system of the equipment turns. It is important to exert pressure during this step, to remove all air from the dough. The tray that will receive the dough must be greased with a little oil, so that the dough does not stick to the tray and is allowed to slide.

The croquettes must quickly be cut to the same size, using a knife (Figure 13P - stage 15), so that the dough does not break. The knife should be rinsed in water to facilitate cutting. To finalize the savory pastry, dip fingertips in water and mold the cut ends with moistened fingers (Figure 13 - stage 16) so that the ends of the croquettes are more rounded.

Croquettes are sold frozen or pre-fried (180° C for 35 seconds) and frozen. Fry the frozen croquettes when the oil is at 170° C for 3 to 4 min in a covered pan, as the croquettes may explode if the dough is too wet.

In addition to salt, other spices can be added to the dough, such as onion, cilantro, basil, oregano, cheese and parsley.

The dough can also be used to make savory foods in different formats (coxinha, dumpling, risole, gnocchi) and with the desired filling (codfish, bacon, shrimp, ground beef, beef jerky, chicken, chicken with catupiry cheese, vegetables, sausage, heart of palm, pizza, cheese, cheese and ham, among others) (Figure 14). Savory pastries tend to be quite sticky and need to be breaded. The flour used for breading, in addition to removing the sticky quality of the pastries, becomes an oil absorption barrier during frying and increases the crispness of the product.

Photos: Luise de Oliveira Sena (Embrapa/CNPMF) e Luciana Alves de Oliveira (Clayuca-CIAT, Colômbia)

Figure 13. Stages of processing of cassava dough for preparation of savory pastries in Clayuca-CIAT, Colombia.

Photos: Luise de Oliveira Sena

Figure 14. Frozen (A), frying (B) and fried (C) croquettes and coxinhas made from stuffed cassava dough.

Flour processing

To manufacture cassava flour it is important to use the same variety and the same. Root washing prior to manual peeling is recommended. Processing begins after root peeling, using the root pulp without peel, and must begin immediately after harvesting. Peeling in the "Recôncavo da Bahia" region is usually done by the half-half procedure (Figure 15 B), where person initially peels half of the root, holding the other half with soil-dirty peel (dirty hands) and another person grabs the root by the peeled half (clean hands) and peels the other half. There is equipment that washes the roots and partly remove the outer skin of the root.

Completely peeling the roots must mainly be done in roots where the peel is not white. Partial peeling can influence the quality of the flour, as it can lead to dark spots and / or darkening of the final product.

The Cigana Preta variety of cassava is the most widely used for flour production in Cruz das Almas region and neighboring cities. According to farmers, this variety is easier to peel than other varieties planted in the region, such as *Salangor Preta* and *Platina Branca*, and produces better quality flour.

The peeled root should not be placed directly on the ground, but can instead be placed in plastic boxes (Figure 15 C). The roots should be washed with treated water (Figure 15 D) to remove sticky skin, sand and other adhered dirt.

The next step is root grinding, which is done using an electric grater, also called *cevador* or *caititu* (Figure 16 A). The grater contains a cylinder, preferably with serrated stainless steel blades (Figure 16 B - indicated with arrow), that can be replaced as needed.

Excess water in the grated dough should be removed before roasting, using a manual (Figure 17 A) or hydraulic pressing equipment. The grated cassava dough (Figure 17 B) is placed in raffia bags or thin-mesh nylon fabric (Figure 17 B and C - indicated with arrow) and pressed onto pallets (Figure 17 D - indicated with arrow) for the removal of excess water, also known as "manipueira" (cassava wastewater). If the nylon mesh is used, a mold will be necessary (Figure 17 E - indicated with arrow) to place the mesh and then the dough on top. The pressing time will depend on the amount of ground dough and the equipment used. For the production of *Copioba* flour, which is the most popular in the Recôncavo da Bahia region, the ground dough is left exposed for a few hours at room temperature before or during pressing, resulting in natural fermentation and increased acidity of the product.

Photos: Luciana Alves de Oliveira

Figure 15. Cassava root for flour production (A), peeled using “half-half” procedure (B) and completely peeled (C) and washed in treated water (D).

Photos: Luciana Alves de Oliveira

Figure 16. Cassava root grater (A), metal cylinder (top view) with standing steel blades (B) and grinding roots (C).

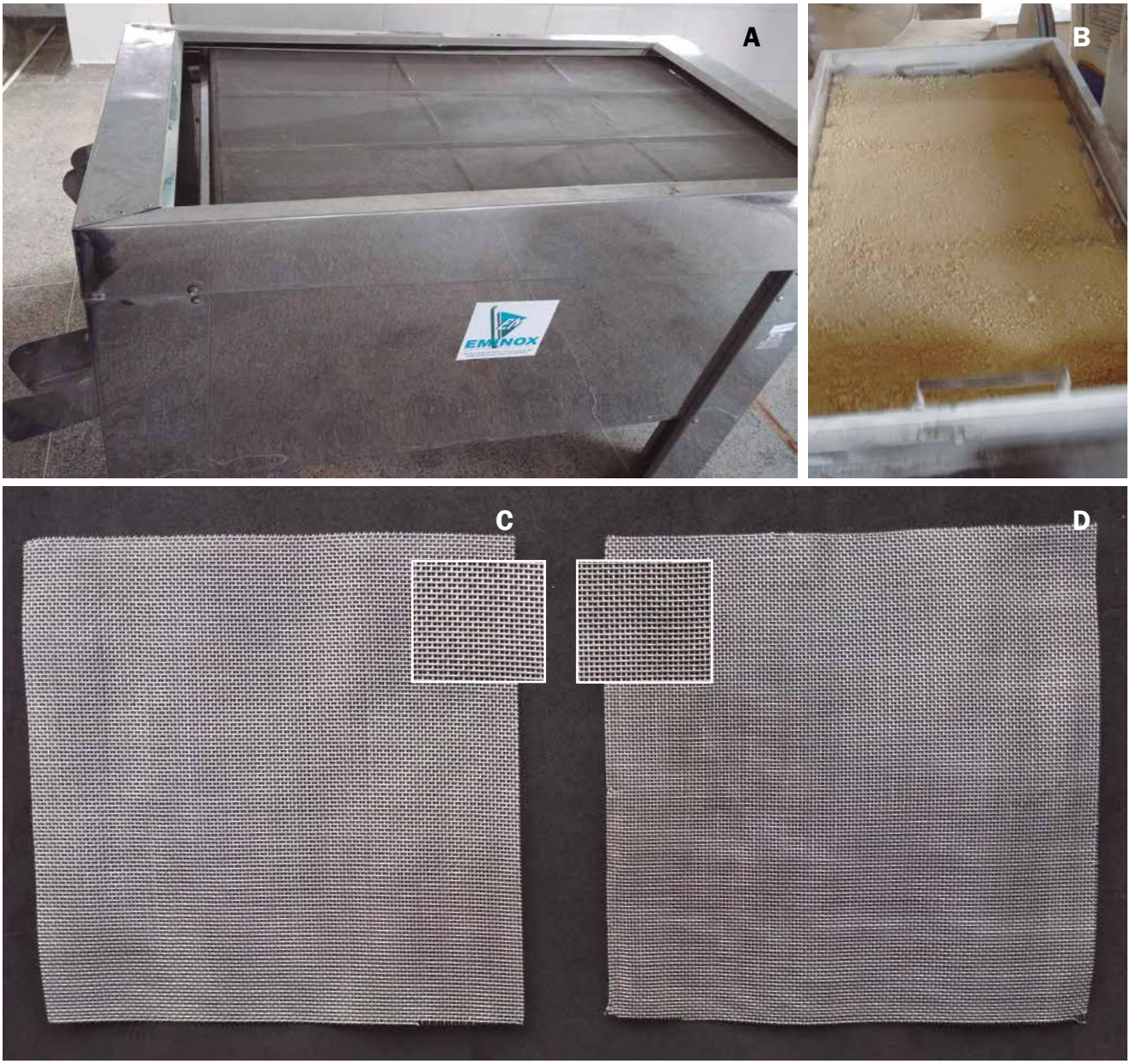
Photos: Luciana Alves de Oliveira

Figure 17. Hand press (A), placing the dough on nylon mesh (B), folded nylon mesh to maintain the dough during pressing (C), placing of another pallet (D) to place the box (E).

The ”manipueira” and peel can be used for animal feed, soil fertilization and irrigation.

The dough becomes compact due to compression in the press and needs to be crumbled. This procedure is performed using the same root grater (Figure 17 C).

To manufacture fine dry flour, considered to be of better quality in the Recôncavo da Bahia region, it is recommended to pass the crumbled dough through a hand or mechanical sieve (Figure 18 A and B) with a galvanized 26 or 28 mesh sieve (Figure 18 C) to standardize the grain size of the flour and remove the fiber (central root fiber) before drying and toasting. The higher the mesh number, the finer the flour obtained.



Photos: Luciana Alves de Oliveira

Figure 18. Mechanical sifter (A and B) and sieve mesh 26 (C) and 28 (D).

The dough is manually placed in the oven using a squeegee or an electric paddle stirrer (Figure 19 A). The dough is added slowly into the oven with the reeds moving, so as not to tangle, as in the process of making the pirão (thickened broth using cassava flour) in which the cassava flour is gradually added so as not to form lumps. The dough must pass through a higher temperature (between 180° C to 250° C) to reduce moisture; a process known as: drying, scalding, grilling, zanzar or zazar (Figure 19 B). Then, the oven-dried dough must pass through the sifter (Figure 18 A) again to separate lumps.

For the roasting stage (Figure 19 C), a milder oven is recommended, with a temperature between 120° C and 150° C. At this stage the product progressively loses moisture, changes in color from white to cream (Figure 20) and becomes increasingly crisp, reaching the ideal point for consumption, within the desired standards. Copioba flour takes on a cream color during roasting.

Photos: Luciana Alves de Oliveira

Figure 19. Rotating oven (A), drying stages of ground dough (B) and roasting (C).

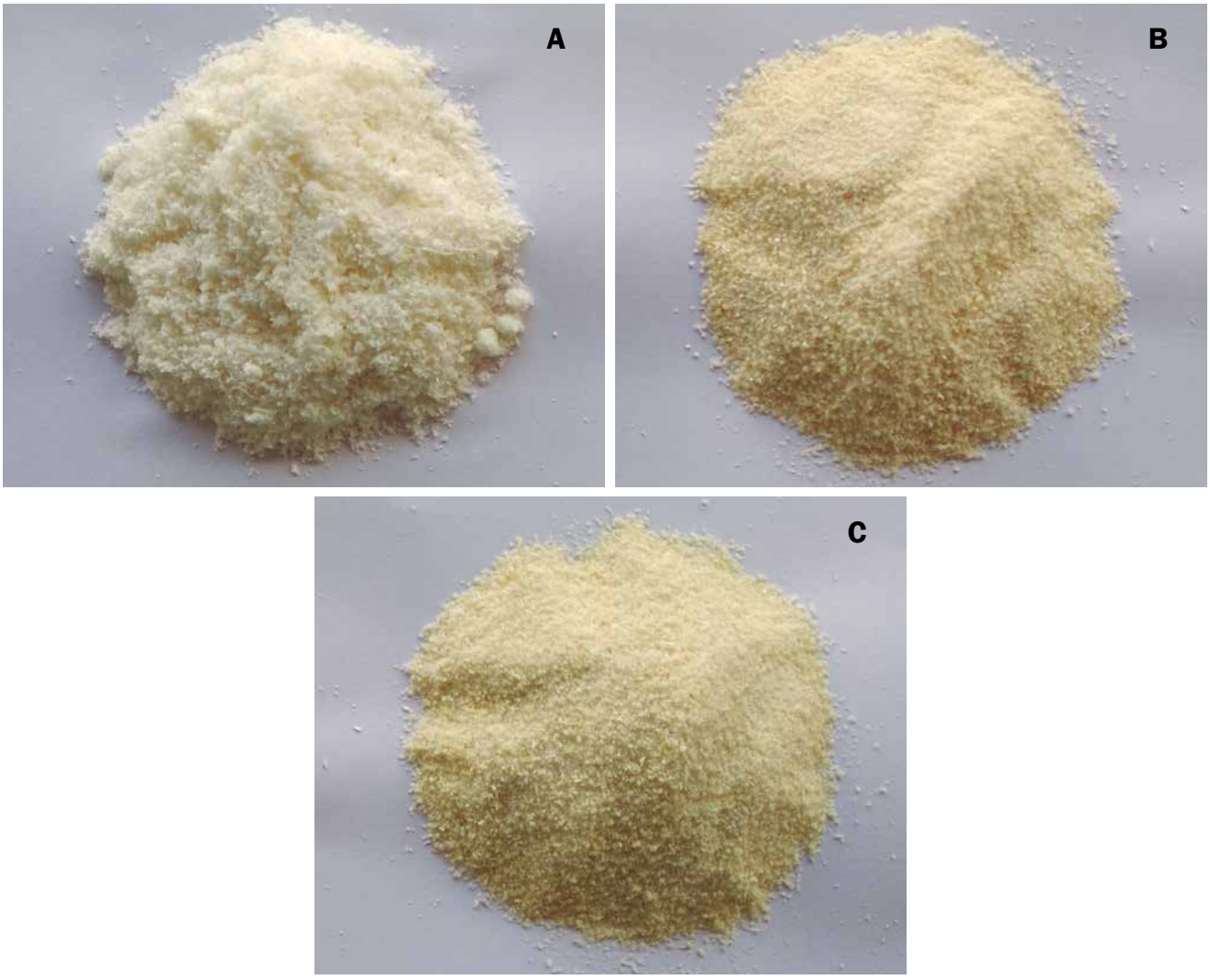


Photo: Luciana Alves de Oliveira

Figura 20. Ground, pressed and reground cassava root (A), dry dough through sifter (B) and *Copioba* flour (C).

After roasting, the flour should be sifted immediately, thus cooling the product and avoiding its burning. The flour is sieved again in the sifter (Figure 18 A).

In other regions of Bahia (north, northeast and central west), thicker and uneven flour in grain size predominate and little attention is given to the crispness of the final product. To keep the flour crispy, the packaging used in the storage and sale of the product is very important.

A recommendation is that the product, when it is ready and cold, be placed in 50 kg plastic bags, which are more appropriate than reusing bags of wheat flour or cotton. These can be used to protect plastic bags during transportation and sale.

The 1 kg packages can be made of polypropylene, which preserves the low moisture of the flour, instead of polyethylene packages, which keep the product crisp for a shorter time.

Flour is classified according to the Ministry of Agriculture, Livestock and Supply (MAPA, as per its Portuguese name) in groups according to the technical process employed in its manufacture (dry, wet or *bijusada*), in relation to acidity (low or high) and for wet and dry flour in classes according to granulometry (fine, medium or coarse) and in types (1, 2 and 3).

The processes used in the manufacture of dry and wet flour follow basically the same steps, with the addition of the process of natural fermentation of the roots (*pubagem*) for the wet flour group (Northern region). *Bijusada* flour (South and Southeast regions) predominantly comes in the form of irregular flakes and is a light product (low density).

Cassava flour consumed in the Recôncavo da Bahia region is of the dry type. Dried flour must have a moisture content lower than 13%, maximum ash content of 1.4%; 2.3% crude fiber (on dry base) and no dirt in the 1 kg sample. The best quality dried flour (type 1) must have a starch content greater than 86%. Dried flour is considered fine when all flour passes through the 2 mm (two millimeter) mesh sieve and is retained by up to 10% in the 1 mm mesh sieve. It is considered thick when the product is retained by more than 10% in the 2 mm mesh sieve. The odor, taste, color and homogeneity of the product must be normal or characteristic of the product type.

Small-scale starch processing (artisanal)

The initial steps in the fabrication of cassava starch, also known as *fécula* or *polvilho*, are the same as for flour. For the fabrication of starch it is important to use the same variety, at the same age and immediate peeling and grind the roots after harvesting. Root grinding should be done after careful peeling, using the pulp without any traces of peel; this procedure ensures better starch quality.

The yield of starch extraction depends on the electric grater used, which should allow for greater root disintegration. The grater's saws should be well sharpened and the cylinder leveled to prevent loss of unground root pieces.

The crushed cassava root dough should pass through the starch extractor (Figure 21 A and 21 B), which should have sufficient water to cover the sieve and stirrer paddle before adding the ground root (Figure 21 C). The dough should be slowly added to the extractor until reaching its capacity; for example 70 kg of ground root for the extractor in Figure 21.

Photos: Luciana Alves de Oliveira

Figure 21. Starch extractor (front view A and inside view B) and sieve of the equipment covered with water before adding the ground dough (C).

The ground dough is mixed with water in the starch extractor (Figure 22 A), favoring the passage of starchy water (similar in appearance to milk) through the equipment sieve (Figure 21 B).

The starchy water that comes out of the extractor should be collected in a fiberglass trough for starch or gum separation (Figure 22 B). The trough has a lateral opening (Figure 23) for water to drain after starch sedimentation, also known as settling the starch or decantation.

Photos: Luciana Alves de Oliveira

Figure 22. Mixture of water with ground cassava dough (A) and starchy water exiting the extractor (B).

Photo: Luciana Alves de Oliveira

Figure 23. Fiberglass trough and highlight of side outlet for water drainage.

It is common for starch extraction to be performed on a portion of the ground dough used for flour production. The dough used for starch extraction should correspond to 20% to 30% of the total mass of flour manufacture, to allow mixing of the dough without starch with the rest of the flour dough. The process of pressing, crumbling, sieving and drying the dough in the oven then follows, to make flour. The amount of ground dough, from which the starch can be extracted, is defined by the starch content in the cassava root, so that the starch is extracted and also a good quality flour. This partial extraction is performed to obtain a product other than flour and considering that starch production is economically profitable. In the production of Copioba flour, the extraction of starch is smaller.

According to the Ministry of Agriculture, Livestock and Supply (MAPA) Normative Instruction No. 23 of December 14, 2005, cassava starch is classified in two groups, according to the manufacturing technology used: starch and tapioca. Starch is the product extracted from unfermented cassava roots, obtained by decanting or other suitable processes, with moisture less than 14%; while tapioca is the product that is presented in the form of irregular granules, with moisture less than 15%. Ready-made tapioca dough from different brands sold in Cruz das Almas, Bahia, presented 34% to 44% of moisture and were produced in different cities in Bahia (Jaguaquara, Laje, Maragojipe and Santo Antônio de Jesus), Paraná (Querência do Norte and Terra Boa) and Mato Grosso do Sul (Ivinhema). For ready-made tapioca dough, so far, there is no standardization.

Packaging and labeling

Packaging

The packaging is a container that holds the product in order to protect it during transportation, distribution, storage and handling, against damage, collisions, vibrations and compressions that occur throughout the journey.

The development of packaging labels has been gaining more prominence in the current market, because in addition to these basic functions related to protection and conservation, it is possible to include information on composition, legal issues, validity, use, among others.

The product image is its business card, as the consumer always looks for the product first by appearance, and food packaging can help to shape the attitudes of consumers. Thus, food packages prepared by family farms should reflect their quality, both in the process and in the raw material and the product itself, reinforcing competitiveness. It is interesting to include on the packaging or label that the product is from a family farm, which will attract consumer attention.

The development of websites, creation of the company's visual identity and label with characteristics of the cultural elements and the identity of the place of production is recommended, as well as a text describing where the product comes from, to attract new customers. This care can delight the consumer.

It is important for the consumer to know that behind the product there is a production chain that begins in the land, in farming and involves family farmers who deliver quality products to the market.

Types of packaging

Food packaging is made up of various types of materials. The purpose of packaging is to preserve quality and protect food, and can be made of glass, plastic or cardboard.

The low-density polyethylene plastic bag is the most commonly used packaging for **cassava flour**, as it is impact resistant and is a good barrier for water, as well as being transparent and colorless. We can also find kraft paper packed flour on the market, which can be molded as boxes or bags, having the advantage of being recyclable and biodegradable.

Plastic used for **frozen cassava** is low density polyethylene due to its transparency, cold resistance, lightness and non-toxic characteristics. These packages resist the passage of odors, withstand damage caused by sharp parts of food and do not tear easily, even when subjected to low temperatures.

Cassava chips need to maintain crispness and flavor. The packaging that maintains the crispness and flavor of the chips for a longer time is the one with plastic film of polypropylene and aluminum plastic film, due to the good mechanical properties and barrier to light and moisture, leaving the product crunchy and avoiding oil oxidation.

It is common to use polypropylene plastic bags for the packaging of fried chips because they are cheaper, are sold in small quantities and are easier to find. Polypropylene packaging is transparent and therefore gives greater visibility to the product, but the chips will have a shorter shelf life due to oil oxidation.

The packaging of the minimally processed sweet cassava sold in vacuum is 12 micron poly nylon, which has three protective barriers, but requires the use of a vacuum sealer.

For any product is necessary to use secondary packaging for transportation. Cardboard boxes or transparent polyethylene plastic bags, properly labeled, resistant to damage that may occur during transport and storage ensure the integrity of the product throughout its validity period.

Labeling

The product must also address all legal issues required by the market, regarding packaging and labeling. In case of inadequacy or non-conformity in the labels, the product can be collected and may incur a fine.

According to the National Health Surveillance Agency (Anvisa, as per its Portuguese name), a label is any inscription, caption and image or any descriptive or graphic material that is written, printed, stamped, engraved or pasted on food packaging.

The product must be labeled according to the following regulations in force:

Mapa Ordinance 371/97	Technical regulation for food labeling
Anvisa RDC 359/03	Technical regulation on portions of packaged food for nutrition labeling
Anvisa RDC 360/03	Technical regulation on nutritional labeling of packaged food
Mapa Normative Instruction nº 52/2011	Technical regulation of cassava flour

In Brazil, general labeling must include the following information:

1. Identification of the product, including the brand.
2. Name and address of manufacturer.
3. Ingredient list.
4. Net content.
5. Manufacturing date.
6. Expiration date or maximum time frame for consumption.
7. Lot number.
8. Nutritional information table.

All foods and beverages must have mandatory nutrition labeling, including products derived from sweet or bitter cassava. Minimally processed or frozen cassava or any product whose packaging is less than 100 cm^2 are exempt from mandatory nutrition labeling.

Whenre necessary, the label must contain instructions on the appropriate way of use, including defrosting or the treatment that must given by consumer for the correct use of the food.

In nutrition labeling, the information must be per portion of the food, such as a tapioca beiju (20 g).

Below is an example with the nutritional information of precooked and frozen sweet cassava sticks and cassava flour:

Sweet cassava precooked frozen sticks

Nutritional Information 100 g portion (10 sticks)		
Quantity per portion		% DRV (*)
Energetic value	120 kcal = 504 kJ	6
Carbohydrates	28 g	9
Proteins	1 g	1
Total fat	0 g	0
Saturated fat	0 g	0
Trans fat	0 g	**
Dietary fiber	1 g	4
Calcium	28 mg	3
Irom	0.9 mg	6
Sodium	0 mg	0

* Daily reference values based on a diet of 2,000 kcal or 8,400 Kj. Your daily values may be higher or lower depending on your energy needs.

** DRV not established

Toasted cassava flour

Nutritional Information 50g portion (½ cup)		
Quantity per portion		% DRV (*)
Energetic value	182 kcal = 764 kJ	9
Carbohydrates	44 g	15
Proteins	1 g	1
Total fat	0 g	0
Saturated fat	0 g	0
Trans fat	0 g	**
Dietary fiber	3.2 g	13
Calcium	32.5 mg	3
Irom	0.55 mg	4
Sodium	0 mg	0

* Daily reference values based on a diet of 2,000 kcal or 8,400 Kj. Your daily values may be higher or lower depending on your energy needs.

** DRV not established

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Embrapa

Cassava & Fruits

This book was designed to assist family farmers and cassava processors in the 'Recôncavo Baiano' region as to the necessary steps for root processing. Thus, the book presents detailed information on harvest and postharvest, good manufacturing practices, the possibilities of processing sweet cassava (minimum processing, frozen, pre-cooked and frozen - sticks or pieces, chips, dough preparation for savory pastries) and the processing of bitter cassava as flour and starch on a small-scale, in addition to the product packaging and labeling.

It is hoped that with this information, family farmers will be able to sell the processed root with quality, thereby achieving new markets, improving income and living conditions.

MINISTRY OF
AGRICULTURE, LIVESTOCK
AND FOOD SUPPLY

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