Punjab Horticultural Postharvest Technology Centre
Punjab Agricultural University, Ludhiana

PHPTC Newsletter

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DRYING TECHNOLOGY FOR FRUITS AND VEGETABLES

Dehydration is one of the oldest and potential methods for preservation of fruits and vegetables. Dehydrated foods are gaining momentum in the present day as they are classified as convenient and instant foods with minimal processing efforts. Due to their high moisture content, these are susceptible to spoilage by micro-organisms and enzymatic reactions. Removal of the water (75-90%) present in fresh commodity results in reduction of the water activity, thereby making food resistant to microbial attack and hence, leads to shelf life extension at ambient conditions. The removal of water in fruits and vegetables is carried out by the application of heat and this heat is usually supplied in the form of solar energy or artificially generated hot air using food dehydrators.

Advantages of drying: Drying of food products offers innumerable benefits mentioned below-

- Reduction in water activity helps check bio-chemical and microbiological deterioration
- Reduction in weight, size and volume of the food material leads to easy and cheap transportation
- Shelf stable at room temperature with simple and cheap packaging requirements
- Easy and economical way to save surplus food for long time
- Excellent source of fibre and carbohydrates with low fat content make it a healthy choice

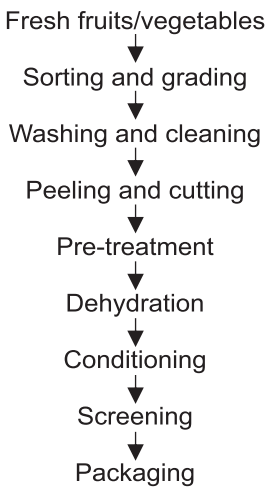

Figure 1. General flowsheet depicting dehydration process of fruits and vegetables

General process for dehydration of fruits and vegetables has been shown in figure 1. The detail process is described in the subsequent sections.

1. **Selection & Preparation of fruit-** The selection of fruit or vegetable should be done as per season. The selected fruit or vegetable should be sorted for any bruises and spoilage. Firm produce should be selected for achieving high quality product. Sorted produce should be cleaned thoroughly of any dust, soil and insects using wash water. After washing, manual peeling can be done using sharp knives or mechanical peelers can be used for large quantity. Following peeling operation, cutters are employed to cut fruits & vegetables in dices, cubes, slices, rings form as shown in Figure 2. Pressure cookers are also used to form mash if flakes are desired. Care should be taken for produce such as apples, brinjal, pears, potatoes *etc.* to cut them while dipped in water containing potassium/sodium metabisulphite/brine solution as they turn brown immediately after cutting and may affect final quality of produce. This treatment holds utmost importance as it drastically affects the final quality of produce. Soft and small fruits such as berries are used whole after washing and should be softly handled to avoid bruising. Thickness of the cut produce should be appropriate as too thick pieces will take longer to dry and too thin pieces will tend to stick to drying trays.

Figure 2. Preparation of vegetables for dehydration

2. **Pre-treatment-** The cut produce is subjected to various pre-treatments such as blanching, sulphuring or syruping to enhance final quality of the produce.

Blanching: Blanching is defined as hot water/steam treatment ranging from few seconds to few minutes following immediate cold water dip to inactivate polyphenol oxidase enzyme that cause browning in produce. One of the major advantages of blanching is that it helps preserve color and improve drying operations. Steam blanching is done using a steamer or sieve fitted with lid (Figure 3). Steam blanching is mostly done for delicate produce like leafy vegetables, pulpy fruits & vegetables. Prepared fruits & vegetables are put into steamer or sieve not more than 2 inches deep and steam is applied till required time. In hot water blanching, the cut produce is tied in muslin cloth and immersed in hot water (85-90°C) for recommended time (Figure 3).

Figure 3. Steam blanching (L) and water blanching (R)

Sulphuring/Sulphiting: Sulphur treatment is also done to preserve colour of final produce and mostly done for fruits. Sulphur has antioxidant and preservative effect that is very effective in retarding the browning of fruits when enzymes are not inactivated by high temperature during drying. Sulphur dioxide also helps to reduce degradation of carotenoids and ascorbic acid during drying operations. Sulphur treatment can be given in either gas form known as sulphuring or dipping form known as sulphiting. Usually, 4-5 g sulphur/Kg fruit is burnt in enclosed chamber to allow SO2 fumes to be absorbed by fruit slices. Sulphiting treatment is done by dipping fruits in potassium metabisulphite or sodium metabisulphite solution for certain period of time.

Syruping: This treatment is done for fruits only wherein the fruit pieces are dipped in concentrated sugar solution (50-60%) for a period of 18-24 hours. Sulphur salts can also be added to sugar solution to further maintain color during drying. After syruping, fruits slices are rinsed with water prior to drying to reduce stickiness. These fruits are called osmotically dried fruits as there is impregnation of sugar into fruit slices due to osmotic effect and the final moisture content in them lies between 22-25% and thus are labeled as semi-moist fruits.

3. **Dehydration-** Following pre-treatment, the produce is artificially dried in electric forced air dehydrators in mostly two stages or three stages with variations in temperature. The produce is kept on perforated trays made of stainless steel with 2-4 cm deep food layer. In first stage, the temperature is adjusted to 60±5°C for a period of 3-4 hours. The second stage commences at temperature of 45±5°C till moisture content reaches 8% for vegetables and 14-15% for fruits. The moisture content in fruits does not reduce beyond 15% due to presence of high amount of sugars whereas in vegetables it can be easily reduced below 10%. Care should be taken to avoid case hardening problem in dried product where the produce dries from outside but is still soft/watery from inside. This condition can happen if very high temperature is employed during initial stage of drying leading to hard exterior and soft interior. The relative humidity (RH) of the air in the drier should be below 60%. As RH is reduced, the air in the drier has increased capacity to absorb moisture and remove in the form of water vapor. In case of solar drying, full 2 days heat is required to successfully dry the product and also care is to be taken to prevent condensation of evaporated water vapours in the inside plastic sheets of dryer. The average yield of dehydrated product is around 10-12% (Approximately 100g dried product from 1Kg fresh produce). Dehydration techniques can be broadly divided into three main categories as illustrated in Figure 4. For small batches most commonly hot air cabinet drier is used as shown in Figure 5.

4. **Conditioning-** Conditioning operation is to unload the dried produce and holding in bins or boxes to evenly distribute the moisture content to prevent mold growth. The dried product should be brought to room temperature prior

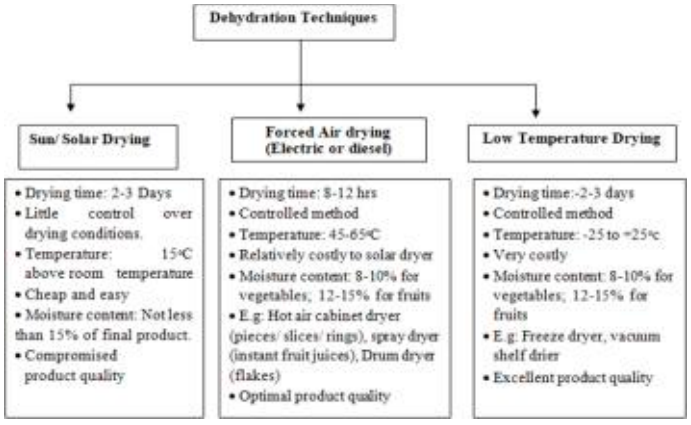

Figure 5. Loading of carrot slices (L); Hot air cabinet drier loaded with bittergourd slices (R)

to packing, sealed airtight and conditioned for 7- 10 days followed by intermittent shaking to distribute moisture throughout the produce.

5. **Screening-** The dried product is inspected/screened to remove under-size (fines), discolored, over- size particles, foreign materials, stems etc. to create uniform quality product.

6. **Packaging-** The dried produce should be packaged in food grade plastic bags under hygienic conditions as shown in Figure 6. The packaged product should be stored in cool, dry place safe from rodents and pests. Sweating can occur if dried product is packed immediately after dehydration and not allowed to cool for a period of 30-60 minutes. This condition can lead to mold growth inside packages due to condensation of water vapors.

Figure 6. Dried fenugreek (L) and carrot slices (R) packed in ziplock polythene bags

7. **Reconstitution of dried product-** Dried fruits and vegetables are reconstituted *i.e.* to restore moisture by dipping in water before consumption. Reconstitution time depends upon the size and shape of dried product, larger the size, more is the time required and vice-versa. Reconstituted vegetables looks like fresh as shown in Figure 7 and can be used for further cooking. Dried vegetables dipped in warm water reconstitute quickly within 1-2 hours whereas in cold water it take 5-6 hours. Semi-moist fruits such as raisins, can be eaten as such without rehydration.

Figure 7. Rehydrated dried bittergourd after dipping in warm water

Market Potential: Global market of dehydrated fruits and vegetables has positively surged in recent past due to lifestyle changes and consumer purchasing pattern. As India witness huge losses of fruits & vegetables every year, therefore dehydration technique can offer a huge potential to preserve fruits and vegetables with minimum processing requirement. The dehydration technology offers cutting edge benefits to investors as they fetch profitable margins due to minimum spoilage rate. Moreover, health consciousness among masses makes dehydrated fruits & vegetables a healthy choice to be consumed as nutritionally rich snack item. As per Times of India (2018), 10% growth of dehydrated vegetables led by dried onion and garlic has been documented in Indian market. This has shown a new avenue to farmers to generate additional income as they earlier use to sale onion and garlic at throw away prices during glut season. Most of the dehydrated vegetables are being used in instant soups, Maggie *masala* noodles, as snacks and in medicines. However, consumption of dehydrated fruits and vegetables in Indian household is still in infancy but there is a huge demand overseas. This trend is slowly being picked up by Indian people and most of the purchase is made to hotels. Among different forms of dehydrated produce (flakes, powder, cubes, rings and dices), powder form is anticipated to lead dehydrated fruit & vegetable market and is expected to grow at CAGR of 7.95%. Dried fruits such as kiwis, pineapple, orange, apple, papaya, blueberries etc are fetching huge profits in the confectionery market. Budding entrepreneur and farmers can initiate the start-ups and take advantage of this low cost technology to enhance their income source.

PHPTC Activities

Training Program for Packhouse Worker: Training program on Packhouse Worker was conducted in collaboration with Skill Development Centre, PAU, Ludhiana sponsored by Agricultural Skill Council of India, New Delhi from 16.01.2020 to 14.02.2020. A total of 20 candidates from different regions of Punjab state participated in the training program. The program emphasized on working operations of pack-house of fruits and vegetables with respect to sorting, grading, packaging and storage. Hands-on-training was given to participants on packaging techniques of fruits and vegetables for retail marketing. Different processing technologies particularly dehydration of vegetables were also discussed and hands-on-training was also provided for value addition to fruits & vegetables.

Training Program on Postharvest Management of Fruits and Vegetables: Punjab Horticultural Postharvest Technology Centre (PHPTC) organized one day training programme for the group of 17 officials of Punjab Agri Export Corporation, Chandigarh on 20th February, 2020. These training programme covered wider aspects of different techniques involved in harvesting, precooling, grading, packaging, storage, marketing and food safety regulations of perishable produce.

Participation in ISO 17025:2017 Training Program: PHPTC Scientists, Dr. Ritu Tandon and Dr. Swati Kapoor attended two days training programme on "Understanding and implementing ISO/IEC 17025:2017 including management system documentation and internal auditing" at Chandigarh from 3rd to 4th March, 2020. This training is pre-requisite for acquiring NABL accreditation of Quality Control Laboratory of the Centre.

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