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# CASSAVA CHIPS

## Introduction

Cassava (*Manihot esculenta Crantz*) is cultivated in various different regions of Brazil and its production has been destined both for direct consumption and for the processing industry (DIAS; LEONEL, 2006).

"Table" cassava, also known as sweet cassava, *aipim* or *macaxeira*, is a high-energy food that is widely accepted by the Brazilian population (BORGES et al., 2002; OLIVEIRA; MORAES, 2009). The differentiating factor of the varieties of "sweet" cassava is their low cyanogenic compounds content, which is less than 100 mg per kg of pulp in fresh roots (BORGES et al., 2002).

Despite all of its potential nutritional value, cassava deteriorates faster than other root crops when in elevated temperatures and humidity (GRIZOTTO; MENEZES, 2003). Therefore, its usefulness depends on the use of appropriate conservation technologies, especially those that reduce humidity, as the reduction of the water content limits the microbial development and, consequently, prevents the deterioration of the product (DIAS; LEONEL, 2006).

The culinary consumption of cassava roots is quite widespread, being widely consumed in its cooked, roasted and fried forms, or in the composition of more sophisticated dishes. The cassava used for cooking is marketed as fresh or minimally processed, refrigerated or frozen, or also pre-cooked, facilitating its preparation and consumption (OLIVEIRA et al., 2005).

So-called convenience foods are booming all over the world. Some of the most popular are snack foods and morning cereals. These have been deemed meals (although they are not) due to the fact that they fulfil the needs of people who do not have the time to prepare and eat a full meal. Thus, one way to add value and encourage cassava cultivation is through the production of chip-like fried snacks, as it involves simple technology and a growing market product (ROGÉRIO; LEONEL, 2004).

The frying process gives the cassava roots pleasant characteristics of colour, flavour, texture and palatability (MÁRQUEZ-RUIZ et al., 1990). However, its consumption requires care for the consumer’s health. Considering that a part of the oil is incorporated into the product, it is necessary for this heat transfer medium to be of high quality (CELLA et al., 2002). Hydrogenated fat has been excluded from the food industry due to the presence of trans fats, which may increase the risk of cardiovascular diseases (ANVISA, 2008). Companies have therefore replaced it with vegetable oils, opting for those with greater amounts of saturated fatty acids due to their greater oxidative stability, as is the case of palm oil (CORSINI; JORGE, 2006a,b; JORGE et al., 2005a,b; SEBRAE, 2009).

Besides the type of oil to be used, the residual content of the final product is another factor that should be considered in the production of cassava chips. If the residual oil content is excessive, it raises production costs and may also harm the crispness and flavour of the product. VITRAC et al. (2000) have shown that the texture and oil absorption in chips are related to the loss of water during frying, as the products with higher oil content and moisture tend to be withered. The main factors that affect oil absorption are frying temperature and time, amount of water in raw material, type of oil, and slice thickness. High-moisture raw materials absorb more oil during frying (ROGÉRIO; LEONEL, 2004; ROGÉRIO et al., 2005).

Considering that the texture is the sensory attribute that most influences the quality of these processed products (GRIZOTTO; MENEZES, 2003; 2004), the production of cassava chips should be conducted in such a way as to create a crisp and pleasant texture.

A small-scale study was developed in the Food Technology and Science Laboratory of *Embrapa Mandioca e Fruticultura* during 2005 and 2006, whose objective was the production of cassava chips with lower residual oil content (FUKUDA et al., 2005; OLIVEIRA et al., 2006), which will be described in this document.

*Figure 1. Processing stages of cassava chips*

HARVESTING AND TRANSPORTATION
↓
RECEPTION
↓
SELECTION
↓
WASHING IN RUNNING WATER
↓
SANITATION (200 ppm of active chlorine for 15 minutes)
↓
CUTTING INTO PIECES
↓
PEELING
↓
WASHING OF PEELED ROOTS
↓
REMOVAL OF SURFACE WATER
↓
SLICING
↓
FRYING
↓
SALTING
↓
DRAINAGE OF EXCESS OIL
↓
PACKAGING
↓
WEIGHING
↓
STORAGE

**Process description**

The stages of elaboration were based on the steps suggested by VILPOUX (2003), with modifications (Figure 1). The main innovation of the process consisted in excluding the bleaching stage (heat treatment applied to raw material for a short amount of time, in water at 100°C) prior to frying.

<u>Reception:</u> The cassava should be harvested preferably on the same day of processing, or on the previous day. The roots received from the field, in plastic boxes or burlap sacks, should be kept in an airy place until processing time. In case the cassava is harvested the day before processing, it can be stored overnight in tanks of water. The immersion period in water should not exceed 12 hours, to prevent the fermentation of the roots and, consequently, their deterioration. To

minimize the possibility of root fermentation, chlorine can be added to the water (10 mg per litre of solution). Storage in water facilitates peeling the next day (VILPOUX; CEREDA, 2003). It is recommended to prepare the chlorine solution (10 mg of active chlorine per litre of solution) with 5.0 mL of commercial 2% sodium hypochlorite solution or 1.0 mL of 10% commercial solution for 10 litres of solution.

Selection: The roots intended for processing should be selected based on uniform size and shape, excluding those with spots, stiffened parts or any other type of injury.

It is also recommended to make chips with a sample of the roots, which will represent the batch to be processed, in order to evaluate the quality of these, as cassava roots tend to have many variations. Only process batches of roots that do not yield chips with hardened textures.

Washing: The cassava roots should be dipped in water and then brushed to remove adhered organic matter (Figure 2a).

Sanitation: After washing, sanitize the roots with the bark using a sodium hypochlorite solution (200 mg of active chlorine per litre of solution) for 15 minutes. Prepare the hypochlorite solution with 100 mL of commercial 2% sodium hypochlorite solution or 20 mL of 10% commercial solution for 10 litres of solution (Figure 2b).

Cutting and peeling: Remove the tips of the roots and cut them into cylinders of approximately 12 cm, with the aid of a stainless steel knife. The cylinders should be peeled, with the removal of the skin and inner skin (Figures 2c and 2d).

The yield and losses during the peeling stage vary greatly depending on the quality and storage of the cassava. A worker can peel 200 kg of roots per day, whilst in poor quality roots this yield can drop to 80 kg per day. The processing of thicker roots also increases the speed of peeling (VILPOUX; CEREDA, 2003).

Decreasing post-harvest cassava storage time, with root processing taking place at the most on the next day and storing overnight in water, also improves peeling productivity.

Skin, inner skin and tip losses range, on average, from 25 to 30% of the total root weight and may exceed 40% in thinner roots. The material that is not sliced by the machine is residue that can be availed for the mass production and preparation of dumplings (VILPOUX; CEREDA, 2003).

Washing and draining: After peeling, immerse the cylinders in treated water to remove any adhered skin residue (Figure 2e). Then, drain the surface water. The water used in this step can be reused for the initial washing of the roots.

Slicing: Cut the cassava into slices approximately 0.8 mm thick, using a slicer (Figures 2f and 2g).

For the chips, the thinner the slice, the better the crispness and the shorter the frying time. Once cut, the slices should fall directly into the fryer. This direct fall decreases the adhesion of the slices to each other (VILPOUX, 2003).

Frying: Fry the slices in vegetable oil at a temperature of 150°C to 170°C (Figure 2h).

The quality of the oil used influences the quality of the product and the storage time. The longer the period of use and the greater the oil unsaturation, the greater the degradation of the product (DOBARGAGENES et al., 1989).

The point of disposal of the oil has a great impact on the processing of chips. If discarded too early, it can generate economic losses; if discarded too late, it can compromise the quality of the final product.

To evaluate the quality of the oil, the producer can undertake quick tests such as the Oil Test, sold by PoliControl Environmental Control Instruments, or the Oxifri-Test and Fritest, sold by Merck. These tests provide immediate results, as they are based on the chemical change that occurs during the frying process, usually related to the amount of polar compounds (SANIBAL; MANCINI FILHO, 2002; LOPES; JORGE, 2004).

<u>Salting:</u> Salt the product with 1% salt (sodium chloride). At this stage, other seasonings and flavourings can also be added.

<u>Drainage of excess oil:</u> Drain excess oil on absorbent paper at room temperature. To prevent the product from absorbing moisture from the environment during drainage, this step can be carried out in a greenhouse with forced air circulation at 40°C.

The oil can be drained with the use of a basket centrifuge, which allows eliminating part of the oil, though it should be noted that this step may break the chips (VILPOUX, 2003).

<u>Packaging and weighing:</u> The chips should be weighed in portions ranging from 40 to 80 g, according to the interest of the consumer market. The sealant used can be a hand-held machine, as shown in Figure 2i. In these cases, polyethylene or polypropylene packaging tend to be used. Under these conditions, the product should be consumed within 10 days, even if it is stored in the shade (SEBRAE, 2009).

In systems with greater technological capacity, it is possible to use polypropylene packages with aluminium barriers associated with nitrogen injection (VILPOUX, 2003). Packaging in aluminium barrier and modified atmosphere packages slows down the oil rancification and allows the product to be stored for more than 30 days (VILPOUX, 2003). Therefore, the shelf life of the product will vary depending on the packaging used.

<u>Storage:</u> The packaging and storage of the labelled product should be done at room temperature.

The final product will present a good appearance (Figure 2j), though variations in product quality may occur due to factors such as raw material and oil quality, unevenness of chip thickness, and frying temperature and time.

In the varieties used in the study, this technology reduced the oil content from 16 to 43%, in relation to the process which includes the bleaching step prior to frying. The chips elaborated with the described process were analyzed sensorially and were well accepted by the consumers for all evaluated attributes. As indicated above, the yield of the process depends on the raw material used, with values between 15 and 35% of the total root weight.

*Figure 2. Stages of cassava chip processing: (a) washing, (b) sanitation (200 ppm of active chlorine for 15 minutes), (c) cutting into pieces, (d) manual peeling, (e) washing of peeled roots, (f) slicing, (g) slices, (h) frying, (i) sealing and (j) cassava chips.*

**References**