2.Week: WATER ACTIVITY

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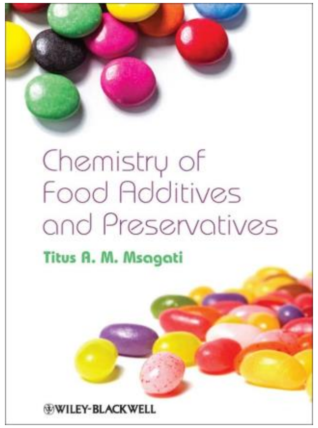

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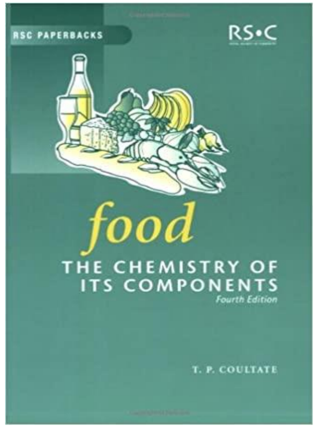

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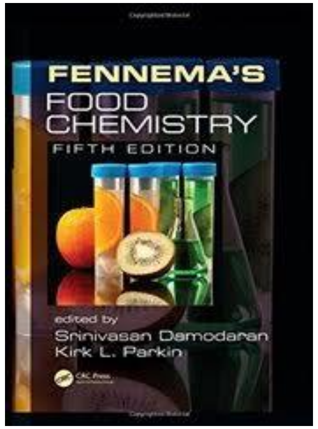

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WATER ACTIVITY

Water acts as a solvent for biological reactions and transport processes, as well as a reactant in several biological reactions. Although high water content is necessary for living cells, it is not desirable for preserving foods against microbial spoilage and other nonmicrobiological degradations during storage.

Water activity of a food is not the same thing as its moisture content. It is a measure of that water which is not bound to the food and is therefore available to microbes and other organisms for growth.

Foods can have a water activity anywhere between 0 (bone dry) and 1 (pure water).

Water activity of a food material reflects the thermodynamic capacity (energy status) or the effective concentration of water in a food material that can actually participate as a chemical agent in various biological and chemical processes.

DEFINITION OF WATER ACTIVITY

According to classical thermodynamics, the activity of water in an aqueous system is related to its effective concentration in the system. The activity of water in the pure state is unity, and in an *ideal* solution, the water activity aw is equal to the mole fraction of water, X_{H2O}, in the solution.

$$a_w = X_{H_2O} = \frac{n_{H_2O}}{n_{H_2O} + n_{solute}}$$

n_{H2O} : is the number of moles of water

n_{solute} : is the number of moles of dissolved solute in the system

Any deviation of from ideality can be accounted for by modifying as

$$a_w = \gamma_w X_w$$

- In ideal systems (solutions) water activity is the mole fraction of water in the system. In nonideal systems however, water activity is a measure of the "effective" concentration (not the mole fraction) of water in a system. It reflects the average energy status of water in a system.

- The fugacity principle is used to measure water activity in a food sample. In practical applications, water activity of a sample is defined as p/p^0 where p is the partial water vapor pressure of the food sample and p^0 is the partial vapor pressure of pure water at equilibrium at the same temperature and pressure.

$$a_w = \left(\frac{f_w}{f_w^0}\right) = \left(\frac{p_w}{p_w^0}\right)$$

p_w :is the partial water vapor pressure above a food material at equilibrium

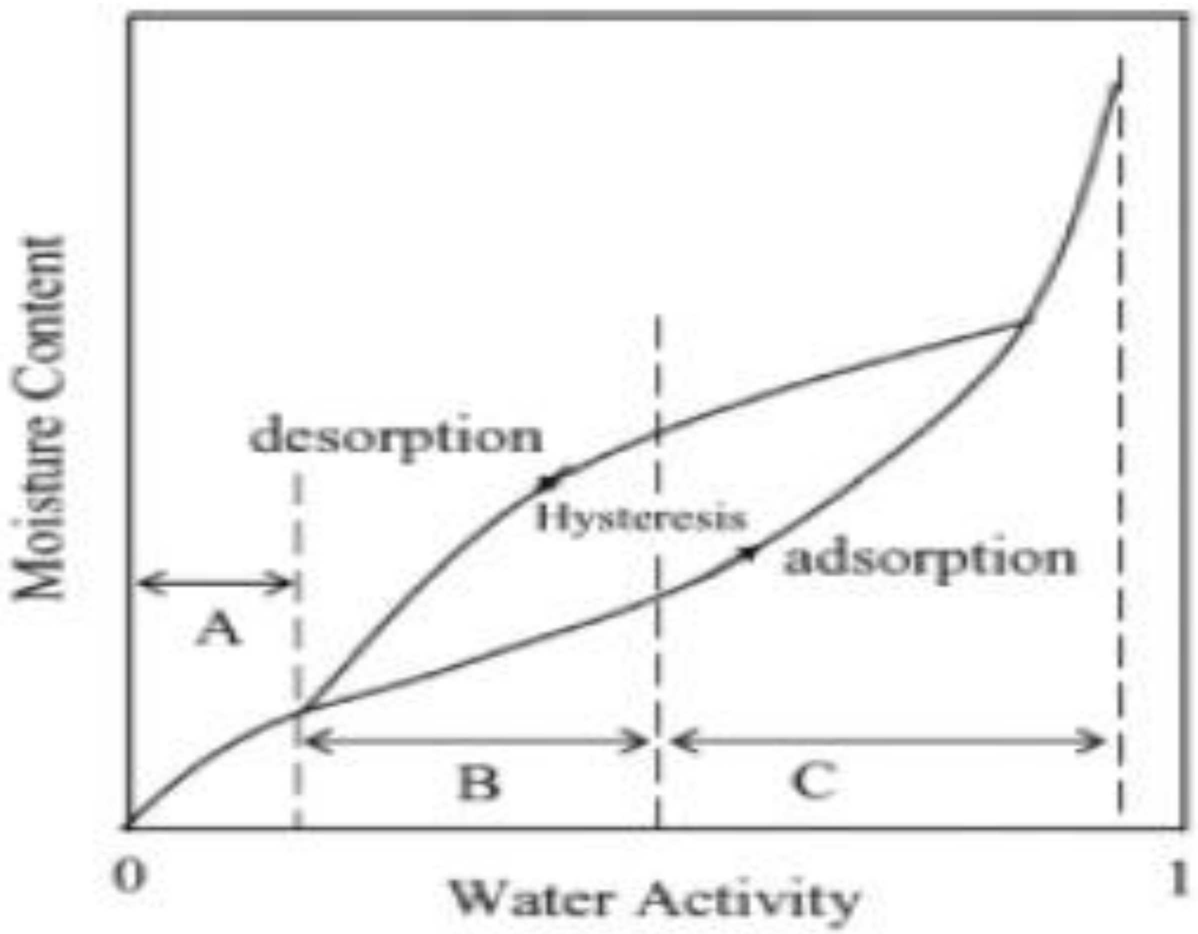
P^0_w :is the partial vapor pressure of pure water at equilibrium at the same temperature and pressure

By measuring water activity in foodstuffs, it is possible to:

* predict which microorganisms will be potential sources of spoilage and infection,
* maintain the chemical stability of foods,
* minimize nonenzymatic browning reactions and spontaneous auto catalytic lipid oxidation reactions,
* prolong the desired activity of enzymes and vitamins in food, and
* optimize the physical properties of foods, such as texture and shelf life.

Moisture Sorption Isotherms

The water activity of a food material is a measure of the change in free energy of water in a food material. This change in free energy arises both from the entropy of mixing (ΔSmix) and the enthalpy (ΔHmix) of water–solute interactions in the food material. Thus, by constructing an inverse plot of the water content of a food as a function of a_w, it is possible to assess the thermodynamic status of water in a food material under various experimental conditions and relate that to chemical and physical changes as well as to microbial spoilage of foods. Such plots are known as “moisture sorption isotherms” (MSIs).



Sorption isotherm for a typical food product, showing the hysteresis.

Source: https://en.wikipedia.org/wiki/Moisture_sorption_isotherm