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Osmotic Dehydration of Fruits and Vegetables

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SUMMARY

Osmotic dehydration is one of the best methods of preservation of food materials. We can preserve fruits and vegetables by this method at very low cost and this is efficient method for preservation of fruits and vegetables. In this article content all about osmotic dehydration, its mechanism, pros, cons etc. but it is not easy that much to preserve fruits and vegetables by this method because there are many factors which influence the osmotic dehydration such as sample size and shape, type of osmotic solution, duration of process, temperature of osmotic solution etc. considering that present scenario it is concluded that is one of the most important food preservation technique in the preservation by dehydration of foods, since it shows some benefits, such as reducing the damage of heat to the flavour, colour, inhibiting the browning of enzymes etc.

INTRODUCTION

Fruits and vegetables contribute an important source of nutrients in daily human diet. Which are helpful for the immune system to build the immunity against various diseases and physiological disorders. India has wide selection of climate and physio-geographical conditions which ensures availability of most quiet fruits and vegetables. Total vegetable and fruit production in the world has been estimated 486 and 392 million tons, respectively. India is the second largest producer of the fruits (90.534 million tons) and vegetables (166.467 million tons) in the world (National Horticulture Board 2015–2016). About 30–40% of total production in developed country is spoiled due to lack of postharvest handling up to consumption. But within the case of developing country like India, the postharvest losses noticed on the brink of 50% of the entire fruits and vegetables production which badly affects the supply of fruits and vegetables to the consumers (Singh et al. 2014). Fruits and vegetables are produced during peak seasons but due to lack of preservation and storage facilities the market become overstocked during such periods and gets rotten before reaching the final consumer. Many processing techniques can be used to preserve or increase shelf life of fruits and vegetables. Drying and dehydration is one of the most important operations that are widely practiced because of considerable saving in packaging, storage and reduce shipping weights, etc. (Chavan and Amarowicz 2012). Dehydration of the fruits and vegetables is one of the oldest forms of food preservation techniques practised by man. Osmotic dehydration is one of the best and suitable method to increase the shelf life of fruits and vegetables. Osmotic dehydration has received greater attention in recent years as an important complementary treatment and food preservation technique in the processing of dehydrated foods, since it presents some benefits, such as reducing the damage of heat to the flavour, colour, inhibiting the browning of enzymes and decrease the energy costs (Khan 2012).

What is Osmotic Dehydration?

"Osmotic dehydration is that the method of removal of water from lower concentration of solute to higher concentration through semi permeable membrane leads to the equilibrium condition in each side of membrane" (Tiwari 2005).Osmotic dehydration is employed for partial removal of water from materials like fruits and vegetables by immersing in aqueous solutions of high pressure like sugar and salts (Pandharipande et al, 2012). Osmotic dehydration found wide application within the preservation of food-materials since it lowers the water activity of fruits and vegetables. Osmotic dehydration is preferred over other methods thanks to their colour, aroma, nutritional constituents and flavour compound retention value.It is a dynamic process, during which water and acid are removed initially then crawl , while sugar penetration is extremely slight initially but increases with the time. Osmotic process won't provides a product of sufficiently low moisture content to be considered a shelf stable product and thus , osmosed product must be further dried, through air, vacuum or freeze drying.

Mechanism of Osmotic Dehydration

Osmotic treatment is actually a combination of dehydration and impregnation processes, which can minimize the negative modifications of fresh food components. Osmotic dehydration, also called a "dewatering impregnation soaking process" is a water removal process that involves the soaking of fruits and vegetables in hypertonic salt or sugar or in a combined solution, to reduce the water content while increasing the soluble solid content (Falade and Igbeka 2007). The raw material is placed in concentrated solutions of soluble solids with higher osmotic pressure and lower water activity. This results in three types of counter mass transfer phenomenon in osmotic dehydration process (Karthiayani 2004; Tiwari 2005; Akbarian et al. 2014).

- Water diffuses out product to the solution, at a faster rate initially and slowly afterwards.
- A solute transfer, from the answer to the product; it makes thus possible to introduce the specified amount of a lively principle, a preservative agent, any solute or nutritional interest, or a sensory quality improvement of the merchandise .
- Leaching out of products own solutes (sugar, organic acids, minerals, vitamins, etc.), which is quantitatively negligible when compares with the first two types of transfer, but essential with regard to the composition of final product.

The schematic diagram of mass transfer during osmotic dehydration process is given in Fig. 1.When a cellular solid material is immersed in hypertonic solution, the cells in the first layer of the material contact the hypertonic solution and begin to lose water because of the concentration gradient between the cells and hypertonic solution; then, they start to shrink. After the cells within the first layer lose water, a "chemical electric potential of water" between the primary layer of cells and second layer of cells is established. Subsequently, the second layer cells begin to pump water to the primary layer cells then shrink. The phenomena of mass transfer and tissue shrinkage are spread from the surface to the centre of the material as a function of the operation time. Finally, the cells within the material center lose water and therefore the mass transfer process tends to equilibrate after an extended period of solid–liquid contact. The mass transfer and the shrinkage of tissue occur simultaneously during osmotic dehydration process (Le Maguer et al. 2003; Phisut 2012). The schematic diagram of osmotic dehydration process is shown in Fig. 2. All the steps given in Fig. 2 might not be followed intrinsically and are subjected to vary considering the kinds of fabric being processed. It is usually not worth-while to use osmotic dehydration technique for more than 50% weight reduction because of the decrease in the osmosis rate with time.

Advantages of Osmotic Dehydration

There are number of advantages of the osmotic dehydration process.

- It minimizes the effect of temperature on food quality and preserves the wholeness of the food, as no high temperature/phase change is required in the process.
- Mild heat treatment favours colour and flavour retention resulting in the product having superior organoleptic characteristics. It is more when syrup is employed as osmotic agent.
- IT increases resistance to heat treatment
- The process is quite simple, economical (energy requirement is 2-3 times less as compared to the conventional drying.
- It prevents the enzymatic browning and inhibits activities of polyphenol oxidases.
- It improves the texture and rehydration properties
- The blanching process could also be eliminated by this process, which reduces cost of processing
- Acid removal and sugar uptake by fruits modifies the composition and improves the taste and acceptability which is called candying effect
- the method could convince be good for production of the able to eat foods like raisins etc.
- the method reduces volume of the products thereby saving within the cost of processing, storage and transport
- Constant immersion of product in osmotic agents avoids the O2 exposure, the product retains better colour
- It protects against the structural collapse of the product during subsequent drying. It helps to retain the form of the dehydrated products

Disadvantages:

It also has some disadvantages (Chaudhari et al., 1993; Ghosh et al., 2004).

- The reduction in acidity level reduces the characteristic taste of some products. This can be overcome by adding fruit acid in the solution.
- Solute uptake and leaching of valuable product constituents often lead to substantial modification of the original product composition with a negative impact on sensory characteristics and nutritional profile.
- Sugar coating is not desirable in certain products and quick rinsing may be necessary after the treatment.
- Sugar uptake results in the development of a concentrated solids layer under the surface of the fruit, upsetting the osmotic pressure gradient across the fruit interface and decreasing the driving force for water flow.
- In terms of final product characteristics, sugar uptake affects both rehydration and flavour retention due to lower rehydration of sugar in the fruit, compared with fruit tissue itself.

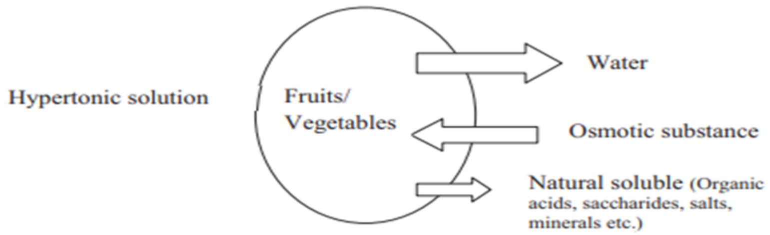

FIG. 1. MASS TRANSFER IN FRUITS OR VEGETABLES DURING OSMOTIC DEHYDRATION PROCESS

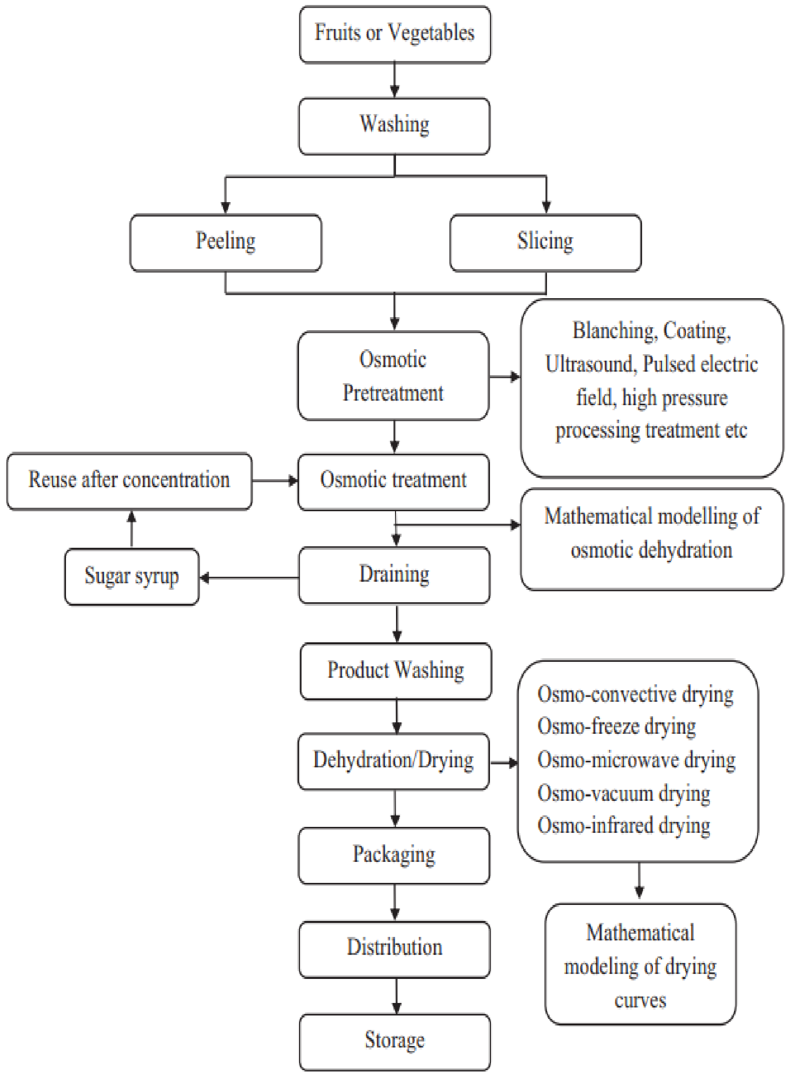

FIG. 2. PROCESS FLOW CHART FOR GENERAL METHOD OF OSMOTIC DEHYDRATION

Factors Affecting Osmotic Dehydration Process

Product characteristics

Species, Variety and Maturity Level

Not only different species, but also different varieties of the same species, even different maturity levels of the same variety have been found to give substantially different response to osmotic dehydration. Under identical conditions five varieties of apricots showed different mass reduction during osmotic dehydration.

Tissue Location

The tissue at different locations in the same fruit or vegetable responds differently to osmotic dehydration. The interconnectivity and pore spaces of two kinds of tissues show different mass transfer due to different pathways of transport.

Size and shape

The rate of osmotic dehydration is affected by the size and shape of the samples, due to different specific surface area or surface to thickness ratio.

Concentration of osmotic solution

The solute choice and concentration depend on several factors, namely the effect on organoleptic properties, solute solubility, cell membrane permeability, its stabilizing effect and cost. The two most common solute types used for osmotic treatments are sugars (mainly with fruits) and salts (with vegetables). The pH of the solution can also affect the osmotic process. Acidification increases the speed of water removal by changes in tissue properties and consequential changes within the texture of fruits and vegetables.

Process/osmotic solution temperature

Temperature of osmotic solution plays an important role in osmotic dehydration process. It is documented that diffusion may be a temperature dependent phenomenon. The most important variable markedly affecting the rate of mass transfer during osmotic dehydration is temperature. Higher process temperature seems to promote faster water loss through swelling and plasticising of cell membranes, faster water diffusion within the product and better mass (water) transfer characteristics on the surface due to lower viscosity of the osmotic medium. the increase in temperature decreases the viscosity of osmotic solution, decreases the external resistance to mass transfer rate at product surface. Thus, it facilitates the outflow of water from fruit and in high diffusion rates of solute into fruit.

Agitation/Stirring Process during Osmotic Process

Agitation is indeed one of the key factors and an adequate level of agitation ensures minimization or elimination of liquid-side mass transfer resistance and constant driving force (Rastogi et al. 2002). The use of highly concentrated viscous sugar solutions creates major problems like floating of food pieces, hindering the contact between food material and therefore the osmotic solution, causing a reduction in the mass transfer rates. Thus, to reinforce mass transfer and to stop the formation of a dilute solution film round the samples, agitation or stirring process are often applied during osmotic dehydration (Moreira et al. 2007; Gupta et al. 2012; Gheybi et al. 2013; Akbarian et al. 2014). However, agitation could also be difficult and should cause damage to the sample. The circulation of syrup with pump is straightforward and quite effective

Sample to solution ratio

The sample weight to solution ratio is a crucial consideration during the osmosis. The change in ratio affects the mass transfer during osmosis up to a particular limit.

Process duration

In general, as the time of osmotic treatment increases, the weight loss increases with a decreasing rate (Chaudhary et al., 1993) Different data on osmotic dehydration of different foods show that, water loss, solid gain and weight loss of foods during osmotic dehydration are related to time and come to equilibrium with respect to time. (Lazarides et al., 1995)

Process pressure

The pressure gradient within the osmotic dehydration process changes the rates of water loss and solid gain. The hydrodynamic mechanism describes the change within the mass transfer by expansion or compression of internal pore gas of tissue.

CONCLUSION

Osmotic dehydration is one of the most important food preservation technique in the preservation by dehydration of foods, since it shows some benefits, such as reducing the damage of heat to the flavour, colour, inhibiting the browning of enzymes, decrease the energy costs, adds value to the finished product, which will be nutritious and available throughout the year. The recent developments in the osmotic dehydration have reduced the time of osmosis and increased the moisture loss with controlled solid gain.

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