1. Week: Water

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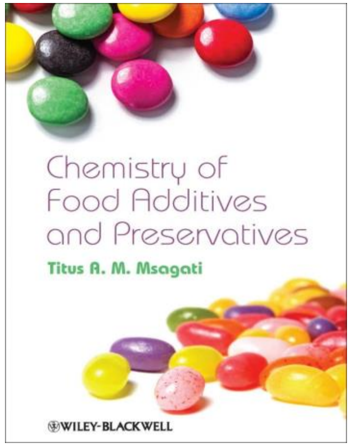
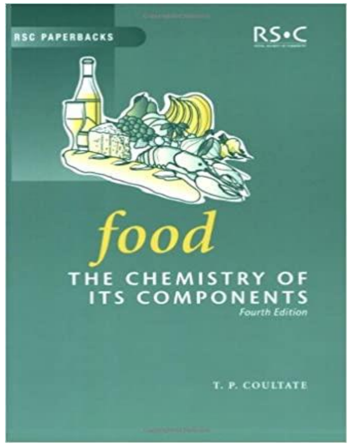
1. 

2. 

3. 

1. Msagati, Titus A.M. 2013. *Chemistry of Food Additives and Preservatives*, JohnWiley & Sons, Ltd, West Sussex, UK.

2. Coultate T. P. 2002. *FOOD: The Chemistry of Its Components*, RSC Paperbacks, Royal Society of Chemistry, Cambridge, UK.

3. Ekşi A., Tayfur M., Ercan A., Bağcı Bosi A. T., Kıvanç P., Soylu P., Berat Özdemir M. ve Şişik N. 2014. *A'dan Z'ye Gıda Katkı Maddeleri*, Detay Yayıncılık, Ankara.

4. https://en.wikipedia.org/wiki/Triple_point#/media/File:Phase-diag2.svg

WATER AND ITS IMPORTANCE FOR FOOD

Water is an important component in many foods. Its content and occurrence status significantly affect the flavor, texture, and stability of foods. Water occurs in multiple states due to interactions with solutes and the interactions significantly affect the bioavailability of water to chemical reactions and microorganisms.

Fresh foods are derived mainly from plant and animal tissues, their water content is also in the range of 50%–95% on wet weight basis. Water is a major component even in fabricated food products, such as foam, emulsion, and gel-type products, and the state of water in such products strongly influences their texture, appearance, and flavor.

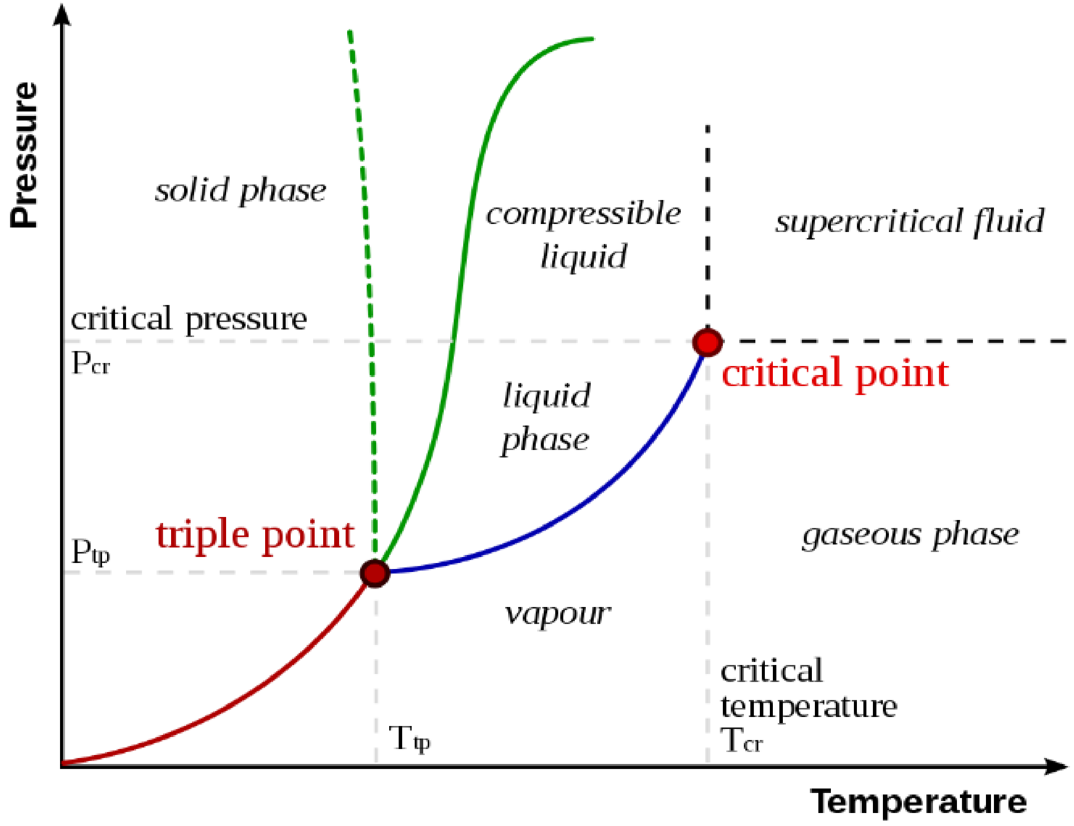
Interaction of water with other components, such as lipids, carbohydrates, and proteins, in a food system profoundly alters their physical and chemical properties, which in turn impacts the sensorial properties and consumer acceptability of foods. Foods containing high water content are good breeding grounds for microbes, which makes them highly susceptible to microbial spoilage.

PHYSICAL PROPERTIES OF WATER

Water is a colorless, odorless and tasteless liquid which, under normal atmospheric conditions, boils at 100 ° C and freezes at 0 ° C. Water exhibits 41 anomalous physical properties. Among these anomalous density, high dielectric permittivity, high surface tension, abnormal thermal properties (i.e., heat capacity, thermal conductivity, thermal diffusivity, and heats of fusion and vaporization), and high viscosity are particularly important in food science.

PHASE RELATIONSHIP OF WATER

The inter-relations between water and its liquid, solid and gaseous states can be explained by the phase diagram.



The diagram shows that, if the pressure is low enough, ice will sublimation into the vapor state. This is the basis of the important method of food dehydration known as freeze drying.

Source: https://en.wikipedia.org/wiki/Triple_point#/media/File:Phase-diag2.svg

Delicate food extracts, for example that of coffee in the manufacture of the instant product, are first frozen and than subjected to a high vacuum. The latent heat of sublimation for ice at 0 ° C is 677.8 cal This high figure means that when the vacuum is first drawn on the frozen material the temperature can drop to such an extent that the water is no longer removed at a satisfactory rate. In the usual commercial process, known as accelerated freeze drying, this is counteracted by applying radiant heat to the frozen material until almost all the water is removed. Of course, the temperature is maintained well below 0 ° C throughout the process.

WATER in FOODS - TYPES of WATER

Foods are composed of proteins, polysaccharides, minerals, pigments, and many other constituents in addition to water. These constituents interact with water and significantly affect the properties and status of water. The states of water in foods depend on the composition of foods and the physical status of the components. Water states and contents significantly influence the structure, processing properties, and stability of foods.

Generally, the water in foods can be divided as ''free (bulk) water'' and ''bound water''.

Free (Bulk) Water

Bulk water or free water is not chemically bound to nonaqueous compounds and mainly includes water that is physically entrapped. Based on the physical interaction, free water is further divided into two types:

***Entrapped water*:** Water of this type is entrapped by microstructures or ultrastructures and cannot flow freely as pure water.

***Capillary water*:** Water of this type is restricted in the gaps between cells or the capillaries of food structures. Capillary water has similar reduced fluidity and vapor pressure as entrapped water.

Bound Water

Bound water is water that exists in the vicinity of solutes and other nonaqueous constituents and binds to other solutes through covalent bonds and does not freeze at -40 degrees C. According to the binding strength, bound water is further divided into the following three types:

Constitutional water: Water of this type is a constituent of other compounds and binds the most tightly. Water in hydrates belongs to this type.

Monolayer water: Water of this type is the first layer water bound to the hydrophilic groups of solutes. The forces involved include mainly water-ion or water-polar association, followed by hydrogen bonding between water and solutes.

Multilayer water: Water of this type refers to water distributed in multiple layers around nonaqueous components. The forces involved are water-water and water-solute hydrogen bonding. Multilayer water binds tightly to nonaqueous components, but the strength is lower than that of monolayer water. Besides, multilayer water has changed properties compared with ordinary water.

Bound water and free (bulk) water differ in the following:

1. Bound water associates with nonaqueous constituents more tightly and its vapor pressure is much lower than free water. More energy is required for removing bound water than free water and the removal of bound water might irreversibly degrade the flavor, texture, and other properties of foods.
2. Bound water freezes in much lower temperature than free water. This explains why plant seeds and microbial spores can survive low temperatures. In contrast, juicy fruits and vegetables have much higher water contents and their tissues are susceptible to damage by ice crystals in low temperatures.
3. Bound water cannot dissolve solutes.
4. Free water can be utilized by microorganisms, while bound water cannot.