Central Agricultural
Broadcasting and Television School
中央农业广播电视学校

AGRICULTURAL PRODUCT DRYING TECHNOLOGY AND ITS APPLICATION

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PART.02

Drying Methods and Applications

The Role of Drying Technology

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Drying technology

- Reducing post-harvest losses
- Safe storage
- Enabling diverse food processing options

Loss Reduction

Moisture characteristic

- Fresh fruits and vegetables **contain >90% water**.

Related Losses

- **Improper handling** during harvesting, transportation, storage and marketing → **spoilage** → losses **25% - 30%** → substantial **economic impact**.

Drying Benefits

- Drying mitigates such losses by **converting produce into products** (e.g., dried fruits & vegetables).

Safe Storage

- ## Healthier Alternative
  - **Dehydrated foods** offer **a heathier alternative to traditional preservation methods.**
- ## Limitations of Traditional Methods
  - **Traditional methods**: pickling, smoking, or canning may involve **carcinogenic risks** or **nutrient loss**.
- ## Benefits
  - Dehydrated foods **provide convenient, safe**, **and environmentally friendly options**.





New Product Processing Methods

■ Dual positioning of drying technology

- An important means of food preservation.
- An essential method for high-quality food processing.

Most agricultural and food products rely on drying as a key step in their production.

Drying Method

Natural Drying

Artificial Drying

Equipment-based Drying

The choice of drying method, equipment, and operational parameters should be aligned with the specific purpose of drying.

1. Natural Drying

Definition

- **Natural drying** uses **environmental conditions** like **sunlight** and **wind** to **remove moisture** from products.

Advantages

- Simplicity.
- Minimal equipment.
- Low cost.

Limitations

- Long drying time.
- Uneven moisture reduction.
- Large space requirements.
- Poor hygiene.
- High susceptibility to climate and regional conditions.
- Nutrient loss.

1. Natural Drying

Sun drying

- Raw materials exposed to sunlight.
- Common for grains and cereals.
- Used for traditional products such as dried daylilies and dried fish.

Air drying

- Moisture is removed from wet materials.
- Driven by vapor pressure difference between the material and the surrounding air.

Shade drying or hanging drying

- Raw materials are dried under well-ventilated indoor spaces or shelters.
- Natural airflow facilitate moisture removal.

1. Natural Drying

Natural Drying of Grapes – Process Example

01 Raw material selection

02 Alkali dippingt

03 Rinsing

04 Tray loading

05 Drying

06 Closed conditioning for moisture equalization

07 Threshing

08 Destemming

09 Packaging

1. Natural Drying

Natural Drying of Grapes – Process Example

- **Raw Material Selection**
  - **Choose suitable grapes**

    Thin skins, thick pulp, full maturity → higher sugar content & better taste.
  - **Remove defective fruits**

    Remove damaged, rotten, or diseased grapes to prevent contamination.
  - **Group by similar size**

    Ensures unform drying.

1. Natural Drying

Natural Drying of Grapes – Process Example

Alkali Soaking Treatment

- Purpose: Remove surface impurities.
- Industrial processing:
  - Soaks in alkali solutions (e.g., sodium hydroxide) → disrupts the wax layer and accelerates drying.
- Homemade production: Saltwater rinsing can be used instead.

Special Drying Process for White Grapes

- **White grapes require sulfur fumigation:** approximately 2 kg sulfur per ton of grapes.
- Sun exposure until grapes turn brown → transferred to a shaded drying room for further drying.

1. Natural Drying

Natural Drying of Grapes – Process Example

Shade-drying Environment

- **Basis for Shade-Drying Room Size**
  - Size of drying room depends on **available land or grape quantity**.
- **Structure & Specifications of Shade-Drying Rooms**
  - **Layout:** Mostly **rectangular** with **flat roofs**, walls built from **soil blocks**.
  - **Dimensions: 6–8 m length**, **4 m width**, and **3 m height**.
- **Spacing Requirement for Shade-Drying Rooms**
  - Adjacent rooms are separated by **about 3 m**.

1. Natural Drying

Natural Drying of Grapes – Process Example

Rehydration and Subsequent Processing

Purpose of Rehydration

- Ensures even moisture distribution (for uniform drying).

Subsequent Processing Flow

- Grapes then sorted, destemmed and organized before final packaging.

2. Artificial Drying

Fire-based Oven

Structure

- Built directly on the ground or in a pit, with fire at the bottom, charcoal above, and trays or mats placed for holding the material to be dried.

Advantages

- Simple equipment, low investment, low cost.

Disadvantagess

- Low production capacity, slow drying, poor product quality (with smoky flavor), and high labor intensity.

Application Status

- Rarely used today, mostly applied to low-moisture fruits and vegetables.

2. Artificial Drying

Drying Room

Composition of Drying Room

- Includes main building, heating system, ventilation and humidity control, and loading equipment.

Advantages

- Suitable for large-scale production, fast drying, good quality, flexible equipment, relatively low construction cost, and locally sourced materials.

Disadvantages

- High energy consumption, potential pollution (e.g., coal burning), and higher production cost.

2. Artificial Drying

Drying Room

Applicable Drying Processes

- High-soluble solids, whole fruits (e.g., jujubes, persimmons): Low-high-low temperature sequence.
- Low-soluble solids, sliced/shredded fruits (e.g., chili, apple): High-low temperature sequence.

Typical Drying Temperature

- 55–60℃ for most fruits and vegetables.

2. Artificial Drying

Artificial Drying of Dried Persimmon

Product Attribute: Dried persimmon is a common snack product made from fruits.

Core Processing Flow

- **First Drying Phase**

  Peeling raw persimmons → placing on trays → transferring to a drying room → performing sulphur fumigation → conducting the first drying → rehydration → kneading → sun or shade drying.

- **Second Drying Phase**

  Second drying → cooling → rehydration → shaping → forming sugar bloom → final shaping.

- **Finished Product Phase**

  Final packaging → finished product.

2. Artificial Drying

Artificial Drying of Dried Persimmon

- **Key Points for the First Drying**
  - Initial temperature is controlled at around **40° C**, then **gradually increased** until the **peel softens** and **a surface crust forms**.
- **Key Points for the Second Drying**
  - After rehydration, dry at **50–55° C** until the fruit **shrinks**, becomes **pliable**, and reaches **~30% moisture**.

2. Artificial Drying

Artificial Drying of Dried Persimmon

Key Points for Bloom Formation

- **The white crystalline bloom** on the surface, primarily composed of **mannitol** and **glucose**, exudes from the fruit flesh, providing **appropriate sweetness** and a **desirable texture**.

Key Points for Pre-Finished Product Treatment

- The **dried persimmons layered**, **fully enclosed**, them, and left to **dry until the sugar bloom forms**.

3. Equipment-based Drying

Classification of drying equipment

By operating pressure

atmospheric dryers vs. vacuum dryers

By operation mode

batch type vs. continuous-type

By heating method

conduction heating vs. convection heating

By drying process

absolute drying vs. non-absolute drying

3. Equipment-based Drying

The First Generation of Drying Equipment

- **Bed-type / box-type dryers**
  - Examples include **kiln**, **tray**, **tunnel**, and **belt** drying.
- **Used for solid materials**
  - Such as **grains**, **sliced vegetables**, and **block-shaped foods**.

- **Hot-air convection drying**
  - Relied on **hot air convection** to **heat the material** and **remove moisture**.
- **Conveyor-based operation**
  - Materials placed on **conveyor belts** for continuous airflow drying.

3. Equipment-based Drying

The Second Generation of Drying Equipment

- **Spray drying & drum drying**
  - Designed for **liquid**, **slurry**, **and paste like materials**.
- **Drum drying**
  - Materials and heating surfaces **remain in motion** → improves **drying uniformity**.
- **Efficient powder conversion**
  - Effectively **convert liquid/paste materials into powders**, expanding range of processed products.

3. Equipment-based Drying

The Third Generation of Drying Equipment

- **Types**
  - Freeze-drying vs. osmotic dehydration.
- **Features and application scenarios of each type**
  - **Freeze-drying:** Preserves the **original shape** of products while minimizing the loss of **color**, **flavor**, and **bioactive compounds**.
  - **Osmotic dehydration:** Immerses materials in **hypertonic solutions** (such as sugar or salt solutions), commonly used for **fruits and vegetables**.

- **technical advantages**
  - Typically require **no heating** and can **retain product quality** under **low-temperature conditions**.

3. Equipment-based Drying

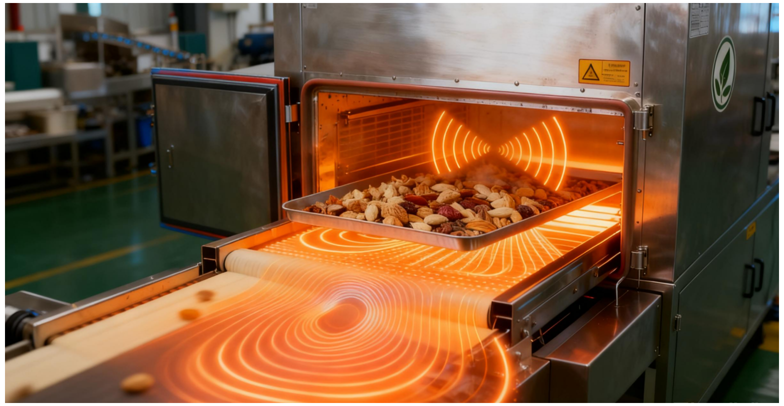
The Fourth Generation of Drying Equipment

Microwave / radio-frequency wavs

- Enables **simultaneous inside-outside heating**, unlike traditional surface heating.

Moisture removal from within cells

- Technologies such as **microwave drying** and **radio frequency drying** initiate **moisture removal from within cells** with **water diffusing outward**.



Technical advantages

- Maintain **product quality** while addressing **environmental concerns** through improved **energy efficiency**.

Summary

Core Goals of Each Generation of Technologies

1st generation

Focused on **loss reduction** and **shelf-life extension**.

2nd generation

Emphasized **product diversification** and **value addition**.

3rd generation

Enabled **preservation of functional compounds** under **low-temperature conditions**.

4th generation

Integrate **energy-saving measures** with **quality preservation**, reflecting current demands for **sustainability and efficiency**.