RQF LEVEL 5

FOPRT503

FOOD PROCESSING

Roots And Tubers Processing into Starch & Crisps

TRAINEE'S MANUAL

October, 2024

ROOTS AND TUBERS PROCESSING INTO STARCH &CRISPS

KOICA Korea International Cooperation Agency

TQUM TVET Quality Management Project

2024

AUTHOR'S NOTE PAGE (COPYRIGHT)

Copies available from:

- *HQs: Rwanda TVET Board-RTB*
- *Web: www.rtb.gov.rw*
- **KIGALI-RWANDA**

Original published version: October 2024

ACKNOWLEDGEMENTS

The publisher would like to thank the following for their assistance in the elaboration of this textbook:

The publisher would like to thank the following for their assistance in the elaboration of this training manual:

Rwanda TVET Board (RTB) extends its appreciation to all parties who contributed to the development of the trainer's and trainee's manuals for the TVET Certificate V in Food Processing, specifically for the module **"FOPRT503: Roots and Tubers Processing into Starch &Crisps."**

We extend our gratitude to KOICA Rwanda for its contribution to the development of these training manuals and for its ongoing support of the TVET system in Rwanda
We extend our gratitude to the TQUM Project for its financial and technical support in the development of these training manuals.

We would also like to acknowledge the valuable contributions of all TVET trainers and industry practitioners in the development of this training manual.
The management of Rwanda TVET Board extends its appreciation to both its staff and the staff of the TQUM Project for their efforts in coordinating these activities.

This training manual was developed:

Under Rwanda TVET Board (RTB) guiding policies and directives

Under Financial and Technical support of

COORDINATION TEAM

RWAMASIRABO Aimable

MARIA Bernadette M. Ramos

NTAHONTUYE Felix

Production Team

Authoring and Review

RUVUGO Jean Claude

NIYOTWAGIRA Annonciata

Validation

MUTUYEYEZU Sylvie

MUKANEZA Germaine

Conception, Adaptation and Editorial works

HATEGEKIMANA Olivier

GANZA Jean Francois Regis

HARELIMANA Wilson

NZABIRINDA Aimable

DUKUZIMANA Therese

NIYONKURU Sylvestre

NDAGIJIMANA Vincent

Formatting, Graphics, Illustrations, and infographics

YEONWOO Choe

SUA Lim

SAEM Lee

SOYEON Kim

WONYEONG Jeong

NDAYISABA Olivier

NSEKANABO HamZa

Financial and Technical support

KOICA through TQUM Project

TABLE OF CONTENT

ACRONYMS

%: Percentage

°C: Degree Celsius

°F: Degree Fahrenheit

ADF: Acid Detergent Fiber

CA: Controlled atmosphere storage

CBT/A: Competency-Based Training and Assessment

CFU: Colony forming unit

CIP: Cleaning in Place

COP: Cleaning out of Place

E. coli: Escherichia coli

e.g: Example

EFSA: European Food Safety Authority

FDA: Food and Drug Administration

FFA: Free Fatty Acids

FIFO: First In First Out

FOP: Food Processing

gr: Gram

IC: Indicative content

kHz: Kiloheiz

KOICA: Korea International Cooperation Agency

MAP: Modified atmosphere packaging

Mm: Millimetre

MPN: Most Probable Number

MSG: Monosodium glutamate

NaCl: Sodium Chloride

NDF: Neutral Detergent Fiber

PE: Polyethylene

pH: Hydrogen potential

PP: Polypropylene

PPE: Personal protective equipment

PTS: Press-to-Seal

PVC: Polyvinyl chloride

RTB: Rwanda TVET Board

SDA: Sabouraud Dextrose Agar

TQUM Project: TVET Quality Management Project

TSS: Technical Secondary School

VFFS: Vertical Form-Fill-Seal

INTRODUCTION

This trainee's manual includes all the knowledge and skills required in food processing specifically for the module of **"Roots and Tubers Processing into Starch & Crisps".** Trainees enrolled in this module will engage in practical activities designed to develop and enhance their competencies. The development of this training manual followed the Competency-Based Training and Assessment (CBT/A) approach, offering ample practical opportunities that mirror real-life situations.

The trainee's manual is organized into Learning Outcomes, which is broken down into indicative content that includes both theoretical and practical activities. It provides detailed information on the key competencies required for each learning outcome, along with the objectives to be achieved.

As a trainee, you will start by addressing questions related to the activities, which are designed to foster critical thinking and guide you towards practical applications in the labor market. The manual also provides essential information, including learning hours, required materials, and key tasks to complete throughout the learning process.

All activities included in this training manual are designed to facilitate both individual and group work. After completing the activities, you will conduct a formative assessment, referred to as the end learning outcome assessment. Ensure that you thoroughly review the key readings and the 'Points to Remember' section.

MODULE CODE AND TITLE: FOPRT503 ROOTS AND TUBERS PROCESSING INTO STARCH &CRISPS

Learning Outcome 1. Receive Roots and Tubers
Learning Outcome 2. Prepare Roots and Tubers
Learning Outcome 3. Make Starch
Learning Outcome 4: Make Crisps

Indicative contents

1.1 Preparing Workplace
1.2 Selecting Packaging Materials used in Processing of Starch and Crisps
1.3 Selecting Seasoning Ingredients used in Crisps Making
1.4 Analysing the Quality of Roots and Tubers
1.5 Storing Raw Materials

Key Competencies for Learning Outcome 1.Receive Roots and Tubers

Knowledge	Skills	Attitudes
• Description of tools and equipment used in processing roots and tubers into starch and crisps • Description of cleaning agents • Description of packaging materials of starch and crisps • Description of seasoning ingredients used in crisps making • Description of quality parameters of roots and tubers • Description of the factors affecting deterioration of roots and tubers	• Selecting tool and equipment • Adjusting tools and equipment • Cleaning tools and equipment • Checking the cleanliness of workplace • Arranging workplace • Selecting packaging materials used in processing of starch and crisps • Selecting seasoning ingredients used in crisps making • Checking the quality of raw materials • Storing roots and tubers	• Being responsible while selecting tools and equipment • Being diligent in cleaning work place • Having awareness of safety precautions when using cleaning agents. • Being a critical thinker in evaluating the quality of raw materials. • Being accurate in sorting raw materials based on size, quality, and other criteria. • Being good observer to

		identify defects or abnormalities. ● Being organizer in storage practices. ● Being a Problem-solver to identify and address any issues that may arise during storage.

Duration: 8 hrs

Learning outcome 1 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Describe correctly the tools and equipment used in processing roots and tubers into starch and crisps
2. Select appropriately the tool and equipment used in processing roots and tubers into starch and crisps according to the selection criteria
3. Adjust correctly tools and equipment used in processing roots and tubers into starch and crisps
4. Describe correctly cleaning agents used in processing roots and tubers into starch and crisps
5. Clean correctly the workplace, tools and equipment used in processing roots and tubers into starch and crisps
6. Check effectively cleanliness of workplace for processing roots and tubers into starch and crisps
7. Arrange properly the workplace for processing roots and tubers into starch and crisps
8. Describe correctly packaging materials used in processing roots and tubers into starch and crisps
9. Select properly packaging materials used for processing roots and tubers into starch and crisps
10. Describe correctly seasoning ingredients used in processing roots and tubers into crisps
11. Select properly seasoning ingredients used in processing roots and tubers into crisps
12. Describe correctly the quality parameters of roots and tubers for processing roots and tubers into starch and crisps
13. Check effectively the quality of raw materials for making starch and crisps
14. Describe correctly the factors affecting deterioration of roots and tubers for processing roots and tubers into starch and crisps
15. Store properly roots and tubers for processing roots and tubers into starch and crisps

Resources

Equipment	Tools	Materials
• Washing machine • Peeling machine • Slicing machine • Grater • Desander • Blancher • Flavouring machine • Packaging machine • Dewatering machine • De-oiling machine • Frying machine • Sorting and grading machine • Sedimentation tank • Centrifuge • Drying machine, • weighing scale • PPE • Working table • Grinder • High pressure water machine.	• Brushes • Sieves • Spoons • Knives • Basins • Dustbins • Squeegee • Brooms • Mop • Buckets • Moisture-meter • Thermometer • Cooling Rack • Timer	• None Packaging materials • Cleaning products • Crisps Seasonings • Roots and tubers(Cassava, sweet potatoes, yam, Irish potatoes) • Labels • Cooking oil • Towels

Indicative content 1.1.Preparing Workplace

Duration: 3 hrs.

Theoretical Activity 1.1.1: Description of tools and equipment used in processing roots and tubers into starch and crisps

Tasks:

1: Answer the following questions related to description of the tools and equipment used in roots and tubers processing into starch and crisps

i. What do you understand by terms starch and crisps?
ii. What could be the tools and equipment used in the processing of roots and tubers into starch and crisps?
iii. Based on the list of tools and equipment provided in question (ii) what could be the use of each tool and equipment?
iv. What could be the safety precautions followed when using tools and equipment for processing roots and tubers into starch and crisps?

2: Write your answers on paper, flip chart.
3: Present the findings/answers to the whole class.
4: For more clarification, read the key readings 1.1.1

Key readings 1.1.1.: Description of tools and equipment used in processing roots and tubers into starch and crisps

- **Difference between Starch and crisps**

✓ **Starch** is a refined carbohydrate extracted from roots and tubers and used mainly as a thickening agent or in food processing.

✓ **Crisps** are a snack food made by slicing and frying or baking roots and tubers, often with added seasonings for flavour.

- **List and use of tools and equipment:**

✓ **Tools and equipment for Starch production:**

Peeler: Cleans and prepares the roots/tubers for further processing by removing the skin.

Manually peeler:

Mechanical peeler:

- **Grater or Grinder**: Breaks down the roots/tubers into a pulp to release the starch.

- **Mixer:** Combines the pulp with water to facilitate starch extraction.

- **Sieve or Filter:** Separates the starchy liquid from the solid fibrous parts.

- **Centrifuge:** Spins the mixture to separate the starch from excess water, improving purity.

- **Dryer or Dehydrator:** Removes moisture from the separated starch to produce a fine powder.

- **Washers (e.g., drum washers, rotary washers**): Removes dirt, soil, and other impurities from the roots and tubers.

- **Packaging machines (e.g., baggers, sealers):** Packs the final product (starch or crisps) into containers or bags for distribution.

- **Desander:** To remove sand in starch slurry to improve starch taste. According to the principle of gravity separation, the starch slurry is pumped into the cyclone by a pressure pump, where the bottom stream removes sand while starch slurry flows through the top to achieve the purpose of sand removal.

- **Rasper:** For fully crushing. Rasper is a high efficient cassava grater which can fully destroy the cassava structure, so that the tiny starch granules can be disintegrated and separated from the cassava tubers. With water as medium, this cassava starch processing machine can fully crush cassava into pulp by relying on high-speed rotating. This is the most advanced cassava grater whose crushing rate is more than 94%. And the grated starch slurry can passes through the 1.2-1.4 mm mesh.

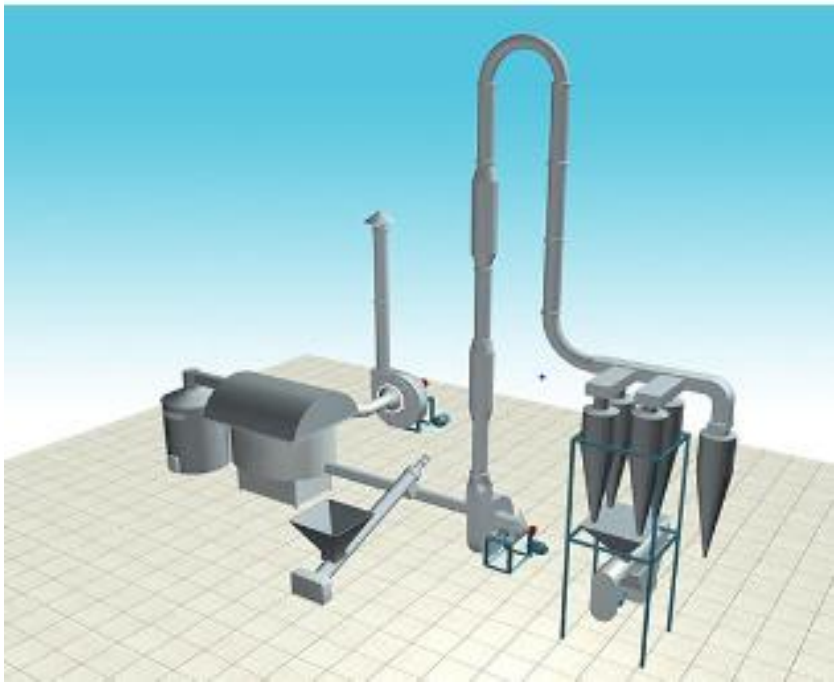
- **Centrifuge sieve & Fine fiber sieve:** To separate fibers from starch slurry. The crushed starch slurry need to be sieved in this step to separate fibers from starch slurry. The large fibers are removed by using centrifugal sieve and fine fibers are

further removed by fine fiber sieve.

- **Peeler centrifuge:** To dewater starch milk to faciliate drying. The starch millk is dewatered to achieve the required moisture content (less than 40%) for drying, and the water content of the cassava starch can reach 36.5% after dewatering by DOING peeler centrifuge

- **Dryer:** To dry starch to meet international standard. The wet material enters the drying pipe from the powder feeding machine, where it will mix with the

heated high speed fresh air. In the drying pipe of the starch processing machine, the high speed hot air will dry starch to required moisture by heat exchange.



✓ **Tools and equipment for Crisps Production:**

- **Peeler:** Removes the skin from the roots/tubers to ensure a clean, uniform product.

- **Slicer:** Cuts the roots/tubers into thin, even slices for consistent cooking.

- **Fryer or Oven:** Cooks the slices, creating the desired crispy texture.

- **Seasoning machine:** Adds flavorings to enhance taste.

- **Cooling Rack:** Helps crisps cool down and become crispier while allowing excess oil to drain.

- **Washer**s (e.g., drum washers, rotary washers): Removes dirt, soil, and other impurities from the roots and tubers.

- **Packaging machines** (e.g., baggers, sealers): Packs the final product (starch or crisps) into containers or bags for distribution.

- **Safety precaution while using tools and equipment :**

✓ Ensure all operators are properly trained in using each piece of equipment.

✓ Use gloves, goggles, and other relevant PPE to protect against injuries.

✓ Perform regular maintenance checks to ensure equipment is in good working condition.

- ✓ Be familiar with emergency shut-off procedures and have first aid kits readily available.
- ✓ Maintain a clean workspace to prevent accidents and contamination

Practical Activity 1.1.2: Selection and adjustment of tools and equipment used in roots and tubers processing into starch & crisps

Task:

1: You are requested to go to the roots and tubers processing workshop to select and adjust tools and equipment used in processing roots and tubers into starch and crisps.

2: Apply safety precautions.

3: Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key readings 1.1.2

5: Perform the task provided in the application of learning 1.1.

Key readings 1.1.2. Selection and adjustment of tools and equipment used in roots and tubers processing into starch & crisps

- **Criteria for Selecting Tools and Equipment for Processing Roots and Tubers into Starch and Crisps**

When selecting tools and equipment for processing roots and tubers into starch or crisps, consider the following factors:

- ✓ **Scale of Production:**
  - Small-scale: For home or small-scale production, simple tools like graters, knives, and pots might suffice.
  - Large-scale: For commercial production, specialized equipment like peelers, raspers, centrifugal separators, and industrial fryers are necessary.
- ✓ **Desired Outcome:**

- Starch: For starch production, equipment that effectively separates starch from fiber, such as centrifugal separators or sieves, is crucial.
- Crisps: For crisp production, equipment that can slice, fry, or bake evenly, like slicers, fryers, and ovens, is essential.

✓ **Efficiency and Safety:**

- Efficiency: Equipment should be efficient in terms of time, energy consumption, and throughput.
- Safety: Safety features are important, especially when dealing with sharp tools or hot equipment.

✓ **Cost:**

- Initial cost: Consider the initial purchase price of the equipment.
- Maintenance costs: Factor in the ongoing costs of maintenance, repairs, and energy consumption.

✓ **Durability and Reliability:**

- Durability: Equipment should be durable and able to withstand heavy use.
- Reliability: Equipment should be reliable and have a low failure rate.

✓ **Ease of Use and Cleaning:**

- User-friendly: Equipment should be easy to operate and maintain.
- Cleanability: Equipment should be easy to clean and sanitize.

✓ **Compliance with Food Safety Regulations:**

- Regulations: Ensure that equipment complies with relevant food safety regulations and standards.

- **Selection and Adjustment of Tools and Equipment for Roots and Tubers Processing**

Tools and equipment to adjust

✓ **Washers, brushes, graders.**

Adjust the water pressure and flow rate of the washer to effectively remove dirt and debris. Adjust the grading machine to separate the roots or tubers based on size.

✓ **Peeling machines or manual peelers.**

Adjust the blade settings on peeling machines to ensure proper peeling without excessive waste. For manual peeling, ensure the blade is sharp and the technique is efficient.

- ✓ **Slicers, dicers, or shredders.**

Adjust the blade settings to achieve the desired size and shape of the cuts. Ensure the equipment is sharp to prevent uneven cuts and reduce waste.

- ✓ **Blanchers or steamers (for blanching), fryers or ovens (for frying).**

Adjust the temperature and time settings for blanching or frying to achieve the desired texture and flavor. Ensure the equipment is clean and well-maintained to prevent contamination.

- ✓ **Dehydrators or drying ovens.**

Adjust the temperature and airflow settings to ensure efficient moisture removal. Monitor the drying process to prevent over-drying or under-drying.

- ✓ **Grinders or mills.**

Adjust the grinding settings to achieve the desired particle size and quality of the starch. Ensure the equipment is clean and free of contaminants.

Theoretical Activity 1.1.3: Description of cleaning agent in processing roots and tubers into starch and crisps

Tasks:

1.Answer the following questions related to the description of cleaning in processing roots and tubers into starch and crisps.

i. What do you understand by cleaning agents?
ii. What could be the selection criteria of cleaning agents used in processing roots and tubers into starch and crisps?
iii. What could be the safety precautions that should be respected while using cleaning agents?
iv. Which are the direction for using cleaning agent?
v. What are the factors affecting effectiveness of cleaning?
vi. Differentiate wet cleaning from dry cleaning as methods of cleaning
vii. Differentiate Cleaning in Place from Cleaning out place as techniques of cleaning

2.Write your answers on paper, flip chart.
3.Present the findings/answers to the whole class.
4: For more clarification, read the key readings 1.1.3

Key readings 1.1.3.: Description of cleaning in processing roots and tubers into starch and crisps

- **Description of cleaning agents:**

✓ **Types of cleaning agent**

Cleaning agents are substances used to remove dirt, stains, grease, and other impurities from surfaces. They work by breaking down or emulsifying the materials that need to be cleaned, making them easier to rinse away.

The main types of cleaning agents commonly used are:

Detergents

Purpose: Detergents help to remove dirt, soil, and organic matter from the surfaces of roots and tubers. They work by reducing the surface tension of water, making it easier for the water to penetrate and lift away contaminants.

Types:

- **Alkaline Detergents:** Effective at breaking down organic soils and fats.
- **Neutral Detergents**: Generally used for mild cleaning and are less harsh on equipment and surfaces.

Examples: Sodium hydroxide solutions, potassium hydroxide solutions, and commercial cleaning products designed for food processing.

Sanitizers

Purpose: Sanitizers are used to reduce the microbial load on surfaces to safe levels, preventing contamination. They are especially important in ensuring food safety.

Types:

Chlorine-Based Sanitizers: Commonly used because they are effective against a broad range of microorganisms.

Iodine-Based Sanitizers: Effective against bacteria and fungi, often used in food processing.

Quaternary Ammonium Compounds (Quats): Provide broad-spectrum antimicrobial activity and are used in various concentrations.

Examples: Sodium hypochlorite (bleach), iodine solutions, and quaternary ammonium solutions.

- **Acidic Cleaners**

Purpose: Acidic cleaners are used to remove mineral deposits, scale, and rust from equipment and surfaces. They can also help to neutralize alkaline residues left by other cleaning agents.

Types:

Organic Acids: Such as citric acid, which is often used in food processing.
Inorganic Acids: Such as phosphoric acid, used for heavier scale and rust removal.
Examples: Citric acid, phosphoric acid, and vinegar.

- **Alkaline Cleaners**

Purpose: Alkaline cleaners are effective at breaking down proteins, fats, and other organic residues. They are typically used in the initial stages of cleaning to remove heavy soils.

Types:

Caustic Soda: Used for heavy-duty cleaning.
Potassium Hydroxide: Used in some food processing applications for its effective grease-cutting properties.
Examples: Sodium hydroxide and potassium hydroxide.

- **Solvents**

Purpose: Solvents are used to dissolve and remove specific types of contaminants that are not easily removed by water-based cleaning agents. They are generally used for specific cleaning tasks.

Types:

Organic Solvents: Used to remove oils and greases.
Alcohols: Sometimes used for final rinsing or sanitizing.
Examples: Ethanol, isopropanol, and various hydrocarbon solvents.

- **Enzyme Cleaners**

Purpose: Enzyme cleaners use specific enzymes to break down organic materials such as starches, proteins, and fats, making them easier to remove.

Types:

Protease Enzymes: Break down proteins.
Amylase Enzymes: Target starches.
Lipase Enzymes: Decompose fats and oils.
Examples: Commercial enzyme-based cleaning products specifically formulated for food processing.

- **Oxidizing Agents**

Purpose: Oxidizing agents are used for disinfecting and sanitizing purposes. They can also be used to remove organic and inorganic impurities.

Types:

Hydrogen Peroxide: Used for disinfection and sometimes in combination with other agents.

Ozone: Used in some advanced cleaning and sanitizing systems.

Examples: Hydrogen peroxide solutions and ozone generator

- **Selection criteria of cleaning agents used in processing roots and tubers into starch and crisps**

When selecting cleaning agents for processing roots and tubers into starch and crisps, consider the following criteria:

- ✓ **Effectiveness:** The cleaning agent should effectively remove soil, debris, and microbial contaminants without damaging the tubers.
- ✓ **Safety:** The agent must be safe for food contact and not leave harmful residues that could affect the final product.
- ✓ **Compatibility:** It should be compatible with the materials used in the processing equipment and not cause corrosion or damage.
- ✓ **Environmental Impact:** Prefer agents that are biodegradable and have minimal environmental impact.
- ✓ **Regulatory Compliance:** Ensure the cleaning agents meet food safety regulations and standards specific to the region or country.
- ✓ **Cost:** Evaluate the cost of the cleaning agent relative to its effectiveness and overall impact on the processing operation.

- **Safety precautions when using cleaning agents include:**

- ✓ Proper Training: Ensure that all personnel are trained in the correct use and handling of cleaning agents.
- ✓ Personal Protective Equipment (PPE): Use appropriate PPE such as gloves, goggles, and masks to protect against exposure.
- ✓ Ventilation: Work in well-ventilated areas to avoid inhaling fumes or vapors.
- ✓ Storage: Store cleaning agents according to manufacturer instructions, in a cool, dry place, away from incompatible substances.
- ✓ Labeling: Always read and follow the manufacturer's instructions on the label for proper usage and emergency measures.
- ✓ First Aid: Be aware of first aid procedures for exposure or accidental ingestion.
- ✓ Disposal: Dispose of cleaning agents and their containers in accordance with local regulations and environmental guidelines.

- **Directions for using cleaning agents**

Directions for using cleaning agents generally include:

- ✓ Dilution: Follow the recommended dilution ratios as specified by the manufacturer.
- ✓ Application: Apply the cleaning agent to the surface or equipment as directed, ensuring thorough coverage.
- ✓ Contact Time: Allow the agent to remain in contact with the surface for the recommended period to ensure effectiveness.
- ✓ Scrubbing/Rinsing: Use appropriate scrubbing tools if required and thoroughly rinse with water to remove all residues.
- ✓ Drying: Ensure that the cleaned surfaces are properly dried if necessary, to prevent contamination or corrosion.
- ✓ Storage and Handling: Follow specific guidelines for storing and handling the cleaning agents.

- **Factors affecting the effectiveness of cleaning**

Factors affecting the effectiveness of cleaning include:

- ✓ **Concentration:** The concentration of the cleaning agent can impact its ability to dissolve or emulsify contaminants.
- ✓ **Temperature:** Higher temperatures can enhance the cleaning agent's effectiveness, but it's important to stay within safe limits.
- ✓ **Time:** The duration the cleaning agent remains in contact with the surface affects its ability to remove contaminants.
- ✓ **Mechanical Action**: Scrubbing or agitation can help in removing stubborn dirt and residues.
- ✓ **Water Quality**: The hardness or contamination level of the water used can affect the performance of the cleaning agent.
- ✓ **Nature of Contaminants**: The type and amount of soil or debris present will influence the cleaning process.
- ✓ **pH Levels**: The pH of the cleaning agent can impact its ability to remove specific types of stains or residues.

- **Cleaning methods:**

- ✓ **Wet Cleaning:**

Method: Uses water and detergents or cleaning solutions.

Process: Involves soaking, scrubbing, and rinsing with water.

Effectiveness: Generally effective for removing water-soluble and organic soils.

- ✓ **Dry Cleaning:**

Method: Uses solvents other than water.

Process: Involves applying solvents to remove stains without using water.

Effectiveness: Ideal for items sensitive to water or when water may cause damage.

- **Cleaning techniques:**

✓ **Cleaning in Place (CIP):**

Method: Involves cleaning equipment or machinery without disassembling it.

Process: Cleaning solutions are circulated through the system to clean internal surfaces.

Advantages: Minimizes downtime and labor, maintains equipment integrity.

✓ **Cleaning out of Place (COP):**

Method: Involves removing equipment parts and cleaning them separately.

Process: Parts are disassembled, cleaned manually or in a specialized machine, and reassembled.

Advantages: Allows for thorough cleaning of parts that are difficult to clean in place.

Practical Activity 1.1.4. Arranging the work place for processing roots and tubers into starch and crisps

Task:

1.You are requested to go to the roots and tubers processing workshop to Clean and arrange the work place for processing roots and tubers into starch and crisps.

2.Apply safety precautions.

3.Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key readings 1.1.4

5: Perform the task provided in the application of learning 1.1

Key readings 1.1.4: Arranging the work place for processing roots and tubers into starch and crisps

- **Procedures for cleaning the working area, tools, and equipment for processing root and tuber into starch and crisps**:

✓ **Disassembly of Equipment:**

- Break down equipment into individual parts: This will allow for more thorough cleaning and sanitization.
- Follow manufacturer's instructions: Refer to the equipment manual for specific disassembly procedures.

✓ **Pre-Rinse:**

- Rinse the working area, tools, and equipment with water: Remove any visible debris or food particles.
- Use a gentle stream of water to avoid damaging delicate components.

✓ **Manual Cleaning:**

- Clean the working area, tools, and each component of equipment with water, detergent, brushes, and scrubbers:
- Use a suitable detergent: Choose a detergent that is effective against food residue and bacteria.
- Pay attention to hard-to-reach areas: Scrub crevices, corners, and joints thoroughly.
- Use appropriate brushes and scrubbers: Select brushes and scrubbers that are suitable for the surfaces being cleaned.

✓ **Rinsing:**

- Rinse the working area, tools, and equipment with clean water: Remove any detergent residue.
- Ensure that all surfaces are thoroughly rinsed to prevent contamination.

✓ **Sanitization:**

- Sanitize the working area, tools, and each component of equipment:
- Use a food-grade sanitizer: Follow the manufacturer's instructions for dilution and application.
- Allow the sanitizer to contact all surfaces for the recommended time.
- Pay particular attention to areas that may harbor bacteria, such as cutting boards and grinders.

✓ **Final Rinsing:**

- Rinse the working area, tools, and each component of equipment with potable water: Remove any remaining sanitizer residue.
- Ensure that the equipment is completely rinsed before reassembly.

✓ **Drying:**

- **Procedures of arranging the workplace for processing roots and tubers into starch and crisps:**

✓ **Assess Available Space:**

- Measure the area: Determine the dimensions of the space available for your processing operations.

- Consider layout: Plan the layout of the workspace to optimize workflow and minimize movement.

✓ **Designate Zones:**

- Harvesting and cleaning zone: This area should be near the source of roots and tubers for easy access.
- Processing zone: This area should have enough space for equipment like grinders, dryers, and sifters.
- Packaging and storage zone: This area should be easily accessible for storing finished flour and packaging materials.

✓ **Arrange Equipment Strategically:**

- Place equipment in logical order: Arrange equipment based on the processing flow to minimize movement.
- Group related equipment: Place similar equipment together for efficient operation.
- Consider workspace: Ensure there is enough space around equipment for easy access and operation.

✓ **Ensure Adequate Ventilation:**

- Provide proper ventilation: This is especially important for drying processes to prevent mold and mildew.
- Consider natural ventilation or mechanical fans: Ensure good airflow throughout the workspace.

✓ **Provide Sufficient Lighting:**

- Ensure adequate lighting: Proper lighting is essential for safe and efficient operations.
- Consider natural light or artificial lighting: Ensure sufficient illumination in all areas.

✓ **Maintain Cleanliness:**

- Regularly clean the workspace: Remove food debris, dust, and other contaminants to prevent contamination of the flour.
- Sanitize equipment: Regularly sanitize equipment to maintain hygiene and prevent the spread of bacteria.

✓ **Consider Storage:**

- Provide storage for raw materials: Store roots and tubers in a cool, dry place.
- Store finished flour: Store flour in airtight containers in a cool, dry place.

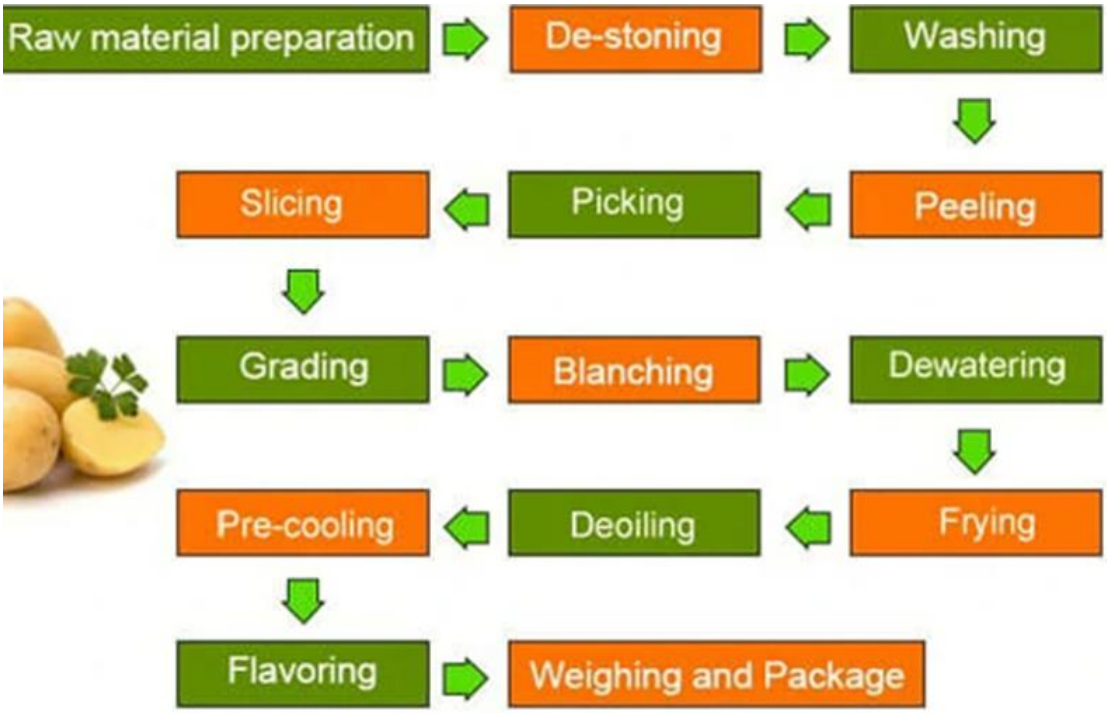
✓ **Implement Safety Measures:**

- Provide safety equipment: Ensure workers have access to safety gear like gloves, aprons, and protective eyewear.
- Mark hazardous areas: Clearly mark areas with potential hazards, such as sharp equipment or slippery floors.
- Follow safety guidelines: Adhere to safety regulations and best practices.

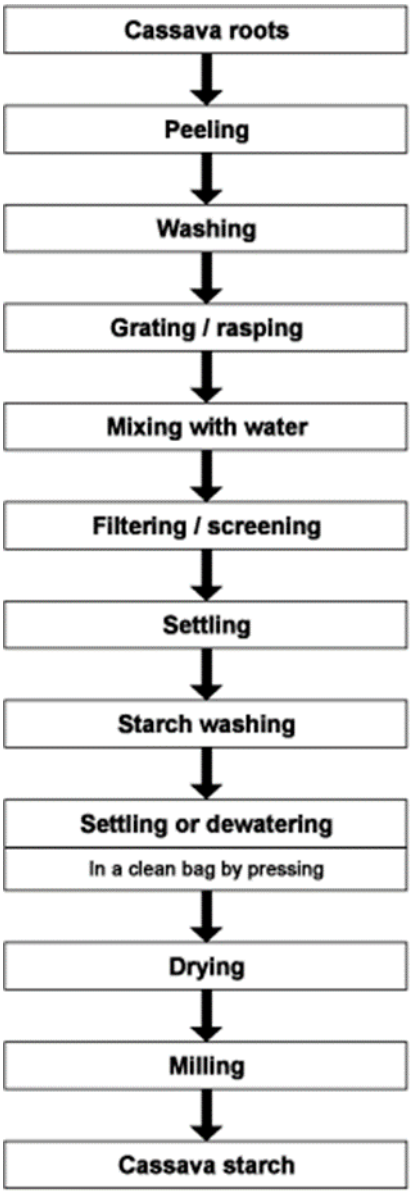
✓ **Consider Ergonomics:**

- Arrange equipment at a comfortable height: Ensure that workers can operate equipment without straining their bodies.
- Provide ergonomic seating: Provide comfortable chairs for workers who need to sit for extended periods.

- **Crisps production flow chart**:



- **Cassava starch production flowchart:**


Cassava roots
Peeling
Washing
Grating / rasping
Mixing with water
Filtering / screening
Settling
Starch washing
Settling or dewatering
In a clean bag by pressing
Drying
Milling
Cassava starch

Practical Activity 1.1.5. Checking the cleanliness of workplace in processing roots and tubers into starch and crisps

Task:

1.You are requested to go to the roots and tubers processing workshop to Check the cleanliness of workplace for processing roots and tubers into starch and crisps

2.Apply safety precautions.

3.Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key readings 1.1.5

5: Perform the task provided in the application of learning 1.1

Key readings 1.1.5: Checking the cleanliness of workplace in processing roots and tubers into flour

- **Methods of checking cleanliness of workplace**

The following are methods used to check the cleanliness of workplace:

- ✓ **Visual Test**

Purpose: The visual test is used to identify obvious signs of dirt, spills, and residues that might indicate poor cleanliness.

Procedure:

Inspect Work Surfaces (check countertops, floors, and walls for any visible dirt, spills, or residues. Look for stains, grease, or food particles and ensure that surfaces are free from any signs of contamination).

Check equipment (examine tools and equipment for visible residues or build-up of food particles,Look for any signs of wear and tear or damage that could harbor contaminants)

Evaluate Storage areas (inspect storage areas for cleanliness, including shelves, storage bins, and packaging materials , ensure that all items are stored properly and that no spills or residues are present)

Inspect Waste areas(Check waste bins and disposal areas to ensure they are clean and emptied regularly, Ensure that waste is managed appropriately and that there are no leaks or odors)

Document Findings: Record any visible issues and take corrective actions as needed. Document areas that require further cleaning or maintenance.

- ✓ **Swab Test**

Purpose: The swab test detects the presence of microorganisms on surfaces, which can be indicative of cleanliness and hygiene.

Procedure:

Prepare Materials: Gather swab sticks, a sterile collection solution (e.g., neutralizing buffer), and a portable incubator or laboratory for analysis.

Select Test Areas: Choose surfaces that are frequently touched or are known to be high-risk areas (e.g., cutting boards, countertops, equipment handles).

Collect Samples: Moisten the swab with the sterile collection solution.

Swab the selected surface in a systematic manner to cover the entire area. Ensure to swab in a zigzag or overlapping pattern to get a representative sample.

Transfer and Process Samples: Place the swab in a sterile tube with the collection solution and seal it.

Send the samples to a laboratory or place them in an incubator if testing on-site. Incubate the samples according to the manufacturer's guidelines (usually 24-48 hours).

Analyze Results: Compare the results to acceptable hygiene standards. Presence of high levels of microorganisms may indicate inadequate cleaning.
Take corrective action if necessary, such as increasing the frequency of cleaning or adjusting cleaning procedures.

Document Results: Record the findings and any actions taken to address cleanliness issues. Maintain records for future reference and audits.

- ✓ **Acidity Test**

Purpose: The acidity test measures the pH level of surfaces or solutions to ensure they are within safe ranges, as certain pH levels can indicate microbial contamination.

Procedure:

Prepare Materials: Obtain pH test strips or a pH meter suitable for surface testing. Ensure they are calibrated and in good working condition.

Select Test Areas: Choose surfaces or solutions that are likely to be prone to contamination (e.g., areas where food is prepared or processed).

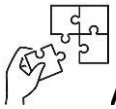
Perform the Test: For Surfaces: Moisten a clean cloth or swab with distilled water and wipe the surface to collect a sample. Test the pH of the water collected ad for Solutions: Dip a pH test strip or probe into the solution and compare the color change or digital reading to the pH scale.

Interpret Results: Compare the pH level to acceptable hygiene standards. Extreme pH values (either very high or very low) can indicate contamination or improper cleaning.
Take corrective actions if the pH is out of the acceptable range, such as adjusting cleaning agents or improving cleaning procedures.

Document Results: Record the pH readings and any subsequent actions taken. Maintain records for future reference and ensure compliance with hygiene standards

Points to Remember

- When describing tools and equipment used in processing roots and tubers into starch and crisps, consider:
  - ✓ Functions
  - ✓ Materials
  - ✓ Specific tasks it performs in the production process
  - ✓ Safety precautions or procedures associated with using the tool or equipment.
- While selecting tools and equipment used in processing roots and tubers into starch and crisps
  - ✓ Ensure the tool or equipment is designed and capable of handling the intended tasks efficiently.
  - ✓ Choose tools and equipment that are appropriate for the scale of production and the volume of materials being processed.
- While adjusting tools and equipment used in processing roots and tubers into starch and crisps
  - ✓ Refer to the user manual for specific instructions on adjusting the tool or equipment.
  - ✓ Prioritize safety during adjustments, following proper procedures and wearing appropriate protective gear.
- While using cleaning agents in cleaning:
  - ✓ Always prioritize safety
  - ✓ Choose cleaning agents that are effective for the specific contaminants and surfaces.
  - ✓ Follow the manufacturer's instructions for using cleaning agents
- While cleaning and organizing workplace for processing roots and tubers into starch and crisps:
  - ✓ Always prioritize safety when working in a food-processing environment.
  - ✓ Maintain a clean and sanitized environment to prevent contamination.
- While checking cleanliness of workplace:
  - ✓ Conduct a thorough inspection of all areas of the workspace.
  - ✓ Pay attention to potential hiding spots for dirt and debris.
  - ✓ Record your findings for future reference.
  - ✓ Take prompt action to address any cleanliness issues identified



Application of learning 1.1.

you are requested to go to roots and tubers processing workshop to do the following tasks:

Task1. Select and adjust tools and equipment for process roots and tubers into starch and crisps

Task 2. Clean workplace, tools and equipment for processing roots and tubers into starch and crisps

Task3: Check cleanliness of workplace for processing roots and tubers into starch and crisps

Task 4. Arrange the roots and tubers processing workshop

Indicative content 1.2.Selection of Packaging Materials used in Processing of Starch and Crisps

Duration:1 hrs.

Theoretical Activity 1.2.1: Description of packaging materials of starch and crisps

Tasks:

1:Answer the following questions related to the description of packaging materials for starch and crisps

i. What could be the packaging materials for starch and crisps
ii. What are the advantages and disadvantages of using plastic, paper, aluminium, glass, packaging for starch and crisps?
iii. What factors should be considered when selecting packaging materials for starch and crisps?

2:Write your answers on paper, flip chart.

3:Present the findings/answers to the whole class.

4: For more clarification, read the key readings 1.2.1

Key readings 1.2.1.: Description of packaging materials for starch and crisps

- **Common Packaging Materials**

✓ **Plastic:** Lightweight, flexible, and cost-effective. Common types include polyethylene (PE), polypropylene (PP), and polyvinyl chloride (PVC).

✓ **Paper**: Renewable, biodegradable, and often recyclable. Can be used as bags, boxes, or liners.

✓ **Aluminium**: Durable, barrier properties against moisture and oxygen, but can be more expensive.

✓ **Glass:** Transparent, recyclable, and provides a premium appearance. However, it can be heavy and fragile.

✓ **Laminates**: Combinations of different materials (e.g., plastic, paper, aluminium) to offer specific properties like moisture resistance, barrier properties, or aesthetics.

- **Advantages and Disadvantages of packaging materials**:

✓ **Plastic:**

- **Advantages:** Lightweight, flexible, cost-effective, can be printed with high-quality graphics
- **Disadvantages**: May not be biodegradable, can contribute to plastic pollution

✓ **Paper:**

Advantages: Renewable, biodegradable, recyclable, can be printed with natural inks

Disadvantages: Less durable than other materials, may not have strong barrier properties.

✓ **Aluminium:**

Advantages: Durable, excellent barrier properties against moisture and oxygen, recyclable

Disadvantages: Can be more expensive, may not be suitable for all products

✓ **Glass:**

Advantages: Glass Transparent, recyclable, provides a premium appearance.

Disadvantages: Heavy, fragile, may not be suitable for all packaging formats

✓ **Laminates:**

Advantages: Can offer a combination of properties (e.g., strength, barrier properties, aesthetics).

Disadvantages: May be more complex to produce and recycle

- **Factors for selecting packaging materials**

✓ **Product Protection:** The packaging should protect the starch or crisps from moisture, oxygen, contamination, and damage.

✓ Product Appeal: The packaging should be visually appealing and align with the brand's image.

✓ **Functionality:** The packaging should be easy to open, close, and store.

✓ **Cost:** The packaging material should be cost-effective within the overall product budget.

✓ **Sustainability:** Consider the environmental impact of the packaging material and its recyclability.

✓ **Regulatory Compliance:** Ensure the packaging complies with all relevant food safety and labeling regulations.

✓ **Distribution Channel:** The packaging should be suitable for the intended distribution channel (e.g., retail, wholesale, online).

Practical Activity 1.2.2. Selecting packaging materials for starch and crisps

Task:

1:You are requested to go to the roots and tubers processing workshop to Select packaging materials for processing roots and tubers into starch and crisps
2:Apply safety precautions.
3:Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.
4: Read the key readings 1.2.2
5: Perform the task provided in the application of learning 1.2

Key readings 1.2.2.Selecting packaging materials for starch and crisps

- **Procedure for Selecting Packaging Materials**

✓ Identify Product Requirements:

- Determine the specific needs of your starch or crisps product, such as:
- Shelf life
- Moisture sensitivity
- Barrier properties
- Visual appeal
- Cost
- Sustainability
- Regulatory compliance

- ✓ Evaluate Packaging Materials:
- Research available packaging materials and their properties.
- Consider the advantages and disadvantages of each material based on your product requirements.
- Evaluate the cost-effectiveness of different materials.
- ✓ Assess Packaging Formats:
- Determine the most suitable packaging format for your product (e.g., bags, pouches, boxes, cans).
- Consider factors such as convenience, portability, and visual appeal.
- ✓ Evaluate Barrier Properties:
- Assess the packaging material's ability to protect the product from moisture, oxygen, and other environmental factors.
- Consider using laminates or coatings to enhance barrier properties if necessary.
- ✓ Consider Sustainability:
- Evaluate the environmental impact of the packaging material, such as its recyclability, biodegradability, or use of renewable resources.
- ✓ Assess Regulatory Compliance:
- Ensure that the packaging material complies with all relevant food safety and labelling regulations.
- ✓ Test Packaging:
- Conduct tests to evaluate the packaging material's performance under various conditions (e.g., temperature, humidity, storage).
- Assess the packaging's ability to protect the product and maintain its quality.
- ✓ Consider Consumer Preferences:
- Research consumer preferences and trends to select packaging that is appealing and aligns with your target market.
- ✓ Evaluate Cost-Effectiveness:
- Compare the costs of different packaging materials and packaging formats.

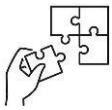
- Consider the long-term costs associated with packaging, such as storage, transportation, and disposal.

✓ Make a Final Decision:

- Based on your valuation ,select the packaging material that best meets the needs of your product and your business objectives.

Points to Remember

- Selecting packaging materials that will effectively protect and promote starch and crisps products while meeting the needs of both consumers and regulatory requirements**.**
- Select the packaging material that meets the needs of the product and the business objectives**.**



Application of learning 1.2.

You are requested to go in roots and tubers processing workshop to select the packaging materials for processing roots and tubers into starch and crisps.

Indicative content 1.3.Selecting Seasoning Ingredients used in Crisps Making

Duration: 1 hrs.

Theoretical Activity 1.2.1: Description of seasoning ingredients used in crisps making

Tasks:

1.Answer the following questions related to the description of seasoning ingredients for crisps:

(i)What could be the seasoning ingredients for crisps?

2.Write your answers on paper, flip chart.

3.Present the findings/answers to the whole class.

4: For more clarification, read the key readings 1.3.1

Key readings 1.3.1.: Description of seasoning ingredients for crisps making

- **Seasoning ingredients**

Seasonings are ingredients added to food to enhance its flavor. They can include:

✓ **Dry Powders**

- Salt: The most common seasoning, adding a savory flavor and enhancing the perception of other flavors.
- Pepper: Provides a spicy and peppery taste, ranging from mild to hot.
- Herbs: Dried herbs like parsley, oregano, thyme, and rosemary add a savory and aromatic flavor profile.
- Spices: Spices such as paprika, cumin, chili powder, and curry powder provide unique and complex flavors.
- Flavor Enhancers: Monosodium glutamate (MSG) and hydrolyzed proteins can enhance the overall savory flavor.

✓ **Oils and Fats**

- Vegetable Oils: Sunflower oil, olive oil, canola oil, and other vegetable oils can be used to add a buttery or oily flavor and enhance crispiness.

- Butter: Provides a rich, creamy flavor and contributes to the golden-brown color of crisps.
- Ghee: Clarified butter with a higher smoke point, suitable for high-temperature cooking.

✓ **Liquids**

- Vinegar: Adds a tangy or acidic flavor, often used in combination with other seasonings.
- Soy Sauce: Provides a salty and umami flavor, commonly used in Asian-inspired crisps.
- Citrus Juices: Lemon or lime juice can add a bright, citrusy flavor.

✓ **Emulsions**

- Mayonnaise: A creamy emulsion of oil, egg yolks, and vinegar, often used as a base for seasoning blends.
- Mustard: Adds a tangy and spicy flavor, often used in combination with other seasonings.
- Ranch Dressing: A popular emulsion made with buttermilk, sour cream, herbs, and spices.

Practical Activity 1.3.2. Selecting seasoning ingredients for crisps

Task:

1:You are requested to go to the roots and tubers processing workshop to select seasoning ingredient for crisps
2:Apply safety precautions.
3:Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.
4: Read the key readings 1.3.2
5: Perform the task provided in the application of learning 1.3

Key readings 1.3.2.Selecting seasoning ingredients for crisps

- **Selection criteria for seasoning ingredients**

When selecting seasoning ingredients for crisps, consider the following factors:

- ✓ Flavor profile: Choose seasonings that complement the base flavor of the crisps and appeal to your target audience.
- ✓ Texture: The seasoning should enhance the texture of the crisps. For example, coarse salt can add a crunchy texture, while powdered seasonings provide a smoother finish.
- ✓ Adhesion: The seasoning should adhere well to the crisps to prevent flaking or shedding.
- ✓ Cost: Consider the cost of the seasoning ingredients and their impact on the overall product cost.
- ✓ Sustainability: Choose sustainable and ethically sourced seasoning ingredients whenever possible.
- ✓ Regulatory compliance: Ensure that the seasonings comply with all relevant food safety and labeling regulations.

- **Selecting procedure:**

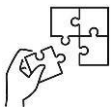
To select the right seasoning ingredients for crisps, follow these steps:

- ✓ Determine the desired flavor profile: Decide what kind of taste you want to achieve with your crisps. Consider the type of crisp (potato, tortilla, etc.), the target audience, and popular flavor trends.
- ✓ Research seasoning options: Explore a variety of herbs, spices, and other flavorings that can complement the base flavor of your crisps. Consider using flavor profiles that are familiar to your target audience or experimenting with new combinations.
- ✓ Consider flavor balance: Ensure that the seasoning ingredients you choose will create a balanced and harmonious flavor profile. Avoid overwhelming the natural flavor of the crisps.
- ✓ Test different combinations: Experiment with various combinations of seasonings to find the perfect blend for your crisps. Consider using flavor profiles that are popular in your region or culture.

- ✓ Consider texture and appearance: The seasoning ingredients should enhance the texture and appearance of the crisps. For example, a light dusting of paprika can add a vibrant color and a subtle spice.
- ✓ Consider cost and availability: Evaluate the cost and availability of the seasoning ingredients you choose. Some ingredients may be more expensive or harder to find than others.
- ✓ Conduct taste tests: Once you have selected a few seasoning combinations, conduct taste tests to determine the best option. Ask friends, family, or colleagues for their feedback.

Points to Remember

- The seasoning ingredients can be used individually or in combination to create a wide variety of flavors and textures for crisps.
- While selecting seasoning ingredients for crisps:
  - ✓ Consider the desired taste profile, the type of crisp, and consumer preferences.
  - ✓ Avoid using too many different seasoning ingredients, as this can create a confusing or overpowering flavor.



Application of learning 1.3.

You are requested to go in roots and tubers processing workshop to select seasoning ingredients for crisps making.

Indicative content 1.4: Analysing Quality Parameters of Roots and Tubers

Duration: 1hrs

Theoretical Activity 1.4.1: Description of quality parameters of roots and tubers

Tasks:

1.Answer the following questions related to the description of quality parameters of roots and tubers

(i)What could be the quality parameters of roots and tubers used in processing roots and tubers into starch and crisps?

2.Write your answers on paper, flip chart.

3.Present the findings/answers to the whole class.

4: For more clarification, read the key readings 1.4.1

Key readings 1.4.1.Description of quality parameters of roots and tubers

- **Quality parameters of roots and tubers**
  - **Physical Characteristics**

Physical characteristics are important for assessing the visual and sensory qualities of roots and tubers, such as appearance, texture, and shape. These qualities also affect their storage and processing potential.

Physical Characteristics:

- **Size and Shape**: Roots and tubers should be uniform in size and shape for marketability. Deformed or excessively small roots may be rejected.
- **Color**: The outer skin and flesh color should match the typical characteristics of the variety. Discoloration or browning can indicate spoilage or injury.
- **Firmness**: A firm texture indicates that the tuber is fresh. Softness or mushiness may indicate over-ripeness or damage.
- **Presence of defects**: Signs of bruising, cuts, cracks, mold, or diseases should be noted as these can impact quality.
- **Surface cleanliness**: Tuber cleanliness is essential. Soil and contaminants on the surface may reduce the tuber's market appeal.

Chemical Composition

Chemical composition analysis involves assessing the nutritional value and the presence of toxic substances in roots and tubers. These parameters influence the edibility, nutritional benefits, and suitability for processing.

Chemical Composition Parameters:

- **Carbohydrates**: Roots and tubers are mainly composed of starch. The starch content affects the texture, cooking properties, and digestibility.
- **Proteins**: The protein content is essential for the nutritional value, although it is generally lower in roots and tubers compared to other food groups.
- **Fat Content**: While generally low, fat content is a useful indicator of energy value and may vary depending on the variety.
- **Vitamins and Minerals**: Tubers may contain essential vitamins (such as Vitamin C) and minerals (such as potassium and magnesium), which affect their nutritional quality.
- **Toxins**: Some tubers (like cassava) may contain naturally occurring toxins (e.g., cyanogenic glycosides). These must be analyzed to ensure the tubers are safe for consumption.
- **Sugar Content**: Particularly important in varieties like sweet potatoes, where sugar levels affect sweetness and consumer preference.

Practical Activity 1.4.2. Analysing quality parameters of roots and tubers

Task:

1.You are requested to go to the roots and tubers processing workshop to analyse quality parameters of roots and tubers used in processing roots and tubers into starch
2.Apply safety precautions.
3.Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.
4: Read the key readings 1.4.2
5: Perform the task provided in the application of learning 1.4

Key readings 1.4.2.Analysing quality parameters of roots and tubers

- **Analysis techniques of quality parameters of roots and tubers:**

Analysis Techniques of physical characteristics

- **Visual Inspection**: The most straightforward method, involving a visual check for defects, discoloration, or surface damage. It's typically combined with tactile methods (feel) to assess texture.
- **Physical Measurements**:
    - **Moisture Content**: Moisture levels are vital as high moisture content can lead to rapid spoilage, while low moisture content can indicate dehydration or poor storage. Measuring moisture content is critical for estimating shelf life.
    - **Dry Matter**: Dry matter content, which is the solid part of the tuber (excluding water), affects texture, cooking properties, and nutritional quality. A higher dry matter content is generally preferred for processing.

Analysis Techniques of chemical properties

- **Chemical Analysis**: Methods like high-performance liquid chromatography (HPLC) or spectrophotometry are used to determine the levels of specific nutrients (e.g., vitamins, minerals, starch, or sugars).
    - **Starch content**: Can be measured using iodine-staining methods, enzymatic assays, or gravimetric methods.
    - **Protein and fat content**: Measured through standard analytical methods such as Kjeldahl for protein and Soxhlet extraction for fat.
    - **Toxin Detection**: For varieties like cassava, chemical tests or specialized equipment (e.g., gas chromatography-mass spectrometry, GC-MS) can be used to detect harmful substances like cyanide compounds.

Application of Analysis Techniques

To assess the quality of roots and tubers, the following analysis techniques are commonly applied:

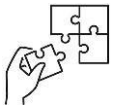
- **Visual Inspection**: This is a quick and non-destructive method to check the general appearance of roots and tubers, including color, shape, size, and any visible damage or diseases.
- **Physical Measurement**:
    - **Moisture Content**: This can be measured using a moisture analyser or oven drying method. The moisture content is calculated based on the weight difference before and after drying.

- **Dry Matter Content**: This is often determined by drying the sample to a constant weight in an oven. The dry weight is then divided by the total weight and multiplied by 100 to get the percentage of dry matter.

- **Chemical Analysis**:
  - **Moisture Content & Dry Matter**: Standard techniques for moisture content (e.g., oven drying at 105°C) also help in determining dry matter.
  - **Starch and Sugar Content**: Iodine staining and enzymatic assays can measure starch, while HPLC or enzymatic tests can measure sugars.
  - **Nutrient and Toxin Analysis**: Advanced techniques like HPLC, GC-MS, and colorimetric assays allow the detailed analysis of vitamins, minerals, and toxins in tubers.

Points to Remember

- While describing quality parameters of roots and tubers considering physical characteristics and chemical composition.
- While analysing quality of roots and tubers:
  - ✓ Conduct a thorough analysis of all relevant quality parameters.
  - ✓ Use accurate and reliable methods for measurements and tests.
  - ✓ Follow safety guidelines when handling chemicals and equipment
  - ✓ Record your findings clearly and comprehensively.



Application of learning 1.4.

You are requested to go in roots and tubers processing workshop to analyse the quality of roots and tubers used to process roots and tubers into starch and crisps.

Indicative content 1.5: Storing Raw Materials

Duration: 2 hrs.

Theoretical Activity 1.5.1: Description of the factors affecting deterioration of roots and tubers

Tasks:

1.Answer the following questions related to the description of quality parameters of roots and tubers

(i) What could be the factors affecting deterioration of roots and tubers?

2.Write your answers on paper, flip chart.

3.Present the findings/answers to the whole class.

4: For more clarification, read the key readings 1.5.1

Key readings 1.5.1.Description of the factors affecting deterioration of roots and tubers making.

- **Factors Affecting Deterioration of Roots and Tubers**

✓ **Physiological Factors**

- Respiration: Roots and tubers continue to respire after harvest, consuming oxygen and releasing carbon dioxide. This respiration process leads to loss of moisture, nutrients, and quality.
- Sprouting: Some roots and tubers may start to sprout after harvest, which can lead to loss of quality and nutritional value.
- Enzymatic Activity: Enzymes present in the roots and tubers can continue to function after harvest, leading to changes in texture, flavor, and nutritional composition.

✓ **Physical Factors**

- Temperature: High temperatures can accelerate respiration, enzymatic activity, and microbial growth, leading to rapid deterioration. Low temperatures can slow down these processes but may also cause chilling injury in some varieties.
- Humidity: High humidity can promote mold growth and microbial spoilage. Low humidity can lead to excessive drying and shriveling.
- Mechanical Damage: Bruises, cuts, or other physical injuries can provide entry points for pathogens and accelerate deterioration.

✓ **Pathological Factors**

- Diseases: Roots and tubers can be affected by various diseases caused by fungi, bacteria, or viruses, leading to rot, discoloration, and loss of quality.
- Pests: Insects, rodents, and other pests can damage roots and tubers, making them susceptible to spoilage.
- Microbial Spoilage: Bacteria, fungi, and molds can cause decay, discoloration, and off-flavors.

Practical Activity 1.5.2. Storing roots and tubers

Task:

1.You are requested to go to the roots and tubers processing workshop to store roots and tubers

2.Apply safety precautions.

3.Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key readings 1.5.2

5: Perform the task provided in the application of learning 1.5

Key readings 1.5.2.Storing roots and tubers

- **Storage Conditions for Roots and Tubers**

To ensure the quality and longevity of stored roots and tubers, it is essential to maintain optimal storage conditions.

✓ **Temperature**

- Cool, but not freezing: Most roots and tubers thrive in cool temperatures, typically between 32-45°F (0-7°C). Freezing can damage the tissues and reduce their quality.
- Avoid fluctuations: Maintain a consistent temperature to prevent stress on the products.

✓ **Humidity**

- Moderate humidity: Roots and tubers require a moderate level of humidity to prevent excessive drying or moisture loss. High humidity can promote mold growth.
- Ventilation: Ensure adequate ventilation to maintain a balanced humidity level and prevent condensation.

- ✓ **Light**
  - Dark storage: Roots and tubers are sensitive to light, which can cause greening or sprouting. Store them in a dark or dimly lit environment.
- ✓ **Ventilation**
  - Adequate airflow: Provide sufficient ventilation to remove excess moisture and prevent the buildup of gases that can contribute to spoilage.
  - Avoid drafts: Excessive drafts can cause the roots and tubers to dry out.
- ✓ **Packaging**
  - Appropriate containers: Use containers that are clean, dry, and breathable. Avoid using airtight containers that can trap moisture.
  - Bulk storage: For larger quantities, consider storing the roots and tubers in bulk, ensuring proper ventilation and protection from damage.
- ✓ **Regular Inspection**
  - Monitor for signs of spoilage: Regularly check the stored products for any signs of damage, mold, or decay.
  - Remove damaged products: Discard any damaged or spoiled items to prevent contamination of the rest.

- **Storage Methods for Roots and Tubers**

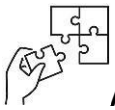
- ✓ **Traditional Storage Methods**
  - Pits or trenches: A simple and low-cost method, especially suitable for small-scale storage. Roots and tubers are buried in pits or trenches lined with leaves or straw to protect them from the elements.
  - Storage houses: These structures can be built using various materials (e.g., wood, stone, brick) and can be equipped with ventilation and temperature control features.
- ✓ **Improved Low-Cost Storage Methods**
  - Bulk storage in ventilated bins or silos: Roots and tubers are stored in large containers with ventilation to control humidity and prevent spoilage.
  - Modified atmosphere packaging (MAP): Using plastic sheets or bags to create a controlled atmosphere around the stored products, reducing respiration and spoilage.
  - Earthing: Covering the stored roots and tubers with soil to create a humid environment that slows down respiration.
- ✓ **Improved Higher Cost Storage Techniques**
  - Cold storage facilities: Storing roots and tubers in refrigerated warehouses or cold rooms to maintain a low temperature and humidity.

- Controlled atmosphere storage (CA): Controlling the levels of oxygen, carbon dioxide, and nitrogen in the storage environment to optimize storage conditions.
- Irradiation: Using ionizing radiation to extend shelf life and control pests.

- **Procedure for Applying Storage Methods**
  - ✓ Harvesting: Harvest roots and tubers at the appropriate maturity stage.
  - ✓ Cleaning and grading: Remove dirt, debris, and damaged or low-quality products.
  - ✓ Preparation: Prepare the storage area by cleaning and disinfecting it.
  - ✓ Sorting: Sort the roots and tubers based on size and quality.
  - ✓ Packaging: If applicable, package the roots and tubers in suitable containers or bags.
  - ✓ Storage: Place the products in the chosen storage method, ensuring proper ventilation and temperature control.
  - ✓ Monitoring: Regularly monitor the storage conditions and check for signs of spoilage or damage

Points to Remember

- Taking appropriate measures to prevent deterioration and maintain the quality of stored roots and tubers
- Maintaining optimal temperature, humidity, and ventilation is crucial for preserving quality of roots and tubers



Application of learning 1.5.

You are requested to go in roots and tubers processing workshop to store roots and tubers for starch and crisps making

Learning outcome 1 end assessment

Written assessment

I. **Ready the statements below related to receiving roots and tubers and encircling the letter corresponding to the correct response**

1.When selecting equipment for processing roots and tubers, which of the following factors should be considered?

A. Scale of production
B. Desired product quality
C. Safety
D. All of the above
E. None of the above

2.Which of the following is not a factor to consider when selecting equipment?

A. Cost
B. Efficiency
C. Product type
D. Color

3.Detergents are used to:

A. Remove dirt and debris
B. Sanitize surfaces
C. Remove mineral deposits
D. All of the above
E. None of the above

4. Which of the following is a dry seasoning for crisps?

A. Salt
B. Oil
C. Vinegar
D. Mayonnaise

5.Emulsions are mixtures of:

A. Dry powders and liquids.
B. Oils and fats.
C. Oils and water.
D. Acids and bases.

6.Potatoes are a type of:

A. Root
B. Tuber
C. Fruit

7.Which of the following is not a physical characteristic of roots and tubers?

A. Color

B. Texture
C. Moisture content
D. Size

8.Which of the following is a chemical characteristic of roots and tubers?

A. Shape
B. Starch content
C. Surface texture
D. Germination

9.Which of the following is a biodegradable packaging material?

A. Plastic
B. Aluminum
C. Paper
D. Glass

10.Which of the following factors can affect the deterioration of roots and tubers?

A. Temperature
B. Humidity
C. Mechanical damage
D. All of the above
E. None of the above

11.Roots and tubers should be stored in a:

A. Warm and humid environment.
B. Cool and dry environment.
C. Cold and wet environment.
D. all of the above
E. None of the above

12.Cold storage is suitable for:

A. Storing roots and tubers at high temperatures.
B. Preventing mold growth.
C. Increasing respiration.
D. None of the above
E. All of the above

13.Modified atmosphere packaging (MAP) is used to:

A. Control the levels of oxygen, carbon dioxide, and nitrogen.
B. Increase humidity.
C. Reduce temperature.
D. All of the above
E. None of the above

14.Visual inspections are used to:

A. Assess the cleanliness of surfaces.

B. Check for equipment malfunctions.
C. Monitor temperature and humidity.
D. All of the above
E. None of the above

II. Read carefully the statements below related to receiving roots and tubers and answer by True if the statement is correct or answer by False if the statement is wrong

1.The size and shape of the root or tuber are factors to consider when selecting equipment.
2.The desired quality of the final product is not relevant to equipment selection.
3.The scale of production should be considered when choosing equipment.
4.Safety is not a crucial factor in equipment selection.
5. Alkaline cleaners are suitable for removing grease and organic matter
6. Oils and fats are used to add flavor and moisture to crisps
7. Sweet potatoes are a type of tubers
8. Starch content is not a relevant quality parameter for root and tuber products
9. Paper is not suitable for packaging crisps due to its moisture absorption
10. Mechanical damage can accelerate deterioration

Practical assessment

The Production unit operating in your school wants to start a business of processing roots and tubers into starch and crisps for the purpose of exportation but it has low skills in receiving roots and tubers. You are requested to demonstrate how to receive roots and tubers for processing into starch and crisps by performing the following tasks within 4hours:

Task1. Prepare workplace
Task2. Select pckaging materials for starch and crisps
Task3. Select seasoning ingredients for crisps
Task4. Analyse the quality of roots and tubers
Task5. Store raw materials

END

Reference

Martinez, J. P. (2019). *A comprehensive guide to starch and crisp making equipment (pp. 200-215).* Advanced Food Tech Publications

Taylor, H. L. (2017). *Potato crisps: A guide to production and flavoring techniques (pp. 150-165). Snack Master Press.*

White, D. F. (2021). *Starch and snack production: Tools and machinery (pp. 90-105).* Snack Tech Publishing.

Indicative contents
2.1 Sorting of Raw Materials **2.2 Washing Roots and Tubers** **2.3 Peeling Roots and Tubers** **2.4 Grinding Roots and Tubers for Starch** **2.5 Slicing Roots and Tubers for Crisps**

Key Competencies for Learning Outcome 2.Prepare Roots and Tubers

Knowledge	Skills	Attitudes
• Identification of roots and tubers sorting parameters • Identification of factors to consider in choosing washing methods • Identification of factors to consider in choosing peeling methods • Identification of factors to consider in choosing grinding methods of roots and tubers • Description of popular shapes of sliced root and tubers	• Sorting of raw materials • Washing roots and tubers • Peeling roots and tubers • Grinding roots and tubers • Slicing roots and tubers	• Being accurate while sorting roots and tubers • Being carefully while washing, peeling and grinding roots and tubers • Being precise while slicing roots and tubers

Duration: 10hrs

Learning outcome 2 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Identify correctly the roots and tubers sorting parameters.

2.Sort properly roots and tubers according to sorting parameters of roots and tubers

3. Identify correctly the factors to consider in choosing washing methods of roots and tubers

4. Wash properly roots and tubers used in processing roots and tubers into starch and crisps

5. Identify correctly the factors to consider in choosing peeling methods of roots and tubers

6. Peel correctly roots and tubers used in processing roots and tubers into starch and crisps

7. Identify the factors to consider in choosing grinding methods of roots and tubers

8. Grind effectively roots and tubers used in processing roots and tubers into starch

9. Describe correctly the popular shapes of sliced root and tubers used for processing roots and tubers into crisps

10. Slice correctly roots and tubers used in processing roots and tubers into crisps

Resources

Equipment	Tools	Materials
• Washing machine • Peeling machine • Belt conveyors • Slicing machine • Grater • Sorting and grading machine • Sedimentation tank • Centrifuge	• Brushes • Sieves • Spoons • Knives • Basins • Dustbins • Towels • Squeegee • Brooms	• Cleaning products • Roots and tubers such as yam, sweet potatoes, Irish potatoes and cassava • Labels

• weighing scale • PPE • working table • Grinder • Hydro-cyclones • High pressure water machine • Decanter	• Mop • Buckets • Timers	

Indicative content 2.1.Sorting of raw Materials

Duration: 2 hrs

Practical Activity 2.1.1: Sorting of roots and tubers

Task:

1. You are requested to go to the roots and tubers processing workshop to Sort roots and tubers used in processing roots and tubers into starch and crisps.

2.Apply safety precautions.

3.Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key readings 2.1.1

5: Perform the task provided in the application of learning 2.1

Key readings 2.1.1 Sorting of roots and tubers

- **Purpose of sorting roots and tubers**
  - ✓ **Quality Control**

Identify and Separate Damaged Produce: Sorting helps to identify and separate roots and tubers that are damaged, diseased, or overripe. By removing these from the batch, you ensure that only the best quality produce is used or sold.

Maintain Freshness: Sorting ensures that fresh and firm roots and tubers are kept separate from those that are starting to deteriorate, helping to preserve the quality of the good produce for a longer period.

- ✓ **Safety and Health**

Prevent Foodborne Illness: Sorting helps in identifying and removing produce that may be starting to rot or show signs of contamination, thus reducing the risk of foodborne illnesses.

Reduce Spoilage: By removing damaged or spoiled tubers, you prevent the spread of decay to other healthy produce, thus minimizing spoilage and potential waste.

- ✓ **Efficient Use**

Optimize Usage: Sorting allows you to use the highest quality roots and tubers for immediate consumption or long-term storage.

Less suitable produce can be prioritized for recipes that use cooked or processed ingredients, thus optimizing the use of your resources.
Better Planning: Knowing which produce is in good condition helps in meal planning and inventory management, leading to better utilization and less waste.

- ✓ **Storage and Handling**

Appropriate Storage Conditions: Sorting helps in categorizing roots and tubers according to their condition, which informs the appropriate storage methods. For instance, healthy produce can be stored in a cool, dark place, while damaged ones might need to be used sooner or processed.
Extended Shelf Life: By separating and addressing any issues with the produce early, you can extend the shelf life of the healthy roots and tubers and reduce the frequency of spoilage.

- ✓ **Aesthetic and Market Value**

Presentation: In commercial settings, well-sorted produce looks more appealing, which can enhance market value and consumer satisfaction. For example, grocery stores or farmers' markets often sort produce to present the best quality items to customers.
Consumer Confidence: High-quality, well-sorted produce can increase consumer confidence and satisfaction, leading to repeat business and positive reviews.

- ✓ **Waste Reduction**

Minimize Waste: By identifying and using damaged or less desirable produce quickly, you can reduce waste. For example, less fresh tubers can be used for soups, stews, or composting, rather than being discarded.
Sustainable Practices: Effective sorting contributes to more sustainable food practices by making the most out of the produce and reducing unnecessary waste.

- **Roots and tubers sorting parameters**

When sorting roots and tubers, several parameters are essential for ensuring quality and suitability for various uses.

- ✓ **Size**: Refers to the dimensions of the roots or tubers. Sorting by size helps in standardizing the product and meeting market requirements. Different sizes may be used for different purposes or markets.
- ✓ **Colour**: The color of the skin and sometimes the flesh of the root or tuber. Consistent color is often a sign of uniform quality, while discolorations might indicate problems.
- ✓ **Weight**: It helps in categorizing products into different grades.

- ✓ **Maturity**: Indicates whether the roots or tubers have reached their full development. Mature roots are typically more flavorful and have better storage qualities.
- ✓ **Blemishes**: Surface imperfections such as scars, cuts, or spots.
  Blemishes can affect the appearance and quality of the product.
- ✓ **Defects**: Includes any issues that affect the usability or quality, such as rot, insect damage, or other abnormalities. Defects are often a reason for downgrading or discarding products.
- ✓ **Variety**: Different types of roots and tubers may have unique characteristics. Sorting by variety helps in meeting specific market demands and ensuring product consistency.
- ✓ **Firmness**: Refers to the texture of the root or tuber. Firmness can indicate freshness and proper storage conditions. Softer or mushy tubers may be overripe or deteriorating.

- **Application of sorting methods:**

✓ **Manual sorting**

Manual sorting is a labor-intensive process where workers use their hands and eyes to evaluate each root or tuber. Here's the step-by-step procedure:

Procedure:

Step 1: Preparation:

- Gather roots or tubers in one area.
- Ensure there is proper lighting and workstations for workers.
- Provide sorting tables or conveyor belts for ease of handling.

Step 2: Inspection:

- Workers inspect each root or tuber individually for:
  - **Size**: Categorizing by small, medium, and large.
  - **Color**: Checking for uniform color, rejecting discolored or off-color tubers.
  - **Weight**: Weighing to ensure it meets desired weight categories.
  - **Maturity**: Checking for overripe or immature tubers.
  - **Blemishes & Defects**: Removing those with visible damage like cuts, bruises, rot, or spots.
  - **Firmness**: Ensuring the tubers are firm and not soft or squishy.

Step 3: Sorting:

- Once identified, workers place the tubers into different bins or containers based on the inspected parameters, such as size, maturity, or quality.
- Defective or inferior tubers are separated for disposal or further processing (like composting).

Advantages:

- High precision and attention to detail.
- Can sort based on visual inspection of defects and quality.
- Ideal for small batches or high-quality markets.

Disadvantages:

- Time-consuming and labor-intensive.
- Not suitable for large-scale operations.

- **Mechanical sorting of roots and tubers:**

Mechanical sorting involves using machines that help automate the sorting process. These machines can sort tubers based on various characteristics such as size, weight, and sometimes shape or surface defects. This method increases efficiency and consistency compared to manual sorting.

Procedure for mechanical sorting: Procedure:

Step 1: Machine Setup:

- Install and calibrate sorting machines such as vibrating screens, rollers, or optical sorters.
- Machines should be set up to handle the expected volume of roots or tubers.

Step 2: Feeding the Tubers:

- Roots or tubers are placed onto a conveyor belt or vibrating platform where they are transported to the sorting machine.

Step 3: Sorting by Size and Weight:

- **Size**: Vibrating screens or rotating rollers separate tubers into different sizes as they pass through the machine.
- **Weight**: Weight-based sorting machines (such as digital scales or air jets) classify tubers into weight categories.

Step 4: Defect Removal:

- Machines can be equipped with cameras or infrared sensors to identify blemishes and surface defects tubers.
- Defective tubers are rejected and diverted to a separate bin or area.

Step 5: Final Check:

- The sorted tubers are collected and further examined for quality control to ensure they meet standards.

Advantages:

- Efficient for large-scale operations.
- Faster and less labor-intensive compared to manual sorting.
- Reduces human error and ensures consistency.

Disadvantages:

- Machines may not be as precise when it comes to detecting subtle quality issues (e.g., minor surface blemishes).
- High initial setup cost for equipment.
- Not adaptable to different tuber varieties or irregularly shaped products.

3. Combination Sorting (Manual + Mechanical Sorting)

Combination sorting uses both manual and mechanical methods to ensure that the sorting process is both efficient and thorough. This method is ideal for medium to large-scale operations where high quality is still a priority.

Procedure:

Step 1: Initial Mechanical Sorting:

- Begin by feeding the tubers through a mechanical sorter (such as a vibrating screen or a weight-based sorting system) to remove major defects and to sort by size and weight.

Step 2: Manual Inspection:

- After the mechanical sorting, workers manually inspect the tubers for defects that the machines might have missed, such as subtle blemishes, minor defects, or variations in texture and firmness.

Step 3: Sorting by Quality:

- Workers will further classify tubers based on visual quality (color, maturity) and remove any that are overripe, damaged, or unsuitable for sale.

Step 4: Final Sorting and Packaging:

- Once the tubers are sorted by size, quality, and weight, they are grouped accordingly for packaging.
- The final batch is packaged with uniformity to meet market standards.

Step 5: Waste Disposal:

- Inferior or non-marketable tubers are separated and disposed of or sent for processing (e.g., for animal feed, composting, or secondary products).

Advantages:

- Combines the efficiency of machines with the precision of manual labor.
- Reduces labor costs while maintaining high-quality standards.
- Suitable for large-scale operations requiring attention to detail.

Disadvantages:

- Requires both investment in machinery and labor.
- Can still be labor-intensive, especially for final inspection.

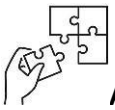
Summary of Sorting Methods:

Method	Procedure	Advantages	Disadvantages
Manual Sorting	Manual inspection of size, weight, defects, color, and maturity.	High precision, ideal for small batches, attention to detail.	Time-consuming, labor-intensive, slow for large-scale.
Mechanical Sorting	Automated sorting using machines for size, weight, and defects.	Fast, efficient for large-scale, reduces labor.	Expensive setup, less precision for subtle defects.
Combination Sorting	Combination of mechanical sorting for bulk, followed by manual inspection for fine quality control.	Balances efficiency and precision, adaptable.	Requires both labor and equipment, can still be labor-intensive.

Points to Remember

- When sorting roots and tubers for starch and crisps making:

  ✓ Assess the overall appearance of the roots and tubers, looking for any signs of damage, discoloration, or defects.
  ✓ Keep accurate records of the sorting process, including the date, quantity, and any quality issues identified. This documentation can be used for traceability and quality control purposes.



Application of learning 2.1.

You are requested to go in roots and tubers processing workshop to sort Irish potatoes for processing them into starch and crisps

Indicative content 2.2.Washing Roots and Tubers

Duration: 2 hrs.

Practical Activity 2.2.1: Washing roots and tubers

Task:

1. You are requested to go to the roots, tubers processing workshop to wash roots and tubers used in processing roots and tubers into starch and crisps.
2.Apply safety precautions.
3.Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.
4: Read the key readings 2.2.1
5: Perform the task provided in the application of learning 2.2

Key readings 2.2.1. Washing roots and tubers

- **Purpose of Washing Roots and Tubers**

✓ **Removal of Soil and Debris:**

- Soil and organic matter must be removed to ensure the produce is clean and presentable.

✓ **Pesticide and Chemical Residue Removal:**

- Washing helps to reduce pesticide residues and other chemicals that may be on the surface.

✓ **Microbial Safety:**

- Washing can reduce the load of potentially harmful microorganisms that could pose health risks.

✓ **Preparation for Processing:**

- Clean roots and tubers are necessary for further processing, such as peeling, slicing, or cooking.

✓ **Aesthetic Appeal:**

- A clean appearance enhances the visual appeal of the produce, which can affect marketability.

- **Factors to Consider in Choosing Washing Methods**

✓ **Specific Type of Root/Tuber:**

- Different types of roots and tubers (e.g., potatoes, carrots, sweet potatoes) may require different washing methods due to their size, shape, and surface texture.

✓ **Soil Content:**

- The amount and type of soil (e.g., sandy, clayey) on the tubers will influence the choice of washing method. Heavier soils may require washing that is more intensive.

✓ **Desired Level of Cleaning:**

- Determine how clean the produce needs to be based on its intended use. For instance, produce destined for fresh consumption may require a higher level of cleaning compared to that intended for processing.

✓ **Production Volume:**

- The scale of production affects the choice of washing method. High-volume operations may require more automated or efficient washing systems.

✓ **Cost and Resource Availability:**

- Consider the cost of the washing equipment and the availability of resources such as water and energy.

✓ **Environmental Impact:**

- Assess the environmental impact of the washing method, including water usage and waste management.

- **Application of Washing Methods**

  ✓ **Deeping in Water:**

  Procedure:

  - ✓ Submerge roots and tubers in a tank of water.
  - ✓ Use agitation (e.g., stirring) to help dislodge soil and debris.

  Applications /advantages

  - Suitable for removing loose soil and debris from roots and tubers with moderate soil content.
  - Often used as a preliminary cleaning step before more intensive washing methods.

  Considerations/ Disadvantages

  - Water temperature and quality should be monitored.
  - The method may be less effective for heavy soil or for produce with a rough surface.

  ✓ **Spray Wash:**

  Procedure:

  - ✓ Use high-pressure sprays of water to clean the surface of roots and tubers.
  - ✓ Water can be sprayed from various angles to ensure thorough cleaning.

  Applications/advantages

  - Effective for removing soil and debris from produce with smooth to moderately rough surfaces.
  - Commonly used in conjunction with other washing methods.

  Considerations/disadvantages

- Requires a reliable water source and pressure system.
- May need additional steps to remove stubborner soil or residues.

✓ **Wash on Belt-Conveyor:**

Procedure:

✓ Roots and tubers move along a conveyor belt through a washing system equipped with brushes, sprays, or water jets.

Applications/advantages

- Suitable for high-volume operations.
- Provides continuous washing and can incorporate various cleaning mechanisms.

Considerations/Disadvantaages

- The system needs to be adjusted based on the type of produce and the soil content.
- Regular maintenance of the conveyor and washing components is required.

✓ **Brushing:**

- **Dry Brushing Method**

- **Purpose:** This method is used primarily for removing loose dirt and soil from the surface of tubers, especially for products that are not heavily soiled or for those intended for markets that prefer minimal water use.
- **Procedure:**
  - Tubers are placed on a conveyor belt or other surface.
  - **Rotary Brushes:** Rotary or mechanical brushes are used to scrub the surface of the tubers gently. The brushes rotate as the tubers pass through, loosening dirt and debris.
  - **Manual Brushing:** In some small-scale operations, workers may manually brush the tubers using hand-held brushes, especially when dealing with more delicate produce or irregularly shaped tubers.
- **Advantages:**
  - Does not require water, making it an eco-friendly option.
  - Ideal for tubers that are not too dirty, preserving their skin integrity.
  - Reduces the risk of waterborne diseases.

- **Limitations:**
  - Not effective for cleaning tubers that have deeply embedded soil.
  - Requires a higher degree of manual labor, particularly in small-scale operations.

Wet Brushing Method

- **Purpose:** This method combines the action of brushing with water to provide a more thorough cleaning, particularly for tubers that are heavily soiled.
- **Procedure:**
  - **Water Spray:** Water is sprayed onto the tubers while they are passed over a series of rotating brushes. The brushes help to dislodge the dirt from the surface, while the water helps to rinse away the loosened soil.
  - **Combination of Brushes and High-pressure Jets:** High-pressure water jets may also be combined with mechanical brushes to clean the tubers more effectively.
  - Tubers are often passed through a series of brushes and water sprays to ensure all dirt is removed.
- **Advantages:**
  - More effective for heavily soiled tubers.
  - Helps in cleaning the crevices and irregular surfaces of tubers.
  - Improves the visual appeal of the product by removing stubborn dirt.
- **Limitations:**
  - Water consumption is higher compared to dry brushing, which can increase operational costs.
  - Tubers may be more prone to bruising if not handled carefully.
  - Water use may contribute to waterborne contamination if not properly treated.

✓ **Ultrasonic Cleaning:**

Procedure:

✓ Produce is submerged in a tank filled with water and ultrasonic waves are applied to dislodge soil and debris from the surface.

Applications:

- Effective for delicate or irregularly shaped produce.
- Provides thorough cleaning at a microscopic level.

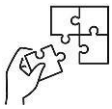
Considerations/Disadvantages

- Requires specialized equipment and can be more expensive.
- Suitable for high-value or delicate produce where high levels of cleanliness are required.

Points to Remember

when washing roots and tubers for starch and crisps production:

- ✓ Ensure that all dirt, soil, and debris are removed from the surface of the roots and tubers.
- ✓ Use clean water, follow proper sanitation practices, and maintain a clean work environment.



Application of learning 2.2.

You are requested to go in roots and tubers processing workshop to wash Irish potatoes for processing them into starch and crisps

Indicative content 2.3.Peeling Roots and Tubers

Duration: 2 hrs.

Practical Activity 2.3.1: Peeling roots and tubers

Task:

1. You are requested to go to the roots, tubers processing workshop to Peel roots and tubers used in processing of roots and tubers into starch and crisps

2. Apply safety precautions.

3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key readings 2.3.1

5: Perform the task provided in the application of learning 2.3

Key readings 2.3.1. Peeling roots and tubers

- **Purposes of Peeling Roots and Tubers**

  ✓ **Removal of Skin:**

  - **Edibility:** The skin of some roots and tubers may be tough or unpleasant to eat.
  - **Taste and Texture:** Peeling can improve the texture and taste of the produce.

  ✓ **Aesthetic Appeal:**

  - **Presentation:** Peeling enhances the visual appeal, making the produce more attractive for consumers or in prepared dishes.

  ✓ **Safety and Hygiene:**

  - **Contaminants:** Peeling removes any residual soil, pesticides, or potential contaminants on the skin.

- **Microbial Safety:** It helps in reducing the risk of microbial contamination, especially for produce that is consumed raw.

✓ **Processing Efficiency:**

- **Uniformity:** Peeling ensures a uniform surface that is important for even cooking or processing.

✓ **Product Consistency:** It can improve consistency in processed products, such as chips or slices.

- **Factors to Consider in Choosing Peeling Methods**

✓ **Quantity:**

- **Volume of Produce:** High volumes may necessitate automated or mechanical methods, while smaller quantities can be efficiently handled manually.

✓ **Desired Outcome:**

- **Level of Peel Removal:** Decide if you need to remove just the outer skin or also a layer of the underlying flesh.
- **Surface Quality:** Consider whether a smooth or slightly rough surface is required.

✓ **Type of Root/Tuber:**

- **Skin Thickness:** Different tubers have varying skin thicknesses (e.g., potatoes vs. carrots), which affects the choice of peeling method.
- **Shape and Size:** Irregularly shaped or very small produce may be more challenging to peel mechanically.

✓ **Availability of Equipment:**

- **Equipment Type:** Consider what equipment is available and its suitability for the type and volume of produce being processed.
- **Maintenance and Cost:** Evaluate the cost and maintenance requirements of mechanical peeling equipment.

- **Application and Procedures of Peeling Methods**

✓ **Manually Peeling**

Procedure:

- ✓ Use a peeler, knife, or other hand tools designed for peeling.
- ✓ Hold the root or tuber firmly and peel away the skin in a consistent direction to minimize waste and ensure uniformity.
- ✓ After peeling, rinse the produce to remove any remaining skin or debris.

Applications:

- **Small Volumes:** Ideal for small batches or in settings where mechanization is not practical.
- **Delicate Produce:** Suitable for delicate roots and tubers where mechanical peeling might cause damage.

Considerations/Disadvantages

- **Time-Consuming:** Manual peeling is labor-intensive and may be slower than mechanical methods.
- **Skill Level:** Requires skill and practice to achieve uniform results and minimize waste.

✓ **Mechanical Peeling**

Types of Equipment:

- **Drum Peelers:** Produce is rotated inside a drum with abrasive surfaces that peel off the skin.
- **Brush Peelers:** Brushes or rollers remove the skin through abrasion.
- **Knife Peelers:** Mechanical peelers with rotating knives that cut away the skin.
- **Ultrasonic Peelers:** Use ultrasonic waves to assist in peeling, often used for delicate produce.

✓ **Operation/procedure**

Load the produce into the machine according to the manufacturer's instructions. The equipment will automatically handle the peeling process based on its design.

Applications:

- **High Volumes:** Suitable for large-scale operations where efficiency and speed are crucial.
- **Consistent Results:** Provides uniform peeling and can handle a variety of root and tuber types.

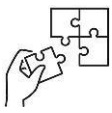
Considerations/disadvantages

- **Initial Cost:** Mechanical peelers can be expensive, but they offer efficiency and consistency for large volumes.
- **Maintenance:** Regular maintenance is required to keep the equipment in good working condition.
- **Adjustment:** The equipment settings may need to be adjusted based on the type and size of the produce.

Points to Remember

- When peeling roots and tubers for starch and crisps production, consider the following key points:

  ✓ Consider the yield of the product after peeling. Peeling may reduce the overall yield.
  ✓ Wear appropriate protective gear, such as gloves and safety glasses, to prevent injuries.
  ✓ Use appropriate peeling equipment that is suitable for the specific root or tuber being processed.



Application of learning 2.3.

You are requested to go in roots and tubers processing workshop to peel cassava and irish potatoes for processing them into starch and crisps respectively.

Indicative content 2.4: Grinding Roots and Tubers for Starch

Duration: 2 hrs

Practical Activity 2.4.1: Grinding roots and tubers for starch

Task:

1. You are requested to go to the roots and tubers processing workshop to grind roots and tubers for starch.

2. Apply safety precautions.

3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key readings 2.4.1

5: Perform the task provided in the application of learning 2.4

Key readings 2.4.1. Grinding roots and tubers

- **Purpose of Grinding Roots and Tubers for Starch**

  - ✓ **Starch Extraction:**

    - **Starch Content:** Roots and tubers like potatoes, cassava, and yams contain high levels of starch, which can be extracted through grinding.
    - **Uses:** Extracted starch is used in food products, industrial applications, and as a thickening or binding agent in various recipes.

  - ✓ **Value Addition:**

    - **Processing:** Grinding converts raw roots and tubers into a form that can be processed further, adding value and expanding their use.

  - ✓ **Product Consistency:**

- **Uniformity:** Grinding ensures a consistent texture and quality of starch, which is crucial for achieving desired results in end products.

- **Factors to Consider in Choosing Grinding Methods**

✓ **Desired Starch Quality:**

- **Purity:** The quality of starch depends on the fineness of the grind and the effectiveness of separating the starch from other components like fiber and cellulose.
- **Granulation:** Different methods produce varying granule sizes, which may affect the starch's performance in different applications.

✓ **Production Capacity:**

- **Volume:** High-volume operations require efficient and continuous grinding systems, while smaller operations can use less intensive methods.
- **Batch Size:** Consider whether you need to process large or small batches, as this influences the choice of equipment.

✓ **Available Resources:**

- **Equipment Costs:** Budget for purchasing and maintaining grinding equipment.
- **Energy Consumption:** Evaluate the energy efficiency of the grinding method to manage operational costs.
- **Labor Requirements:** Consider the amount of labor needed for operation and maintenance, which affects overall operational efficiency.

- **Grinding Methods:**

✓ **Traditional Methods**

- **Manual Grinding:**

Procedure:

✓ **Tools:** Use mortar and pestle, or hand-powered grinders.

- ✓ **Technique:** Manually crush and grind the roots and tubers into a coarse paste or powder.

Applications:

- **Small Scale:** Suitable for small quantities or artisanal production.
- **Delicate Processing:** Often used in settings where precision and control are needed.

Considerations:

- **Labor-Intensive:** Requires significant manual effort and time.
- **Inconsistent Results:** May produce unevenly ground starch and lower extraction efficiency.

- **Wet Grinding:**

Procedure:

- ✓ **Tools:** Use a traditional wet mill or grinder that employs water to aid in grinding.
- ✓ **Technique:** Add water to the roots and tubers as they are ground to produce a slurry, which can be processed to extract starch.

Applications:

- **Traditional Practices:** Common in artisanal and small-scale starch production.
- **Cultural Recipes:** Often used in traditional food processing.

Considerations:

- **Water Usage:** Requires water, which needs to be managed and disposed of.
- **Labor and Time:** More efficient than manual methods but still requires significant effort.

✓ **Modern Methods**

- **Mechanical Grinding:**

Procedure:

- ✓ **Equipment:** Use industrial grinders, mills, or crushers designed for high-volume processing.
- ✓ **Technique:** Mechanically crush and grind roots and tubers into fine powder or slurry.

Applications:

- **High-Volume Production:** Suitable for large-scale operations and continuous processing.
- **Consistency:** Provides uniform granulation and efficient starch extraction.

Considerations:

- **Cost:** Higher initial investment but more efficient in the long run.
- **Maintenance:** Requires regular maintenance and proper handling.

Mechanical grinding by using different types of mills
Hammer Mills:

Procedure:

- ✓ **Equipment:** Use hammer mills with rotating hammers to grind the produce.
- ✓ **Technique:** The produce is shattered into smaller pieces and ground into a fine powder.

Applications:

- **Efficient Grinding:** Effective for high-volume grinding and can handle various types of roots and tubers.
- **Versatility:** Suitable for different textures and sizes of produce.

Considerations:

- **Energy Consumption:** Can be energy-intensive, so consider energy costs.
- **Maintenance:** Regular maintenance is needed to keep the equipment in good working order.

- **Attrition Mills:**

Procedure:

- ✓ **Equipment:** Use attrition mills where the produce is ground between two surfaces.
- ✓ **Technique:** The friction between the surfaces grinds the produce into a fine powder.

Applications:

- **Fine Grinding:** Produces very fine starch, suitable for high-quality applications.
- **Uniformity:** Offers consistent particle size and quality.

Considerations:

- **Cost:** Generally, more expensive and may require specialized maintenance.
- **Complexity:** More complex than other grinding methods, requiring skilled operation.

- **Ultrasonic Milling:**

Procedure:

- ✓ **Equipment:** Use ultrasonic mills that apply ultrasonic waves to the grinding process.
- ✓ **Technique:** The ultrasonic waves assist in breaking down the produce into fine particles.

Applications:

- **Delicate Processing:** Suitable for fine grinding and extracting high-purity starch.
- **Innovation:** Often used in advanced applications and research.

Considerations:

- **Cost:** High initial cost and requires specialized equipment.
- **Efficiency:** Can be highly efficient but may not be necessary for all applications.

Points to Remember

- When grinding roots and tubers for starch production, consider the following key points:
  - ✓ Select the appropriate type of grinder based on the desired particle size and capacity.
  - ✓ Monitor the temperature during grinding to prevent overheating, which can damage the starch.

Application of learning 2.4.

You are requested to go in roots and tubers processing workshop to grind cassava for processing them into starch.

Indicative content 2.5: Slicing Roots and Tubers for Crisps

Duration: 2 hrs.

Theoretical Activity 2.5.1: Description of popular shapes of sliced root and tubers

Tasks:

1. Answer the following questions related to description of popular shapes of sliced root and tubers

   (i) What could be the popular shapes of sliced root and tubers used in processing roots and tubers into crisps?

2. Write your answers on paper, flip chart.

3. Present the findings/answers to the whole class.

4: For more clarification, read the key readings 2.5.1

Key readings 2.5.1. Description of popular shapes of sliced root and tubers

- **Popular shapes of sliced root and tubers**

When slicing roots and tubers, different shapes can enhance their visual appeal, cooking characteristics, and suitability for various dishes. Here's a description of popular sliced shapes and their typical uses:

✓ **Round**

Description:

Shape: Slices are cut into circles or discs.

Thickness: Can vary from thin (chips) to thick (round slices for roasting or grilling).

Applications:

Uniform Cooking: Ideal for even cooking and presentation, such as in stir-fries, salads, and sautéed dishes.

Common Uses: Potato chips, carrot rounds for salads, and roasted root vegetables.

- ✓ **Oval**

Description:

Shape: Slices are cut into an elongated circular shape, resembling an oval.

Thickness: Similar to round slices, can be thin or thick.

Applications:

Visual Appeal: Adds variety to the plate and can be used in dishes where presentation is important.

Common Uses: Oval slices for grilling or baking, often used for dishes that require slightly larger, aesthetically pleasing pieces.

✓ **Wavy/Crinkle**

Description:

Shape: Slices have a distinctive wavy or crinkled pattern, often achieved using a crinkle cutter or special knife.

Texture: The wavy edges create more surface area and a textured appearance.

Applications:

Texture: Provides a unique texture and crispiness, often used for snacks and fried items.

Common Uses: Crinkle-cut fries, chips, and garnishes.

✓ **Wedge-Shaped**

Description:

Shape: Slices are cut into triangular or wedge shapes.

Thickness: Can vary based on desired size and cooking method.

Applications:

Cooking Versatility: Ideal for roasting, baking, or grilling as the shape allows for crispy edges and tender interiors.

Common Uses: Potato wedges, sweet potato wedges

✓ **Rings**

Description:

Shape: Slices are cut into circular rings, often from tubers like onions or radishes.

Thickness: Rings can be thin or thick depending on the desired texture.

Applications:

Presentation: Rings are visually appealing and often used as a garnish or main component in dishes.

Common Uses: Onion rings, radish rings in salads, and as a decorative element in various recipes.

✓ **Star-Shaped**

Description:

Shape: Slices are cut into star shapes using a star-shaped cookie cutter or mold.

Texture: Adds a decorative and festive appearance.

Applications:

Presentation: Ideal for garnishing or creating visually appealing dishes, especially for festive or themed events.

Common Uses: Star-shaped root vegetables for holiday platters or decorative side dishes.

- ✓ **Spiral-Cut**

Description:

Shape: Slices are cut into a spiral pattern, often achieved with a spiralizer or specialized cutting tool.

Texture: Creates a spiral, often elongated, with a distinctive appearance.

Applications:

Unique Presentation: Adds visual interest and is often used for garnishing or in dishes where a unique texture is desired.

Common Uses: Spiral-cut potatoes for chips, spiralized vegetables for salads, and decorative garnishes.

- ✓ **Heart-Shaped**

Description:

Shape: Slices are cut into heart shapes using a heart-shaped cookie cutter or mold.

T**exture**: Provides a cute and thematic appearance.

Applications:

Special Occasions: Ideal for themed dishes or special occasions such as Valentine's Day.

Common Uses: Heart-shaped carrots or potatoes in salads, soups, or as part of a festive dish.

Practical Activity 2.5.2: Slicing roots and tubers for crisps

Task:

1.You are requested to go to the roots and tubers processing workshop to Slice roots and tubers for crisps
2.Apply safety precautions.
3.Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.
4: Read the key readings 2.5.2
5: Perform the task provided in the application of learning 2.5

Key readings 2.5.2. Slicing roots and tubers for crisps

- **Procedures for manual and mechanical slicing methods:**

✓ **Manual Slicing Methods**

- **Using a Knife**

Procedure:

✓ Place the root or tuber on a cutting board. Use a sharp knife to slice the produce into thin, even slices.

✓ Aim for uniform thickness, typically between 1-2 mm for crisps, to ensure even cooking.

✓ Be cautious and use a stable cutting board to prevent accidents and achieve consistent slices.

Applications:

Small Batches: Ideal for small-scale or artisanal production.

Precision: Useful for precise cuts and controlling thickness.

Considerations:

Labor-Intensive: Requires significant manual effort and can be time-consuming.

Consistency: Achieving uniform thickness may be challenging without experience.

- **Using a Mandoline Slicer**

Procedure:

- ✓ Adjust the mandoline slicer to the desired thickness setting.
- ✓ Hold the root or tuber securely and slide it along the mandoline to create even slices.
- ✓ Use the safety guard provided to protect your fingers and ensure consistent slicing.

Applications:

Consistency: Provides more uniform slices compared to manual knife cutting.

Versatility: Can be adjusted for different slice thicknesses.

Considerations:

Safety: Always use the safety guard to prevent injuries.

Maintenance: Regular cleaning and maintenance are needed to keep the mandoline in good condition.

- ✓ **Mechanical Slicing Methods**
  - **Commercial Slicer**

Procedure:

- ✓ Adjust the slicer to the desired thickness setting.
- ✓ Feed the roots or tubers into the slicer, which will automatically cut them into uniform slices.
- ✓ Ensure the slicer is properly calibrated and safe to use before starting.

Applications:

High Volume: Suitable for large-scale production and continuous slicing.

Uniformity: Ensures consistent slice thickness and quality.

Considerations:

Cost: Commercial slicers can be expensive but are efficient for high-volume operations.

Maintenance: Regular cleaning and maintenance are essential to keep the equipment in optimal working condition.

- **Rotary Slicer**

Procedure:

- ✓ Wash and peel the roots or tubers.
- ✓ Adjust the rotary slicer to the desired thickness.
- ✓ Insert the produce into the rotary slicer, where rotating blades will cut it into slices.
- ✓ Follow the manufacturer's instructions for safe operation and to achieve the desired slice thickness.

Applications:

Efficient Slicing: Effective for slicing large quantities of roots and tubers quickly.

Consistency: Produces consistent slices with minimal manual effort.

Considerations:

Cleaning: Ensure the slicer is cleaned thoroughly after use to prevent contamination.

Adjustments: Make sure to calibrate the slicer for uniform thickness.

- **Centrifugal Slicer**

Procedure:

- ✓ Wash and peel the roots or tubers.
- ✓ Place the produce into the centrifugal slicer.
- ✓ The centrifugal force and rotating blades will slice the produce into thin, even pieces.
- ✓ Operate the slicer according to the manufacturer's guidelines for optimal results.

Applications:

High Efficiency: Suitable for large-scale processing with high efficiency.

Uniform Cuts: Produces uniform slices quickly and efficiently.

Considerations:

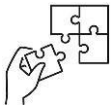
Energy Consumption: Typically requires more energy compared to manual methods.

Maintenance: Regular maintenance is required to ensure the equipment remains in good working order

Points to Remember

- When slicing roots and tubers for crisps making:

  ✓ Select the desired shape based on the type of crisp you want to create.
  ✓ Consider the desired cooking time when selecting the thickness. Thinner slices will cook faster than thicker slices.
  ✓ Use a suitable slicer that is designed for cutting thin, even slices of roots and tubers.
  ✓ Handle sharp blades with care to avoid injuries.
  ✓ Wear appropriate protective gear, such as gloves and safety glasses, when using slicing equipment.



Application of learning 2.5.

You are requested to go in roots and tubers processing workshop to slice irish potatoes for processing them into crisps.

Learning outcome 2 end assessment

Theoretical assessment

I. Read carefully the statements below related to prepare roots and tubers and answer by encircling the letter corresponding to the right answer.

1. Which one of the following is a key parameter for sorting roots and tubers?

A) Shape

B) Color

C) Size

D) All of the above

E) None of the choice

2. When choosing a washing method for roots and tubers, what is a critical factor to consider?

A) Desired level of cleaning

B) Thickness of the skins

C) Color of the produce

D) Type of packaging used

3. What is an important consideration when selecting a peeling method for roots and tubers?

A) Available equipment

B) Season of the year

C) Origin of the produce

D) Type of cooking method

4.Which grinding method is most suitable for high-volume production of roots and tubers?

A) Manual grinding

B) Hammer mill

C) Mortar and pestle

D) Traditional hand grinder

5.Which shape of sliced root or tuber is commonly used for creating a unique texture in dishes?

A) Round

B) Wavy/Crinkle

C) Star-shaped

D) Oval

6. When choosing a washing method for roots and tubers, what is a critical factor to consider?

A) Desired level of cleaning

B) Thickness of the skins

C) Color of the produce

D) Type of packaging used

7. What is a primary reason for washing roots and tubers before processing?

A) To enhance flavor

B) To remove soil and contaminants

C) To improve texture

D) To change color

8. Which method is often used to peel roots and tubers on a small scale?

A) Drum peeler

B) Knife

C) Brush peeler

D) Ultrasonic cleaner

9.What is a critical factor in selecting a grinding method for roots and tubers?

A) Desired starch quality

B) Season of the year

C) Color of the produce

D) Type of packaging used

10. Which peeling method uses rotating blades to remove skin from roots and tubers?

A) Manual peeling

B) Drum peeler

C) Knife peeling

D) Ultrasonic peeling

11.For high consistency and volume, which slicing method is commonly used?

A) Mandoline slicer

B) Manual knife

C) Mortar and pestle

D) Crinkle cutter

II.**Ready carefully the statements below related to prepare roots and tubers and answer by True (T) if the statement is correct and False (F) if the statement is wrong.**

1. Sorting roots and tubers based on their size, shape, and color is crucial for ensuring uniform quality.

2. Ultrasonic cleaning is the most common method used for washing roots and tubers in small-scale operations.
3. Mechanical peeling methods are generally more labor-intensive than manual methods.
4. The shape of sliced roots and tubers, such as star-shaped or spiral-cut, primarily affects their cooking time.
5. The primary purpose of grinding roots and tubers is to prepare them for immediate consumption as a whole.

Practical assessment

Your school has received a command from UBURYOHE Company to supply to it 20 kg of ground cassava for starch extraction and 10 kg sliced irish potatoes for crisps, you are requested to go in the production unit of your school to do the following tasks within 4 hours. All materials, tools and equipment are available in production unit of school.

Task 1: Sort cassava and irish potatoes

Task 2: Wash cassava and irish potatoes

Task 3: Peel cassava and irish potatoes

Task 4: Grind cassava for starch

Task 5: Slice irish potatoes for crisps

END

Reference

Foster, R. D. (2017). *Advanced methods in root and tuber processing: Techniques for peeling and slicing (pp. 120-135).* Agricultural Science Publishing.

Jackson, P. W. (2018). *Root crop handling and processing: A guide to peeling, washing, and grading (pp. 75-92).* Crop Science Publications.

Roberts, C. T. (2015). *Processing techniques for roots and tubers: Peeling, washing, slicing, and grading (pp. 45-60.* Food Processing Technology Press.

Indicative contents

3.1 Purifying the Wet Starch

3.2 Drying of Wet Starch

3.3 Grinding Starch

3.4 Sifting Starch

3.5 Modifying of Native Starch

3.6 Analysing Quality of Starch

3.7 Storing of Starch

Key Competencies for Learning Outcome 3.Make Starch

Knowledge	Skills	Attitudes
• Description of purification methods • Description of drying methods • Description of grinding methods • Description of sifting methods • Description of modifying methods • Description of starch quality characteristics • Description of labelling requirements of starch • Identification of storage conditions of starch	• Purifying the wet starch • Drying the wet starch • Grinding starch • Sifting starch • Modifying native starch • Checking the quality of starch • Packaging the starch • Labelling the starch • Storing starch	• Being careful during purification and drying starch • Being attention during sifting • Being cleanliness in grinding and packaging • Being methodical in labelling • Being environmental awareness on packaging material • Being awareness on storing conditions

		• Being Responsible to ensure if the products are stored

Duration: 16 hrs

Learning outcome 3 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Describe correctly purification methods of wet starch
2. Purify properly wet starch according to purification methods
3. Describe correctly the drying methods for wet starch
4. Dry effectively the wet starch according to drying methods
5. Describe correctly the grinding methods of starch
6. Grind properly the starch according to grinding methods
7. Describe correctly sifting methods of starch
8. Sift effectively the starch according to sifting methods
9. Describe correctly modification methods of starch
10. Modify properly the native starch according to modification methods
11. Describe correctly the starch quality characteristics
12. Analyse correctly quality characteristics of starch
13. Pack appropriately the starch according to filling methods
14. Describe correctly the labelling requirements of starch
15. Label properly the packaged starch according to labelling requirements
16. Identify correctly the storage conditions of starch
17. Store properly the starch according to storage conditions

Resources

Equipment	Tools	Materials
● Sedimentation tank ● Centrifuge ● Drying machine ● Weighing scale ● PPE ● Working table ● High pressure water machine	● Brushes ● Sieves/ strainers ● Spoon ● Knives ● Basins ● Dustbins ● Towels ● Squeegee ● Brooms ● Mop ● Buckets ● Moisture-mete ● Timers	● Packaging materials ● Cleaning products ● Roots and tubers such as Potatoes, sweet potatoes, yam, cassava ● Labels

Indicative content 3.1.Purifying the Wet Starch

Duration: 2 hrs

Theoretical Activity 3.1.1: Description of purification methods of wet starch

Tasks:

1. Answer the following questions related to description of purification methods of wet starch
   i. What do you understand by term purification in starch making?
   ii. What could be the purpose of purifying wet starch?
   iii. What could be the methods of purification?
   iv. Based on the methods of purification provided in question (iii) what could be the factors affecting purification methods?
   v. What could be the Selection criteria for starch purification method?
2. Write your answers on paper, flip chart.
3. Present the findings/answers to the whole class.
4: For more clarification, read the key readings 3.1.1

Key readings 3.1.1.: Description of purification methods of wet starch

- **Definition of purification in starch making**

Purification in starch making refers to the process of removing impurities and non-starch components from the raw starch obtained from various sources like corn, potatoes, or tapioca. This process aims to obtain a pure, high-quality starch that meets the required standards for various applications, such as food products, industrial uses, or pharmaceuticals. Purification ensures the starch has the desired properties, such as viscosity, color, and texture, by eliminating proteins, fibers, lipids, and other unwanted substances.

- **Purpose of purifying wet starch**

✓ Removing Impurities: Eliminate proteins, fibers, fats, and other contaminants that could affect the starch's quality and functionality.
✓ Improving Quality: Enhance the texture, color, and consistency of the starch to meet specific industry standards and applications.
✓ Ensuring Consistency: Achieve uniformity in the product's properties, which is crucial for both industrial and food applications.

- ✓ Increasing Shelf Life: Purified starch is less prone to microbial growth and degradation, thereby extending its shelf life.
- ✓ Facilitating Processing: Remove components that may interfere with further processing steps or the final application of the starch.

- **Methods of purification of wet starch**

✓ **Wet Fractionation**

Wet fractionation is a process that uses solvents to extract, precipitate, and centrifuge proteins, oils, carbohydrates, and fibers from a mixture**.**

Wet fractionation methods rely on physical differences in the properties of starch and its associated components. They typically include:

- **Sedimentation**: After mixing the starch with water, allow the mixture to sit undisturbed. Over time, heavier particles settle to the bottom of the container due to gravity. The clearer liquid (supernatant) is then decanted or siphoned off, leaving behind the settled starch and impurities.

Application: This is often used as an initial step to separate coarse and fine impurities from the starch.

- **Centrifugation:** The starch suspension is placed in a centrifuge, which spins at high speeds to create a centrifugal force. This force separates components based on their density, with heavier starch granules moving towards the bottom of the centrifuge tubes.

Application: Useful for separating starch from fine particles, suspended solids, and some liquid impurities. It can also help in refining starch to a higher purity.

- **Sieving:** The starch slurry is passed through a series of sieves or mesh screens of varying sizes to separate particles based on their size.

Application: Effective for removing larger, undesired particles and for grading the starch based on particle size.

✓ **Aqueous Extraction**

Aqueous extraction methods use different aqueous solutions to selectively extract or remove components from the starch:

- **Steeping:** The starch is soaked in water (sometimes with additives) for an extended period. This process hydrates the starch and allows soluble components and some impurities to dissolve into the water.

Application: Commonly used in the wet milling process of grains to facilitate the separation of starch from other components.

- **Alkaline Extraction:** The starch is treated with an alkaline solution (e.g., sodium hydroxide). The alkaline conditions help dissolve or modify certain impurities or structural components.

Application: Often used to remove protein and other contaminants from the starch.

- **Acid Treatment:** The starch is treated with an acidic solution (e.g., sulfuric acid). The acid can hydrolyze certain impurities and help in the removal of specific types of contaminants.

Application: Typically employed to break down and remove proteins and other impurities that are sensitive to acidic conditions.

✓ **Enzymatic Modification**

Enzymatic treatments involve using specific enzymes to modify or remove impurities without affecting the starch significantly:

- **Alpha-Amylase Treatment**: Alpha-amylase enzymes are added to the starch slurry to break down starch molecules into smaller oligosaccharides or maltodextrins.

Application: Useful for reducing the viscosity of starch pastes and improving the quality of starch for certain applications. Also helps in reducing residual proteins and other components.

- **Glucoamylase Treatment:** Glucoamylase enzymes are used to further break down oligosaccharides into glucose units.

Application: This treatment can be used to produce high-glucose syrups from starch and also aids in refining starch by breaking down residual polysaccharides.

✓ **Physical Separations**

Physical separation methods involve the use of physical processes to isolate or purify starch:

- **Filtration:** The starch suspension is passed through filter media (e.g., mesh filters, paper filters) that trap larger particles while allowing the liquid and smaller particles to pass through.

Application: Effective for removing suspended solids and clarifying starch suspensions.

- **Chromatography:** The starch is separated based on interactions with a stationary phase and a mobile phase. Techniques such as column chromatography or thin-layer chromatography are used.

Application: Useful for analyzing and separating different starch fractions or other components based on their chemical properties.

- **Membrane Separation:** The starch slurry is forced through semi-permeable membranes that separate components based on size and other characteristics. Techniques like ultrafiltration or nanofiltration are commonly used.

Application: Effective for concentrating starch solutions, removing small contaminants, and separating different starch fractions based on molecular size.

- **Factors affecting purification methods**

✓ **Type of Impurities**: Different methods are needed depending on whether the impurities are proteins, fibers, fats, or colorants.
✓ **Starch Source:** The type of raw material (e.g. potatoes) can influence the choice of purification method due to varying levels and types of impurities.
✓ **Purity Requirements:** Higher purity standards may require more advanced or multiple purification techniques.
✓ **Cost and Efficiency:** The cost-effectiveness and efficiency of the method in terms of time, resources, and operational complexity.
✓ **Environmental Impact**: The environmental considerations and disposal of chemicals or waste products generated during purification.
✓ **Processing Conditions:** Factors such as temperature, pH, and concentration of reagents can impact the effectiveness of the purification process.
✓ **Scale of Production:** Large-scale operations may require different methods or combinations of methods compared to small-scale production.

- **Selection criteria for the starch purification method**

Selection criteria for choosing a wet starch purification method may include:

✓ **Purity Level Required:** The desired purity level of the final starch product dictates the choice of purification method.
✓ **Nature of Impurities:** The specific types of impurities present in the raw starch determine which purification techniques are most effective.
✓ **Cost Efficiency:** The cost of the purification process relative to the benefits and overall production budget.
✓ **Process Compatibility:** Compatibility with existing production equipment and processes.

- ✓ **Environmental and Safety Considerations**: Impact on the environment and safety of chemicals or procedures used.
- ✓ **Quality of End Product**: Ability of the method to achieve the desired quality attributes of the starch, such as viscosity, color, and texture.
- ✓ **Regulatory Compliance**: Compliance with industry regulations and standards for starch purity.
- ✓ **Operational Feasibility**: Ease of implementation and integration into the production workflow, including labor and time requirements.

Practical Activity 3.1.2: Purifying a wet starch

Task:

1. You are requested to go to the roots and tubers processing workshop to purify wet starch

2. Apply safety precautions (wear PPE).

3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key reading 3.1.2

5: Perform the task provided in the application of learning 3.1

Key readings 3.1.2. Purifying wet starch

- **Purification wet starch methods and procedures**
- ✓ **Wet Fractionation methods**
  - **Sedimentation**

Steps:

- ✓ Mix the wet starch slurry with water to create a homogeneous mixture.
- ✓ Allow the mixture to stand undisturbed for a period, typically several hours to overnight.
- ✓ Carefully decant the clear liquid (supernatant) from the top, leaving the settled starch and impurities at the bottom.

- ✓ Remove the settled starch from the bottom, which may require additional washing to improve purity.

Centrifugation

Steps:

- ✓ Load the wet starch slurry into centrifuge tubes or containers.
- ✓ Spin the tubes at high speeds in a centrifuge.
- ✓ The centrifugal force causes the denser starch particles to move to the bottom of the tube, while lighter impurities remain in the supernatant.
- ✓ Remove the supernatant and collect the centrifuged starch.

Sieving

Steps:

- ✓ Pass the wet starch slurry through a series of sieves with varying mesh sizes.
- ✓ The sieves separate particles based on size, with larger particles retained on the sieve and smaller particles passing through.
- ✓ Collect the separated fractions for further processing or analysis.
- ✓ **Aqueous Extraction**

Steeping

Steps:

- ✓ Immerse the wet starch in water, sometimes with additives to aid in impurity removal.
- ✓ Maintain the mixture at a controlled temperature for a specified period to allow soluble impurities to dissolve.

- ✓ Draining: Drain the water, which now contains dissolved impurities, and collect the hydrated starch.

Alkaline Extraction

Steps:

- ✓ Treat the wet starch with an alkaline solution (e.g., sodium hydroxide).
- ✓ Allow the alkaline solution to react with the starch, often with stirring and maintaining a controlled temperature.
- ✓ After the reaction, neutralize the alkaline solution, typically using an acid.
- ✓ Wash the starch to remove residual alkaline and soluble impurities.

Acid Treatment

Steps:

- ✓ Mix the wet starch with an acidic solution (e.g., sulfuric acid).
- ✓ Allow the acid to react with impurities, often with stirring and temperature control.
- ✓ Neutralize the acid, typically with a base.
- ✓ Wash the starch to remove residual acid and dissolved impurities.

✓ **Enzymatic Modification methods**

- **Alpha-Amylase Treatment**

Steps:

- ✓ Add alpha-amylase enzyme to the wet starch slurry.
- ✓ Incubate the mixture at optimal conditions (temperature and pH) for the enzyme to hydrolyze starch into smaller oligosaccharides.
- ✓ Terminate the enzyme activity by adjusting the temperature or pH, or by adding an enzyme inhibitor.
- ✓ Separate the resulting oligosaccharides from the starch, if needed, through filtration or centrifugation.

- **Glucoamylase Treatment**

Steps:

- ✓ Add glucoamylase enzyme to the starch slurry.
- ✓ Incubate the mixture to allow glucoamylase to break down oligosaccharides into glucose.
- ✓ Terminate the enzyme activity as described for alpha-amylase treatment.
- ✓ Filter or centrifuge to separate the glucose syrup from the starch, if necessary.

✓ **Physical Separations**

- **Filtration**

Steps:

- ✓ Pass the starch slurry through a filter medium (e.g., mesh, paper, or membrane).
- ✓ The filter medium retains larger particles and allows the liquid to pass through.
- ✓ Collect the filtrate (liquid passing through) and the retained solids.

- **Chromatography**

Steps:

- ✓ Prepare the chromatography column with a stationary phase (e.g., gel or resin).
- ✓ Load the starch slurry onto the column.
- ✓ Pass a mobile phase (e.g., buffer) through the column to elute different components based on their interactions with the stationary phase.

✓ Collect fractions of eluted components for analysis or further processing.

Membrane Separation

Steps:

✓ Pass the starch slurry through a membrane with specific pore sizes (e.g., ultrafiltration or nanofiltration membranes).

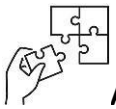
✓ The membrane retains particles or molecules larger than the pore size and allows smaller molecules to pass through.

✓ Collect the permeate (liquid passing through) and the retentate (material retained by the membrane).

Points to Remember

- When describing purification methods of wet starch:
  - ✓ Specify selection criteria of purification methods
  - ✓ Specify factors affecting purification methods
  - ✓ Explain how the purification method removes impurities such as fiber, protein, and other non-starch components.
  - ✓ Specify the type of purification method, such as sedimentation, filtration, centrifugation, or solvent extraction.
  - ✓ Highlight the advantages of the purification method, such as efficiency, cost-effectiveness, or environmental friendliness.
  - ✓ Discuss any potential disadvantages or limitations of the method, such as energy consumption, equipment costs, or the risk of starch degradation.
- Maintain appropriate temperature conditions to ensure efficient starch extraction and prevent degradation.
- Adjust the pH of the starch suspension to optimize the purification process and minimize losses.
- Optimize the process time to achieve the desired level of purity without excessive energy consumption or degradation.
- Choose equipment that is suitable for the scale of production and the desired throughput.
- Select equipment that is efficient in terms of energy consumption and starch recovery.

- Consider the ease of maintenance and the availability of spare parts for the chosen equipment.
- Conduct regular quality tests on the purified starch to ensure it meets the desired specifications for purity, viscosity, and other properties.
- Maintain accurate records of the purification process, including equipment settings, conditions, and test results.
- Consider the environmental impact of the purification method, such as water usage, energy consumption, and waste generation.
- Implement proper waste management practices to minimize environmental impact and comply with regulations.



Application of learning 3.1.

You are requested to go in roots and tubers processing workshop to purify the wet starch of cassava.

Indicative content 3.2.Drying of Wet Starch

Duration: 4 hrs

Theoretical Activity 3.2.1: Description of drying methods of wet starch

Tasks:

1. Answer the following questions related to description of drying methods of wet starch

   i. What could be the purpose of drying wet starch?

   ii. What could be the methods of drying wet starch?

2. Write your answers on paper, flip chart.

3. Present the findings/answers to the whole class.

4: For more clarification, read the key readings 3.2.1

Key readings 3.2.1.: Description of drying methods of wet starch

- **Purpose of drying wet starch**

  Drying wet starch serves several key purposes:

  - **Preservation**: Reduces moisture content to prevent microbial growth and spoilage, extending the shelf life of the starch.
  - **Storage**: Facilitates easier and more cost-effective storage and handling by converting the starch into a stable, solid form.
  - **Processing:** Prepares the starch for further processing or use in applications that require dry starch, such as in food products, adhesives, or pharmaceuticals.
  - **Product Quality**: Enhances the quality of the starch by removing excess moisture, which can affect its texture, flowability, and performance in applications.
  - **Transportation**: Reduces the weight and volume of the starch, lowering transportation costs and making logistics more efficient.

- **Methods of drying wet starch**

  ✓ **Air Drying:** Wet starch is spread out in thin layers and exposed to ambient air to evaporate moisture. This method can be done using trays or racks in a well-ventilated area.

Advantages: Simple and cost-effective, especially for small-scale operations.

Disadvantages: Time-consuming and may not be suitable for large volumes or in environments with high humidity.

- ✓ **Spray Drying:** Wet starch slurry is atomized into a fine mist and introduced into a hot air stream in a spray dryer. The moisture evaporates rapidly, leaving behind fine dry starch particles.

Advantages: Efficient for large-scale production, produces a fine powder, and allows precise control over drying conditions.

Disadvantages: Requires significant energy and investment in equipment.

- ✓ **Fluidized Bed Drying:** Wet starch particles are suspended and fluidized by a stream of hot air in a fluidized bed dryer. The heat evaporates the moisture, and the dried starch particles are collected.

Advantages: Provides uniform drying and good control over drying parameters. Suitable for granular starch.

Disadvantages: Can be expensive and requires careful control of air flow and temperature.

- ✓ **Freeze Drying (Lyophilization):** Wet starch is frozen and then placed in a vacuum chamber where the frozen moisture is sublimated directly from ice to vapor.

Advantages: Preserves the structure and properties of the starch better than other methods. Ideal for sensitive starches that might degrade with heat.

Disadvantages: High cost and energy consumption, making it less suitable for large-scale operations.

- ✓ **Drum Drying:** Wet starch slurry is spread onto a heated drum surface. As the drum rotates, the starch dries and is scraped off as a thin, dried layer.

Advantages: Suitable for large volumes and can produce a fine,

Practical Activity 3.2.2: Drying wet starch

Task:

1. You are requested to go to the roots and tubers processing workshop to dry wet starch

2.Apply safety precautions (wear PPE).

3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key reading 3.2.2

5: Perform the task provided in the application of learning 3.2

Key readings 3.2.2. Drying wet starch

- **Drying methods and procedures:**

✓ **Air Drying**

Procedure and Steps:

Preparation: Prepare the wet starch by spreading it into thin layers. If the starch is in a slurry or paste, it should be spread evenly on trays or racks.

Setup: Arrange the trays or racks in a well-ventilated area. Ensure good air circulation around the starch.

Drying: Allow the starch to air dry over time. Depending on the ambient temperature and humidity, this can take several hours to days.

Monitoring Check periodically to ensure even drying and to avoid potential issues such as mold or uneven drying.

Completion: Once the starch reaches the desired moisture content, remove it from the trays or racks and store it in an airtight container to prevent reabsorption of moisture.

✓ **Spray Drying**

Procedure and Steps:

Preparation: Dissolve the wet starch in water to create a slurry or solution of a specific concentration.

Feed Solution: Pump the starch slurry through a nozzle or atomizer into the drying chamber.

Atomization: The nozzle atomizes the slurry into fine droplets.

Drying: The droplets are introduced into a chamber with a hot air stream. The hot air rapidly evaporates the moisture from the droplets.

Collection: The dried starch particles are collected from the chamber, usually via a cyclone separator or bag filter.

Cooling: The collected powder may be cooled to prevent moisture pickup.

- ✓ **Drum Drying**

Procedure and Steps:

Preparation: Prepare the wet starch by creating a slurry or paste. Ensure the consistency is suitable for application on the drum surface.

Application: Apply the wet starch to the surface of a heated drum using a feeding mechanism. The drum should be preheated to the desired temperature.

Drying: As the drum rotates, the starch spreads and dries on the heated surface. The rotation helps to keep the starch in contact with the heat.

Scraping: Once the starch is dried, it is scraped off the drum surface by a blade or scraper.

Cooling: The dried starch flakes or sheets are cooled and broken down into powder if needed.

- ✓ **Fluidized Bed Drying**

Procedure and Steps:

Preparation: Prepare the wet starch, usually in granular form, and load it into the fluidized bed chamber.

Fluidization: Introduce hot air into the chamber at a velocity that causes the starch particles to become suspended (fluidized).

Drying: The hot air circulates through the bed, causing rapid evaporation of moisture from the starch particles.

Monitoring: Monitor the temperature, airflow, and moisture content to ensure efficient drying and to prevent overheating.

Collection: Once drying is complete, collect the dry starch from the bottom of the fluidized bedchamber.

✓ **Freeze Drying (Lyophilization)**

Procedure and Steps:

Preparation: Prepare the starch solution and place it in containers suitable for freezing.

Freezing: Freeze the starch solution rapidly to form ice crystals. This can be done using a freezer or a specialized freezing unit.

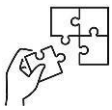
Vacuum: Transfer the frozen starch to a vacuum chamber. Reduce the pressure to create a low-pressure environment.

Sublimation: Apply gentle heat to the frozen starch. The ice sublimates directly from solid to vapor, leaving behind dry starch.

Collection: Collect the dry starch powder from the chamber. The powder is usually porous and lightweight

Points to Remember

- Drying method must maintain or improve the desired properties of the starch, such as viscosity, solubility, and appearance.
- Each drying method has its specific applications and benefits depending on the scale of production and the properties of the starch being dried**.**



Application of learning 3.2.

You are requested to go in roots and tubers processing workshop to dry cassava wet starch.

Indicative content 3.3.Grinding Starch

Duration: 2hrs

Theoretical Activity 3.3.1: Description of grinding methods of starch

Tasks:

1. Answer the following questions related to description of grinding methods of starch
   i. What could be the purpose of grinding starch?
   ii. Differentiate grinding methods of starch?
   iii. Identify the factors to consider in grinding of starch?
2. Write your answers on paper, flip chart.
3. Present the findings/answers to the whole class.
4. For more clarification, read the key readings 3.3.1

Key readings 3.3.1.: Description of grinding methods of starch

- **Purpose of Grinding Starch**
  - ✓ **Increase Surface Area:** Grinding starch increases its surface area, which can enhance its solubility and improve its performance in applications like thickening or binding.
  - ✓ **Improve Texture:** In food products, finely ground starch can improve texture, mouthfeel, and consistency. For example, in baked goods, finely ground starch helps in achieving a smooth texture.
  - ✓ **Enhance Digestibility:** In some cases, grinding can make starch easier to digest by breaking it down into smaller particles.
  - ✓ **Facilitate Processing:** In industrial settings, finely ground starch can be more easily processed, mixed, or incorporated into formulations.
  - ✓ **Optimize Functional Properties:** For applications such as adhesives or coatings, grinding can optimize the functional properties of starch, like viscosity and adhesive strength.
- **Methods of Grinding Starch**
  - ✓ **Hammer Milling**: This method uses high-speed hammers to crush the starch into smaller particles.
    It is effective for large-scale production and can produce a fine powder.

- ✓ **Roller Milling:** In this method, starch is passed through a series of rollers that crush and grind it. It's commonly used in flour mills and can produce a uniform particle size.
- ✓ **Air Classification:** This method involves using air streams to separate particles based on size. It's often used to obtain very fine starch powders.
- ✓ **Ball Milling:** In ball milling, starch is ground by rotating it with steel or ceramic balls. This method can produce very fine powders and is often used for specialty applications.
- ✓ **Cryogenic Grinding:** This method involves cooling the starch with liquid nitrogen before grinding, which helps in achieving a finer and more consistent powder.

- **Factors to Consider in Grinding Starch**

- ✓ **Particle Size**: The desired particle size will depend on the intended application. Finer particles may be needed for certain products, while coarser particles might be sufficient for others.
- ✓ **Temperature Sensitivity:** Starch can be sensitive to heat. Excessive heat during grinding can cause starch to gelatinize or degrade, affecting its functional properties. Methods that minimize heat generation are preferred.
- ✓ **Moisture Content:** The moisture content of starch can affect its grinding efficiency and final texture. Starch should be appropriately dried or conditioned before grinding.
- ✓ **Type of Starch:** Different types of starch (e.g., corn, potato, tapioca) have different properties and may require specific grinding methods or conditions.
- ✓ **Equipment Efficiency:** The choice of grinding equipment affects the efficiency and quality of the final product. Proper maintenance and calibration of equipment are essential.
- ✓ **Safety and Cleanliness:** Starch dust can be a safety hazard, so appropriate dust control measures should be in place. Also, equipment must be kept clean to avoid contamination.
- ✓ **Cost and Scalability**: The method chosen should be cost-effective and scalable according to the production needs.

Practical Activity 3.3.2: Grinding starch

Task:

1. You are requested to go to the roots and tubers processing workshop to grind starch
2. Apply safety precautions (wear PPE).
3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.
4. Read the key reading 3.3.2
5. Perform the task provided in the application of learning 3.3

Key readings 3.3.2. Grinding starch

- **Grinding starch methods and procedures:**

✓ **Hammer Milling:**

Procedure and Steps:

✓ Feed Preparation: Ensure the starch is dry and free of large impurities.
✓ Feeding: Introduce the starch into the hammer mill. This usually involves a hopper that feeds the material into the milling chamber.
✓ Milling: In the hammer mill, the starch is subjected to high-speed rotating hammers or blades that impact and crush the material. The size of the particles is controlled by the screen or mesh size at the bottom of the mill.
✓ Collection: The ground starch passes through the screen and is collected in a designated container.
✓ Inspection: Check the particle size distribution to ensure it meets the required specifications.

Roller Milling:

Procedure and Steps:

✓ Feed Preparation: Clean and dry the starch. Remove any large particles or contaminants.
✓ Feeding: Feed the starch into the roller mill. This can be done via a hopper or conveyor system.

- ✓ Milling: The starch passes between two or more rotating cylinders (rollers) that crush and shear the material. The gap between the rollers can be adjusted to control the particle size.
- ✓ Sifting: After milling, the starch is often sifted to separate the fine particles from coarser ones.
- ✓ Collection: Collect the finely milled starch.
- ✓ Inspection: Ensure the particle size and quality meet the required standards.

Air Classification:

Procedure and Steps:

- ✓ Feed Preparation: Dry and prepare the starch, removing any large particles.
- ✓ Feeding: Introduce the starch into the air classifier. This is typically done using a pneumatic conveyor.
- ✓ Classification: In the air classifier, the starch is suspended in a stream of air. Centrifugal forces and air flow separate particles based on size and density. Fine particles are carried away by the air stream, while coarser particles are collected separately.
- ✓ Collection: Collect the classified starch into containers.
- ✓ Inspection: Verify that the particle size distribution is consistent with the desired specifications.

Ball Milling:

Procedure and Steps:

- ✓ Feed Preparation: Prepare and dry the starch. Ensure it is free from large impurities.
- ✓ Loading: Place the starch and milling media (e.g., steel or ceramic balls) into the ball mill.
- ✓ Milling: The ball mill rotates, causing the balls to impact and grind the starch. The motion of the balls crushes the starch into a fine powder.
- ✓ Discharge: Once milling is complete, discharge the ground starch from the mill.
- ✓ Collection: Collect the milled starch and check the particle size.
- ✓ Inspection: Ensure the ground starch meets the required size and quality.

Points to Remember

- Select the most appropriate grinding method and equipment by carefully considering the factors in grinding starch, to achieve the desired particle size and quality of the starch for the specific application.
- While grinding starch:
    - ✓ Wear PPE
    - ✓ Select the best grinding methods
    - ✓ Respect the grinding procedures

Application of learning 3.3.

You are requested to go in roots and tubers processing workshop to grind the dried cassava starch.

Indicative content 3.4: Sifting starch

Duration: 2hrs

Theoretical Activity 3.4.1: Description of sifting methods of starch

Tasks:

1.Answer the following questions related to description of sifting methods of starch

i. What could be the purpose of sifting starch?
ii. What could be the methods of sifting starch?
iii. What could be the Factors to consider in choosing sifting methods of starch?

2. Write your answers on paper, flip chart.

3. Present the findings/answers to the whole class.

4: For more clarification, read the key readings 3.4.1

Key readings 3.4.1.: Description of sifting methods of starch

- **Purpose of sifting starch**
  - ✓ Particle Size Separation: Sifting helps to separate fine starch particles from coarser ones, ensuring a uniform particle size for various applications.
  - ✓ Quality Control: It helps in maintaining consistency in product quality by removing oversized particles and ensuring the starch meets specific quality standards.
  - ✓ Improved Performance: For applications in food processing or pharmaceuticals, uniform starch particle size can improve the functionality and performance of the final product.
  - ✓ Removal of Impurities: Sifting can help remove impurities or contaminants that might be present in the starch, improving the purity of the final product.
  - ✓ Enhanced Solubility and Texture: Consistent particle size can enhance the solubility and texture of the starch in its end-use applications.

- **Methods of Sifting Starch**

✓ **Vibratory Sifting:** uses vibration to separate particles based on size, ensuring a consistent, fine product.

Advantages:

- Efficient for high volumes.

- Effective in removing fine impurities.

Disadvantages:

- Can be noisy.
- Requires regular maintenance to ensure effective operation.

✓ **Rotary Sifting:** involves rotating drums or screens to achieve separation of particles.

Advantages:

- Suitable for large quantities.
- Consistent and uniform sifting.

Disadvantages:

- Mechanical parts may require regular maintenance.
- Potential for higher energy consumption.

✓ **Pneumatic Sifting:** utilizes air pressure and airflow to separate particles.

Advantages:

- Effective for very fine and very coarse particles.
- Can be highly efficient and adaptable to different types of starch.

Disadvantages:

- Requires a well-maintained air system.
- Can be costly to install and operate.

✓ **Centrifugal Sifting:** uses centrifugal force to separate particles based on size and density.

Advantages:

- Very effective for separating fine and coarse particles.
- High efficiency in handling different types of materials.

Disadvantages:

- High energy consumption.
- Requires precise maintenance to avoid imbalances and operational issues.

- **Factors to Consider in Choosing Sifting Methods for Starch**

✓ Particle Size Requirements:

Mesh Size: Choose a sifting method based on the required particle size distribution. Fine screens or classifiers may be needed for fine powders, while coarser sieves are suitable for larger particles.

✓ Throughput Capacity:

Volume: Consider the volume of starch to be sifted. High-throughput applications might require automated or continuous sifting methods like vibratory screens or rotary sieves.

✓ End-Use Requirements:

Application-Specific Needs: Depending on whether the starch is for food, pharmaceuticals, or industrial use, the required purity and particle size may vary.

✓ Efficiency and Speed:

Processing Time: Evaluate the speed and efficiency of the sifting method. Automated systems like vibratory screens can process larger quantities more quickly than manual methods.

✓ Cost and Budget:

Investment: Consider the cost of the sifting equipment and its maintenance. Balance between initial investment and operational costs.

✓ Maintenance and Cleaning:

Ease of Maintenance: Ensure that the sifting equipment is easy to clean and maintain to prevent cross-contamination and ensure long-term efficiency.

✓ Space and Layout:

Facility Constraints: Assess the space available in your facility for sifting equipment. Some methods may require more space or have specific installation requirements.

✓ Dust Control:

Dust Generation: Some sifting methods may generate dust. Choose equipment that includes dust control measures if necessary to maintain a clean and safe working environment.

Practical Activity 3.4.2: Sifting starch

Task:

1. You are requested to go to the roots and tubers processing workshop to sift starch

2. Apply safety precautions (wear PPE).

3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key reading 3.4.2

5: Perform the task provided in the application of learning 3.4

Key readings 3.4.2. Sifting starch

- **Sifting methods and procedures:**

✓ **Vibratory Sifting**

Procedure:

Preparation: Position the vibratory sifter on a stable surface. Ensure it is clean and dry.

Loading: Pour the starch into the hopper or feeder of the vibratory sifter.

Operation: Activate the sifter. The machine will use vibration to move the starch across a screen mesh.

Sifting: The vibration causes the starch to pass through the mesh, separating finer particles from coarser ones.

Collection: Collect the sifted starch from the designated discharge area.

Maintenance: Regularly check and clean the sifter to prevent clogging and contamination.

✓ **Rotary Sifting**

Procedure:

Preparation: Set up the rotary sifter and ensure it is properly aligned and functioning.
Loading: Feed the starch into the rotary drum or screen.

Operation: Start the rotation mechanism. The rotating drum or screen causes the starch to move along the surface, where it is sifted through perforations or mesh.

Sifting: As the drum or screen rotates, finer starch particles pass through while coarser particles are retained.

Collection: Collect the sifted starch from the output section and any larger particles from the discharge area.

Maintenance: Clean the rotary sifter regularly to maintain efficiency.

- ✓ **Pneumatic Sifting**

Procedure:

Preparation: Set up the pneumatic sifter, ensuring all air filters and components are clean and functioning.

Loading: Feed the starch into the air classifier.

Operation: Activate the airflow system. Air is forced through the starch, lifting and separating fine particles from coarser ones.

Sifting: The finer particles are carried by the air stream to a collection area, while coarser particles fall away.

Collection: Collect the sifted starch from the collection chamber and separate out coarser particles as needed.

Maintenance: Regularly check and clean air filters and other components to ensure efficient operation.

- ✓ **Centrifugal Sifting**

Procedure:

Preparation: Ensure the centrifugal sifter is clean and assembled correctly.

Loading: Feed the starch into the centrifugal chamber.

Operation: Start the centrifuge. The spinning motion creates a force that pushes particles outward against a screen or mesh.

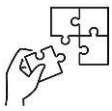
Sifting: Finer particles pass through the mesh, while coarser particles are separated and collected.

Collection: Collect sifted starch from the collection bin and larger particles from the discharge port.

Maintenance: Regularly clean and inspect the sifter to maintain optimal performance.

Points to Remember

- By considering the factors in choosing sifting methods, you can select the most appropriate sifting method for your starch processing needs, ensuring that the final product meets the desired specifications and quality standards.
- By following the sifting methods and procedures, you can ensure that the starch is sifted effectively, resulting in a smoother and more consistent product.



Application of learning 3.4.

You are requested to go in roots and tubers processing workshop to sift the dried cassava starch.

Indicative content 3.5: Modifying Starch

Duration: 2 hrs

Theoretical Activity 3.5.1: Description of modifying methods of native starch

Tasks:

1. Answer the following questions related to description of modifying methods of starch
    i. What could be the purpose of modifying native starch?
    ii. Describe the methods used to modify native starch?
    iii. Discuss on the changes that could be occur during modification of native starch?
2. Write your answers on paper, flip chart.
3. Present the findings/answers to the whole class.
4. For more clarification, read the key readings 3.5.1

Key readings 3.5.1.: Description of modifying methods of native starch

- Purpose of Modifying Native Starch

✓ **Improved Functional Properties:**

Thickening and Gelation: Enhance the thickening power or gelling properties of starch for better texture in food products.

Stability: Improve resistance to temperature fluctuations, freeze-thaw cycles, or mechanical stress in processed foods.

✓ **Specific Application Needs:**

Industrial Uses: Tailor starch for use in non-food industries like pharmaceuticals, paper, textiles, and adhesives.

Specialty Products: Adjust starch properties for specific product formulations, such as instant foods or low-fat products.

✓ **Enhanced Texture and Consistency:**

Food Texture: Modify texture to achieve desirable mouthfeel, creaminess, or smoothness in food products.

Consistency: Ensure uniformity in products that require consistent viscosity or gel strength.

✓ **Increased Resistance:**

Heat and Acid Resistance: Improve the starch's performance in conditions where high temperatures or acidic environments are present.

Shear Resistance: Enhance stability during mixing or processing where mechanical agitation is involved.

- **Difference between Native starch and Modified starch**

Native Starch:

Definition: Native starch is the starch in its natural, unaltered form as it is extracted directly from plant sources.

Structure: It retains its original granular structure and characteristics found in nature, including its amylose and amylopectin composition.

Properties: Native starch has limited functional properties like low solubility in cold water, low thickening ability, and poor resistance to heat and shear forces.

Uses: It's commonly used in its raw form in food products like sauces, soups, and bakery items. It is also used in non-food products like paper, textiles, and pharmaceuticals.

Processing: It undergoes minimal processing, such as washing, drying, and milling.

Modified Starch:

Definition: Modified starch is starch that has been chemically, physically, or enzymatically altered to enhance its functional properties, such as stability, texture, and viscosity under various conditions.

Structure: The modification process changes the starch's molecular structure, which can result in changes to the size, shape, and gelatinization properties of the starch granules.

Properties: Modified starches have enhanced properties like increased water solubility, higher resistance to heat, better freeze-thaw stability, and improved thickening ability. They are also more adaptable to a wide range of conditions like acidic environments, high shear, or high temperature.

Uses: Modified starches are used in a broader range of food applications (like instant pudding, dressings, and processed meats), as well as industrial uses such as adhesives, pharmaceuticals, and cosmetics.

Processing: Modified starch undergoes treatment such as acid hydrolysis, oxidation, cross-linking, or esterification to alter its properties.

Differences:

- ✓ **Processing**: Native starch is unaltered, while modified starch has undergone treatments to change its properties.
- ✓ **Functional Properties**: Modified starch has improved characteristics (e.g., better stability, viscosity) compared to native starch.
- ✓ **Uses**: Native starch is typically used in more basic applications, while modified starch is used where specialized characteristics are needed.
- ✓ **Adaptability**: Modified starch can perform in a wider variety of conditions (temperature

- **Methods of Modifying Native Starch**
  - ✓ **Physical Modification:**

Physical modifications could involve changes in the granular structure, thereby modifying its gelatinization behavior, swelling, and solubility behavior. These processes are commonly implemented when modifying starch for food applications.

- Pre-gelatinization: Cooking and drying starch to make it soluble in cold water, used for instant foods and convenience products.
- Shearing: Applying mechanical stress to break down starch granules, affecting their size and properties.
- Micronization: Grinding starch into finer particles to improve solubility and dispersion.

  - ✓ **Chemical Modification:**

Chemical modification is a process that introduces functional groups to starch polymers to improve their nutritional and structural properties. The process can involve:

- Acetylation: Introducing acetyl groups to reduce viscosity and improve freeze-thaw stability.
- Cross-linking: Creating chemical bonds between starch molecules to increase resistance to heat, acid, and shear.
- Oxidation: Treating starch with oxidizing agents to reduce molecular weight and modify its gelatinization properties.

  - ✓ **Enzymatic Modification:**

- Amylolysis: Using amylase enzymes to break down starch into simpler sugars, altering its thickening and gelling properties.
- Debranching: Enzymatically removing branches from amylopectin to produce starches with different gel properties.

- **Changes Occur During Modification of Native Starch**

✓ **Physical Changes:**

Granule Morphology:

- Pre-gelatinization: Granules lose their original structure and become more amorphous.
- Shearing: Granules may break or become fragmented.
- Micronization: Granules are reduced to smaller sizes, increasing surface area.

Crystallinity:

- Pre-gelatinization: Loss of crystalline structure due to gelatinization.
- Shearing: Partial disruption of crystalline regions.
- Micronization: Potential alteration in the crystalline structure due to size reduction.

Gelatinization:

- Pre-gelatinization: Starch has already been gelatinized and dissolves in cold water to form gels.
- Shearing May affect the gelatinization temperature and behavior.
- Micronization: Can affect how easily starch gelatinizes in various systems.

✓ **Chemical Changes:**

- Degree of Polymerization:
- Acetylation: Generally remains the same but can influence interactions between starch molecules.
- Cross-linking: Maintains a higher degree of polymerization under harsh conditions.
- Oxidation: Reduces the degree of polymerization by breaking down starch chains.
- Chemical Substitution:
- Acetylation: Introduction of acetyl groups alters solubility and stability.
- Cross-linking: Formation of chemical bonds between chains changes physical properties.
- Oxidation: Introduction of oxidative groups affects starch properties.

Oxidation:

Oxidation: Changes the starch structure by introducing aldehyde or carboxyl groups, modifying properties like clarity and viscosity.

Practical Activity 3.5.2: Modifying of native starch

Task:

1. You are requested to go to the roots and tubers processing workshop to modify native starch

2. Apply safety precautions (wear PPE).

3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key reading 3.5.2

5: Perform the task provided in the application of learning 3.5

Key readings 3.5.1.: Modifying native starch

- **Methods of modifying starch and procedures:**
  - ✓ **Physical Modification**
    - **Pre-gelatinization**

Procedure:

Preparation: Mix starch with water to achieve a slurry.

Heating: Cook the slurry under controlled conditions (temperature and time) to gelatinize the starch. This involves raising the temperature until the starch granules swell and release their amylose content.

Drying: Dry the gelatinized starch using methods such as spray drying, drum drying, or freeze-drying to remove water.

Grinding (if necessary): Pulverize the dried starch to achieve the desired particle size.

- **Shearing**

Procedure:

Preparation: Mix starch with water to create a slurry.

Shearing: Subject the slurry to high shear forces using equipment such as a high-speed blender, homogenizer, or extruder.

Processing: Control shear time and intensity based on desired outcomes.

Drying (if Required dry the sheared starch if necessary.

- Micronization

Procedure:

Preparation: Place starch into a micronizer or jet mill.

Micronization: Use high-velocity air or other mechanical forces to grind the starch into very fine particles.

Collection: Collect the micronized starch and store it in a dry environment.

✓ **Chemical Modification**

- **Acetylation**

Procedure:

Preparation: Dissolve starch in water to form a slurry.

Acetylation: Add acetylating agents such as acetic anhydride or sodium acetate to the slurry under controlled conditions (temperature and pH).

Reaction: Allow the reaction to proceed, typically for several hours, ensuring complete acetylation of the starch.

Neutralization and Washing: Neutralize the reaction mixture, then wash and dry the modified starch.

- **Cross-linking**

Procedure:

Preparation: Dissolve starch in water to create a slurry.

Cross-linking: Add cross-linking agents such as phosphates (e.g., sodium tripolyphosphate) or other chemical agents under controlled conditions.

Reaction: Allow the cross-linking reaction to proceed, usually by heating.

Neutralization and Washing: Neutralize, wash, and dry the cross-linked starch.

- **Oxidation**

Procedure:

Preparation: Dissolve starch in water to create a slurry.

Oxidation: Treat the slurry with oxidizing agents such as sodium hypochlorite or ozone.

Reaction: Allow the oxidation reaction to proceed, which typically involves controlled pH and temperature.

Neutralization and Washing: Neutralize the reaction mixture, then wash and dry the oxidized starch.

- ✓ **Enzymatic Modification**
  - **Amylolysis**

Procedure:

Preparation: Dissolve starch in water to create a slurry.

Enzyme Addition: Add amylase enzymes (e.g., alpha-amylase) to the slurry.

Reaction: Allow the enzyme to act on the starch, breaking it down into smaller molecules or sugars.

Stopping the Reaction: Heat or chemically inactivate the enzyme to stop the reaction.

Purification: Remove any residual enzyme and dry the modified starch if necessary.

- **Debranching**

Procedure:

Preparation: Dissolve starch in water to create a slurry.

Enzyme Addition: Add debranching enzymes such as isoamylase or pullulanase.

Reaction: Allow the enzyme to break down branch points in amylopectin, resulting in a starch with fewer branches.

Stopping the Reaction: Heat or chemically inactivate the enzyme to stop the reaction.

Purification: Remove any residual enzyme and dry the modified starch if necessary.

Points to Remember

- Understanding the changes occur during modifications helps in selecting the right modification method to achieve the desired characteristics for various applications.
- Modified starch, also called starch derivatives, is prepared by physically, enzymatically, or chemically treating native starch to change its properties.

Application of learning 3.5.

You are requested to go in roots and tubers processing workshop to modify the cassava native starch.

Indicative content 3.6: Analysing Quality of Starch

Duration: 2 hrs.

Theoretical Activity 3.6.1: Description of starch quality characteristics

Tasks:

1. You are requested to answer the following questions related to description starch quality characteristics:

   i. Identify the sensory characteristics of starch
   ii. How would you describe the texture and solubility as physical properties of starch?
   iii. What could be the Chemical properties of starch
   iv. What could be the essential compositional requirements and limits for starch in terms of moisture content, protein levels, ash content, and other relevant parameters?

2. Write your answers on paper, flip chart.

3. Present the findings/answers to the whole class.

4. For more clarification, read the key readings 3.6.1

Key readings 3.6.1.: Description of starch quality characteristics

- **Sensory Characteristics of starch**
  - ✓ **Color:**

Description: Starch should typically be white or off-white. Any discoloration may indicate contamination or degradation.

Quality Indicators: Uniform color throughout the product. Any yellowing, browning, or other discoloration could signal poor quality or spoilage.

- ✓ **Taste:**

Description: Starch should have a neutral or bland taste.

Quality Indicators: Any off-flavors or bitterness can suggest contamination or the presence of impurities.

- ✓ **Odor:**

Description: Starch should have little to no odor.

Quality Indicators: A fresh, neutral smell is desirable. Any sour, rancid, or otherwise unusual odor could indicate spoilage or contamination.

✓ **Free from Foreign Matter:**

Description: Starch should be free from foreign particles or contaminants.

Quality Indicators: The absence of visible impurities such as dirt, debris, or foreign substances is crucial for food safety and quality.

- **Physical Properties of starch**

✓ **Solubility:**

Description: Starch's solubility depends on its type and modification. Native starches generally have limited solubility in cold water but can gelatinize upon heating.

Quality Indicators: Good starch should exhibit appropriate solubility or gelation behavior as per its intended application. For modified starches, solubility characteristics should match specifications.

✓ **Texture:**

Description: Texture can range from powdery to granular, depending on the starch type and processing.

Quality Indicators: The starch should have a consistent texture. It should not be excessively gritty or lumpy, indicating proper milling and processing.

- **Chemical Properties of starch**

✓ **Iodine Test:**

Description: The iodine test is used to determine the presence of starch. Starch forms a blue or purple complex with iodine.

Procedure: Add a few drops of iodine solution to a starch suspension.

Quality Indicators: A blue or purple color confirms the presence of starch. A negative result may indicate improper starch content or contamination.

- **Compositional Quality Requirements and Limits**

✓ **Moisture Content:**

Description: Refers to the amount of water present in the starch. Excess moisture can affect storage stability and quality.

Limits: Typically, moisture content should be less than 14% for most starches.

Quality Indicators: Moisture content should be within specified limits to avoid spoilage and ensure shelf life.

✓ **pH:**

Description: Measures the acidity or alkalinity of the starch.

Limits: The pH of starch typically ranges from 4.5 to 7.0.

Quality Indicators: pH should be within the specified range to ensure proper functionality and avoid adverse effects on the product.

✓ **Total Acidity:**

Description: Indicates the amount of acidic components present in the starch.

Limits: Usually measured in terms of acetic acid or similar. Limits vary by application but are generally low.

Quality Indicators: Low total acidity is preferred to avoid adverse effects on starch properties.

✓ **Fibre:**

Description: Represents the amount of fiber in the starch, which is typically minimal in refined starches.

Limits: Should be minimal, often less than 0.5%.

Quality Indicators: Low fiber content is preferred for a smooth, uniform texture.

✓ **Sulphated Ash:**

Description: Measures the inorganic residue remaining after incineration of the starch.

Limits: Usually less than 0.5% for most starches.

Quality Indicators: Low sulphated ash content indicates purity and minimal contamination.

✓ **Chloride:**

Description: Measures the amount of chloride present, often as a result of processing or contamination.

Limits: Typically, less than 0.1% for most starches.

Quality Indicators: Low chloride levels are desirable to prevent adverse effects on starch functionality and taste.

- **Microbiological Requirements and Limits**

✓ **Total Aerobic Count:**

Description: Measures the total number of aerobic microorganisms present in the starch.

Limits: Should be very low, generally less than 1,000 colony-forming units per gram.

Quality Indicators: Low aerobic counts are essential to ensure the starch is free from spoilage microorganisms.

✓ **Escherichia coli:**

Description: A type of bacteria that can indicate fecal contamination.

Limits: Should be absent in 100 grams of starch.

Quality Indicators: Absence of E. coli is critical for food safety.

✓ **Salmonella:**

Description: A pathogenic bacterium that can cause foodborne illness.

Limits: Should be absent in 25 grams of starch.

Quality Indicators: Absence of Salmonella ensures the starch is safe for consumption.

✓ **Yeast and Mould:**

Description: Measures the presence of yeast and mould organisms.

Limits: Should be low, typically less than 100 colony-forming units per gram.

Quality Indicators: Low levels are crucial to avoid spoilage and ensure product quality.

Practical Activity 3.6.2: Analysing starch quality characteristics

Task:

1. You are requested to go to the roots and tubers processing workshop to analyse starch quality characteristics

2. Apply safety precautions (wear PPE).

3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key reading 3.6.2

5: Perform the task provided in the application of learning 3.6

Key readings 3.6.2. Analysing starch quality characteristics

- **Methods for analysing sensory characteristics**

✓ **Color:**

Method: Visual Inspection

Procedure:

✓ Observe the starch sample under natural or standardized lighting conditions.
✓ Compare the color to a standardized color chart or reference sample.

Tools: Colorimeters or spectrophotometers can provide more precise measurements of color.

✓ **Taste:**

Method: Sensory Evaluation

Procedure:

✓ Prepare a starch slurry or solution according to typical use conditions.
✓ Conduct a taste test with trained sensory panelists.
✓ Evaluate for any off-flavors or bitterness.

Tools: Sensory panels, trained testers, and standardized testing procedures.

✓ **Odor:**

Method: Sensory Evaluation

P**rocedure**:

- ✓ Smell the starch sample directly or after preparing a slurry.
- ✓ Note any unusual or off-odors.

Tools: Sensory panels and trained testers.

- ✓ **Free from Foreign Matter:**

Method: Visual Inspection and Sieving

Procedure:

- ✓ Inspect the starch sample visually to check for foreign particles.
- ✓ Use sieves or screens to separate any large contaminants.

Tools: Magnifying glass, sieves.

- **Methods for analyzing physical properties**

- ✓ **Solubility:**

Method: Solubility Test

Procedure:

- ✓ Prepare a starch slurry or solution in water.
- ✓ Stir the mixture and allow it to settle.
- ✓ Filter or centrifuge the mixture and measure the amount of starch dissolved.

Tools: Beakers, stirrers, filters, centrifuges.

- ✓ **Texture:**

Method: Texture Analysis

Procedure:

- ✓ Prepare a starch sample as per its typical use (e.g., gel or paste).
- ✓ Measure texture properties using a texture analyzer.
- ✓ Analyze parameters like firmness, cohesiveness, and viscosity.

Tools: Texture analyzers, rheometers.

- **Methods for analyzing Chemical Properties**

- ✓ **Iodine Test:**

Method: Iodine-Starch Test

Procedure:

- ✓ Prepare a starch suspension in water.
- ✓ Add a few drops of iodine solution to the suspension.
- ✓ Observe the color change (blue or purple indicates the presence of starch).

Tools: Iodine solution, test tubes, pipettes.

- **Methods for analyzing Compositional Quality Requirements and Limits**

✓ **Moisture Content:**

Method: Oven Drying Method

Procedure:

- ✓ Weigh a sample of starch.
- ✓ Dry it in an oven at a specified temperature (usually 105°C) until a constant weight is achieved.
- ✓ Weigh the sample again and calculate the moisture content.

Tools: Analytical balance, drying oven.

✓ **pH:**

Method: pH Meter

Procedure:

- ✓ Prepare a starch slurry in distilled water.
- ✓ Measure the pH of the slurry using a pH meter.

Tools: pH meter, beakers.

✓ **Total Acidity:**

Method: Titration

Procedure:

- ✓ Prepare a starch solution.
- ✓ Titrate with a standard alkaline solution (e.g., sodium hydroxide) using a pH indicator.
- ✓ Calculate the total acidity based on the volume of titrant used.

Tools: Burette, titration flask, pH indicator, sodium hydroxide solution.

✓ **Fibre:**

Method: Acid Detergent Fiber (ADF) or Neutral Detergent Fiber (NDF) Method

Procedure:

- ✓ Weigh a starch sample.
- ✓ Treat it with acid or neutral detergent to dissolve non-fiber components.
- ✓ Weigh the remaining fiber and calculate the content.

Tools: Fiber analyzer, filtration equipment.

- ✓ **Sulphated Ash:**

Method: Sulphated Ash Test

Procedure:

- ✓ Weigh a starch sample.
- ✓ Incinerate the sample in a furnace at high temperature (usually 600°C).
- ✓ Treat the ash with sulfuric acid to form sulphated ash.
- ✓ Weigh the sulphated ash and calculate the percentage.

Tools: Muffle furnace, analytical balance.

- ✓ **Chloride:**

Method: Silver Nitrate Titration

Procedure:

- ✓ Prepare a starch sample solution.
- ✓ Titrate with a silver nitrate solution in the presence of a chromate indicator.
- ✓ Calculate the chloride content based on the volume of titrant used.

Tools: Burette, titration flask, silver nitrate solution, chromate indicator.

- **Methods for analyzing Microbiological Requirements and Limits**
- ✓ **Total Aerobic Count:**

Method: Plate Count Method

Procedure:

- ✓ Prepare a starch suspension.
- ✓ Plate the suspension on a suitable agar medium (e.g., Plate Count Agar).
- ✓ Incubate and count the colonies formed.

Tools: Agar plates, incubator, colony counter.

- ✓ **Escherichia coli:**

Method: Most Probable Number (MPN) Method or Membrane Filtration

Procedure:

- ✓ Prepare a starch suspension.
- ✓ Use MPN or filter the sample through a membrane and place it on selective agar (e.g., Eosin Methylene Blue Agar).
- ✓ Incubate and check for E. coli colonies.

Tools: Selective agar, membrane filters, incubator.

- ✓ **Salmonella:**

Method: Enrichment and Selective Agar Method

Procedure:

- ✓ Enrich the starch sample in a selective broth.
- ✓ Plate on selective agar (e.g., Xylose Lysine Deoxycholate Agar).
- ✓ Incubate and verify the presence of Salmonella colonies.

Tools: Selective broth, selective agar, incubator.

- ✓ **Yeast and Mould:**

Method: Plate Count Method

- ✓ **Procedure:**
- ✓ Prepare a starch suspension.
- ✓ Plate the suspension on Sabouraud Dextrose Agar (SDA).
- ✓ Incubate and count yeast and mould colonies.

Tools: SDA plates, incubator, colony counter.

Points to Remember

- By adhering to the sensory, physical, chemical, compositional, and microbiological requirements, starch can be produced and used effectively in various applications while ensuring safety and quality.
- The methods and procedures used for starch quality analysis helping to ensure that
- starch meets the required quality standards for its intended applications, ensuring safety, functionality, and consistency.

Application of learning 3.6.

You are requested to go in roots and tubers processing workshop to analyse cassava starch quality characteristics.

Indicative content 3.7: Storing of Starch

Duration: 2hrs

Practical Activity 3.7.1: Packaging of starch

Task:

1. You are requested to go to the roots and tubers processing workshop to package starch

2. Apply safety precautions (wear PPE).

3 .Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key reading 3.7.1

5: Perform the task provided in the application of learning 3.7

Key readings 3.7.1. Packaging starch

- **Purpose of packaging starch**
  - ✓ Protection
  - ✓ Preservation
  - ✓ Safety
  - ✓ Convenience
  - ✓ Branding and Marketing
  - ✓ Legal and Regulatory Compliance
  - ✓ Functional Suitability

- **Filling methods of starch**

✓ **Automated Filling Systems**

Automated filling systems are designed to handle high-volume production efficiently and consistently. They are ideal for scenarios where large quantities of starch need to be packaged quickly and accurately.

- **Volumetric Fillers:** dispense a precise volume of starch into containers using fixed-volume chambers or pistons.

Procedure:

- ✓ Calibration: Set the desired volume on the machine.
- ✓ Filling: The machine draws starch into the chamber or piston and dispenses it into containers.
- ✓ Sealing: Containers are then sealed or capped.

Applications: Packaging of starch into bags, pouches, or containers where a consistent volume is crucial.

Advantages: High speed and consistent filling volumes.

Challenges: May require adjustment for different particle sizes or flow properties.

- Weighing Fillers

Description: Use load cells and scales to measure the weight of starch being filled into containers.

Procedure:

- ✓ Setup: Calibrate the scale to the desired weight.
- ✓ Filling: Starch is dispensed into containers until the target weight is achieved.
- ✓ Verification: Weighed containers are checked for accuracy.

Applications: Suitable for bulk filling where precise weight control is necessary.

Advantages: High accuracy in weight control.

Challenges: Requires calibration and maintenance for accuracy.

- **Auger Fillers**

Description: Utilize an auger screw to transport and dispense powdered starch into containers.

Procedure:

- ✓ Setup: Adjust the auger speed and fill volume settings.
- ✓ Filling: The auger moves starch from a hopper into containers.
- ✓ Sealing: Containers are sealed after filling.

Applications: Ideal for fine powders and materials with varying flow characteristics.

Advantages: Effective for powders with poor flow properties.

Challenges: Auger jams or wear may occur with abrasive or sticky powders.

- **Pneumatic Fillers**

Description: Employ air pressure to move and fill powders into containers.

Procedure:

Setup: Adjust air pressure and fill volume settings.

Filling: Pneumatic systems convey starch through tubes and into containers.

Sealing: Containers are sealed or capped after filling.

Applications: Bulk packaging and handling of fine or delicate powders.

Advantages: Gentle handling reduces damage to powder.

Challenges: Requires careful control of air pressure to avoid overfilling or dust generation.

- **Vertical Form-Fill-Seal (VFFS) Machines**

Description: Form and seal bags from a roll of film, fill them with starch, and seal them.

Procedure:

- ✓ Film Feeding: Roll of film is fed into the machine.
- ✓ Bag Formation: The film is formed into a bag shape.
- ✓ Filling: Starch is dispensed into the bag.
- ✓ Sealing: Bags are sealed and cut to the desired length.

Applications: High-speed, continuous packaging of consumer-sized bags or pouches.

Advantages: Efficient and cost-effective for high-volume production.

Challenges: Requires precise film and filling adjustments.

- ✓ **Manual Filling Systems**

Manual filling systems are suited for smaller-scale operations or where automation is not cost-effective. They offer flexibility and are often used for custom or low-volume packaging.

- **Scoop and Fill**

Description: Use a scoop or ladle to manually transfer starch into containers.

Procedure:

- ✓ Scooping: Use a scoop to transfer starch from a bulk container to individual containers.
- ✓ Leveling: Level the top of the container to ensure consistent fill.

Applications: Small batches or artisanal production.

Advantages: Low cost and flexibility for different container sizes.

Challenges: Labor-intensive and less precise.

- **Manual Weighing Fillers**

Description: Utilize manual scales to measure and fill starch into containers.

Procedure:

- ✓ Weighing: Place containers on a scale and fill with starch until the desired weight is achieved.
- ✓ Sealing: Containers are sealed or capped manually.

Applications: Situations requiring precise weight measurement with lower volume.

Advantages: Greater control over weight accuracy.

Challenges: Time-consuming and requires manual handling.

- **Funnel and Spout Systems:** Use funnels and spouts to transfer starch into containers.

Procedure:

- ✓ Setup: Position a funnel over the container.
- ✓ Filling: Pour starch into the funnel, allowing it to flow into the container.

Applications: Filling larger bags or containers where automation is not feasible.

Advantages: Simple and low-cost equipment.

Challenges: Less efficient for large volumes and potential for spillage.

- **Handheld Augers:** Portable auger systems used for manual filling.

Procedure:

- ✓ Setup: Adjust the auger for the desired fill volume.
- ✓ Filling: Use the auger to dispense starch into containers

Theoretical Activity 3.7.2: Description of labelling requirements of starch

Tasks:

1. Answer the questions related to description of labelling requirements of starch
    i. What could be the labelling requirements of starch?
2. Write your answers on paper, flip chart.
3. Present the findings/answers to the whole class.
4: For more clarification, read the key readings 3.7.2

Key readings 3.7.2. Description of labelling requirements of starch

- **Purpose of Labelling**

✓ Consumer Information: To provide consumers with clear and accurate information about the starch product.
✓ Regulatory Compliance: To comply with legal and regulatory requirements for product labelling.
✓ Safety and Usage Instructions: To offer guidance on the safe handling and proper use of the starch.
✓ Branding and Marketing: To promote the product and attract consumers.
✓ Traceability: To enable tracking of the product throughout the supply chain.

- **Labelling Information**

✓ Product Name:

Description: The name of the starch product, such as "Corn Starch," "Tapioca Starch," or "Potato Starch."

Purpose: Identifies the product and differentiates it from other starches or ingredients.

✓ Ingredients List:

Description: A list of all ingredients used in the starch product, if applicable.

Purpose: Provides transparency about the composition of the product and helps consumers with allergies or dietary restrictions.

✓ Net Weight:

Description: The total weight of the starch contained in the package.

Purpose: Informs consumers of the quantity of product they are purchasing.

✓ Nutritional Information:

Description: Details on the nutritional content of the starch, such as calories, carbohydrates, proteins, fats, and dietary fiber.

Purpose: Provides nutritional data to help consumers make informed dietary choices.

✓ Usage Instructions:

Description: Guidelines on how to use the starch, including mixing instructions, cooking times, or application methods.

Purpose: Ensures that consumers use the starch correctly for the intended application.

✓ Storage Instructions:

Description: Recommendations for storing the starch to maintain its quality, such as temperature and humidity conditions.

Purpose: Helps preserve the product's effectiveness and extends shelf life.

✓ Expiration Date or Best Before Date:

Description: The date by which the starch should be used to ensure optimal quality and safety.

Purpose: Provides information on the product's shelf life and helps prevent use beyond its effectiveness or safety.

✓ Batch Number or Lot Code:

Description: A unique identifier for the production batch or lot.

Purpose: Facilitates traceability and recall if there are issues with the product.

✓ Manufacturer Information:

Description: Name, address, and contact information of the manufacturer or distributor.

Purpose: Provides a point of contact for inquiries or issues and ensures accountability.

✓ Country of Origin:

Description: The country where the starch was produced or processed.

Purpose: Indicates the origin of the product, which can be important for quality assurance and regulatory compliance.

✓ Certifications and Claims:

Description: Any relevant certifications (e.g., organic) or claims (e.g., gluten-free).

Purpose: Provides additional information about the product's quality and attributes, which can influence purchasing decisions.

✓ Safety Warnings:

Description: Any specific warnings related to the product, such as handling precautions or potential allergens.

Purpose: Ensures that consumers are aware of any safety issues related to the product.

✓ Bar Code or QR Code:

Description: A machine-readable code for inventory management and scanning at retail points.

Purpose: Facilitates efficient tracking, sales processing, and inventory control.

Practical Activity 3.7.3: Storing of starch

Task:

1. You are requested to go to the roots and tubers processing workshop to store starch

2. Apply safety precautions (wear PPE).

3. Present out the methods and procedures of storing starch

4-. Store starch

5. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

6. Read the key reading 3.7.3

Key readings 3.7.3. Storing starch

- **Storage conditions of starch**

✓ **Temperature**

- Optimal Range:

Description: Store starch at a cool, stable temperature.

Recommended Range: Typically, between 10°C to 25°C (50°F to 77°F), but specific requirements may vary depending on the type of starch and manufacturer recommendations.

Purpose: Prevents degradation of starch and maintains its functional properties.

- Avoid Temperature Fluctuations:

Description: Keep the storage area at a consistent temperature.

Purpose: Prevents condensation and potential quality issues.

✓ **Humidity**

- Low Humidity:

Description: Maintain a dry environment with low relative humidity.

Recommended Range: Relative humidity should be kept below 60%.

Purpose: Prevents moisture absorption, which can lead to clumping, caking, or microbial growth.

- Moisture-Proof Packaging:

Description: Use packaging that resists moisture ingress, such as plastic bags with sealable closures or moisture-proof containers.

Purpose: Keeps starch dry and prevents spoilage.

✓ **Light**

- Dark Storage:

Description: Store starch in a dark environment or use opaque packaging.

Purpose: Protects starch from light exposure, which can cause oxidation and degrade its quality.

- Packaging Materials:

Description: Utilize packaging that blocks light or minimizes light exposure.

Purpose: Ensures starch stability and effectiveness.

✓ **Container and Packaging**

- Sealed Containers:

Description: Use airtight or well-sealed containers.

Purpose: Prevents contamination, moisture absorption, and exposure to air.

- Clean and Dry:

Description: Ensure that containers and packaging materials are clean and dry before use.

Purpose: Reduces the risk of contamination and spoilage.

- Bulk Storage:

Description: For large quantities, use silos or bulk bins with proper sealing and ventilation.

Purpose: Manages large volumes efficiently while maintaining quality.

Handling Procedures

✓ **Cleanliness:**

Description: Maintain a clean storage environment.

Purpose: Ensures that the starch remains free from contaminants such as dust, dirt, or pests.

✓ **Proper Handling:**

Description: Use clean tools and equipment to handle starch.

Purpose: Prevents contamination and maintains product integrity.

✓ **Avoiding Cross-Contamination:**

Description: Store starch away from other materials that could cause contamination.

Purpose: Prevents cross-contamination with other substances or chemicals.

- **Inventory Management**

✓ **First In, First Out (FIFO):**

Description: Implement FIFO inventory practices.

Purpose: Ensures that older stock is used before newer stock, reducing waste and ensuring freshness.

✓ **Regular Inspection:**

Description: Conduct regular inspections for signs of deterioration or contamination.

Purpose: Identifies potential issues early and prevents spoilage.

✓ **Inventory Records:**

Description: Maintain accurate records of starch inventory, including batch numbers and storage conditions.

Purpose: Facilitates traceability and quality control.

✓ **Pest Control**

- **Pest Management:**

Description: Implement measures to control pests in storage areas.

Purpose: Prevents infestations that could lead to contamination or spoilage.

- **Inspection and Maintenance:**

Description: Regularly inspect storage areas for signs of pests and maintain cleanliness.

Purpose: Ensures a pest-free storage environment.

- **Procedure for storing starch**

✓ Choose a suitable container: Opt for airtight containers made of glass, stainless steel, or food-grade plastic. Avoid containers with cracks or chips.
✓ Store in a cool, dry place: Keep the container away from direct sunlight, heat sources, and excessive humidity. A pantry or cupboard is ideal.
✓ Seal the container tightly: Ensure the lid is securely fastened to prevent moisture and air from entering.
✓ Label the container: Indicate the contents and date of storage for easy reference.
✓ Consider refrigeration or freezing: For long-term storage, consider refrigerating or freezing the starch. However, refrigeration might cause the starch to clump slightly.
✓ Check for signs of spoilage: Regularly inspect the starch for any changes in color, texture, or odor. If you notice any issues, discard it.

Points to Remember

- Always wear the PPE while you are packaging the starch to avoid contamination
- Remember to follow the labelling guidelines, in order to ensure that the starch labels are accurate, informative, and compliant with relevant regulations.
- Follow the storage guidelines in order to store effectively roots and tubers starch and ensure its quality and safety for future use.

Application of learning 3.7.

You are requested to go in roots and tubers processing workshop to store cassava starch.

Learning outcome 3 end assessment

Theoretical assessment

I. Ready carefully the statements below related to starch making and answer by encircling the letter corresponding to the correct answer.

1. What does the purification process in starch making aim to achieve?

a. Increase the starch yield

b. Remove impurities and non-starch components

c. Enhance the color of the raw starch

d. Add flavor to the starch

2. Which method of starch purification involves using gravity to separate heavier particles from the starch suspension?

a. Centrifugation

b. Sedimentation

c. Sieving

d. Filtration

3. What is the primary purpose of alkaline extraction in starch purification?

a. Remove proteins and some contaminants

b. Increase starch viscosity

c. Break down starch into glucose

d. Enhance the color of the starch

4. Why might enzymatic treatments be used in starch purification?

a. To break down starch molecules into simpler sugars

b. To remove colorants from the starch

c. To enhance the texture of the starch

d. To separate starch based on particle size

5. What factor is NOT typically considered when selecting a starch purification method?

a. Type of impurities

b. Cost and efficiency

c. Environmental impact

d. Packaging design of the final starch product

6. What is one of the primary purposes of drying wet starch?

a. To increase its moisture content for better consistency
b. To convert it into a liquid form for easier application
c. To reduce moisture content to prevent microbial growth and spoilage
d. To enhance its color for better visual appeal

7. Which method of drying wet starch involves spreading it in thin layers and exposing it to ambient air?

a. Spray Drying
b. Fluidized Bed Drying
c. Freeze Drying
d. Air Drying

8. Which grinding method involves using high-speed hammers to crush starch into smaller particles?

a. Roller Milling
b. Cryogenic Grinding
c. Ball Milling
d. Hammer Milling

9. What factor should be considered when grinding starch to avoid affecting its functional properties?

a. Particle size only
b. Temperature sensitivity to prevent gelatinization or degradation
c. The color of the starch
d. The brand of grinding equipment

II. Ready the statements below related to starch making and answer by True (T) if the statement is correct and False (F) if the statement is wrong

1. Modified starches always have the same solubility as native starches.

2. The presence of E. coli in starch is a major concern for food safety.

3. High humidity is ideal for storing starch

4. The net weight is not necessary for food products.

5. Cross-contamination should be avoided in starch storage.

6. Pest control measures are unnecessary for starch storage

7. Sifting helps in maintaining consistency in product quality by removing oversized particles.

8. Starch should typically be white or off-white. Any discoloration may indicate contamination or degradation.

9. A high moisture content in starch is desirable for long-term storage.

Practical assessment

Your school was given tools and equipment that are used to process cassava root into starch. However, the institution lacks a trained technician in the processing of roots and tubers who could use those tools and equipment to make cassava starch. The school manager chose to appoint you in the processing of roots and tubers. Perform the following tasks to resolve the aforementioned problem within 6hours.

All materials, tools and equipment are available in production area of your school.

Task 1: Purify wet cassava starch
Task 2: Dry wet cassava starch

Task 3: Grind dried cassava starch

Task 4: Sift cassava starch
Task 5: Modify cassava native starch
Task 6: Analyse quality of cassava starch
Task 7: Store cassava starch

Note:

The tasks should be performed within six (6) hours

END

Reference

Masamba, W. R. (2003).). Development and evaluation of maize and cassava starch-based cold-setting adhesives for case sealing. *Malawi Journal of Agricultural Science*, 65–76.

Matsui, K. N. (2004). *Cassava bagasse-Kraft paper composites: Analysis of the influence of impregnation with starch acetate on tensile strength and water absorption properties. Carbohydrate Polymers.*

Maziya-Dixon, B. A. (2005). *Effect of variety and drying methods on physico-chemical properties of high-quality cassava starch from yellow cassava root. African Crop Science Conference Proceedings, 7, 835–841.*


CRISPS
CRISPS
CRISPS
CRISPS

Indicative contents

4.1 Blanching Sliced Roots and Tubers

4.2 De-Watering Sliced Roots and Tubers

4.3 Frying Sliced Roots and Tubers

4.4. De-Oiling Crisps

4.5. Seasoning of Crisps

4.6. Cooling of Crisps

4.7 Analysing the Quality of Crisps

4.8. Storing of Crisps

Key Competencies for Learning Outcome 4: Make Crisps

Knowledge	Skills	Attitudes
• Description of blanching methods of sliced roots and tubers • Description of dewatering methods of sliced roots and tubers • Description of frying methods of sliced roots and tubers • Description of Changes occur during frying • Description of de-oiling methods • Description of seasoning methods	• Blanching sliced roots and tubers • De-watering sliced roots and tubers • Frying sliced roots and tubers • De-oiling crisps • Seasoning of crisps • Cooling of crisps • Analysing the quality of crisps • Packaging the crisps	• Being attentiveness to maintaining precise blanching times and temperatures to ensure quality and safety. • Being diligence in ensuring thorough dewatering to prevent sogginess and achieve optimal crispiness • Being vigilance in monitoring the frying process to avoid overcooking and ensure uniformity • Being awareness of the implications of changes occur during frying on the quality

● Description of cooling methods ● Description of crisps quality requirements and testing methods ● Description of sealing methods ● Description of labelling requirements and regulations	● Sealing the crisps ● Monitoring storage conditions of crisps	and safety of the final product ● Being commitment to maintaining product quality by effectively removing excess oil ● Being precise in seasoning to balance flavor while avoiding over- or under-seasoning ● Being carefully in cooling crisps to ensure they remain crisp and of high quality ● Being attentive to quality control to ensure product standards ● Being compliance with regulations and attention to accuracy in labelling. ● Being vigilance in maintaining storage conditions to prevent spoilage

Duration: 16 hrs.

Learning outcome 4 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Describe correctly blanching methods of sliced roots and tubers for crisps
2. Blanche effectively sliced roots and tubers according to choosing factors of blanching methods
3. Describe correctly de-watering methods of sliced roots and tubers for crisps
4. De-water effectively sliced roots and tubers according to choosing factors of dewatering methods
5. Describe correctly frying methods of sliced roots and tubers for crisps
6. Fry effectively roots and tubers according to frying conditions
7. Describe correctly the Changes occur during frying of roots and tubers for crisps
8. Describe correctly de-oiling methods for crisps
9. De-oil effectively crisps according to choosing factors of de-oiling methods
10. Describe correctly seasoning methods for crisps
11. Season effectively crisps according to choosing factors of seasoning methods
12. Describe correctly cooling methods for crisps
13. Cool effectively crisps according to choosing factors of cooling methods
14. Describe correctly crisps quality requirements and testing methods for crisps
15. Analyse properly crisps physical quality parameters according to product specification
16. Describe correctly sealing methods and their advantages and disadvantages for crisps
17. Package properly the crisps according to the packaging methods
18. Seal effectively crisps according to the sealing methods
19. Describe correctly the labelling requirements of crisps according to product specification
20. Monitor effectively storage conditions of crisps according to storage procedures

Resources

Equipment	Tools	Materials
• Blancher • Flavouring machine • Dewatering machine • De-oiling machine • Frying machine • Sorting machine • Cooling system • Weighing scale • PPE • Working table • High pressure water machine • Labelling machine • Oil tank • Vacuum nitrogen packaging machine	• Brushes • Sieves • Spoons, • Knives • Basins • Dustbins • Towels • Squeegee • Brooms • Mop • Buckets • Moisture-meter • Thermometer • Pallet • Mixing bowls • Spoons • Shakers • Timers • Colanders and draining rack	• Packaging materials • Cleaning products • Seasonings • Roots and tubers • Labels • Cooking oil

Indicative content 4.1.Blanching Sliced Roots and Tubers

Duration: 2 hrs

Theoretical Activity 4.1.1: Description of blanching methods of sliced roots for crisps

Tasks:

1. Answer the following questions related to description of blanching methods of sliced roots for crisps

(I) What do you understand by blanching methods of sliced roots and tubers for crisps?

2. Write your answers on paper, flip chart.

3. Present the findings/answers to the whole class.

4: For more clarification, read the key readings 4.1.1

Key readings 4.1.1.: Description of blanching methods of sliced roots for crisps

- **Purpose of Blanching**

Blanching sliced roots and tubers for crisps is a critical pre-processing step that prepares the raw slices for the frying or baking processes that will turn them into crispy snacks.

- ✓ Preserve Color: Blanching helps retain the vibrant color of roots and tubers, preventing them from turning brown or gray during storage and frying.
- ✓ Improve Texture: It helps in achieving a uniform texture by softening the vegetables slightly, which contributes to a better final crisp texture.
- ✓ Reduce Enzymatic Activity: Blanching deactivates enzymes that can cause off-flavors, discoloration, and loss of nutrients.
- ✓ Improve Crispiness: Blanching removes excess starch, which helps the crisps achieve a desirable crunchiness and reduces the risk of them becoming greasy.
- ✓ Enhance Shelf Life: It helps in preserving the quality of the roots and tubers during storage, whether fresh or frozen.

- **Factors to consider for choosing blanching methods**

✓ **Type of Root or Tuber:**

Potatoes: Commonly used for crisps; require thorough blanching to remove excess starch.

Sweet Potatoes: Typically need a shorter blanching time to preserve their texture and sweetness.

✓ **Thickness of Slices:**

Thin Slices: Require shorter blanching times to avoid overcooking.

Thicker Slices: Need longer blanching times to ensure even heat penetration and texture improvement.

✓ **Desired Texture:**

Crispy: Requires precise blanching to balance texture—too short can result in undercooked crisps, while too long can make them too soft.

✓ **Cooking Method:**

Frying: Blanching is crucial to remove excess starch and achieve a crispy texture.

Baking: Blanching still helps in reducing the starch and improving texture, but the method may be slightly less critical compared to frying.

- **Blanching Conditions**

✓ **Temperature:**

- Water Blanching: Typically done at 85-95°C (185-203°F).
- Steam Blanching: Generally performed at 85-90°C (185-194°F).
- Microwave Blanching: The temperature is less consistent, so it's important to ensure even cooking throughout.

✓ **Time:**

- Potatoes: 2-4 minutes for thin slices, 4-6 minutes for thicker slices.
- Sweet Potatoes: 2-3 minutes for thin slices, 3-5 minutes for thicker slices.

- **Blanching Methods:**

✓ Water Blanching:

Sliced roots and tubers are submerged in boiling water for a specified time. After blanching, they are quickly cooled in ice water to halt the cooking process.

Advantages:

This method is effective

Disadvantages:

May result in some loss of water-soluble nutrients.

✓ **Steam Blanching:**

Slices are exposed to steam for a specified duration. This method is often preferred as it preserves more nutrients compared to water blanching and reduces the risk of nutrient loss.

Advantages:

- Preserves more nutrients compared to water blanching.
- Less water usage and minimal flavor loss.

Disadvantages:

- May require specialized equipment.
- Requires precise timing to avoid uneven cooking.

✓ **Microwave Blanching:**

Slices are microwaved for a short period. This method is convenient and can be efficient, but it requires careful monitoring to avoid uneven blanching.

Advantages:

- Fast and convenient for small batches.
- Retains nutrients well.

Disadvantages:

- May not be suitable for large quantities.
- Uneven cooking can occur if not monitored closely.

Practical Activity 4.1.2: Blanching sliced roots and tubers for crisps

Task:

1. You are requested to go to the roots and tubers processing workshop to Blanche roots for crisps

2. Apply safety precautions (wear PPE).

3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key reading 4.1.2

5: Perform the task provided in the application of learning 4.1.

Key readings 4.1.2. Blanching sliced roots and tubers for crisps

- **Application of Blanching Methods**

✓ **Water Blanching**

Procedure:

- ✓ Boil water in a large pot.
- ✓ Submerge the sliced roots/tubers in the boiling water.
- ✓ Blanch for the recommended time based on thickness.
- ✓ Immediately transfer to ice water to stop the cooking process.
- ✓

Steam Blanching

Procedure:

- ✓ Set up a steamer or a pot with a steaming rack.
- ✓ Bring water to a boil to generate steam.
- ✓ Place the sliced roots/tubers on the rack above the boiling water.
- ✓ Steam for the recommended time based on thickness.

Microwave Blanching

Procedure:

- ✓ Place the slices in a microwave-safe bowl.
- ✓ Add a small amount of water (about 2 tablespoons per cup of slices).
- ✓ Cover and microwave on high for the recommended time based on thickness.

✓ Stir halfway through to ensure even cooking.

Points to Remember

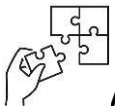
- Choosing the right blanching method depends on the type of root or tuber, slice thickness, desired texture, and the final cooking method.
- For effective blanching:

✓ Use fresh, high-quality ingredients.

✓ Control blanching time and temperature

✓ Ensure proper cooling

✓ Consider equipment



Application of learning 4.1.

You are requested to go to roots and tubers processing workshop to blanche sliced irish potatoes for crisps.

Indicative content 4.2.De-watering of Sliced Roots and Tubers

Duration: 2 hrs.

Theoretical Activity 4.2.1: Description of dewatering methods of sliced roots and tubers

Tasks:

1. Answer the following questions related to description of de-watering methods of sliced

Roots for crisps

(i)What do you understand by dewatering methods of sliced roots and tubers for crisps?

2. Write your answers on paper, flip chart.

3. Present the findings/answers to the whole class.

4: For more clarification, read the key readings 4.2.1

Key readings 4.2.1.: Description of dewatering methods of sliced roots and tubers

- **Purpose of De-Watering sliced roots and tubers**

✓ Improve Crispness: Excess moisture can prevent roots and tubers from becoming crispy when cooked. Removing moisture helps achieve the desired crisp texture in the final product.

✓ Reduce Frying Time: Lower moisture content in the slices means less water needs to be evaporated during frying, which can lead to more efficient cooking and reduced frying time.

✓ Prevent Oil Absorption: Excess moisture can lead to increased oil absorption, making the crisps greasy. Proper de-watering helps in minimizing oil uptake.

✓ Enhance Product Quality: De-watering helps in achieving uniform cooking and a consistent texture, contributing to a higher quality product.

- **Factors to Consider in Choosing De-Watering Methods**

✓ Desired Final Moisture Content: Different methods achieve varying levels of moisture removal. The chosen method should align with the required moisture content for the crisps.

- ✓ Roots and Tubers Varieties: Different types of roots and tubers (e.g., potatoes, sweet potatoes, yam) have different moisture contents and characteristics. The de-watering method should be suitable for the specific variety being processed.
- ✓ Speed: The efficiency and speed of the de-watering process are crucial for maintaining production timelines. Faster methods can increase throughput but may have trade-offs in terms of cost or quality.
- ✓ Uniformity: Consistent moisture removal is important for uniform cooking. Methods should ensure that all slices are evenly de-watered.
- ✓ Capital and Operational Cost: The cost of acquiring and maintaining de-watering equipment must be considered. Some methods may have higher initial costs but lower operational costs, or vice versa.
- ✓ Energy Consumption: The energy requirements of different de-watering methods should be evaluated to optimize operational efficiency and minimize costs.

- **De-Watering Methods**

- ✓ **Salting Method:** The salting method involves sprinkling or soaking sliced roots and tubers in salt to draw out moisture. Salt draws water out through osmosis, where water moves from an area of lower solute concentration (inside the slices) to an area of higher solute concentration (the salted surface).

Advantages:

- Simple and low-cost.
- Helps in reducing moisture effectively.

Disadvantages:

Adds sodium to the product, which might be undesirable for some consumers.

Requires thorough rinsing to avoid excessive salt content.

- ✓ **Spinning in a Salad Spinner**: the slices are placed in the basket of the salad spinner, which is then spun rapidly. The centrifugal force generated by spinning forces the water out of the slices and into the outer bowl.

Advantages:

- Quick and effective for removing surface water.
- Simple and inexpensive.

Disadvantages:

- Primarily removes surface moisture; not effective for deeper moisture.
- Suitable for small-scale operations.

- ✓ **Patting Dry with Paper Towels:**

- Involves placing the sliced roots or tubers on a surface, such as a countertop or tray, and gently blotting them with paper towels to absorb excess surface moisture.

Advantages:

- Easy to implement.
- Inexpensive.

Disadvantages:

- Labor-intensive.
- May not remove enough moisture for larger batches.

✓ **Vacuum Drying:** Uses reduced pressure to lower the boiling point of water, allowing moisture to evaporate at lower temperatures.

Advantages:

- Effective at removing moisture while preserving flavor and nutrients.
- Suitable for large-scale production.

Disadvantages:

- High capital and operational costs.
- Requires energy to maintain vacuum conditions.

✓ **Centrifugation:** Slices are placed in a centrifugal dryer, which spins at high speeds to remove moisture through centrifugal force.

Advantages:

- Efficient at removing moisture quickly.
- Suitable for high-volume processing.

Disadvantages:

- Equipment can be costly.
- May require additional steps to ensure uniformity.

✓ **Microwaving:** Uses microwave energy to heat and evaporate moisture from slices quickly.

Advantages:

- Quick and convenient for small batches.
- Energy-efficient compared to some other methods.

Disadvantages:

- Not suitable for large-scale operations.
- Requires careful monitoring to avoid uneven drying.

Practical Activity 4.2.2: De-watering sliced roots and tubers

Task:

1. You are requested to go to the roots and tubers processing workshop to de-water roots for crisps

2. Apply safety precautions (wear PPE).

3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key reading 4.2.2

5: Perform the task provided in the application of learning 4.2

Key readings 4.2.2. De-watering sliced roots and tubers

- **De-watering methods and procedures**

✓ **Salting Method**

Procedure:

✓ Sprinkle salt evenly over the sliced roots or tubers.
✓ Allow the salt to draw out moisture, typically for 15-30 minutes.
✓ Rinse off excess salt and pat the slices dry with paper towels.
✓ **Spinning in a Salad Spinner**

Procedure:

✓ Place the sliced roots or tubers in a salad spinner.
✓ Spin to remove surface moisture through centrifugal force.
✓ **Patting Dry with Paper Towels**

Procedure:

✓ Lay out the slices on paper towels.
✓ Use additional paper towels to blot and absorb surface moisture.
✓ **Vacuum Drying**

Procedure:

- ✓ Place the blanched slices in a vacuum drying chamber.
- ✓ Reduce pressure to evaporate moisture at lower temperatures.
- ✓ **Centrifugation**

Procedure:

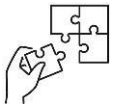
- ✓ Place the blanched slices in a centrifuge.
- ✓ Spin at high speeds to remove moisture through centrifugal force.
- ✓ **Microwaving**

Procedure:

- ✓ Spread the sliced roots or tubers on a microwave-safe plate.
- ✓ Microwave in short intervals, checking and stirring to remove moisture.

Points to Remember

- A number of factors, such as the temperature, humidity, and airflow, can affect the dewatering process.
- Ensure adequate airflow to facilitate moisture removal and prevent product sticking.
- Adjust dewatering time based on moisture content, slice thickness, and desired final product.
- Regularly clean and maintain dewatering equipment to prevent contamination and ensure optimal performance.



Application of learning 4.2.

You are requested to go to roots and tubers processing workshop to de-water blanched sliced irish potatoes.

Indicative content 4.3.Frying Sliced Roots and Tubers

Duration: 2 hrs.

Theoretical Activity 4.3.1: Description of frying method of sliced roots and tubers

Tasks:

1. Answer the following questions related to description of frying methods of sliced roots for crisps

(i)What do you understand by frying methods of sliced roots and tubers for crisps?

2. Write your answers on paper, flip chart.

3. Present the findings/answers to the whole class.

4: For more clarification, read the key readings 4.3.1

Key readings 4.3.1.: Description of frying method of sliced roots and tubers

- **Purpose of Frying Sliced Roots and Tubers**

✓ T**exture Development**: Frying removes moisture from the slices and creates a crispy texture. The high temperature causes the starches in the slices to gelatinize and become crisp.

✓ **Flavor Enhancement**: The frying process imparts a desirable flavor through Maillard reactions and caramelization. This enhances the overall taste of the crisps.

✓ Appearance: Frying gives the crisps a golden-brown color, which is visually appealing and signals the desired level of crispiness to consumers.

✓ Shelf Life: Frying helps in extending the shelf life of the crisps by reducing moisture, which inhibits microbial growth and spoilage.

- Frying Conditions

✓ Temperature

Typical Range: Frying temperatures for crisps usually range from 160°C to 180°C (320°F to 356°F).

Importance: Maintaining the right temperature is crucial for achieving the desired crispiness without overcooking or burning the slices.

✓ Time

Typical Range: Frying time can vary but generally ranges from 2 to 5 minutes depending on slice thickness and fryer type.

Importance: Adequate frying time ensures that the slices are cooked evenly and reach the desired crispiness. Too short a time can result in soggy crisps, while too long can lead to burning.

- **Factors to consider in choosing frying methods**

✓ **Desired Oil Content**

Low Oil Content: Methods like air frying or vacuum frying typically result in lower oil content, which may be preferred for health-conscious consumers.

Higher Oil Content: Traditional frying methods tend to have higher oil content, which can impact flavor and texture.

✓ **Crisp Characteristics**

Texture: The method should produce crisps with the right texture—crisp and crunchy without being overly greasy.

Color: Desired color should be golden brown, which indicates proper frying.

✓ **Production Volume**

Scalability: Methods need to be chosen based on whether the production is small-scale (e.g., batch frying) or large-scale (e.g., continuous frying).

✓ **Cost and Efficiency**

Capital and Operational Costs: The choice of frying method should align with budget constraints, including initial equipment costs and ongoing operational costs.

✓ **Oil Type**

Type of Oil: The choice of oil affects flavor, health characteristics, and frying performance. Common oils include canola, sunflower, and palm oil.

✓ **Frying Process**

Uniformity: The method should ensure even frying to avoid uneven texture and color.

✓ **Flavour Impact**

Oil Absorption: Different methods affect how much oil is absorbed, which can impact flavor and overall healthiness.

- **Frying Methods**

✓ **Batch Frying**

Advantages:

- Simple setup and operation.
- Suitable for small to medium production volumes.

Disadvantages:

- Less efficient for large-scale production due to the need for batch processing.
- Potential for inconsistent quality if not monitored carefully.

✓ **Continuous Frying**

Advantages:

- High efficiency and suitable for large-scale production.
- Consistent quality and uniformity.

Disadvantages:

- Higher initial capital cost.
- Requires careful maintenance and monitoring to ensure consistent product quality.

✓ **Vacuum Frying**

Advantages:

- Lower oil content and enhanced nutritional profile.
- Retains more flavor and color compared to conventional frying.

Disadvantages:

- High capital and operational costs.
- Requires specialized equipment and expertise.

✓ **Air Frying**

Advantages:

- Reduced oil usage and lower fat content.
- Suitable for small to medium-scale production.

Disadvantages:

- Limited capacity compared to traditional or continuous fryers.
- May require multiple batches for larger volumes.

✓ **Microwave Frying**

Advantages

- Quick and convenient for small batches.
- Lower oil content compared to conventional frying.

Disadvantages:

- Limited scalability for larger production volumes.
- May not achieve the same texture and flavor as traditional frying methods

Theoretical Activity 4.3.2: Description of changes occur during frying of sliced roots and tubers

Tasks:

1. Answer the following questions related to Description of changes occur during frying of sliced roots and tubers

(i)What could be the changes occur during frying of sliced roots and tubers?

2. Write your answers on paper, flip chart.

3. Present the findings/answers to the whole class.

4: For more clarification, read the key readings 4.3.1

Key readings 4.3.2. Description of Changes occur during frying of sliced roots and tubers

- **Changes occur during frying of sliced roots and tubers**

✓ **Physical Changes**

- Moisture Removal

Process: Water inside the slices evaporates rapidly due to the high temperature of the oil.

Effect: Reduces moisture content, leading to a crispy texture as the water turns into steam and escapes.

- Starch Gelatinization

Process: Heat causes starch granules within the slices to swell, burst, and absorb water, forming a gel-like consistency.

Effect: Contributes to the formation of a crispy outer layer as the gelatinized starch solidifies during cooling.

- Surface Browning

Process: The Maillard reaction and caramelization of sugars occur, leading to browning of the outer surface.

Effect: Develops a desirable golden-brown color and enhances flavor.

- Oil Absorption

Process: Some oil is absorbed into the slices, especially if they have not been thoroughly dried.

Effect: Affects the texture and flavor, with excessive oil leading to a greasy product and minimal oil contributing to a lighter, crispier texture.

- Evaporation and Expansion

Process: As moisture evaporates, steam expands and causes the slices to puff up.

Effect: Creates a lighter, airy texture in the final product.

- Slicing Deformation

Process: Heat and moisture loss can cause the slices to shrink or warp.

Effect: Results in a more irregular shape and size, which can impact the uniformity of the final product.

✓ **Chemical Changes**

- Lipid Oxidation

Process: The high temperature of frying can cause oxidation of fats in the oil and in the slices.

Effect: Leads to off-flavors and rancidity if oil is reused or not properly monitored. It can also affect the nutritional quality of the product.

- Acrylamide Formation

Process: Acrylamide forms from the reaction between reducing sugars and the amino acid asparagine during frying, particularly at high temperatures.

- Effect: Acrylamide is a potential carcinogen, so its formation is a concern for health and food safety.
- Vitamin and Mineral Loss

Process: High temperatures can lead to degradation of sensitive vitamins (e.g., Vitamin C) and minerals.

Effect: Reduces the nutritional content of the fried product, particularly for heat-sensitive nutrients.

- Flavor Compound Formation

Process: The Maillard reaction and caramelization create new flavor compounds and enhance the overall taste.

Effect: Develops complex flavors and aromas that contribute to the appealing taste of the final product.

Practical Activity 4.3.3: Frying sliced roots and tubers

Task:

1: You are requested to go to the roots and tubers processing workshop to fry sliced roots and tubers for crisps
2. Apply safety precautions (wear PPE).
3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.
4: Read the key reading 4.3.3
5: Perform the task provided in the application of learning 4.3

Key readings 4.3.3. Frying sliced roots and tubers

- **Frying Methods and Procedures**
  - ✓ **Batch Frying**

Procedure:

Preparation: Heat the oil in a deep fryer or pan to the desired temperature.

Frying: Place the sliced roots or tubers into the hot oil in batches, ensuring not to overcrowd the fryer.

Monitoring: Fry until the slices achieve the desired color and crispiness.

Draining: Remove the crisps and drain excess oil on paper towels.

✓ **Continuous Frying**

Procedure:

Preparation: Oil is continuously heated in a large fryer.

Frying: Slices are continuously fed into the fryer on a conveyor belt.

Monitoring: Frying time and temperature are controlled to maintain consistent quality.

Draining: Crisps are continuously removed and drained using a built-in system.

✓ **Vacuum Frying**

Procedure:

Preparation: Place the slices in a vacuum fryer.

Frying: Fry at reduced pressure, which lowers the boiling point of the oil and allows for lower temperature frying.

Monitoring: Adjust temperature and pressure to achieve the desired texture and color.

Draining: Remove and drain crisps.

✓ **Air Frying**

Procedure:

Preparation: Preheat the air fryer.

Frying: Place the slices in the air fryer basket.

Monitoring: Cook using hot air circulation at high temperatures.

Draining: Air fryers usually do not require additional draining.

✓ **Microwave Frying**

Procedure:

Preparation: Arrange slices on a microwave-safe tray.

Frying: Use a microwave with a specific setting for frying, or perform multiple short bursts of microwaving.

Monitoring: Check for desired crispiness and adjust time as needed.

Draining: No additional draining required.

Points to Remember

- The choice of frying method for sliced roots and tubers depends on several factors including desired oil content, crisp characteristics, production volume, cost, and efficiency.
- Frying is a complex process that involves a combination of physical and chemical changes, resulting in the production of crispy, flavourful chips.
- The oil should be heated to a high temperature, typically around 350-375°F (175-190°C), to ensure the slices cook quickly and evenly
- The frying time varies depending on the thickness of the slices and the desired level of crispiness.
- Avoid overcrowding the fryer, as this can lower the oil temperature and result in soggy crisps.

Application of learning 4.3.

You are requested to go in the root and tubers processing workshop to fry sliced irish potatoes.

Indicative content 4.4: De-oiling Crisps

Duration: 2 hrs.

Theoretical Activity 4.4.1: Description of de-oiling methods of crisps

Tasks:

1. Answer the following questions related to description of de-oiling methods of sliced roots for crisps

(i)What do you understand by de-oiling methods of crisps?

2. Write your answers on paper, flip chart.

3. Present the findings/answers to the whole class.

4: For more clarification, read the key readings 4.4.1

Key readings 4.4.1. Description of de-oiling methods of crisps

- **Purpose of De-Oiling**
  - ✓ Reduce Oil Content: De-oiling helps in lowering the oil content in crisps, which can make the product healthier and more appealing to consumers who are conscious of fat intake.
  - ✓ Improve Crispiness: Excess oil can lead to sogginess and a greasy texture. Removing extra oil ensures that the crisps maintain their desired crispiness.
  - ✓ Enhance Flavor: Excess oil can dilute the flavor and affect the taste of the crisps. By reducing oil, the flavor of the crisps can be more pronounced and enjoyable.
  - ✓ Increase Shelf Life: Lower oil content can help in reducing rancidity and spoilage, thus extending the shelf life of the crisps.
  - ✓ Improve Product Appearance: Removing excess oil helps in achieving a cleaner, less greasy appearance, which can be more appealing to consumers.
- **De-Oiling Methods**
  - ✓ **Centrifugal De-Oiling**

Advantages:

- Efficient: Removes a significant amount of surface oil quickly.

- Consistent: Provides uniform de-oiling across batches.

Disadvantages:

- Cost: Requires investment in specialized equipment.
- Capacity: May not be suitable for very large-scale operations without multiple machines.

✓ **Vibration De-Oiling**

Advantages:

- Gentle: Less likely to damage the crisps compared to methods that are more aggressive.
- Cost-Effective: Generally, less expensive than centrifugal de-oiling systems.

Disadvantages:

- Efficiency: May not remove as much oil as centrifugal methods.
- Consistency: Oil removal can vary depending on the vibration settings and the size of the crisps.

✓ **Airflow De-Oiling**

Advantages:

- Non-Contact: No direct contact with the crisps, reducing the risk of breakage.
- Versatile: Can be adapted for various production scales.

Disadvantages:

- Energy Consumption: Requires energy to power the airflow system.
- Effectiveness: May not remove as much oil as centrifugal methods, especially if the oil is deeply embedded.

✓ **Adsorption De-Oiling**

Advantages:

- Selective: Can target specific types of oil or residues.
- Flexibility: Various adsorbent materials can be used depending on the desired outcome.

Disadvantages:

- Material Costs: Requires purchasing and handling of adsorbent materials.
- Maintenance: Adsorbent materials need to be managed and replaced regularly.

Practical Activity 4.4.2: De-oiling crisps

Task:

1. You are requested to go to the roots and tubers processing workshop to de-oil crisps

2. Apply safety precautions (wear PPE).

3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key reading 4.4.2

5: Perform the task provided in the application of learning 4.4

Key readings 4.4.2. De-oiling crisps

- **De-Oiling Methods and Procedures**

✓ **Centrifugal De-Oiling**

Procedure:

- ✓ **Preparation**: Place the hot, freshly fried crisps into a centrifugal de-oiling machine.
- ✓ **Centrifugation**: The machine uses high-speed spinning to create a centrifugal force that expels oil from the surface of the crisps.
- ✓ **Collection**: The expelled oil is collected in a separate container, and the crisps are discharged with reduced oil content.

✓ **Vibration De-Oiling**

Procedure:

- **Preparation**: Place the crisps on a vibrating conveyor or mesh.
- **Vibration**: The conveyor vibrates, causing the excess oil to drain away from the crisps.
- **Collection**: Oil is collected below the conveyor, and the crisps move to the next stage.

✓ **Airflow De-Oiling**

Procedure:

- **Preparation**: Place the crisps in a chamber with controlled airflow.
- **Airflow**: Blowers or fans generate a strong air stream that removes excess oil from the surface of the crisps.
- **Collection**: The oil-laden air is filtered or vented out, and the crisps are de-oiled.

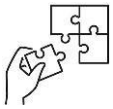
✓ **Adsorption De-Oiling**

Procedure:

- **Preparation**: The crisps are passed through or placed in contact with materials that have high oil-adsorbing properties, such as specific types of powders or granules.
- **Adsorption**: The adsorbent material binds with the excess oil on the surface of the crisps.
- **Removal**: The adsorbent material with the absorbed oil is removed, and the crisps are left with reduced oil content.

Points to Remember

- By selecting the right deoiling method and carefully controlling the process, you can produce crisps with optimal oil content and high-quality product.
- Regularly clean deoiling equipment to prevent contamination and ensure optimal performance.
- Follow manufacturer's recommendations for maintenance and calibration. Of de-oiling machine
- Seal the deoiled crisps in airtight containers to prevent oil reabsorption.
- Monitor and control the temperature during deoiling to prevent damage to the crisps.
- Ensure adequate deoiling time to achieve the desired oil content.



Application of learning 4.4.

You are requested to go in the root and tubers processing workshop to de-oil Irish potatoes crisps

Indicative content 4.5: Seasoning of Crisps

Duration: 2 hrs.

Theoretical Activity 4.5.1: Description of seasoning methods of crisps

Tasks:

1. Answer the following questions related to description of seasoning methods of crisps

(i)What do you understand by seasoning methods of crisps?

2. Write your answers on paper, flip chart.
3. Present the findings/answers to the whole class.
4: For more clarification, read the key readings 4.5.1

Key readings 4.5.1.: Description of seasoning methods of crisps

- **Purpose of Seasoning**

✓ **Flavor Enhancement:** Seasoning adds specific flavors to crisps, making them more appealing and satisfying to consumers. Common flavors include salt, vinegar, cheese, and barbecue.

✓ **Product Differentiation:** Unique and creative seasoning blends help differentiate products in a competitive market, allowing brands to offer distinctive flavors that stand out.

✓ **Consumer Appeal:** Proper seasoning can enhance the overall eating experience, contributing to the texture, aroma, and taste of the crisps, which can drive consumer preference and loyalty.

✓ **Brand Identity:** Consistent seasoning profiles help in building brand identity and recognition, as consumers often associate certain flavors with specific brands.

- **Seasoning Methods**

✓ **Tumbling**

Advantages:

- Even Coating: Provides uniform coverage of seasoning on the crisps.
- Scalability: Suitable for both small and large production batches.

Disadvantages:

- Batch Size: Tumbler size limits the volume that can be processed at one time.
- Consistency: Requires proper calibration to ensure even seasoning across all crisps.

- ✓ **Spraying**

  Advantages:
  - Precise Application: Allows for controlled application of liquid or powdered seasonings.
  - Flexibility: Can be used with a variety of seasoning types and formulations.

  Disadvantages:
  - Equipment Cost: Requires investment in spraying equipment.
  - Uniformity: Must be carefully managed to ensure even application without oversaturation.

- ✓ **Direct Application**

  Advantages :
  - Simplicity: Simple to implement, especially for smaller production scales.
  - Cost-Effective: Low initial equipment investment.

  Disadvantages:
  - Labor-Intensive: Requires more manual labor compared to automated methods.
  - Uniformity: Achieving consistent coverage can be challenging.

- ✓ **Dipping**

  Advantages:
  - Flavor Infusion: Allows for thorough infusion of seasoning into the crisps.
  - Consistency: Ensures even seasoning application.

  Disadvantages:
  - Oil Absorption: Depending on the solution, dipping can add extra moisture or oil.
  - Production Scale: May not be as scalable or efficient for high-volume production compared to other methods.

Practical Activity 4.5.2: Seasoning crisps

Task:

1. You are requested to go to the roots and tubers processing workshop to season crisps

2. Apply safety precautions (wear PPE).

3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key reading 4.5.2

5: Perform the task provided in the application of learning 4.5

Key readings 4.5.2. Seasoning crisps

✓ **Tumbling**

Procedure:

- Preparation: Place the freshly fried crisps into a rotating drum or tumbler.
- Seasoning: Add the seasoning blend into the drum along with the crisps.
- Rotation: The drum rotates, allowing the seasoning to evenly coat the crisps as they tumble and mix.

✓ **Spraying**

Procedure:

- Preparation: Place the crisps on a conveyor or in a seasoning chamber.
- Spraying: Use a spray system to apply a liquid seasoning or seasoning solution onto the crisps. This system can include nozzles that atomize the seasoning for even distribution.
- Drying: Allow the crisps to dry if needed, especially if using a liquid seasoning that requires drying to adhere properly.

✓ **Direct Application**

Procedure:

- Preparation: After frying, place the crisps on a flat surface or conveyor belt.

- Application: Manually or mechanically, sprinkle dry seasoning directly onto the crisps.
- Mixing: Use a mechanical mixer or manually toss the crisps to ensure even distribution of the seasoning.

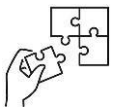
✓ **Dipping**

Procedure:

- Preparation: Prepare a seasoning solution or flavoring bath.
- Dipping: Submerge the freshly fried crisps into the solution for a specific period.
- Draining: Remove the crisps from the bath and allow excess liquid to drain off.
- Drying: Allow the crisps to air-dry or use a drying system to remove any remaining moisture.

Points to Remember

- Choosing the right seasoning method for crisps depends on various factors, including the desired Flavor profile, texture, and production efficiency
- Season immediately after frying while the crisps are still hot to ensure proper adhesion.
- Use a seasoning shaker or a drum tumbler for even distribution.
- Carefully control the amount of seasoning to avoid excessive saltiness or a flavor overload.



Application of learning 4.5.

You are requested to go in the root and tubers processing workshop to season irish potatoes crisps.

Indicative content 4.6: Cooling of Crisps

Duration: 2 hrs

Theoretical Activity 4.6.1: Description cooling methods of crisps

Tasks:

1. Answer the following questions related to description of cooling methods of crisps

(i)What do you understand by cooling methods of crisps?

2. Write your answers on paper, flip chart.

3. Present the findings/answers to the whole class.

4. For more clarification, read the key readings 4.6.1

Key readings 4.6.1.: Description of cooling methods of crisps

- **Purpose of Cooling**

✓ Preserve Crispiness: Cooling helps in maintaining the crispy texture of the crisps by preventing them from becoming soggy due to residual heat or moisture.

✓ Prevent Overcooking: Rapid cooling helps stop the cooking process immediately, which ensures that the crisps do not continue to cook and potentially become overdone.

✓ Prepare for Packaging: Proper cooling is necessary to bring the crisps to a stable temperature before packaging, which helps in maintaining quality during storage and transport.

✓ Minimize Condensation: Cooling prevents condensation inside the packaging, which can lead to moisture absorption and spoilage.

- **Factors Affecting Cooling Efficiency**

✓ **Oil Content**

- Impact: Crisps with higher oil content retain more heat. Effective cooling must account for this to ensure the crisps cool uniformly and quickly.
- Management: De-oiling before cooling can help reduce the amount of heat retained.

✓ **Slice Thickness**

- Impact: Thicker slices retain heat longer than thinner slices, which can affect cooling efficiency. Thicker slices may require more time or more efficient cooling methods.
- Management: Consistent slice thickness can help in achieving uniform cooling.

✓ **Moisture Content**

- Impact: Higher moisture content can affect the cooling process, as excess moisture may lead to condensation during cooling. Proper de-watering before frying and cooling can mitigate this.
- Management: Ensuring that the crisps are well-de-watered before frying helps in effective cooling.

✓ **Shape and Structure**

- Impact: Irregular shapes and structures can affect airflow and cooling efficiency. Uniformly shaped crisps cool more evenly.
- Management: Consistent slice shape and structure help in optimizing the cooling process.

- **Advantages and disadvantages of Cooling Methods**

✓ **Airflow Cooling**

Advantages:

- Cost-Effective: Relatively low operational cost compared to other methods.
- Flexibility: Suitable for various scales of production and different types of crisps.

Disadvantages:

- Cooking Time: May require longer cooling times for large volumes or high oil content crisps.
- Space Requirements: Adequate space is needed for the airflow system and cooling conveyors.

✓ **Drum Cooling**

Advantages:

- Uniform Cooling: Provides consistent cooling across all crisps in the drum.
- Efficient: Can handle large volumes and is suitable for high-throughput production lines.

Disadvantages:

- Initial Cost: Higher capital investment in specialized drum cooling equipment.
- Maintenance: Requires regular maintenance to ensure proper function.

✓ **Fluidized Bed Cooling**

Advantages:

- Efficient: Provides rapid and uniform cooling by suspending crisps in the air.
- Reduced Space: Often requires less space compared to conveyor belt systems.

Disadvantages:

- Complexity: More complex and potentially higher initial cost.
- Airflow Management: Requires precise control of airflow to maintain the fluidized bed.

Practical Activity 4.6.2: Cooling crisps

Task:

1. You are requested to go to the roots and tubers processing workshop to cool crisps
2. Apply safety precautions (wear PPE).
3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.
4: Read the key reading 4.6.2
5: Perform the task provided in the application of learning 4.6

Key readings 4.6.2. Cooling crisps

- **Cooling Methods and Procedures**

✓ **Airflow Cooling**

Procedure:

✓ Preparation: Place the hot, freshly fried crisps onto a cooling conveyor or rack.

- ✓ Airflow: Use high-velocity fans or blowers to direct a stream of cool air over the crisps.
- ✓ Monitoring: Ensure that the airflow is sufficient to cool the crisps evenly and effectively.
- ✓ **Drum Cooling**

Procedure:

- ✓ Preparation: Transfer the hot crisps into a rotating drum or cylinder equipped with cooling features.
- ✓ Cooling: The drum rotates, allowing the crisps to be exposed to a controlled cooling environment, often with air circulation inside the drum.
- ✓ Monitoring: Adjust rotation speed and airflow to ensure even cooling.
- ✓ **Fluidized Bed Cooling**

Procedure:

- ✓ Preparation: Place the crisps in a fluidized bed cooler, which uses a bed of air to suspend and cool the crisps.
- ✓ Cooling: Airflow is used to create a fluidized bed where the crisps are continuously moved and cooled by the air currents.

Monitoring: Ensure that airflow is adjusted to maintain the fluidized bed and achieve effective cooling.

Points to Remember

- Choose a cooling method that suits your needs and the type of crisps you are making. Options include air cooling, rapid cooling, or using a dehydrator.
- Proper airflow is essential for even cooling.
- Maintain a clean and hygienic environment during the cooling process to prevent contamination.

Application of learning 4.6.

You are requested to go in the root and tubers processing workshop to cool irish potatoes crisps.

Indicative content 4.7: Analysing the Quality of Crisps

Duration: 2 hrs.

Theoretical Activity 4.7.1: Description of crisps quality requirements

Tasks:

1. Answer the following questions related to description of crisps quality requirements

(i)What could be the quality requirements of crisps?

2. Write your answers on paper, flip chart.

3. Present the findings/answers to the whole class.

4: For more clarification, read the key readings 4.7.1

Key readings 4.7.1.: Description of crisps quality requirements

- **Crisps quality requirements**

✓ **Physical quality requirements**

- **Colour:** Crisps should have a golden-brown color, which indicates proper frying and caramelization. Variations in color can affect the visual appeal and may indicate overcooking or undercooking.
- **Size:** The size of the crisps should be consistent, with uniform cut sizes contributing to even cooking and a consistent eating experience.
- **Sogginess:** Crisps should be crisp and dry, without any signs of sogginess or moisture, which can indicate improper frying or storage.
- **Oiliness:** Crisps should have a minimal amount of surface oil. Excess oil can affect flavor, texture, and consumer health.
- **Foreign Matter:** Crisps should be free from foreign matter such as burnt pieces, metal shards, or other contaminants.
- **Texture:** The texture should be crisp and crunchy. A desirable texture enhances the eating experience and indicates proper frying.
- **Odour and Flavour:** Crisps should have a pleasant, fresh aroma and flavor that match the seasoning used. Off-flavors or odors can indicate spoilage or improper seasoning.

- **Chemical composition requirements and limits**

✓ Moisture Content: Moisture content should be low to prevent spoilage and maintain crispiness.

- Limits: Typically, moisture content should be less than 2-3% on a dry weight basis

✓ Free Fatty Acids (FFA): FFA levels indicate the extent of oil degradation. Lower FFA levels are preferable for quality.

- Limits: Generally, FFA should be less than 0.5% on a dry weight basis.

✓ Acid Insoluble Ash: This measures the amount of inorganic residue that is not soluble in acids, indicating contamination or improper processing.

- Limits: Should be minimal, generally less than 0.1% on a dry weight basis.

✓ Peroxide Value: Peroxide value indicates the extent of lipid oxidation. Lower values suggest fresher oil.

- Limits: Typically, should be less than 2 meq/kg.

✓ Fat Content on Dry Weight Basis: Fat content impacts flavor and health aspects. The amount should be consistent with product specifications.

- Limits: Usually between 30-40% on a dry weight basis.

✓ Sodium Chloride (NaCl) on Dry Weight Basis: Sodium content affects flavor and dietary considerations. It should match the seasoning specifications.

- Limits: Typically, between 1-2% on a dry weight basis.

- **Microbiological Requirements and Limits**

✓ **Total Viable Count**

- Description: Indicates the number of viable microorganisms present. Lower counts are preferable.
- Limits: Typically should be less than 1000 CFU/g.

✓ Escherichia coli: Presence of E. coli indicates potential contamination and poor hygiene.

- Limits: Should be absent or less than 1 CFU/g.

✓ Salmonella: Salmonella contamination poses health risks and should be absent in crisps.

- Limits: Should be absent or less than 1 CFU/25g.

- ✓ Yeasts and Moulds: High counts of yeasts and moulds indicate spoilage and can affect quality.
  - Limits: Typically less than 100 CFU/g.

Practical Activity 4.7.2: Analysing crisps physical quality parameters

Task:

1. You are requested to go to the roots and tubers processing workshop to analyse physical quality parameters of crisps

2. Apply safety precautions (wear PPE).

3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key reading 4.7.2

5: Perform the task provided in the application of learning 4.7

Key readings 4.7.2. Analysing crisps physical quality parameters

- **Analyzing crisps physical quality parameters**

✓ **Colour**

- Method: Use a colorimeter or spectrophotometer to measure and quantify color. Compare with color standards or reference samples.

✓ **Shape**

- Method: Visual inspection and measurement using calipers or image analysis software to ensure consistency in shape and size.

✓ **Crispness**

- Method: Use a texture analyzer to measure the force required to break the crisps. Sensory evaluation by trained panels can also assess crispness.

✓ **Oiliness**

- Method: Use methods like solvent extraction followed by gravimetric analysis or use an oil analyzer to measure the surface oil content.

✓ **Thickness**

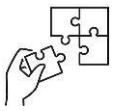
- Method: Measure the thickness of crisps using calipers or automated thickness measurement devices to ensure uniformity.

✓ **Texture**

- Method: Use a texture analyzer to measure parameters such as crunchiness and breaking strength. Sensory evaluation by trained panels can also be used to assess texture.

Points to Remember

- Physical quality requirements of crisps include aspects such as Color, size, sogginess, oiliness, and texture.
- Chemical composition limits focus on moisture content, free fatty acids, acid insoluble ash, peroxide value, fat content, and sodium chloride.
- Microbiological standards involve total viable count, absence of pathogens like E. coli and Salmonella, and yeast and mould counts. Analysing the quality of crisps involves assessing various physical, chemical, and microbiological parameters to ensure the product meets industry standards and consumer expectations.
- By following the guidelines and using appropriate analytical methods, you can ensure that the crisps meet the highest quality standards and are safe for consumption.



Application of learning 4.7.

You are requested to go in the root and tubers processing workshop to analyse the physical quality parameters of Irish potatoes crisps.

Indicative content 4.8: Storing of Crisps

Duration: 2 hrs.

Practical Activity 4.8.1: Packaging crisps

Task:

1. You are requested to go to the roots and tubers processing workshop to pack crisps

2. Apply safety precautions (wear PPE).

3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.

4: Read the key reading 4.8.1

5: Perform the task provided in the application of learning 4.8

Key readings 4.8.1. Packaging crisps

- **Purpose of Packaging**

✓ **Protection:** Packaging safeguards crisps from physical damage, contamination, and environmental factors such as moisture, light, and oxygen. Crisps are particularly susceptible to getting stale or crushed, so packaging helps maintain their quality and freshness.

✓ **Preservation:** Proper packaging helps extend the shelf life of crisps by preventing exposure to air and moisture, which can cause them to go stale or lose their crispiness. It also helps in preserving the flavor and texture of the product.

✓ **Information:** Packaging provides essential information to consumers, including ingredients, nutritional information, expiration dates, and branding. It also serves to inform about any allergens or dietary considerations.

✓ **Marketing:** The packaging is an important marketing tool. Attractive and eye-catching packaging can draw customers' attention and differentiate the product from competitors on store shelves.

✓ **Convenience:**

Packaging makes crisps easy to handle, store, and consume. It provides a resealable option in some cases, allowing consumers to keep the product fresh after opening.

- **Application of Vacuum Nitrogen Packaging**

✓ Vacuum nitrogen packaging is a method specifically used to enhance the preservation and longevity of products like crisps. Here's how it works and its benefits:

✓ Vacuum Sealing: The process involves removing the air from the packaging before sealing it. This reduction of oxygen is crucial because oxygen can cause crisps to go stale or spoil **faster.**

✓ **Nitrogen Flush:** After creating a vacuum, the packaging is flushed with nitrogen gas. Nitrogen is an inert gas that does not react with the food or cause oxidation. By replacing the oxygen in the package with nitrogen, the crisps are protected from oxidation and rancidity.

✓ **Benefits:**

- Extended Shelf Life: By eliminating oxygen, crisps stay fresh for a longer period, retaining their flavor and crispiness.
- Prevention of Staleness: Without oxygen, the fats in the crisps are less likely to become rancid, and the texture remains crunchy.
- Reduced Crumbliness: The vacuum-sealed environment helps prevent the crisps from being crushed or broken during handling and transportation.

Practical Activity 4.8.2: Sealing crisps

Task:

1. You are requested to go to the roots and tubers processing workshop to seal crisps
2. Apply safety precautions (wear PPE).
3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary.
4: Read the key reading 4.8.2
5: Perform the task provided in the application of learning 4.8

Key readings 4.8.2.Sealing crisps

- **Sealing methods of crisp and procedures**

✓ **Heat Sealing**

Heat sealing is the most commonly used method for packaging crisps. It involves the following steps:

Procedure:

✓ Preparation: The crisps are first placed into the packaging bags, which are typically made of laminated films that include layers of plastic, foil, and sometimes paper.

✓ Heating: The top edges of the packaging bag are heated using a heat-sealing machine. The machine applies heat and pressure to the edges of the bag, melting the layers of plastic to create a seal.

✓ Cooling: After heating, the seal is allowed to cool and solidify, ensuring a strong bond that keeps the bag closed.

Advantages:

- Effective Barrier: Heat sealing creates a strong, airtight seal that helps maintain the freshness of the crisps by preventing air and moisture from entering the bag.
- Consistency: Provides uniform sealing, which is crucial for large-scale production.

Disadvantages:

- Temperature Control: Precise temperature control is necessary to avoid damaging the packaging material or compromising the seal quality.
- Material Compatibility: Different types of packaging materials may require specific sealing temperatures and pressures.

✓ **Ultrasonic Sealing**

Ultrasonic sealing uses high-frequency sound waves to seal the packaging material. This method involves:

Procedure:

✓ Preparation: Similar to heat-sealing, the crisps are placed in the packaging, and the top edges are prepared for sealing.

- Ultrasonic Application: Ultrasonic sealing machines use high-frequency sound waves (usually between 20 kHz and 40 kHz) that pass through the packaging material. These sound waves generate localized heat through friction, which melts and fuses the layers of plastic together.

✓ Cooling: The seal is allowed to cool and solidify after the ultrasonic waves have been applied.

Advantages:

- Precision: Ultrasonic sealing allows for very precise and consistent sealing without requiring direct heat contact, which can be advantageous for delicate or heat-sensitive materials.
- Speed: It can be faster than traditional heat sealing, improving production efficiency.

Disadvantages:

- Equipment Cost: Ultrasonic sealing equipment can be more expensive than conventional heat-sealing machines.
- Material Suitability: Not all packaging materials are suitable for ultrasonic sealing.

✓ **Resealable Closures**

Resealable closures are an additional feature that enhances convenience for consumers. They come in several forms:

- Zip Locks: These are plastic strips that can be pressed together to form a seal and then easily opened and resealed. They are commonly used in stand-up pouches and some bags.
- Press-to-Seal (PTS): Similar to zip locks, these closures involve a mechanism where pressing the two parts together creates a seal that can be opened and resealed.
- **Slide Seals:** These involve a sliding mechanism that locks the bag shut. They are less common but can be effective for certain types of packaging.
- **Velcro Closures:** Velcro strips can be used to create a resealable feature. They provide a secure closure but may not be as airtight as zip locks or press-to-seal options.

Advantages:

- Consumer Convenience: Allows consumers to open and reseal the bag easily, which is useful for maintaining freshness over multiple uses.
- Reduced Waste: Helps prevent spills and wastage of the product.

Disadvantages:

- Seal Integrity: The effectiveness of resealable closures can vary, and they might not provide as strong an airtight seal as heat or ultrasonic sealing.

Theoretical Activity 4.8.3: Description of labelling requirements of crisps

Tasks:

1. Answer the following questions related to description of labelling requirements of crisps

(i)What could be the labelling requirements of crisps?

2. Write your answers on paper, flip chart.

3. Present the findings/answers to the whole class.

4: For more clarification, read the key readings 4.8.3

Key readings 4.8.3.: Description of labelling requirements of crisps

- **Purpose of Labeling**
  - ✓ Consumer Information: Provides consumers with clear and accurate information about the product, including ingredients, nutritional value, and potential allergens.
  - ✓ Regulatory Compliance: Ensures that the product complies with food safety and labeling regulations set by authorities such as the FDA (Food and Drug Administration), EFSA (European Food Safety Authority), or other relevant bodies.
  - ✓ Marketing and Branding: Helps in branding and marketing by highlighting unique selling points, such as flavor variety, quality, or special dietary considerations.

- ✓ Traceability: Facilitates traceability and accountability in case of recalls or quality issues, by providing information about the manufacturer and production details.
- ✓ Safety: Informs consumers about any potential hazards, such as allergens or specific dietary restrictions, to ensure the product is safe for consumption.

- **Labeling Information**
  - ✓ Product Name
    - Description: Clearly states the product name, such as "Potato Crisps" or "Kettle-Cooked Potato Chips."
    - Regulation: Must be accurate and reflect the nature of the product.
  - ✓ Ingredient List
    - Description: Lists all ingredients used in the product in descending order of quantity.
    - Regulation: Includes additives, flavorings, and preservatives. Ingredients must be declared using their specific names or standardized terms.
  - ✓ Nutritional Information
    - Description: Provides details on the nutritional content of the product, including:
      - ❖ Energy (calories)
      - ❖ Fat (total and saturated)
      - ❖ Carbohydrates (total and sugars)
      - ❖ Protein
      - ❖ Salt (or Sodium)
    - Regulation: Must be presented per serving and per 100 grams, and comply with local regulations on nutritional labeling.
  - ✓ Allergen Information
    - Description: Identifies any allergens present in the product, such as wheat, dairy, or soy.

- Regulation: Must be clearly highlighted, often in bold or a separate box, to alert consumers with allergies or intolerances.

✓ Expiration Date

- Description: Indicates the date until which the product is expected to remain safe to consume and retain its quality.
- Regulation: Can be expressed as "Use By," "Best Before," or "Expiry Date," depending on the product and local regulations.

✓ Batch Number

- Description: Provides a unique identifier for the product batch.
- Regulation: Essential for traceability in case of recalls or quality issues.

✓ Manufacturer's Details

- Description: Includes the name and contact information of the manufacturer or distributor.
- Regulation: Must be provided for consumer inquiries and in case of complaints or issues.

✓ Country of Origin

- Description: Indicates where the product was manufactured or produced.
- Regulation: Required to inform consumers about the origin of the product.

✓ Storage Instructions

- Description: Provides guidance on how to store the product to maintain its quality.
- Regulation: May include instructions such as "Store in a cool, dry place" or "Keep away from direct sunlight."

✓ Special Claims

- Description: Any claims such as "Gluten-Free," "Low Fat," or "No Added Sugar" should be clearly stated.

- Regulation: Must be truthful and substantiated by evidence. Specific rules apply for health claims and nutritional claims.

✓ Barcode or QR Code

- Description: Provides a scannable code for inventory management and pricing.
- Regulation: Not always required but commonly used for convenience in retail environments.

Practical Activity 4.8.4: Storing crisps

Task:

1. You are requested to go to the roots and tubers processing workshop to store crisps
2. Apply safety precautions (wear PPE).
3. Present your work to the trainer/workshop assistant or whole class. Ask for clarification where necessary
4: Read the key reading 4.8.4
5: Perform the task provided in the application of learning 4.8

Key readings 4.8.4. Storing crisps

- **Key Factors in Monitoring Storage Conditions**

✓ **Temperature**

- Purpose: To prevent the growth of microorganisms and maintain the crispiness of the product.
- Recommended Range: Store crisps in a cool environment, ideally between 15°C and 25°C (59°F and 77°F).
- Monitoring: Use digital thermometers or temperature data loggers to continuously monitor storage temperatures. Regularly check and record temperature readings to ensure they remain within the desired range.

✓ **Humidity**

- Purpose: To avoid moisture absorption which can lead to sogginess and spoilage.
- Recommended Range: Keep relative humidity low, ideally below 60%.
- Monitoring: Use hygrometers or humidity sensors to measure and control the relative humidity in storage areas. Regularly check humidity levels and adjust dehumidifiers or air conditioning systems as needed.

✓ **Light Exposure**

- Purpose: To prevent degradation of the product due to light, which can affect flavor and color.
- Recommended Conditions: Store crisps in a dark or dimly lit environment, or use opaque or light-blocking packaging.
- Monitoring: Ensure that storage areas are shielded from direct sunlight and bright artificial lighting. Check packaging integrity to ensure it provides adequate protection from light.

✓ **Air Quality**

- Purpose: To maintain a clean environment and prevent contamination from airborne particles.
- Recommended Conditions: Ensure good ventilation and control air quality to reduce dust and contaminants.
- Monitoring: Use air filtration systems and regularly inspect storage areas for cleanliness. Implement regular cleaning schedules to maintain air quality.

✓ **Pest Control**

- Purpose: To prevent infestation by pests that can contaminate or damage the product.
- Recommended Conditions: Store crisps in sealed containers or packaging and maintain a clean storage environment.
- Monitoring: Regularly inspect storage areas for signs of pest activity. Use pest control measures such as traps and baits and ensure that any pest issues are addressed promptly.

✓ **Packaging Integrity**

- Purpose: To protect the crisps from external factors such as moisture, air, and contaminants.
- Recommended Conditions: Ensure packaging is intact and properly sealed.
- Monitoring: Regularly check the condition of packaging for any signs of damage or breaches. Conduct periodic quality checks to ensure that the packaging continues to provide adequate protection.

- **Procedures for Monitoring Storage Conditions:**

✓ Routine Inspections

Conduct regular inspections of the storage area to assess conditions and address any issues promptly. Include checks for temperature, humidity, cleanliness, and packaging integrity.

✓ Data Logging

Use data loggers to record temperature and humidity levels continuously. Analyze the data to detect any trends or deviations from the ideal conditions.

✓ Maintenance of Equipment

Ensure that all equipment used for monitoring and controlling storage conditions (e.g., refrigerators, dehumidifiers, air conditioners) is well-maintained and calibrated.

✓ Record Keeping

Maintain detailed records of storage conditions, including temperature and humidity logs, maintenance activities, and inspection reports. This documentation is essential for quality control and traceability.

✓ Employee Training

Train staff responsible for storage and handling of crisps on the importance of maintaining proper storage conditions and how to monitor and manage these conditions effectively.

✓ Corrective Actions

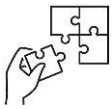
Implement corrective actions if deviations from optimal storage conditions are detected. This may include adjusting temperature settings, repairing equipment, or addressing any sources of contamination

- **Storing procedures of crisps:**

- ✓ Use an airtight container or resealable bag.
- ✓ Store in a cool, dry place away from sunlight.
- ✓ Avoid refrigeration and freezing.
- ✓ Seal containers tightly after each use. Check regularly for freshness.

Points to Remember

- vacuum nitrogen packaging is a highly effective method for keeping crisps fresh and appealing, protecting them from the elements that cause spoilage and maintaining their desirable qualities for an extended period.
- By following the sealing guidelines, you can effectively seal crisps to maintain their quality, freshness, and crispiness.
- By adhering to the labelling requirements, you can ensure that the crisp products meet legal standards and provide consumers with the necessary information to make informed purchasing decisions.
- By following the storage procedures, you can help preserve the quality and freshness of crisps and enjoy them at their best.



Application of learning 4.8.

You are requested to go in the root and tubers processing workshop to store irish potatoes crisps.

Learning outcome 4 end assessment

Written assessment

I.**Ready carefully the statements below related to making crisps and answer by encircling the letter corresponding the correct answer**

1. Which of the following is **NOT** a common blanching method for sliced roots and tubers?
   A. Steam Blanching
   B. Hot Water Blanching
   C. Freeze Blanching
   D. Microwave Blanching
2. Which method of frying is commonly used for commercial production of crisps?
   A. Deep FryingPan Frying
   B. Air Frying
   C. Grilling
3. During frying, which chemical reaction is primarily responsible for the browning of slices?
   A. Caramelization
   B. Lipid Oxidation
   C. Maillard Reaction
   D. Starch Gelatinization
4. What is the main purpose of cooling crisps after frying?
   A. To enhance flavor
   B. To prevent sogginess
   C. To increase moisture content
   D. To soften texture
5. Which test is commonly used to evaluate the crispiness of finished crisps?
   A. Texture Analysis
   B. Colorimeter Test
   C. Moisture Content Test
   D. Flavor Profile Analysis
6. What is a common method for sealing bags of crisps to maintain freshness?
   A. Heat Sealing
   B. Vacuum Sealing
   C. Zip-Locking
   D. Clip Sealing

II. Ready the statements below related to making crisps and answer by True if the statement is correct and answer by False if the statement is wrong.

1. Blanching helps in reducing microbial load and preserving the color of sliced roots and tubers.

2. Patting dry with paper towels is an effective method for removing deep-seated moisture from slices.

3. Frying sliced roots and tubers at too high a temperature can lead to acrylamide formation.

4. Air drying is the most effective method for removing moisture from slices when compared to centrifugal drying.

5. The use of excessive salt in the salting method can lead to undesirable health effects and requires thorough rinsing.

6. The cooling process for crisps is crucial to ensure they maintain a crispy texture by reducing the risk of moisture absorption.

7. Quality testing of crisps involves checking for uniformity in color and texture as well as flavor.

8. Blanching is only done to improve the texture of the slices and has no impact on flavor.

9. The primary function of seasoning is to enhance the flavor profile of the crisps**.**

10 . Storage conditions for crisps should be cool and dry to prevent spoilage and maintain product quality.

Practical assessment

The school has received a gift of tools and equipment used in processing irish potatoes into crisps. However, the school does not have a qualified technician in roots and tubers processing which will use those tools and equipment to make potatoes crisps. To overcome above issue, the school manager decided to hire you as qualified technician in roots and tubers processing to do the following tasks as demonstration how to make potatoes crisps.

Task1: Blanche sliced irish potatoes
Task 2: De-water sliced irish potatoes
Task3: Fry sliced irish potatoes
Task 4: De-oil irish potatoes crisps
Task 5: Season irish potatoes crisps
Task 6: Cool irish potatoes crisps
Task 7: Analyse quality of irish potatoes
Task 8: Store irish potatoes crisps

Note:

The tasks should be performed within five (5) hours

All materials, tools and equipment are available in production area of your school.

END

Reference

Brown, L. A. (2015). *Crispology: The science behind the perfect snack (pp. 88-105).* Snack Science Publishing.

Smith, J. P. (2011). *The art of crisp making: From farm to table pp45-67.*

Taylor, H. L. (2017). *Potato crisps: A guide to production and flavoring techniques (pp. 150-165). Snack Master Press.*

RTB | RWANDA TVET BOARD

October 2024