Unit III – Topic V

Dehydration – types of dryers – advantages and disadvantages

Difference Between Drying and Dehydration

Both the terms 'drying' and 'dehydration' mean the removal of water. But the former term is generally used for drying under the influence of non-conventional energy sources like sun and wind whereas dehydration means the process of removal of moisture by the application of artificial heat under controlled conditions of temperature, humidity and air flow. The Table 1 illustrates the differences between drying and dehydration.

Table 1. Differences between drying and dehydration processes:

Drying	Dehydration
Cheaper	Costlier process.
Colour of dried product is superior when compared to dehydrated product.	Quality is better.
Not practicable unless favourable conditions prevail.	Yield is higher.
	Microclimate can be controlled.
	Easy to maintain sanitary conditions.
	Cooking and keeping quality is better.
	Requires less floor area and fewer trays.

Types of Drying

Basically, drying can be done by two processes viz. natural drying and mechanical dehydration or artificial drying based on source of energy. Natural drying takes place under the influence of sunlight and wind and is of three types viz. sun, solar and shade drying. In natural drying

there is no control over temperature, air flow and humidity whereas in artificial drying, these conditions are well controlled.

Mechanical dehydration or artificial dehydration can be further classified into atmospheric and sub-atmospheric types based on the conditions employed in drying process. On the basis of mode of drying process, drying at atmospheric pressure conditions can be further divided in batch and continuous types. Mechanical drying includes the methods of drying by (1) heated air, (2) direct contact with heated surface e.g. drum drying and (3) application of energy from a radiating microwave or dielectric source.

Commercial dehydrators are generally large in size and various types of dehydrators can be based on circulation of air as (1) Natural and (2) Forced draught. In natural draught, the rising of heated air brings about drying of food in the natural draught method. Examples include kiln, tower and cabinet driers. Forced draught employ currents of heated air that move across the food usually in tunnels. An alternative method is to move the food or a conveyor belt or trays through heated air. Examples include tunnel or belt drier. In forced draught drier, the temperature and humidity can be carefully controlled to get a good dehydrated product but are not in general use because of the cost.

Sun drying:
Drying the food product under natural sunny conditions is called as sun drying. No energy is required for the drying process. To practice sun drying of foods, hot days are desirable with minimum temperatures of 35°C with low humidity. Poor quality produce can not be used for natural drying to achieve good quality dried product. The lower limit of moisture content by this method is approximately 15 per cent. Problems of contamination and intermittent drying are generally encountered with sun drying. It is only possible in areas of low humidity.

Simple equipments are required such as knives, peelers, trays etc. Plastic sheets are also used. Process consists of washing, peeling and preparation of fruit or vegetables. Fruits are generally sulphured whereas vegetables are blanched before drying to prevent enzymatic browning. Fruits are seldom blanched. Fruits are considered to be dry when they show no signs of moisture or stickiness when held firmly in the hand. Vegetables are considered to be dry when they become brittle. At this stage, they should be removed from the dehydrator. The residual moisture in the vegetables should not be more than 6-8 per cent and in fruits 10-20 per cent. Dried fruits can be used as such after soaking, while dried vegetables are usually soaked in water overnight and then cooked.

The Table 2 shows the advantages and disadvantages associated with the sun drying of food products.

Table 2. Advantages and disadvantages of sun drying:

Advantages	Disadvantages
• No energy is	• Slow drying process • Time taking • Molding of food may occur

	require d	due to slow drying • Cannot be carried out in dust, rainy weather

Solar drying:
Solar drying uses designed structures to collect and enhance solar radiation. Solar driers generate high air temperature and low humidity which results in faster drying. This drier is faster than sun-drying, and also requires less drying area. But it cannot be used on cloudy days. Generally, three types of solar driers are used, as (1) the absorption or hot box type driers in which the product is directly heated by sun, (2) the indirect or convection driers in which the product is exposed to warm air which is heated by means of a solar absorber or heat exchanger and (3) drier, which is combination of first and second type.

Shade drying:
This kind of method is used for foods which lose their colour when exposed to direct sunlight for drying. Generally herbs, green and red chillies, okra and beans etc. are dried under shaded area with good air circulation.

A home scale dehydrator or drier:
It consists of a small galvanized box having dimensions of 90x90x60 cm. The lower portion consists of perforated iron tray. The box is fitted on to a wooden frame which is kept about 2-3 feet above ground. At the top there are two slits which can be closed by shutters. About seven trays can be kept in the drier. The material to be heated is kept on trays and heating source can be a gas stove or any other source. The initial temperature of the dehydrator is usually is 43°C which is gradually increased to 60-66°C in the case of vegetables and 66-71°C for fruits. For a home scale drier 100-200 g of sulphur is required for 25 kg fruit. Time required for drying is generally ½ hour to 2 hours.

Oven drying:
A conventional oven with a thermostatic setting of 60°C is suitable for oven drying of fruits, vegetables, fruit leathers and meats . This is a kind of cabinet drier.

Kiln drier:
Also known as kiln evaporator. It consists of two floors. On the top floor, food to be dried is spread and on the lower floor, the furnace is housed. Heat is conveyed by a ventilator. Generally it is used for large pieces of food.

Tower drier:
It is also called as stack type drier. This drier consists of a furnace room containing the furnace, heating pipes and cabinet in which fruits are kept in perforated trays. Heated air from the furnace rises through the trays. Heating is through steam coils placed between the trays. The trays are interchanged as drying progresses.

Tunnel belt drier:
It consists of several parallel sloping and narrow chambers above a furnace room. Trays are passed on a conveyor belt at upper end and removed at the lower end. Air for drying is circulated by a fan. Humidity is controlled by occasionally letting in air. Heating can be direct or by radiation. Indirect heating– heat is passed over material and it is sufficient, but there is

risk of overheating. By radiation air is heated over pipes carrying hot gases from furnace. Steam pipes may also be used.

Belt-trough drier:
In this drier, belt is in the form of a trough, which is made of metal mesh. Hot air is blown through the mesh and food pieces lying on the trough are dried in the process.

Fluidized bed drying:
In this drying method, food pieces are fed on a porous plate and hot air is blown up from the pores through the food particles with just enough force to suspend them in a gentle boiling motion. The fresh food is fed from one side of the drier and dried food is removed from the other end.

Foam mat drying:
Pulps and concentrates are dried by this method. Small amounts of a foaming agent are mixed with the fluid food material and whipped to form low density stable foam. Foams are cast in thin layers onto trays or belts. Foaming is done to expose enormous surface area for quick moisture escape resulting in rapid atmospheric drying at somewhat lower temperature. This is dried by spreading foam on trays as a mat at low temperature. Such dehydration method is known as foam mat drying.
This process takes less time to dry and the dried product can be easily reconstituted. This method is comparatively cheaper than drum drying, spray drying and puffing methods. Orange, tomato, pineapple, and lemon juice powder, apple sauce, baby foods are the products made using this drying technology. The foaming agents used are glycerol monostearate (GMS), egg albumin, guar gum, groundnut protein isolate, carboxy methyl cellulose.

Spray drying:
Spray drier is used to dry purees, low viscosity pastes and liquids, which can be atomized. The material is sprayed in a rapidly moving current of hot air. The dried product drops to the bottom of the drying chamber and is collected. Atomization into minute droplets results in drying in a matter of seconds with common inlet air temperature of about 200°C and properly designed system quickly removes the dried particles from heated zones. This method of dehydration can produce exceptionally high quality with many highly heat sensitive materials including milk and coffee.

Drum or roller drying:
Foods in the form of puree and liquid are dried using this method. This kind of processing is used for preparation of mango flakes, orange flakes, baby foods etc. The pulp of fruit is blended with a small quantity of edible starch and then the blend is adjusted for acidity. The mixture is poured little by little on to heated drum which are made of stainless steel. Drums are revolving at a slow speed. The product dries in the form of a continuous thin sheet or powder. This is broken into small pieces which are then collected in a tin container. Lid has to be placed immediately because the flakes are highly hygroscopic. Drum drying is one of the most energy efficient drying methods and is particularly effective for drying high viscous liquid or pureed foods.

Microwave drying:
In this method, microwaves are used to dry the food product.

Vacuum puffing and dehydration:
For drying at comparatively low temperature, vacuum driers are necessary. Puffing of food is obtained by sudden application of vacuum. Generally used for preparation of orange juice powder or preparation of potato pieces with porous structure. Potato pieces are cooked and while hot they are subjected to vacuum for a short period and then dried. The instant flashing of water vapour from inside leaves the texture porous and also facilitates quick drying.

Freeze drying:
Foods in the pieces and liquids are dried by this method. Fruit juice concentrates are manufactured using freeze drying. The material is frozen on trays and then dried under vacuum. Due to vacuum drying, the material dries directly without passing through the intermediate liquid stage. The principle behind freeze drying is that under certain conditions of low vapour pressure, water can evaporate from ice without the ice melting.
Freeze drying is generally used to dry sensitive and high value liquid as well as solid foods such as juices, coffee, strawberries, chicken dice, mushroom slices etc. The dried product is highly hygroscopic and reconstitutes readily. Taste, flavour and reconstitution property of fruit juice concentrates is excellent. Method is costly because of the equipment cost. Freeze drying in combination with air drying is advantageous in reducing cost of drying. For example- vegetables pieces may be air dried to about 50 per cent moisture and then freeze dried down to 2-3 per cent moisture.

Accelerated freeze drying (AFD):
This is used for drying pieces of food material without disturbing their shape and texture. Product has good reconstitution property, taste and flavour. The pieces of material are kept pressed between two perforated or wire mesh trays inside a cabinet freeze drier. As the material dries, the bulk of the pieces is gradually reduced by decreasing the clearance between the trays is reduced. The dried material retains its shape and regains it on rehydration. Meat etc. are dried using this technique.

Advantages of Drying

Preservation is the main reason but not the only reason for dehydrating foods. Food may be dehydrated for other reasons also viz. to decrease weight and bulk; to retain size and shape of original food; to produce convenience items. Dehydration/ drying is advantageous for being cheaper than the other methods of preservation with less requirement of equipments. Storage of dried food products does not require special facilities like refrigeration etc. Dried food products are simple to store and pack because of their low volume.

Dehydrated foods however, are less popular because of some undesirable changes in colour, taste and flavour during storage and distribution. Dehydration techniques have been improved to overcome most of these defects.

Factors in control of drying:

Various factors affecting rate of drying in a fresh produce include the following:

1. Composition of raw materials: Foods containing high amount of sugar or other solutes dry slowly.
2. Size, shape and arrangement of stacking of produce: Greater the surface area greater is the rate of drying.
3. Temperature as well as humidity and velocity of air: Greater is the temperature differential between the product and the drying medium faster the product dries. Lower the humidity of environment the faster the drying will be.
4. Pressure (atmospheric or under vacuum): Lower the atmospheric pressure the lower the temperature required to evaporate water.
5. Heat transfer to surface (conductive, convective and radiative): The fastest method of heat transfer is radiation consecutively followed by convection and conduction.