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Preserving Freshness, Reducing Waste: The New Era of Food Drying

*Deshapaka Harshini[1], Posham Raghuram[2], Irshad Ahmad Lone[3] and Ansh Singh[4]
[1]PG Scholar, Department of Food Science and Technology, Osmania University, Telangana, India
[2]Teaching Assistant, Dr. Ganta Gopal Reddy Horticulture Polytechnic, Gaddipally, Telangana, India
[3]GIS Specialist, AIC KESAR CELL-Division of Soil Science, Agriculture Insurance Company of India-SKUAST-Kashmir, India
[4]Ph.D. Research Scholar, Department of Vegetable Science, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India
*Corresponding Author's email: deshapakaharshini16@gmail.com

Fresh produce has more moisture than frozen food, and if not stored properly, it can go bad quickly. The cost of existing storage methods like refrigeration and controlled environments is high because they require continuous energy use along the supply chain. Therefore, there is an increasing focus on using drying methods, as they help reduce post-harvest losses, make storage and transportation easier, and ensure food is available all year round. However, fruits and vegetables take a long time to dry with traditional methods like sun or open-air drying, and there is a risk of contamination, which can affect the quality of the final product. To overcome these issues, several advanced drying techniques have been developed and are commonly used for different types of fruits and vegetables. These include sun drying, microwave drying, vacuum drying, infrared drying, freeze drying, oven drying, and various hybrid drying technologies. The main objective of this work is to examine the specific processes involved in drying different crops and their impact on quality, effectiveness, cost-efficiency, and the ability to preserve nutrients.

Purpose of Drying

Drying in food processing serves multiple important functions.
The main purposes of drying are as follows:

1.Extending Shelf-Life: The main goal of drying is to prolong the shelf-life of food. By removing moisture, the water activity is reduced, creating conditions that are not suitable for microbial growth.

2.Inhibition of Microbial Growth: Drying reduces the moisture content in food, which prevents the growth of microorganisms. Without sufficient moisture, microorganisms cannot grow and cause food to spoil, helping to maintain the quality and safety of the dried food for longer periods.

3.Reduction in Enzyme Activity: Enzymes in food are responsible for chemical reactions that can lead to undesirable changes, such as browning, damage to texture, and loss of nutrients. Drying lowers moisture content, slowing down enzyme activity and helping to maintain the food's natural qualities, taste, and nutritional value.

4.Reduction in Weight and Bulk: Drying removes a large amount of water from food, which reduces its weight and size. This makes the dried food lighter and more compact, lowering transportation and storage costs, and makes it more convenient for consumers.

5.Preservation of Nutrients: Drying can help retain the nutritional value of food by minimizing nutrient loss. While some vitamins and minerals might be slightly affected during

the drying process, the nutrient retention is generally better than with other preservation methods that involve higher temperatures or longer exposure to air.

Methods of Drying

1.Solar Drying

• Structures are designed to collect and increase solar radiation for drying.
• Solar drying is faster than traditional drying because it produces high air temperatures and low humidity, which helps preserve the food.
• Drying with solar dryers is faster than with the sun, and it requires less space. However, it is not effective on cloudy days.

2. Shade Drying

• This method is used to prevent color loss in fruits and vegetables when exposed to direct sunlight. Herbs, green and red chillies, okra, beans, and other similar items are typically dried in shaded areas where there is good air circulation.

Home Scale Dehydrator or Drier

• The unit has dimensions of 90x90x60 cm and is made of galvanized steel. It includes a perforated iron tray at the bottom. The box is placed approximately 2-3 feet above the ground on a wooden frame.There are two slits at the top, which can be closed with shutters. The dryer can hold about seven trays.A gas stove or any other heating source can be used to heat the material on the trays. Vegetables and fruits are usually dehydrated at 43°C initially, then the temperature is gradually increased to 60-66°C and 66-71°C. For 25 kg of fruit, 100-200 g of sulphur is needed for a home-scale drier. The average drying time is between half an hour and two hours.

4. Oven Drying

• Fruits, vegetables, fruit leathers, and meat can be dried in a conventional oven with a thermostat set to 60°C.

5. Kiln Drier

• A kiln evaporator is also known as a kiln. It has two floors. The food to be dried is spread out on the top floor, while the furnace is located on the lower floor. A ventilator is used to move the heat. Large pieces of food are typically placed inside it.

5. Tower drier

• It is also known as a stack type drier.

• This drier includes a furnace room that has the furnace, heating pipes, and a cabinet where fruits are placed in perforated trays.

• Heated air from the furnace moves upward through the trays.

• The heating is done using steam coils that are positioned between the trays.

• The trays are swapped out as the drying process continues.

6. Tunnel belt drier

• Above the furnace room are several parallel, sloped, and narrow chambers.

• An upper conveyor belt moves trays, which are then removed at the lower conveyor belt.

• A fan is used to circulate air for the drying process.

Air is occasionally introduced to regulate humidity. It is possible to heat the system directly or through radiation.

• Heat is transferred to the material indirectly, which is generally effective, but there is a risk of overheating.

• The furnace's hot gases are transported through pipes via radiation. It is also possible to use steam pipes.

7. Belt-trough drier

• This dryer has metal mesh belts that look like troughs.

• The food is dried inside the trough by hot air passing through the mesh.

8. Fluidized bed drying

• Food particles are placed on a porous plate, and hot air is blown up through the pores, lifting the particles with just enough force to make them move gently in a bubbling motion.

• Dried food is taken out from one end of the dryer, while fresh food is added from the other.

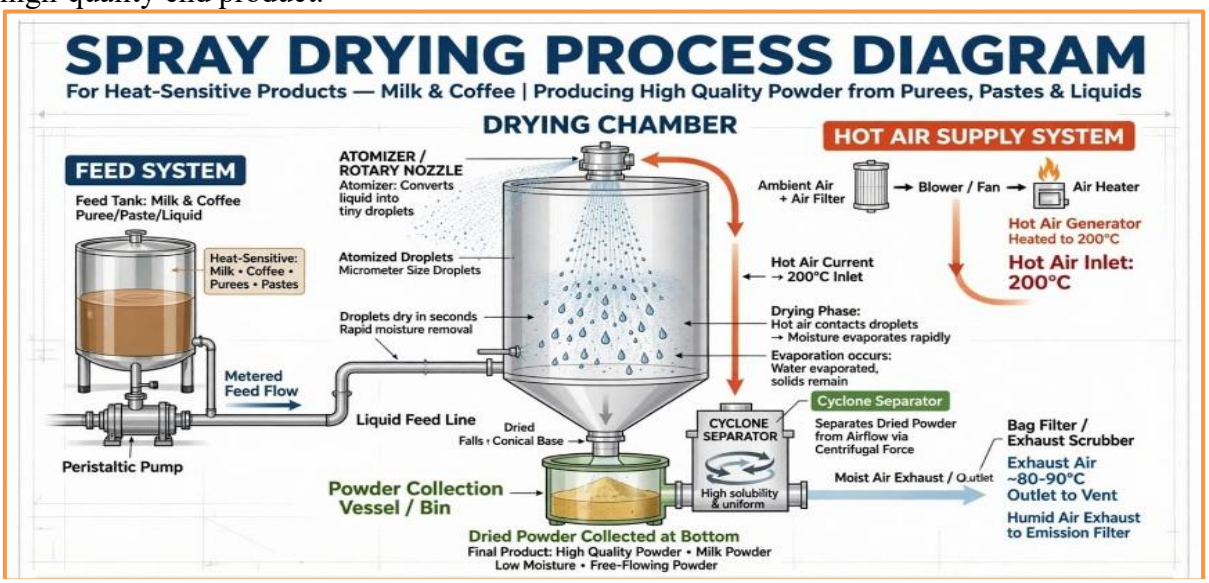
9. Foam mat drying

- This method is used to dry pulps and concentrates.
- A foaming agent is added to the fluid food material to create a stable foam with low density. The foam is spread in thin layers onto trays or belts.
- This process exposes a large surface area, allowing moisture to escape quickly, which results in a fast drying process at a lower temperature.
- The foam is spread on trays and dried at low temperatures as a mat. Foam mat drying is one of the methods used for dehydration.
- This method dries the product quicker, and the dried product can be easily reconstituted.
- Compared to drum drying, spray drying, and puff drying, foam mat drying is a more cost-effective method.

- This drying technology is used to produce orange, tomato, pineapple, and lemon juice powder, apple sauce, and baby foods.
- Glycerol monostearate (GMS), egg albumin, guar gum, groundnut protein isolate, and carboxymethylcellulose are commonly used as foaming agents.

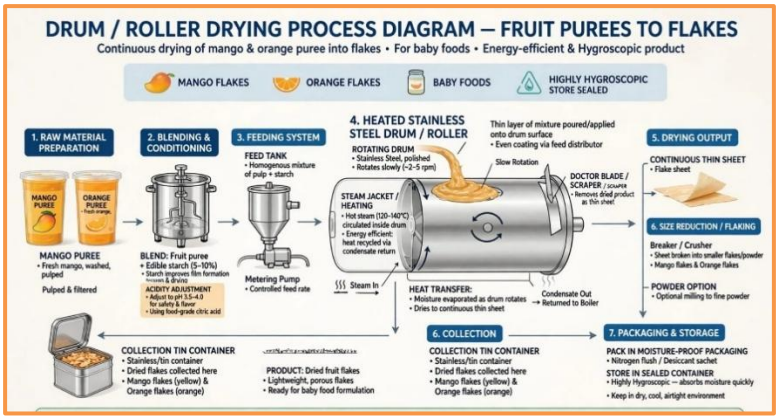
10.Spray drying

• Purees, pastes, and liquids that can be atomized are dried using spray dryers.
• A hot air current is used to spray the material into the drying chamber.
The dried product is collected at the bottom of the chamber.
• By using inlet air temperatures around 200°C and properly designed systems, the material is atomized into tiny droplets, resulting in quick drying within seconds.
• This method is used to dry heat-sensitive products like milk and coffee, achieving a very high-quality end product.



11. Drum or roller drying

• This method is used to dry purees and liquid foods.
• It is used to prepare products like mango flakes, orange flakes, and baby foods.
• The pulp of the fruit is blended with edible starch, and the acidity of the mixture is adjusted.
• The mixture is poured gradually into heated stainless steel drums that rotate slowly.
• As the product dries, it forms a continuous thin sheet or powder. The dried pieces are collected in a tin container after being broken into smaller pieces.
• Since the flakes are highly hygroscopic, the lid should be placed immediately after drying.
• Drum drying is one of the most energy-efficient methods for drying high-viscosity liquids or pureed foods.



12. Microwave drying

•This method uses microwaves to dry food products.

13. Vacuum puffing and dehydration

• Vacuum dryers are used for drying at low temperatures. A quick application of vacuum causes the food to puff up.

• This method is generally used for preparing orange juice powder or making potato pieces with a porous structure.

• While the potato pieces are still hot, they are subjected to vacuum for a short time and then dried.

• The rapid evaporation of water vapour from inside the product causes the texture to become porous, resulting in quick drying.

14. Drying by freezing

•This method is used to dry food pieces and liquids. The process of freeze drying is used to produce fruit juice concentrates.

• The material is frozen on trays under vacuum and then dried. During vacuum drying, the material dries directly without passing through a liquid stage.

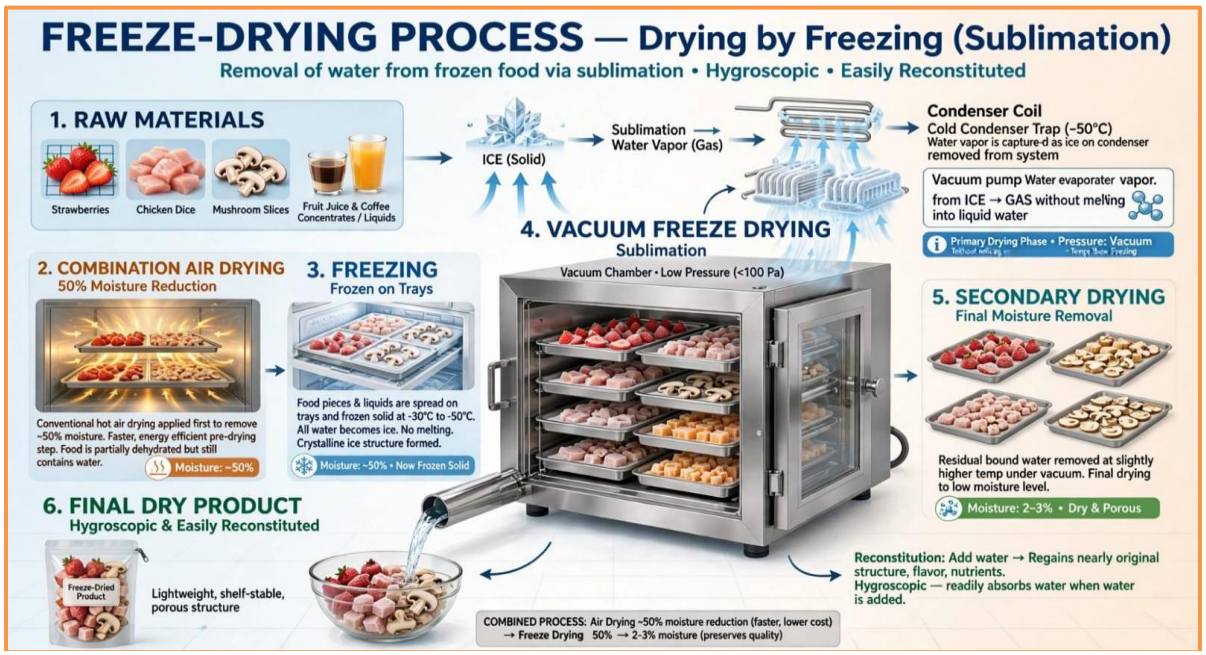
• In freeze drying, water evaporates from ice without melting, under certain conditions of low vapour pressure.

• Foods such as juices, coffee, strawberries, chicken dice, mushroom slices, and other similar products are usually dried using freeze drying.

• Even though the dried product is highly hygroscopic, it can be easily reconstituted. Fruit juice concentrates retain excellent taste and flavour, along with good reconstitution properties. However, this method is expensive due to the high equipment costs.

• Combining freeze drying with air drying can help reduce costs.

For example, vegetables can be air dried to about 50% moisture and then freeze dried to 2-3% moisture.



Factors in the Control of Drying

The rate at which fresh produce dries is influenced by several factors, including:

• Composition of raw materials: Foods that are high in sugar or contain other solutes tend to dry more slowly.

• Size, shape, and arrangement of stacking: A larger surface area leads to quicker drying.

• Temperature, humidity, and air velocity: A greater temperature difference between the product and the drying medium leads to faster drying.
The lower the humidity in the environment, the quicker the drying process will occur.
• Pressure (atmospheric or under vacuum): When atmospheric pressure is lower, the temperature required for water to evaporate is also lower.
• Heat transfer to the surface (conductive, convective, and radiative): Radiation is the fastest way to transfer heat, followed by convection and then conduction.

Process of Food Drying

A. Treatments Of Foods Before Drying

The methods used to prepare food items prior to drying have a major effect on the microbial content, as will be explained.
These pretreatments may include:
1.Sorting and selecting based on size, maturity, soundness, and dimensions,
2.Washing, especially for vegetables and fruits,
3.Peeling vegetables and fruits using hand machines or lye baths for absorption,
4.Cutting into halves, slices, shreds, or cubes,
5.Alkali dipping, which is mainly used for fruits like grapes, raisins, and prunes (dried in the sun), and uses high temperatures with lye (0.1 or 1.5 percent) or sodium carbonate,
6.Blanching or scalding certain fruits and vegetables such as apricots and peaches, and
7.Sulfurization of light-colored fruits and certain vegetables. Fruits can naturally absorb sulfur dioxide, a gas produced by burning sulfur, which results in a sulfur dioxide concentration between 1,000 and 3,000 ppm, depending on the fruit type. Vegetables can also be sulfurized after blanching, using dips in sulfite solutions or by spraying with these solutions.
Sulfurization helps maintain the light color of the food, preserves vitamin C, and may also help retain vitamin A.It also acts as a natural insect repellent and can eliminate many microorganisms.

\Procedures After Drying

The drying process varies depending on the type of food being dried.
1. Sweating: The term "sweating" refers to a method where dried food is stored in containers or bins to allow moisture levels to balance out or reach a desired level. This process is commonly used with dried fruits and specific types of nuts, such as almonds and English walnuts.
2. Packaging: Most foods are packaged right after the drying process to protect them from moisture, microbial contamination, and insect infestation. However, some dried foods like fruits and nuts can be stored for up to one year before being packaged.
3. Pasteurization: Pasteurization is typically applied to dried fruits to eliminate harmful pathogens and spoilage organisms.This process is usually done while the fruit is still in its packaging, and the time and conditions vary depending on the type of fruit. The process generally lasts between 30 to 70 minutes, and it takes place at a relative humidity of 70-100%, with temperatures ranging between 65.6°C and 85°C.

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