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Innovations in Drying for Preservation of Fruit and Vegetables

Engineering

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P. K. Wankhade	Chemical Technology Department, S. G. B. Amravati University
R.S.Sapkal	Chemical Technology Department, S. G. B. Amravati University
V.S.Sapkal	Chemical Technology Department, S. G. B. Amravati University

ABSTRACT

Drying is one of the method of food preservation. Drying preserves foods by removing enough moisture from food to prevent decay and spoilage. Drying of foods, the key is to remove moisture as quickly as possible at a temperature that does not seriously affect the flavor, texture and color of the food. If the temperature is too low in the beginning, microorganisms may survive and even grow before the food is adequately dried. Hard coating of fruit is more difficult for moisture to escape and the food does not dry properly. Some of these materials are heat-sensitive and require careful drying. Drying can be detrimental to the retention of bioactive ingredients. High temperature tends to damage and denature the product, destroy active ingredients, cause case hardening and discoloration, etc. This article briefly summarizes some of the innovative drying methods and selected new developments applicable to drying processing. Food preservation can reduce wastage of a harvest surplus, allow storage for food shortages, and in some cases facilitate export to high-value markets.

INTRODUCTION:

Fruits and vegetables are important sources of essential dietary nutrients such as vitamins, minerals and fiber. Since the moisture content of fresh fruits and vegetables is more than eighty percent. Fruit is as highly perishable commodities. Keeping the product fresh is the best way to maintain its nutritional value, but most storage techniques require low temperatures, which are difficult to maintain throughout the distribution chain. Whereas on the other hand, drying is a suitable alternative for post harvest management especially in our country it exist poorly established low temperature distribution and poor handling technologies. It is noted that over twenty of the world perishable crops are dried to increase shelf-life and promote food security (Grabowski. 2003). Fruits, vegetables and their products are dried to improve storage stability, minimize packaging requirements and reduce the weight in transport. Whereas, in India hardly any portion of perishables are dried which leads to enormous loss in terms of money and labor besides steep rise in prices of commodities during the off season. The preservation of fruits and vegetables through drying dates back many centuries and is based on sun and solar drying techniques. The poor quality and product contamination lead to the development of alternate drying technologies (Bezyma and Kutovoy 2005). Application of heat during drying through conduction, convection and radiation are the basic techniques used to force water to vaporize, while air is forced to apply encourage the removal of vapour. The selection of drying method depends on various factors such as the type of product, availability of dryer, cost of drying and final quality of product. Energy consumption and quality of dried products are other critical parameters in the selection of a drying process. To reduce the use of fossil fuel, electrical energy is an alternate source of energy for drying. Considering these, the present review is focusing on new developments in drying and dehydration and future scope for better drying.

Food losses in the developing world are thought to be 50% of the fruits and vegetables grown and 25% of harvested food grain (Burden, 1989). Water content of properly dried food varies from 5 to 25 percent depending on the type of food.

Background:

Preservation of fruits, vegetables, grains, has been practiced in many parts of the world for many years. Method of preservation is drying. Food spoilage is caused by the action of molds, yeasts, bacteria, and enzymes. The drying process removes desired moisture from food to greatly decrease these destructive effects. Drying is perhaps the oldest, most common and most diverse of chemical engineering unit operations. It competes with distillation as the most energy-intensive unit operation due to the high latent heat of vaporization and the inherent inefficiency of using hot air as the drying medium.

Drying can be done by effective vaporization of the liquid by supplying heat to the wet product. Heat can be supplied by convection (direct dryers), by conduction (contact or indirect dryers), radiation or volumetrically by placing the wet material in a microwave or radio frequency electromagnetic field. Drying of different product is needed for various reasons: need for easy-to-handle free-flowing solids, preservation and storage, reduction in cost of transportation, achieving desired quality of product, etc.

Moisture Content*:* The moisture content of fresh foods ranges from 20% to 90%. Foods require different levels of dryness for safe storage. Safe storage generally requires reducing the moisture content to below 20% for fruits, 10% for vegetables, and 10-15% for grains. If food is properly dried, no moisture will be visible when it is cut.

Moisture Absorption*:* The length of time required to dry food depends upon how quickly air absorbs moisture out of the food. Fast drying primarily depends upon three factors: the air should be warm, dry, and moving. The dryness of air is measured in terms of *relative humidity* (RH). If air is at 100% relative humidity, it has absorbed 100% of the water it can hold at that temperature. If air has a RH near 100%, it must be heated before it will be able to absorb moisture out of food.

Drying of fruits and vegetables:

Drying of fruits and vegetables has been principally accomplished by convective drying (Nijhuis et al. 1998). Various number of studies that have recognize the problems associated with conventional convective drying. Some important physical properties of the products have changed such as loss of colour , change of texture, chemical changes affecting flavour and nutrients and shrinkage (Mayor and Sereno 2004). Apart from, convective drying gives little scope for prior rehydration to further processing after drying for a minimal quality. The high temperature of the drying process affects the quality of product. Lowering the drying process temperature has great potential for improving the quality of dried products (Beaudry et al. 2004). In such conditions, the operating time and the associated cost may be more. So to reduce the operational cost different pretreatments and new method of low temperature and low energy drying methods are experimented. Brief review of new development will be discussed in the following classification.

Classification and Selection of Driers:

Drying techniques may be divided into five general categories based on the way the food is heated. Open-air, or unimproved, solar drying takes place when food is exposed to the sun and wind by placing it in trays, on racks, or on the ground. Although the food is rarely protected from predators and weather, in

some cases screens are used to keep out insects, or a clear roof is used to shed rain. Direct sun driers enclose food in a container with a clear lid, such that sun shines directly on the food. In addition to the direct heating of the solar radiation, the green house effect traps heat in the enclosure and raises the temperature of the air. Vent holes allow for air exchange. Indirect sun driers heat fresh air in a solar collector separate from the food chamber, so the food is not exposed to direct sunlight. This is of particular importance for foods which loose nutritional value when exposed to direct sunlight. Mixed mode driers combine the aspects of direct and indirect types; a separate collector preheats air and then direct sunlight adds heat to the food and air. Hybrid driers combine solar energy with a fossil fuel or biomass fuel such as rice husks. Fueled and electrical power based driers use conventional fuels or utility supplied electricity for heat and ventilation.

Classification of food dryers:

Classification	Description
Open-Air	Food is spread in the sun and wind by placing in trays, on racks, or on the ground. Food is rarely protected from predators and the weather.
Solar Dryers	**Direct:** Food is enclosed in a container with a clear direction allowing sun to shine directly on the food. Vent holes allow for air circulation. **Indirect:** Air is heated in a solar heat collector and then passed through food in the drier chamber. In this way the food is not exposed to direct sunlight. **Mixed Mode:** Combines the direct and indirect types; a separate collector preheats air and direct sunlight adds heat to the food and air.
Hybrid	Combines solar heat with another source such as fossil fuel or biomass.
Electrical and Fuel based	Uses electricity or fossil fuel as a source of heat and ventilation accessories, which can be operated by electrical energy.
Technological / Specific	Used for specific purposes, i.e. Tray, Flash, Batch, Rotary, spray, hot air drier, microwave, RF, Fluidized bed drier etc.

New developments of dryers and emerging drying technologies can be classified into the following categories. The various categories represent the areas in drying technology that require improvement. Whereas, a new development and emerging drying technologies must be cost-effective. This is needed to ensure market acceptance (Mujumdar, 2007).

Necessity of new technology for Drying:

- Drying of variety of products.
- More drying rate than the existing process of drying.
- Improved quality of drying and control over it.
- More use of renewable energy.
- Better environmental control and safer operation.
- Low operating cost, low maintenance cost with more efficiency.

The Drying Process:

Producing safe, high quality dried produce requires careful procedures throughout the entire preservation process. Foods suffer only a slight reduction in nutrition and aesthetics if dried properly however; incorrect drying can dramatically degrade food and brings the risk of food wastage. Only fresh, undamaged food should be selected for drying to reduce the chances of spoilage and help insure a quality product. Drying can preserve a variety of fruits, vegetables, and grains.

Quality of dried product and classification:

Different quality parameters associated with dried food products like colour, its appearance, shape of product, flavour, retention of nutrients, porosity-bulk density, texture, rehydration properties, water activity, insects and other contaminants.

Quality of dried product may be classified on various parameters, which are as follows:

Physical quality

Physical quality of product indicate the changes, such as structure, case hardening, collapse, pore formation, cracking, rehydration, caking and stickiness can influence the quality of final dried products. Quality parameters such as volume, shrinkage, apparent density, colour and rehydration.

Chemical quality

The outermost layer of fruit browning, lipid oxidation, colour loss and change of flavour in foods can occur during drying and storage. Browning reactions can be categorized as enzymatic and non enzymatic (Salunkhe et al. 1991). Enzymatic browning of foods is undesirable because it develops undesirable colour and produces off flavour. Rapid drying through 15–20% moisture range can minimize the time for browning.

Microbial quality

Dried food products are considered safe with respect to microbial hazard. There is a critical water activity below which no micro organisms can grow. Pathogenic bacteria cannot grow below (a_w) of 0.85–0.86, whereas yeast and moulds are more tolerant to a reduced water activity.

Nutritional quality

Fruits, vegetables and their products in the dried form are good sources of energy, minerals and vitamins. However, during the process of dehydration, there are changes in nutritional quality (Sablani 2006). A more number of vitamins such as A, C and thiamine are heat sensitive and sensitive to oxidative degradation. As much as 80% decrease in the carotene content of some vegetables may occur if they are dried without enzyme inactivation.

Conclusion:

A review of the application of drying in postharvest processing is used for both conventional and recent development in drying technologies. So many new views come up in drying technology to reduce the energy utilization and drying processing cost. In the drying technologies like, Tray, Flash, Batch, Rotary, spray, hot air drying, microwave, RF, Fluidized bed drying are providing the great scope for the producing of better quality of dried products. A balanced and improved drying system for the preservation of fruits and vegetables should be cost effective, shorter drying time and with minimum damage to the product. As energy costs, energy efficiency will be a key criterion in the selection, design, and operation of dryers. Use of renewable energy, e.g. solar, wind, geothermal, etc., needs to be examined in depth in order to cut down the use of fossil fuels for postharvest drying. More research needs to be done to make some of the new developments in majority of new dryers are still at the research stage. In the final conclusion, it should be the cost effectiveness of the drying system that will determine in any of the new developing drying technologies which can be adopted in wide range.

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