QUALITY CRITERIA FOR CASSAVA FLOUR PRODUCTION WITH FLASH DRYER

Elaborated by L. Alejandro Taborda Andrade. Revised by Thierry Tran. January 2021

Scaling Flash Drying

Harvest

Appropriate variety and age

Cassava should be 10-12 months old at harvest (Some varieties 15-18 months)

Roots quality

Ensure that harvested cassava roots are fresh, firm, clean, wholesome and free from pests and diseases.

Process soon after harvesting

Transport harvested cassava roots to the processing site quickly. Process within 8-12 hours of harvesting

Influence on yield

Careless peeling, use of tiny, woody, or spoilt roots will lead to a low yield of flour.

Peeling

Peeling loss

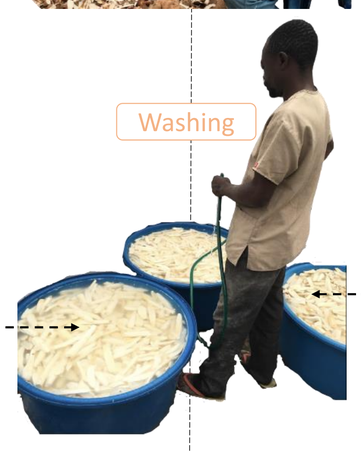
Range from 10 to 22 percent, depending on the Variety and carefulness of the people involved in peeling.

Water quality (chemical and biological)

Parameter WHO guideline (max. acceptable limits)
Appearance and Taste = Should be acceptable
Color = 15 TCU (True Color Unit)
Turbidity = 5 NTU (Nephelometric Turbidity Units)
Total Dissolved Solids = 1000 mg/L
pH = 6.5 - 8.5
Total Hardness = 500 mg/L
Iron (Fe) = 0.3 mg/L
Sodium = 200 mg/L
Potassium = 30 mg/L
Calcium =200 mg/L
Magnesium = 150 mg/L
Manganese (Mn) = 0.5 (P) mg/L
Chloride (Cl) = 250 mg/L
Fluoride (F) = 1.5 mg/L
Nitrite (NO_2) = 3 (acute); 0.2 (chronic) mg/L
Nitrate (NO_3) = 50 (acute) mg/L
Ammonia (NH_3) = 1.5 mg/L
Sulphate (SO_4) = 250 mg/L
Total coliform bacteria = 0 coliforms/100mL
E.coli or thermotolerant coliform bacteria= 0 coliforms/100mL

FAO (2006); WHO (2006)

Washing



Use potable water for washing/ fermentation

Complete absence of dirt, fecal matter or offensive odor in water supplied

Grating

Use clean grating/press machines

Complete absence of dirt inside and outside of the machine. Ensure grater are washed after end of daily operation

Roots quality

Ensure that harvested cassava roots are fresh, firm, clean, wholesome and free from pests and diseases.

Pressing

Cyanide (< CNP 50mg/kg)

Efficient dewatering to remove liquor containing cyanogens

Target humidity

38-40% moisture after pressing

Cyanogenic potential (CNP) analysis

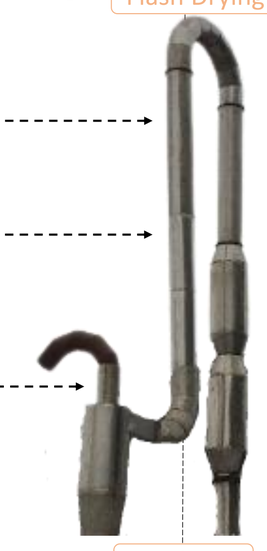
It can be determined by the following two methods:[1]

a. Qualitative test (Quignard's test)
b. Quantitative determination (alkaline titration method)

Moisture Determination [2]

3g of sample of flour
Dry at 105°C for 18hrs (overnight)
The % moisture is calculated by the formula:
% moisture = 100 x $(W_2-W_3)/(W_2-W_1)$
Where:
W_1 = dish weight
W_2 = dish weight + sample weight before drying
W_3 = dish weight + sample weight after drying

Flash Drying



Pipe length

A least 17 to 20 m

Flour Residence time

1.5 to 2 s

Air velocity in the pipe

10-12 m/s

Feed rate of wet flour

300-400 kg/hr

Temperature after cyclone

55-60°C

Temperature before feeder

160-180°C

Packing

Packing and storage of HQCF

Good sealing of polyethylene bags. Use packing materials that are not permeable to air or moisture

Quality characteristics and requirements of HQCF (high quality cassava flour) for food uses[1]

Quality characteristics
(a) Moisture content (MC) <12 %
(b) Starch Content 65-70%
(c) Total ash on dry matter basis, maximum 3%
(d) Acid insoluble ash, maximum by mass 0.15%
(e) Total titratable acidity (as lactic acid) < 0.25%
(f) Crude fiber on dry matter basis, maximum 2%
(g) Pasting Temperature < 74°C
(h) Cook Paste Viscosity, minimum 740 BU
(i) Total cyanogens (CNP) < 10 mg/kg HCNeq
(j) pH > 5.8
(k) Particle size 250 - 500 µm. Alternatively at least 90% by mass shall pass through 0.6mm sieve.

Storing

Storage of HQCF

Regular fumigation of storerooms. Inspection of unit packages during store looking for insects and any other contaminations

[1]Dziedzoave, N. T., Abass, A. B., Amoa-Awua, W. K., & Sablah, M. (2006). *Quality management manual for production of high quality cassava flour*. IITA.
[2]Bainbridge, Z., K. Tomlins, K. Wellings and A. Westby (eds) (1996). Methods for Assessing Quality Characteristics of Non-Grain Starch Staples. Chatham, UK: Natural Resources Institute.

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QUALITY CONTROL OF CASSAVA STARCH

Elaborated by L. Alejandro Taborda Andrade. Revised by Thierry Tran. January 2021

Water
Moisture content

Aluminium container → Dry 15 mins at 105°C → Cool in dessicator → Weigh 3-5g starch in container → Dry 18 hours at 105°C → Record weight of starch after drying

% Moisture content (wet basis) = Weight after drying / Weight before drying x 100, Measurement should be done in triplicates. Target: <13% moisture content

Starch
Polarimetry

Starch solubilized in boiling hydrochloric acid solution → Filter ← Starch dispersed in 40% ethanol

Measurement of optical rotation of filtered solutions

The amount of starch can be determined based on the difference between the optical rotations of the two solutions. Target:

Premium grade: 85%
Grade 1: 83%
Grade 2: 80%

Proteins
Kjeldahl

Kjeldahl method:
- Sulfuric and nitric acid digestion at 420°C
- The amount of nitrogen is obtained by titration of the resulting mixture.
- %Protein = %Nitrogen x 6.25
- Usual value: < 0.3%

Fibers (lignin, cellulose)
Digestion (hydrolysis)

Objective: Detection of contamination of the starch with fibers (cellulose, lignin)

1st digestion in sulfuric acid → 2nd digestion sodium hydroxide → Filter (Whatman 42) → Rinse residue and precipitate with ethanol → Dry (105°C, 18 hours) and record weight → Ignition (600°C, 3 hours) and record weight

% Crude fiber = (Weight after digestion – Weight after ignition) / Weight of sample x 100

Pulp (fiber) contamination
Sieve test

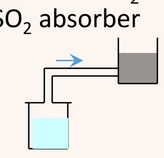
Objective: Check presence of large fibers in cassava starch

Disperse 50g of starch in distilled water → Filter dispersion through a test sieve (106µm) → Collect the leftover on the sieve and transfer to measuring cylinder → Record volume of pulp sediment

A high quantity of sediment indicates that the sieves used in the factory may be damaged. Target: Premium grade < 0.2mL / 50g starch -Grade 1 < 0.5mL / 50g starch- Grade 2 < 1.0mL / 50g starch

Sulfur dioxide (SO_2)
Extraction - titration

Distillation of SO_2 into SO_2 absorber



Sample digestion in hydrochloric acid

Sulfur dioxide is used to improve the yield of starch extraction. The level of SO_2 in the finished product must be measured to check it is within safe limits.

1st determination: Titration with sodium hydroxide (NaOH) → **2nd determination**: Addition of $BaCl_2$ to precipitate sulfur into $BaSO_4$. The weight of precipitate after drying reflects the level of SO_2 in the starch

-Reference: AOAC Monier-Williams method: Double determination by titration and by gravimetric method.

Cyanogens
Extraction - titration

Sample extraction: Grinding + Washing with extraction solution

Objective: Determination of safety of cassava starch

- Total cyanogen: Digestion of the extract by linamarins (enzymatic method) to release cyanide
- Non-glycosidic cyanogens: Acid digestion of the extract
- Free cyanide: Dilution of the extract with buffer.

→ Reaction of the extracts with chloramine T and pyridine/pyrazolone reagents → Colorimetric determination of cyanide by absorbance reading at 620nm

Reference: O'Brien G.M., Taylor A.J. and Poulter H.N. (1991). Improved enzymatic assay for cyanogens in fresh and processed cassava. J. Sci. Food Agric. 56, 277-289.

Minerals (ash)
Ignition

Starch contains small amounts of metal salts from the parent material. The concentration of these salts is determined as the residue (ash) after ignition.

Sample dried at 105°C for 36 hours and ground into powder → Weigh 5g accurately in a crucible → Add 2 drops of ethanol → Heat in muffle furnace at 550°C for 2-3 hours → Cool down in desiccator and record weight of ashes

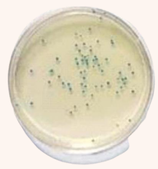
% Ash = 100 x Weight of ashes / Weight of sample
Target: Premium grade: <0.20% Grade 1:<0.30% Grade 2:<0.50%

Bacteria, yeasts and moulds
Colony count

Objective: Detection of bacterial contamination of the starch

Method: Enumeration of total bacterial count per gram of sample
- Disperse cassava starch in buffer solution for culture of micro-organisms.
- Dilute to $1:10^2$, $1:10^3$, $1:10^4$
- Mix with agar solution, pour on petri dish and incubate.
- Plate count and express results in Colony Forming Units (CFU).

Usual value: 10^4 - 10^6 CFU/g



Pour plate method

Starch particle size
Sieve test

Objective: Check the state of the sieves used during the extraction of starch

Weigh 100g of starch in a test sieve (150µm) → Shake → Record the weight of material leftover in the sieve (150µm)

- Target:
  - Premium grade < 1% starch leftover
  - Grade 1: < 3% starch leftover
  - Grade 2: < 5% starch leftover

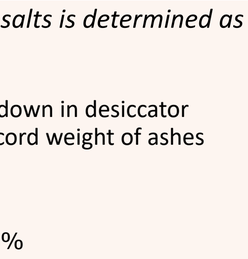
A high weight of starch left in the test sieve indicates that the sieves used in the factory may be damaged.

pH of starch slurry
pH-meter

Objective: Control the acidity of the cassava starch

A low pH can indicate microbial activity during the extraction process, or sulfur dioxide contamination.

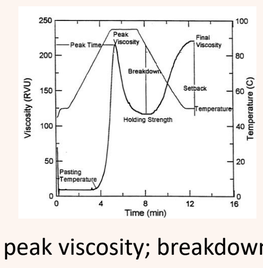
Method: Disperse 25g of starch in 50mL of distilled water
Measure pH with a pH-meter
Target: pH = 4.5 - 7



Gelatinization profile
Visco-analyzer

Objective: Provide a snapshot of the quality of the starch

Method: Measure the changes in viscosity of a starch slurry during gelatinization under controlled conditions.
- Prepare a starch slurry, typically 6-10% in distilled water.
- Gelatinization sequence: Heating from 50 to 95°C; hold at 95°C; cool to 50°C; hold at 50°C.



Instrument: Brabender Visco-Amylograph or Rapid-Visco Analyzer (RVA)

Parameters extracted from the gelatinization profile: Gelatinization temperature; peak viscosity; breakdown; final viscosity.

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