Preface

This document is part of a series of training guides developed under the GRATITUDE project (described below). The Food Safety and Quality Management approaches described were developed and agreed in collaboration between the project partners and reflect the conditions in the target countries.

This training guide on good hygiene and manufacturing practices for the production of cassava wet starch for household and small and medium-sized enterprises (SME), in conjunction with hazards analysis and critical control points (HACCP) for SME, was developed under the European research project GRATITUDE – Gains from losses of root and tuber crops – and is in accordance with the European, African and Vietnamese legislation on food hygiene.

This training guide is a basic document for every food operator working on cassava processing in Vietnam and was developed according to the process used to obtain wet starch in Vietnam.

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Acronyms

EUR  Euro (official currency of the eurozone)
GHP  Good hygiene practices
GMP  Good manufacturing practices
HACCP Hazard analysis and critical control points
HQCF High Quality Cassava Flour
LE   Large enterprises
SME  Small and medium-sized enterprises
VND  Dong (Vietnamese currency)
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1. Introduction

The purpose of elaborating principles of Good Manufacturing Practice (GMP) and Good Hygiene Practices (GHP) for cassava wet starch is to provide operators with the basic rules of processing cassava in order to guarantee compliance with food safety and quality of the derived foodstuff – and therefore guarantee consumers’ health – as well as to minimise weight and quality losses.

The principles of GMP and GHP comply with the Codex Alimentarius and especially with the Regulation of the European Parliament and Council (EC) No. 178/2002, laying down the general principles and requirements of food law and establishing the EFSA (European Food Safety Authority). It also complies with the Vietnamese Law 2010-QH12 and with the African Standard ARS 53/2012 on general principles of food hygiene.

Overview of related legislative guidelines and standards:

- **Regulation of the European Parliament and Council (EC) No. 178/2002** laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety
- **Regulation of the European Parliament and Council (EC) No. 852/2004** on the hygiene of foodstuffs, establishing the rules for the implementation of the HACCP system (Hazard Analysis and Critical Control Points) and the guides to good practices development and dissemination
- **Law on Food Safety No. 2010-QH12 of Vietnam** on the general principles of food hygiene, establishing a code of practices for manufacturing and hygiene of foodstuffs, and rules for labelling and traceability
- **Standard TCVN 5603-2008 of Vietnam** establishing the rules for the implementation of the HACCP system (Hazard Analysis and Critical Control Points) and the guides to good practices development and dissemination
- **African Organisation for Standardisation ARS 846/2012** on the specification of food-grade cassava starch
2. Product description

According to ARS 846/2012, starch is a white, granular, glucose polymer (i.e. a mixture of amylose and amylopectin) with, or without, traces of protein, fats, fibres, and minerals, obtained by wet extraction processing of mature cassava (*Manihot esculenta* Crantz.) root, or cassava chips or cassava flour. Cassava wet starch stands for cassava starch with an average water content of 35% by weight.

3. Requirements for cassava wet starch

According to ARS 846/2012, food grade cassava wet starch shall be:

a) Safe and suitable for human consumption  
b) Free of extraneous matter (i.e. organic matter other than cassava starch and water)  
c) White in colour (or according to colour of the cassava cultivar)  
d) Free from ‘off’ flour and odour  
e) Tasteless  
f) Free of any insects and foreign matters

Compositional requirements of cassava starch shall be:

a) Starch by mass min. 95 %  
b) Cyanide content max. 10 mg/kg  
c) Sulphated ash max. 0.6 % by mass on dry basis;  
d) pH 5–7  
e) Total acidity max. 1 % by mass  
f) Crude fibre max. 0.2 % by mass on dry basis  
g) Chloride, max. 0.64 % by mass  
h) Viscosity, 33–34 cSTM
Physical requirements for cassava starch (on dry basis) shall be:
   a) Not less than 95% of mass of food grade cassava starch shall pass through a sieve of 100–140 μm (0.1–0.12 mm) mesh screen
   b) Food grade cassava starch shall be insoluble in cold water
   c) Food grade cassava starch shall be insoluble in 96 % ethanol

Chemical requirements for cassava starch (on dry basis) shall be:
   a) A blue-black colouration when tested with iodine

Microbiological properties of starch (on dry basis) shall be:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total plate count, CFU/g</strong></td>
<td>$10^4$</td>
</tr>
<tr>
<td><strong>Vibrio cholera, CFU/g</strong></td>
<td>absent</td>
</tr>
<tr>
<td><strong>Escherichia coli, CFU/g, maximum</strong></td>
<td>absent</td>
</tr>
<tr>
<td><strong>Bacillus cereus, CFU/g, maximum</strong></td>
<td>$10^3$</td>
</tr>
<tr>
<td><strong>Salmonella, per 25 g, maximum</strong></td>
<td>absent</td>
</tr>
<tr>
<td><strong>Yeast and mould, CFU/g, maximum</strong></td>
<td>$10^3$</td>
</tr>
<tr>
<td><strong>Staphylococcus aureus, CFU/g, maximum</strong></td>
<td>$10^2$</td>
</tr>
<tr>
<td><strong>Coliforms, per 100 g</strong></td>
<td>absent</td>
</tr>
</tbody>
</table>

Contaminants requirements for starch shall be:
   a) Cyanide content max. 10 mg/Kg (dry matter)
   b) Total mycotoxins max. 10 μg/Kg, aflatoxin B1 max. 5 μg/Kg (dry matter)
   c) Hazardous heavy metals content (lead, cadmium, mercury) must comply with the limits 0.1 mg/kg (ppm) for lead, 0.2 mg/kg (ppm) for cadmium, 0.1 mg/kg (ppm) for mercury. The limits for lead and cadmium are set on a wet basis; the limit for mercury is set for the foodstuff as sold (EU 1881/2006)
   d) Pesticides must comply with the maximum residue level (MRL) of 0.01 mg/kg (ppm) (dry matter) (EU 396/2005)
4. Production process for cassava wet starch

The process for the production of cassava wet starch in Vietnam is reported in Figure 1.

Grating (also known as rasping or grinding) and filtration are the major steps affecting the yield of cassava wet starch. Grating with a grater and filtration through a cloth (by hand or machine) should guarantee the recovery of wet cassava starch, with 35% water content by weight, of 40–60 kg for 100 kg of fresh cassava. A highly industrialised starch recovery process, at large enterprise level, guarantees a yield of 75–95%.
5. Good hygiene practices (GHP) to ensure cassava wet starch specifications

Implementation of these practices is to ensure safety and food quality by avoiding the presence of contaminants. According to the Codex Alimentarius:

- A contaminant is: any substance not intentionally added to food, which is present in such food as a result of the production, manufacture, processing, preparation, treatment, packing, transport or holding of such food, or as a result of environmental contamination.

5.1 Staff Hygiene

Operators who are directly or indirectly in contact with food must maintain an adequate level of cleanliness and behave and operate in an appropriate manner to avoid contaminating the food.

People are a potential source of disease-producing microorganisms which live in parts of the body such as hair, nails, nose, mouth, throat, bowels and sores. Therefore, it is necessary to recommend the following provisions:

- An annual medical examination for every operator concerned with handling or manufacturing of foodstuffs
- The monitoring of staff for lesions caused by Staphylococcus, though clinical examination of arms, hands, face, throat and other exposed skin, to be carried out by a medical practitioner with appropriate food handling experience
- The monitoring of staff for potential Salmonella and Staphylococcus carriers by way of bacteriological analysis
- Medical treatment for those diagnosed positive with a microorganism

Staff who are injured or sick must not handle food and should undergo medical treatment. Cover cuts and wounds with waterproof dressings. Conditions which must be reported to management should include diarrhoea, vomiting, fever, skin lesion, jaundice and discharge from ear, eye or nose.

Staff must wash their hands with soap in the following instances:

(i) At the start of food handling activities
(ii) Immediately after using the toilet
(iii) After handling raw material or any material which could lead to the contamination of the products
In agro-food industries clothing can be a major vector in food contamination. Work clothing must respect some specific principles:

- it must be kept in a separate compartment from personal clothing and the compartment must be kept clean
- it must include a cap which covers all the hair
- it must include shoes which are only worn in the factory

Wearing of personal effects such as jewellery, watches, hairpins, bracelets, bands etc. should be discouraged. Visitors must wear protective clothing and adhere to all personal hygiene requirements. Staff must not smoke, spit, chew gum, sneeze or cough over unprotected food. Domestic animals are not allowed in the factory. Table 1 and Figure 2 summarise the practices which are and are not allowed.

**Table 1: Staff hygiene practices: what is and what is not allowed**

<table>
<thead>
<tr>
<th>Practice</th>
<th>Allowed</th>
<th>Not allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Objects</td>
<td><img src="image" alt="Eye glasses" /> <img src="image" alt="Bracelet" /> <img src="image" alt="Hairpin" /></td>
<td><img src="image" alt="No allowed" /> <img src="image" alt="No allowed" /> <img src="image" alt="No allowed" /></td>
</tr>
<tr>
<td>Shoes</td>
<td><img src="image" alt="Shoe" /></td>
<td><img src="image" alt="No allowed" /></td>
</tr>
<tr>
<td>Injuries/Illness</td>
<td><img src="image" alt="Bandaged hand" /> <img src="image" alt="Bandaged hand" /></td>
<td><img src="image" alt="No allowed" /></td>
</tr>
<tr>
<td>Clothing</td>
<td><img src="image" alt="Hairnet" /> <img src="image" alt="Head scarf" /></td>
<td><img src="image" alt="No allowed" /></td>
</tr>
<tr>
<td>Practice</td>
<td>Allowed</td>
<td>Not allowed</td>
</tr>
<tr>
<td>-------------------</td>
<td>------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>Eating and Drinking</td>
<td><img src="image" alt="Canteen" /></td>
<td><img src="image" alt="In the workplace" /></td>
</tr>
<tr>
<td>Behaviour</td>
<td>The habit of spitting should never be allowed, both for hygiene concerns and for a good personal image</td>
<td><img src="image" alt="DO NOT SPIT" /></td>
</tr>
<tr>
<td>Smoking</td>
<td><img src="image" alt="Designated smoking area" /></td>
<td><img src="image" alt="In the workplace" /></td>
</tr>
<tr>
<td>Animals</td>
<td><img src="image" alt="Animals" /></td>
<td></td>
</tr>
</tbody>
</table>
Figure 2: Example of personal hygiene rules panel to be placed in the working area, in an easily visible position

5.1.1 Staff hygiene facilities and toilets

Hygiene facilities shall be available to staff to ensure that the degree of personal hygiene required is maintained. The facilities shall be located close to the points where hygiene requirements apply and shall be clearly designated.

5.2 Designated eating areas

The staff canteen and designated areas for food storage and consumption shall be situated so that the potential for cross contamination of the production area is minimised.
5.3 Processing plant hygiene: maintenance, cleaning and sanitation

Cleaning and sanitation programmes should be established to ensure that food processing equipment and the work environment are kept in hygienic conditions. The programmes should be monitored for continued suitability and effectiveness. The following conditions should be guaranteed:

a) The processing plant and equipment should be kept in appropriate conditions and state of repair
b) Facilities and equipment shall be maintained in a condition that facilitates wet or dry cleaning and/or sanitation
c) Cleaning and sanitation agents should be food grade, clearly identified, stored separately and used according to the manufacturer’s instructions.

Cleaning aids required during the preparation of HQCF include the following: stiff brooms, soft brooms, soft brushes, hard stiff brushes, mops and mop buckets, vacuum cleaners with accessories, net sponges, mechanical scrubbers, squeegees, sweeping brushes, long handled brushes, water hoses and dusters. Cleaning chemicals may include detergents in the form of soaps, disinfectants, quaternary ammonium compound etc.
6. Good manufacturing practices (GMP) for cassava wet starch

GMP are a combination of manufacturing and quality control procedures aimed at ensuring that products are consistently manufactured according to their specifications. These practices are implemented to ensure the standardisation of the final product through specific steps, the order of which must be respected. GMP are specific for each product.

6.1 Fresh cassava production point (supplier quality assurance)

Cassava suppliers must ensure the quality and safety of the product. In particular:

- Cassava farms must be appropriately located within environments free from hazards
- Plant pest and disease control measures must be undertaken with chemical, biological or physical agents under the supervision of agricultural experts with a thorough understanding of the hazards involved, including the possibility of toxic residues being retained by the crop
- Farmers are to receive training on good agricultural practices, for example in the application of fertilisers, pesticides and the storage of hazardous chemicals
- Weeds must be controlled and destroyed in farm fields and soil must be well conditioned to allow maximum crop yield
- Plant diseases must also be controlled and managed effectively.
- Where possible, records on chemical and fertiliser application regimes as well as farm records should be kept for reference

6.2 Design and facilities

Processing plants should not be sited close to areas with high industrial pollution. The land must slope gently and have a proper drainage system. Facilities must be constructed to keep out pests and permit adequate arrangement, maintenance, cleaning and functioning of equipment. The internal designs must be ideal for good hygiene practices and protect against cross contamination during operation. Structures must be built with durable materials which are easy to maintain, clean and disinfect. The design should minimise the formation of dust from flour during production. Walls and floors should be smooth, impervious and easy to sweep and wash. Ceilings and roofing should be well-finished to minimise the build-up of dirt, condensation and the shedding of particles. Windows should have insect-proof net screens that are easy to clean and allow proper ventilation to minimise dust.
Food contact surfaces must be easy to clean, disinfect and maintain and should be non-toxic to the products. Iron reacts with cyanide, so equipment of this metal should be used with caution. All equipment used for peeling, washing, grating, de-watering, drying and milling should be of a design which will comply with product quality specifications. There should be monitoring devices available to check the product during manufacture. Facilities should be available for handling, cleaning, waste disposal and ensuring staff hygiene. Staff should have protective clothing, nose and mouth guards as well as hairnets. There should be adequate natural ventilation, good lighting, and storage facilities which are ideally separate and prevent access by and harbourage of pests.

Figure 3 shows an example of a **good layout** for food processing.

![Figure 3: An example of a good layout for food processing](image)

**6.3 Walls, floors, Windows and Roofs**

Brooms and brushes must be used to scrub and clean the walls and floor, and dirt hosed away down drains. High-pressure jets must be used for relatively inaccessible spots covered with tenacious soil which cannot be dealt with by a brush. This type of cleaning should be done frequently for wet processing areas of cassava, such as the peeling, grating and de-watering or pressing areas. Smooth floors may be dried using rubber squeegees. Rubber strips of squeegees must be pressed in close contact with the floor by applying pressure on the handle and pushing them along floor. Walls and floors must be scrubbed with detergent solution, rinsed and dried. Warehouse and
storage room floors must be cleaned with a vacuum cleaner to remove dust or spilt dried materials. Appropriate vacuum cleaning attachments must be used to collect dust and to clean roof girders. Roof girders must be cleaned before the floors are cleaned. The order of cleaning must be planned so that dirt is washed down onto a surface to be cleaned and not onto one that has already been cleaned. Cleaning must start from the ceiling down to the floor. Scrubbing and mopping of floors, cleaning of window and window screens must be done using clean water or vacuum cleaning.

6.4 Cleaning and maintenance

Equipment should be well maintained to facilitate sanitation procedures, to function as intended and prevent contamination. Metal deposits from the attrition mill resulting from poor adjustment of the mill plates, and jewellery and contaminants such as grease and lubricating oils, must be avoided in the final products of cassava or yam. Physical and chemical cleaning as well as disinfection should be carried out regularly. Any holes, drains and other access routes of pests should be sealed. Waste from the plant must be disposed of promptly to avoid attracting pests. Responsible staff members should be put in charge of sanitation to monitor and check the effectiveness of cleaning and maintenance, to keep records of cleaning regimes and conduct regular auditing of the premises for sanitation and hygiene.

6.5 Pest Control

Rodents

A staff member must be responsible for monitoring the plant for rodent infestation and for their elimination. Their assignment should include baiting and making recommendations on repairs that are necessary to keep out rodents. Access to processing and storage facilities by rodents must be completely avoided. Cracks must be sealed and holes filled once observed. Containers for storing food must be rodent proof. Traps with bait must be placed along rodent pathways. Anticoagulant rodenticides may be used to kill rodents.

Insects (Drosophilla), cockroaches, houseflies etc.

Regular spraying of the work environment with insecticides and the use of screen netting must be ensured to eliminate insects, cockroaches, houseflies etc. Insecticides must not be used on the production floor during production and must not be sprayed directly over food contact surfaces or equipment that comes in direct contact with food. Dark cabinets and drawers must be regularly checked for eggs of cockroaches and thoroughly cleaned and sprayed with insecticides.
Birds, reptiles and domestic animals

These must be continuously monitored and controlled by appropriate means to avoid product contamination, especially during drying of pulverized cassava pressed cake in the open.

6.6 Control of operations

All medium- to large-scale processing enterprises should implement a HACCP programme to guarantee the safety of their products. Monitoring procedures must check against chemical, microbiological and physical contamination of products. Packaging of food products should permit adequate protection from damage, contamination and allow adequate labelling and must not react chemically with the product. Packaging must be impermeable to water and oxygen.

Records of processing, production and distribution, if kept, will enhance the credibility of the food safety systems. Staff must have the requisite skills and training in food hygiene principles and practices, be able to predict potential risks, and take appropriate preventive and corrective actions. Products revealed to be hazardous to health should be recalled from markets and not sold for human consumption.

6.7 Transportation

During the transportation of food products, avoid the contamination of products and packaging materials. Clean and disinfect vehicles where necessary. Maintain ideal temperatures, humidity and avoid dust and water from coming into contact with products.

6.8 Product Information and Consumer Awareness

Practice the First-in First-out (FIFO) principle of stocking. Mark product containers for lot identification and traceability. Products for the consumer market must bear adequate information for handling, storage, preparation and for safe and correct use of the product.
7. Training

The target group for training are employees who produce cassava wet starch at household or SME level, and for domestic and commercial use. The following instructions are based on the GHP and GMP reported in the previous pages.

7.1 Training Needs

The trainee must have a checklist which contains the following:

**MATERIALS**
1. Raw materials: cassava roots
2. Basins for washing roots
3. Clean water for washing roots and for extracting starch
4. Clean stainless steel knives for peeling or clean stainless steel mechanical peeler
5. Clean cloth or used sacks for washing
6. Clean cloth (cotton or sponge) for dewatering
7. Packaging materials for the finished product

**EQUIPMENT/AREAS**
1. Cassava peeler (in case of mechanical peeling)
2. Cassava grater
3. Well or tanks for sedimentation
4. Storing room

**CLEANING and PROTECTIVE TOOLS**
1. Detergent
2. Disinfectant
3. Gloves
4. Overall
5. Mask for nose
6. Head gear
7.2 Stages of cassava wet starch production

- **Cassava fresh roots**

Use fresh cassava roots harvested 10–12 months after planting. The fresh roots must be healthy, without rot, and well-handled from the farm. Select healthy roots from the lot and discard poor quality roots. Farmers, processors and marketers must be educated to stick to a particular variety of cassava; they should be familiar with each variety and the use of mixed varieties in processing must be discouraged.

The cassava varieties that are most rich in starch generate the smallest amount of residue and require the smallest amount of water for extraction.

Cassava roots must be stored in clean conditions, not directly on the floor. Use a clean cloth to protect the roots from dirt, rodents, pests, contamination with heavy metal from fuels, and microbiological contamination.

In the processing of cassava starch it is vital to complete the whole process within the shortest time possible, since as soon as the roots have been dug up, as well as during each of the subsequent stages of manufacture, enzymatic processes are apt to develop with a deteriorating effect on the quality of the end product. This calls for a well-organised supply of roots within relatively short distances of the processing plant and, furthermore, for organised processing stages that will minimise manufacturing delays. Thus, while simple in principle, the manufacture of good cassava starch requires great care. The roots are normally received from the field as soon as possible after harvest and cannot be stored for more than two days. Since the presence of woody matter or stones may seriously interfere with the grating process by stoppage or by breaking the...
blades, the woody ends of the roots are chopped off with sharp knives before the subsequent processing operations.

**Washing**
Wash sorted cassava root in water to remove sand, dust and impurities. Use good quality water.

![Washing Cassava Roots](image1.png)

**Peeling and soaking in water**
Peel with clean stainless steel knives and remove woody tips. Ensure that the rind is completely removed and avoid excessive waste of roots. Mechanical peelers are available for medium- to large-scale processing. Use potable water to soak peeled cassava roots.

![Peeling Cassava Roots](image2.png)

a) Peeling must be performed on an elevated platform, away from the ground, even in the presence of a protective cloth, to avoid contamination with dirt and chemicals
b) Do not contaminate peeled cassava roots with feet, personal objects and clothing. Cassava peeling must be done inside the factory, as with other operations, and not outside on the ground.

c) Correct way to peel cassava

d) Wrong way to peel cassava, this will result in losses of useful cassava
Cassava peeling tool (for households)

Correct use of the cassava peeling tool
Different options for peeling are possible:

**Option 1 – Periderm removal**

Periderm and stalks of cassava are removed with stainless steel knives; peeled cassava is immersed immediately in water to prevent oxidation or a brownish-yellow colour appearing on the surface of the roots.

![Periderm removal](image1)

a) Periderm removal  

b) de-periderm cassava washing

**Option 2 – Periderm and cortex removal**

One alternative method for peeling the roots is to remove both kinds of outer layer of the roots (periderm and cortex). When the periderm and cortex are totally removed, the roots become white. Peeled roots (de-cortexed roots) must also be immersed immediately into water after peeling.

![Periderm and cortex removal](image2)

a) Periderm and cortex removal  

b) de-periderm and de-cortex cassava washing

**Option 3 – Periderm and cortex removal by chemicals**

Another alternative method of peeling the roots is to remove the periderm and cortex using chemicals. After the root was soaked in $\text{H}_2\text{SO}_4$ 0.2% for 3 hours, the peel (cortex and periderm) were easier to remove from the flesh.
a) Root after chemical treatment. Peel (periderm and cortex) is easily removed

❖ Washing peeled cassava:
Wash peeled cassava roots with clean water to remove any dirt, including sand, soil, leaves or other impurities. Wash immediately after peeling to avoid any change in colour. Repeat 2–3 times until the roots are completely clean.

a) Washed cassava roots should be clean and spotless
b) Do not process cassava roots that are rotten or damaged

**Grating:**

Grate roots properly in a clean stainless steel grater to obtain uniformly smooth mash without lumps. In case of non-uniform mash, grate again until smooth mash is obtained. The smoothness of the mash determines the quality, yield and market value of the finished product.

**NOTE:** The smaller the particles, the higher the yield in starch.

a) The grater should be motorised with petrol or diesel

b) The grater must have a stainless steel grating drum
Cassava wet starch (food grade)
GHP, GMP, HACCP

c) A rusty grater must not be used

A traditional grater made from perforated metal sheet must not be used

d) A rusty grater must not be used

e) A traditional grater made from perforated metal sheet must not be used
f) Load the grater with washed roots while the engine is running

h) Clean woven polyethylene sacks must be used to collect cassava mash after grating. Wash the sacks after use and store in a clean dry place; wash the sacks again before use.

g) Do not use your hands to push cassava roots against the grater
i) At the household level, grated cassava can also be collected in a receptacle and then transferred into a sack for pressing.

**Starch extraction**

Starch is extracted by mixing grated cassava with good quality water. The volume of water used is in the ratio 3:1 with grated cassava (3 x volume of water to 1 volume of grated cassava). The mixture of water and grated cassava is stirred by hand or mechanically until constant turbidity of the slurry. The slurry must be filtered through a cotton cloth (like cheesecloth) to retain fibre and other insoluble substances. The procedure of starch extraction must be done again for the filtered pulp retained in the cloth; in this case the ratio of water used can be reduced to 1:1.

**NOTE: Using groundwater for starch extraction**

The groundwater resources in Vietnam are abundant. While the quality of ground water remains good, there are some pockets of contamination. There is evidence of pollution – from poorly maintained septic tanks, garbage dumping, and industrial effluents and overexploitation in parts of Hanoi, Ho Chi Minh City and the Mekong River Delta. A research project in Hanoi, carried out in 2003, has shown alarming signs of ground water contamination by ammonia in the South of Hanoi. The level of ammonia in the treated water at the three treatment plants is higher than the national standard by 2–8 times.

**Sedimentation**

The filtered starch milk is settled to allow the starch to precipitate. The term ‘settling’ refers to the whole series of operations to separate the pure starch from the soluble and insoluble contaminants. The quality of the starch produced depends to a great extent on the effectiveness of this step, which comprises settling in successive tanks, settling on flour tables, and/or the action of modern separators. Each operation can be
used alone or carried out in different combinations. They all result in a more or less concentrated suspension of starch in pure water.

Settling must be completed within as short a time as possible because of the very rapid chemical changes in the solution (the formation of very stable complexes between starch and proteins, fatty material and so on). As it is almost impossible to separate the pure starch from these complexes, the value of the starch for many purposes is seriously lowered by those processes. At a later stage, when the supernatant water is rich in sugars and other nutrients, microorganisms start to develop and eventually lead to a vigorous fermentation. Alcohols and organic acids are produced, among which butyric acid is particularly noticeable on account of its odour. These biochemical changes exert a negative influence on the quality of the starch as do the above-mentioned physicochemical ones. It is all but impossible to prevent the formation of this acid in the processing of cassava; traces of it are discernible even in very good brands of the finished starch. Indeed, small rural mills can often be located by the smell of butyric acid.

As a consequence of the necessity for speed, the technique of settling has developed rationally from the simple settling tank to the settling table, with a considerable reduction in the time of contact between starch and starch water. In modern processing methods the whole period between grating and drying is reduced to about one hour.

**Sedimentation in tanks**

This is the oldest method, and, indeed, tanks are the obvious means at low production levels in small rural mills. In very small mills, wooden barrels or troughs serve the purpose, but as soon as the production reaches several hundred kilograms of starch per day, it is usual to construct tanks of cemented brickwork sunk into the ground. Rectangular and round tanks or basins are used in the Far East for the settling of starch as well as for the washing and the purification of the settled starch. Generally, the sedimentation basins should have a depth of at least 50cm, with a surface of 2 x 4m. A 50cm layer of starch milk generally generates a starch deposit of 10–15 cm. The surface layer of water contains 6–9% proteins, 0.5% lipids, and 0.2% fibre, and can be used for animal feeding.
a) It is essential that the starch does not remain in contact with cement or masonry any longer than necessary, as this has a notably deteriorating influence on starch quality. Therefore, the bottom of the tanks is covered with a kind of wood which is resistant to the prolonged action of the slurry and does not react with the starch. In addition, a wooden skirting is fitted on the walls up to a height of 10–15cm so that the whole mass of starch contained in a tank full of starch milk will settle against a wooden surface. The lining may be made of tiles rather than wood. Holes (provided with stoppers) are fitted into the walls, preferably at different heights, to let off the supernatant, or excess liquid after settling, one hole just above the floor being used for the purpose of cleaning the tank between settlings.

During settling, a number of tanks are usually filled in succession, the flow of starch milk being conducted to the next tank, after the previous one has been filled up, by means of checks placed in the channels. **Settling in tanks usually takes at least six hours.** After grating, which is often carried out early in the morning, the supernatant liquid is let off in the afternoon. However, when grating is carried out late in the morning, the flour is left to settle overnight, up to 20 hours or more. Although settling is more complete in this case, the action of enzymes and microorganisms may also have progressed.

When settling is complete, supernatant water is let off by removing the stoppers from the holes, beginning with the upper ones, thus reducing turbulence as much as possible. Notwithstanding, in drawing off the last of the supernatant liquid, appreciable amounts of the lighter starch fractions in the upper layers of the sediment go with it. At household levels and in also small and medium-sized enterprises, the drained liquid is not processed in these small mills; it constitutes a loss, which,
together with the starch originally left in suspension, may be estimated at 5–10% of the starch produced.

b) The upper layer of sedimented starch, which has a yellowish-green tint, contains many impurities and is generally scraped off and rejected. This operation must be performed in clean conditions. Do not step on the layer; stay outside the tank and use brushes from outside the tank. Stepping on the starch can cause serious contamination and microbiological and physical hazards.

❖ Dewatering

After removing water and black starch from the top, a sponge, cotton or wool cloth (like towels, bed sheet, blankets), can be put on the starch layer to absorb the remaining amounts of water. These cloths can be easily cleaned and sterilised by washing. Examples of different types of cloths, in order of water holding capacity are: sponge > cotton > wool.

a) Sponge cloth  
b) Cotton towels
b) Cotton (flannel) bed sheet

These cloths can hold more than twice their weight of water. Their use also helps to protect the starch layer from contamination, provided they are kept clean.

**NOTE on the use of coal ash for starch dewatering**
Currently, coal ash is put on the starch sediment in order to reduce moisture; after removing this layer of coal ash, wet starch is sold. **This practice must be avoided.**

Coal ash – the waste material left after coal is burned – contains arsenic, mercury, lead, hexavalent chromium, and over a dozen other heavy metals, many of them toxic, and which can contaminate the starch. Disposal of the growing mounds of coal ash is creating grave risks to human health. Toxic constituents of coal ash are blowing, spilling and leaching (dissolving and percolating) from storage units into air, land and human drinking water, posing an acute risk of cancer and neurological effects as well as many other negative health impacts: heart damage, lung disease, kidney disease, reproductive problems, gastrointestinal illness, birth defects, and impaired bone growth in children.
Storage
After dewatering the wet starch can be stored in the form of tiles or blocks.

a) Wear protective and clean clothing when cutting the blocks. Use a mouth and nose mask to protect the starch against contamination.

b) Cover blocks with a protective cloth or plastics sheets to avoid contamination. The storage room must be clean, without rust or dust. Do not store directly on the ground; store on wood or plastic sheeting.

Wet starch can be stored, to be used for many other purposes in off-seasons. The storage can be done outside in the open, or in an open pit or thatched house.
c) Storage in open pits and in the open air can contaminate the starch. Cover the layer with a cotton bed sheet, anchored to the corners of the pit to avoid direct contact with the starch. The cotton allows respiration and protects against birds and dirt.

Long term storage (2–5 months) of cassava starch results in a number of adverse quality changes. As identified by the industry, these are:

a) reductions in starch paste viscosity after storage

b) loss of starch (in terms of wet weight) during wet storage

c) losses resulting from poor settling of stored starch

d) reduction in optical clarity and discolouration of starch pastes and products prepared from stored starch

e) unpleasant odours arising from pastes prepared from stored starch
**Transportation**

Transport of wet starch must be done according to the GMP reported in the previous section.

a) Cover the blocks with protective cloths. Use clean containers, with no rust, dirt or extraneous matter like glass, metal or wood.

b) as figure a) above

**Packaging and labelling**

Desired quantities of wet cassava starch must be packed in polythene bags and/or sacks, sealed or stitched as appropriate.

Label the packages properly according to the standards of national regulatory agencies. The packaging should not leave any toxic substances or undesirable odours.
or flavours on the product. This product could be packaged in polypropylene sacs lined with thin polythene material for bulk sales, or in smaller bags (paper, polythene/polypropylene) as unit packages for the retail market. The unit packages could be arranged into secondary packages such as cardboard boxes.

In labelling, the following information about the product should be provided:

- The common name and/or brand name
- Name of the manufacturer or packer
- Batch or code number
- Net mass (in metric units)
- Date of manufacture
- Country of origin
- Expiry date
- Preparation, nutritional and storage information
- Other information required by the national regulatory agencies

a) Wet starch preserved under vacuum
b) An example of a vacuum machine for home and household use. Prices start from EUR 15 (approximately VND 412000). Two rolls of plastic bags 28cm x 50m are roughly the same price.

7.3 Equipment cleaning

❖ **Cleaning knives, containers and tanks**

Wash knives, containers and tanks with soap using a sponge and water. Scrub internal and external sections using a sponge with soap and water. Rinse off the soap with abundant water after scrubbing and allow the water to drain off leaving bowls, pans and knives dry after a few minutes. Cleaning should be done before and after every operation. **Caution** – caustic soda should not be used to wash aluminium.

❖ **Cleaning the grater**

Using brushes or sponges, with water, wash cassava residues from the outlet chute, hopper, and rinse off loose residues by spraying water with a hose. Disassemble grating compartments at the close of daily operations and clean off all grated cassava residues using brushes and water. Allow to dry after cleaning before reassembling. Make sure water does not get into the motor or engine of the machine.
8. Hazard analysis and critical control point (HACCP) for cassava wet starch (only for SME and LE)

Cassava wet starch to be marketed should respect the HACCP principles, which are derived from GHP and GMP. The objective of HACCP system is to identify all the hazards related to the production of a specific foodstuff, and define preventive measures and corrective actions to avoid them. Particular benefits of HACCP system are:

a) Preventing possible hazards and supplying safe products
b) Minimising risks of food poisoning
c) Increasing consumer confidence
d) Increasing industry authenticity
e) Supplying active auto-control system
f) Minimising product cost
g) Making marketing easier
h) Increasing products' shelf life
i) Solving product problems systematically
j) Making product export easy, due to its international acceptability
k) Increasing food safety and hygiene awareness among food industry staff

The HACCP requirements should take into account the principles contained in the Codex Alimentarius. They should provide sufficient flexibility to be applicable in all situations, including in small businesses. In particular, it is necessary to recognise that, in certain food businesses, it is not possible to identify critical control points and that, in some cases, good hygienic practices can replace the monitoring of critical control points. Similarly, the requirement of establishing ‘critical limits’ does not imply that it is necessary to fix a numerical limit in every case. In addition, the requirement of retaining documents needs to be flexible in order to avoid undue burdens for very small businesses.

Food safety is a result of several factors:

- legislation should lay down minimum hygiene requirements
- official controls should be in place to check food business operators’ compliance
- food business operators should establish and operate food safety programmes and procedures based on the HACCP principles
Critical control points for HQCF have been identified together with preventive measures, corrective measures and verification tools.

Figure 4: Identification of critical control points (CCPs) in cassava wet starch process
Table 2: HACCP with critical control points for the production of cassava wet starch

<table>
<thead>
<tr>
<th>Step/Material</th>
<th>Hazard</th>
<th>Preventive measure</th>
<th>CCP</th>
<th>Critical Limits</th>
<th>Monitoring Procedure</th>
<th>Corrective action</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Cassava*</td>
<td>Use only sweet cassava variety</td>
<td>Sweetness of cassava</td>
<td>Check variety of cassava before each bath of starch</td>
<td>• Reject bitter varieties</td>
<td>• Train operators to use only sweet variety</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>variety</td>
<td>extraction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Water *</td>
<td>Heavy metals, chemicals, microorganisms,</td>
<td>Water HACCP</td>
<td>Compliance with specifications</td>
<td>• Inform the water authority of contamination</td>
<td>• Stop use of suspect water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>disinfectant overdose, foreign matter</td>
<td>Clean container/pipeline</td>
<td></td>
<td></td>
<td>• Recall suspect wet starch</td>
</tr>
<tr>
<td>C</td>
<td>Peeling</td>
<td>Incomplete removal of peel</td>
<td>Peel in peeled cassava</td>
<td>• Check the peeling operation</td>
<td></td>
<td>• Train operators to peel in the correct way</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Verify efficacy of knives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Washing</td>
<td>Heavy metals, chemicals, microorganisms,</td>
<td>Check water quality and</td>
<td>• Compliance of water with specification</td>
<td>• Inform the water authority of contamination</td>
<td>• Stop use of suspect water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>disinfectant overdose, foreign matter</td>
<td>integrity of cassava</td>
<td>• Integrity of peeled cassava roots</td>
<td></td>
<td>• Recall suspect product</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>before washing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step/ Material</td>
<td>Hazard</td>
<td>Preventive measure</td>
<td>CCP</td>
<td>Critical Limits</td>
<td>Monitoring Procedure</td>
<td>Corrective action</td>
</tr>
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</tr>
<tr>
<td><strong>E</strong> Grating</td>
<td>Contamination with foreign matter, particularly with rust on grater</td>
<td>Grater must be clean and without rust</td>
<td>CCP</td>
<td>Critical Limits</td>
<td>Monitoring Procedure</td>
<td>Corrective action</td>
</tr>
<tr>
<td>F Extraction</td>
<td>Contamination by water and operators, microorganisms, foreign matter</td>
<td>Good hygiene practices</td>
<td>CCP</td>
<td>Critical Limits</td>
<td>Monitoring Procedure</td>
<td>Corrective action</td>
</tr>
</tbody>
</table>
| G Sedimentation| Extraneous matter from environment | • Good hygiene and manufacturing practices  
• Development of undesired microorganisms  
• Reduction of sedimentation time  
• Use of chemicals to speed up starch precipitation | CCP | Critical Limits | Monitoring Procedure | Corrective action |

- **Check integrity of grating machine**
- **Maintenance of the grating machine**
- **Check the stirring procedure**
- **Staff must wear protective clothing and mask**
- **Reject products that do not comply with specifications**
- **Check settling procedure, tanks and times**
- **Good hygiene practices**
- **Reject products that do not comply with specifications**
## Cassava wet starch (food grade)

GHP, GMP, HACCP

### Step/Material | Hazard | Preventive measure | CCP | Critical Limits | Monitoring Procedure | Corrective action
--- | --- | --- | --- | --- | --- | ---
H | Dewatering | • Heavy metal from coal ash  
• Microbiological contamination | • Do not use coal ash  
• Use cotton, sponge or wool clothes to remove water | 1 | Contamination levels comply with international regulations | Good hygiene practices | Use only clean and sterilised cloths

I | Storage | Contamination by pests, chemicals, microorganisms and foreign matter | • Use approved plastics to cover the starch when stored in holes  
• Do not store for more than 3 months in pits (aerobic conditions)  
• Store block of starch under vacuum, in anaerobic conditions | | Compliance of final product with specifications | • Check plastic cover for holes and wear and tear  
• Check sealing machine | Reject products that do not comply with specifications

* Cassava and water quality in Vietnam are established as a pre-requisite
9. Conclusions

Cassava wet starch processing in Vietnam is amenable to some improvements, according to good hygiene and manufacturing practices. For the extraction of starch tap water should be used; tanks used for sedimentation must be improved according to the suggestions given in the training section. Wastewater discharged after sedimentation must be treated after collection in specific basins. Coal ash used in dewatering must be avoided as it is a very toxic compound; other cheap alternatives are possible, such as towels, bed sheets and blankets.

Cassava wet starch is an important commodity from an economic point of view and for the food security of populations for whom cassava is the main source of carbohydrates. Therefore, it is extremely important to process cassava according to good hygiene and manufacturing practices in order to minimise root losses, depreciation and contamination of the final foodstuffs. Food operators must be trained on the production of the cassava wet starch as they are the focal point for protecting the health of consumers.
References


