Osmotic Dehydration

What is Osmosis :-

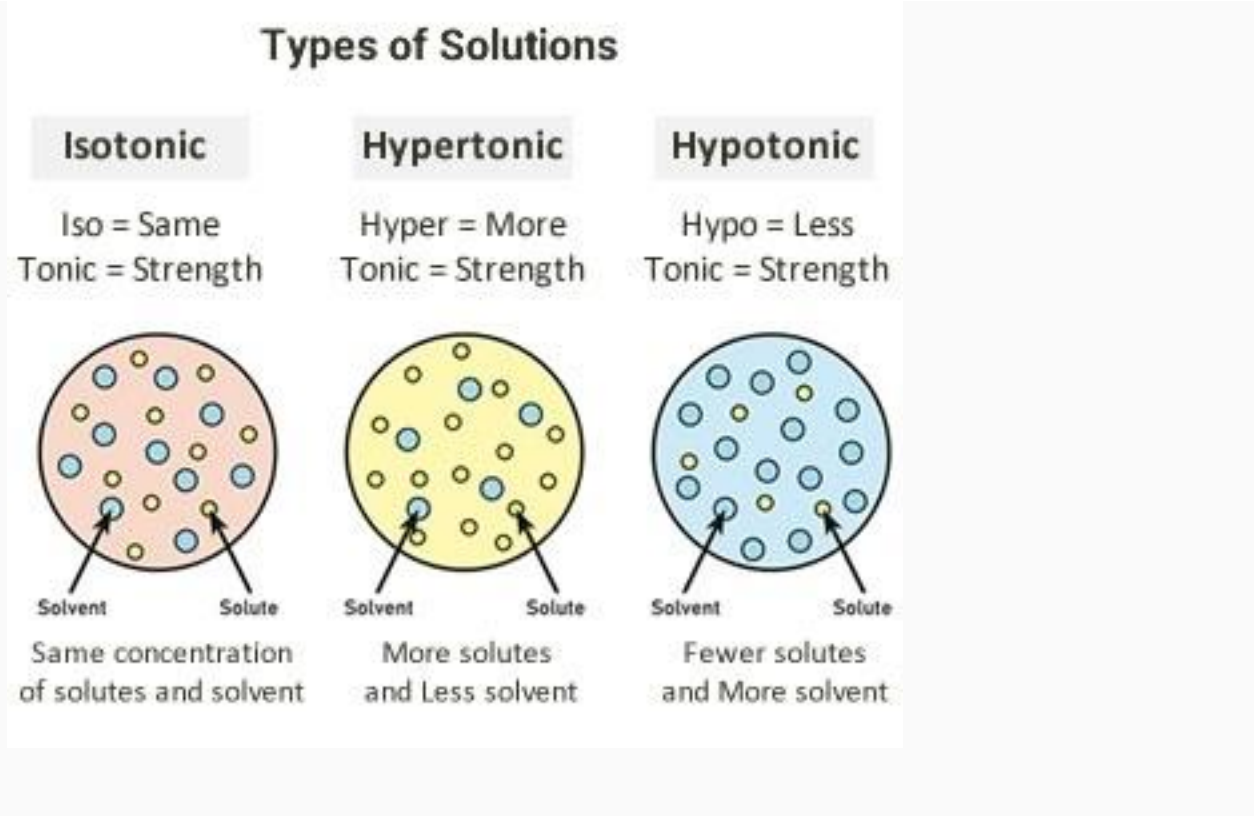
Osmosis is the movement of water through a semi-permeable membrane from a region of high concentration to a region of low concentration, tending to equalize the concentrations of the water. Osmosis is passive transport, meaning it does not require energy to be applied.

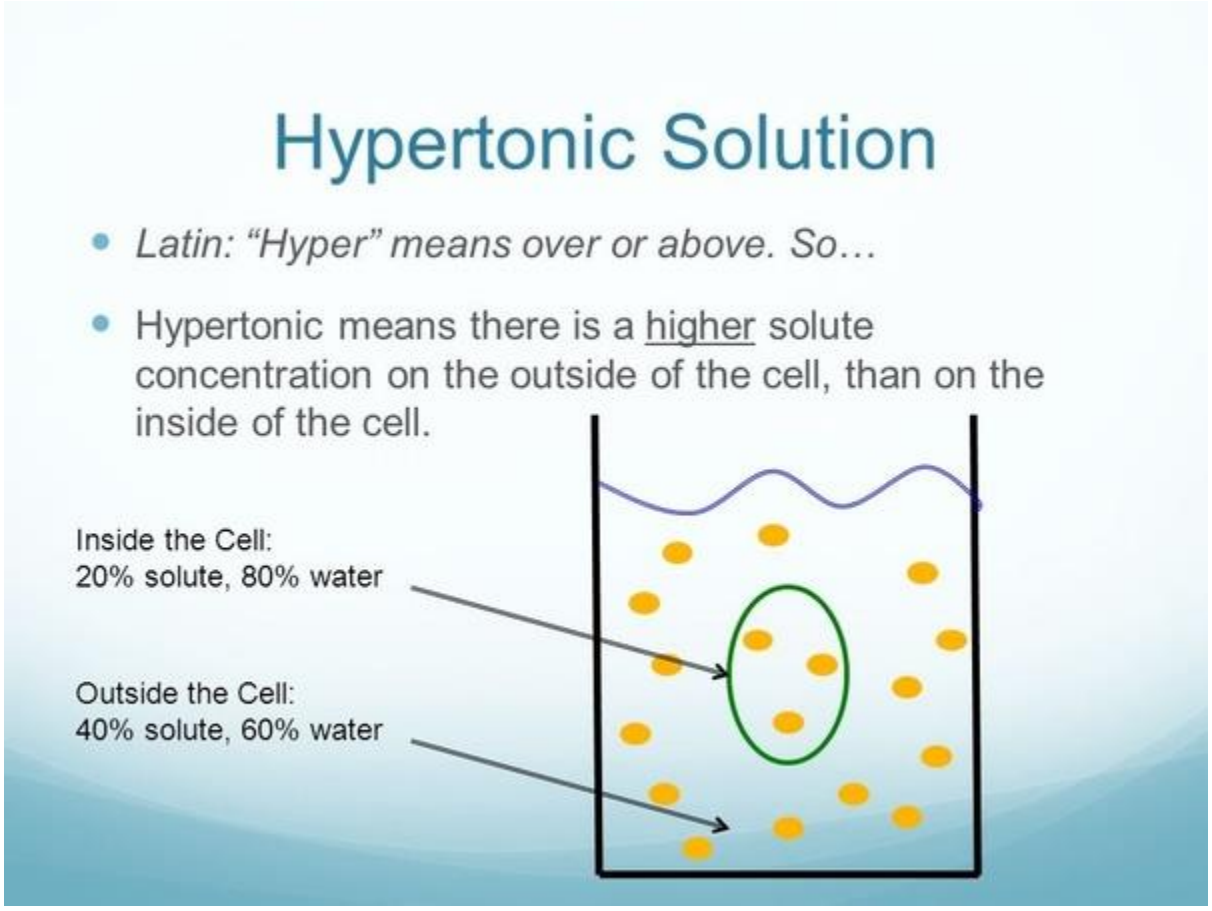
What is Osmotic pressure

Osmotic pressure is the pressure that needs to be applied to a solution to prevent the inward flow of water across a semipermeable membrane. Osmotic pressure can also be explained as the pressure necessary to nullify osmosis

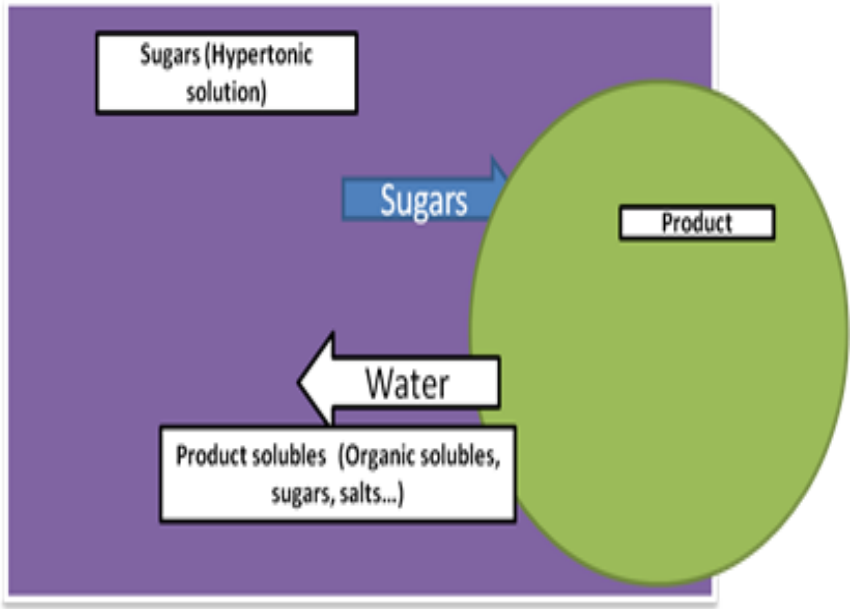
Mechanism

In osmotic dehydration, the fruit or vegetable pieces are immersed in concentrated aqueous solution of high osmotic pressure (hypertonic media) for a specified time and temperature. The driving force for water removal is the concentration gradient between the solution and the intracellular fluid. If the membrane is perfectly semi permeable, solute is unable to diffuse through the membrane into the cells. Selective properties of cell membranes make it possible for water and low-molecular cell sap components diffuse into the surrounding solution of higher osmotic pressure. However, it is difficult to obtain a perfect semi permeable membrane in food systems due to their complex internal structure, and there is always some solid diffusion into the food, which means that osmotic dehydration, is actually combination of simultaneous water and solute diffusion process (Chaudhari et al., 1993;Ghosh et al., 2004).


Types of Solutions
Isotonic
Iso = Same
Tonic = Strength
Hypertonic
Hyper = More
Tonic = Strength
Hypotonic
Hypo = Less
Tonic = Strength
Solvent
Solute
Solvent
Solute
Solvent
Solute
Same concentration of solutes and solvent
More solutes and Less solvent
Fewer solutes and More solvent



If a cell is placed in an hypertonic solution then it will shrink i.e. it will losses water



In general, during osmotic pre-concentration, two major counter current flow take place simultaneously across the semi permeable cell membrane,

(i) water diffusion out of the food into the solution, at a faster rate initially and slowly afterwards and,
(ii) solute penetration in the opposite direction, at a slower rate initially but increasing with time (Chaudhari et al., 1993).
(iii) A third transfer process, leaching of product solutes (sugars, acids, minerals, vitamins) into the medium, although recognized as affecting the organoleptic and nutritional characteristics of the product, is considered quantitatively negligible (Lazarides et al., 1995). Fig.1 shows the different flows, in and out of the fruit/vegetable tissue.

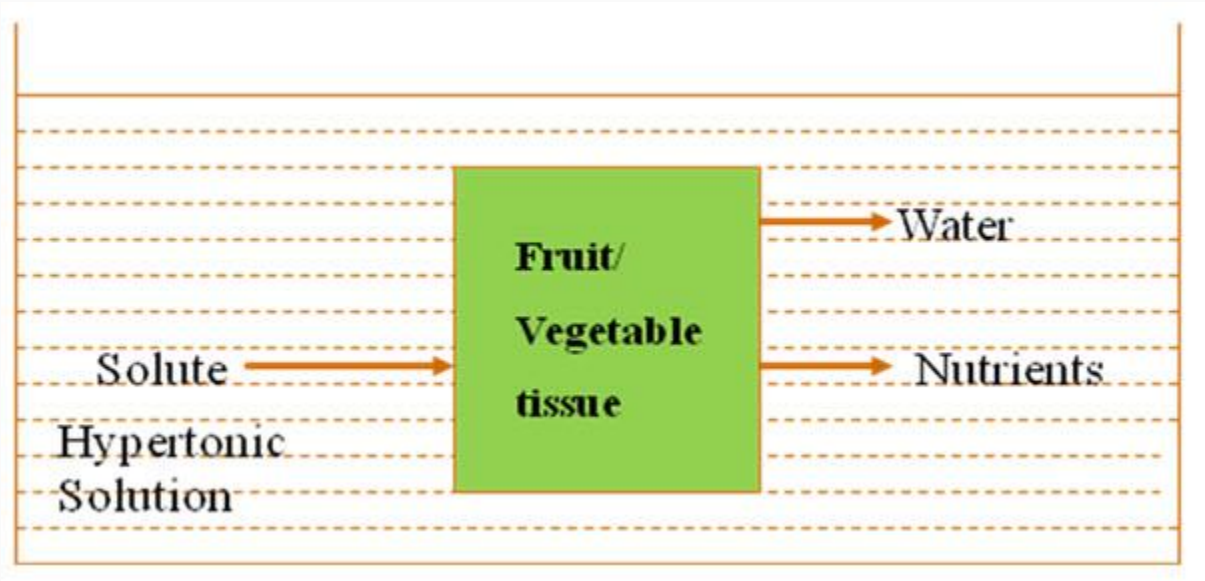


Fig.1. Mass transfer across a fruit/vegetable tissue during osmotic dehydration

Advantages:

The advantages of osmotic dehydration are as follows (Islam and Flink, 1982; Chaudhari et al., 1993; Ghosh et al., 2004).

1. Mild heat treatment favours less heat damage to colour and flavour of the product with superior sensory attributes.
2. The use of sugar or syrup as osmotic agent prevents much of the loss of flavour commonly found with ordinary air or vacuum drying.
3. Enzymatic and oxidative browning is prevented as the fruit pieces are surrounded by sugar, thus making it possible to retain good colour with little or no use of sulpher dioxide.
4. Energy consumption is much less as no phase change of moisture is involved during dehydration. Osmotic dehydration with syrup re-concentration demands two to three times less energy compared to convection hot air drying.
5. Acid removal and sugar uptake by the fruit pieces modify the composition (sugar to acid ratio) and improve the taste and acceptability of the final product.
6. It partially removes water and thus reduces water removal load at the dryer.
7. It increases solid density due to solid uptake and helps in getting quality product in freeze-drying.
8. If salt is used as an osmotic agent, higher moisture content is allowed at the end of the drying as salt uptake influences the water sorption behaviour of the product.
9. The final product shows much lower rehydration rate, lower hygroscopicity and better textural quality after rehydration in comparison to other dehydration techniques.

10. The storage life of the product is greatly enhanced.

11. Simple equipment is required for the process.

Disadvantages*:*

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

1. The reduction in acidity level reduces the characteristic taste of some products. This can be overcome by adding fruit acid in the solution.

2. 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.

3. Sugar coating is not desirable in certain products and quick rinsing may be necessary after the treatment.

4. 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.

5. 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.

Osmotic dehydration process

Since osmotic dehydration generally will not give a product of low enough moisture content to be considered self-stable, it has to be coupled with other methods of drying, viz., hot air drying, vacuum drying, freeze drying etc (Ponting, 1973; Sagar, 2001). The schematic diagram of osmotic dehydration process is shown in Fig. 2. All the steps given in Fig. 2 may not be followed as such and are subjected to change considering the types of material being processed (Chaudhary et al., 1993). It is usually not worthwhile to use osmotic dehydration technique for more than 50% weight reduction because of the decrease in the osmosis rate with time (Chaudhary et al., 1993; Ghosh et al., 2004).

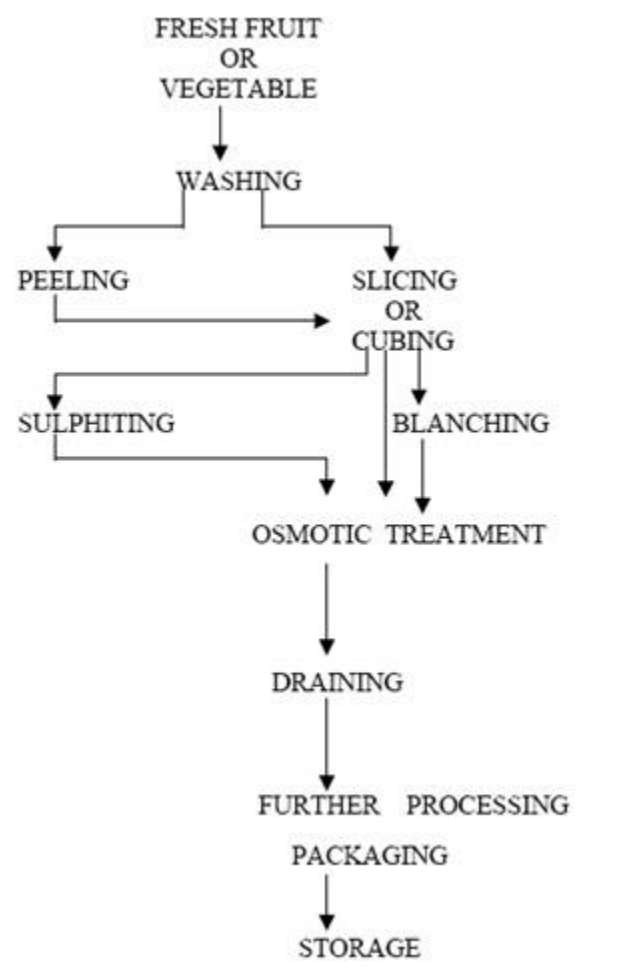


Fig.2.Osmotic dehydration process