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CHAPTER 10

Polyhydric Alcohols

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Introduction

Polyhydric alcohols, or polyols, are valuable aids in formulating a wide range of food products. When present naturally, or when added during processing, they can impart one or more of several beneficial characteristics. These effects include crystallization retardation, improvement of stability on aging, control of viscosity or bodying, preservation, solvency, moisture retention, and others.[39,99–102,120,170]

Natural Occurrence

Many of the commonly used polyhydric alcohols occur in nature. The frequency of occurrence appears to be directly related to the carbon-chain length of the polyol. Two- and three-carbon polyols rarely, if ever, occur in

nature; four- and five-carbon polyols occur occasionally; six-carbon polyols have been found in many instances; and seven-carbon polyols have been observed in only a few cases. This frequency distribution is probably related to the corresponding sugars and their presence in nature, with some specific exceptions. Only one of the tetritols and two of the pentitols have not been observed in natural foods.[106]

Butylene glycol and glycerine are both reported as occurring in fermented products. The presence of 2,3-butylene glycol in tomato conserves has been reported.[38] Glycerine has been reported to occur in fermented products such as wines and beers.[116] The isomer erythritol occurs in algae,[12,152] grasses,[81] and lichens.[62,79] In the group of polyols known as pentitols, *d*-arabitol and ribitol are found in nature. Arabitol is reported in lichens[104] and in a species of mushroom,[58] and ribitol is reported in plants.[124,165] Xylose (wood sugar) is one of the most abundant natural sugars in the plant world. However, xylitol, its corresponding polyhydric alcohol, has not been found.[107]

The hexitols, or six-carbon polyols, are the most widespread.[108] Sorbitol was reported in 1877, when it was isolated from the juice of the berries of the mountain ash tree.[27,123] It has since been reported in other fruit berries[80] and in many fruits, including pears, apples, cherries, prunes, peaches, and apricots,[156] in red seaweed,[75] and in *Sorbus commixta*.[8] Strain has presented a listing of a large number of plants in which the sorbitol content was determined.[146] Mannitol was the first crystalline polyol discovered;[126] and, since it is crystalline, it frequently occurs in plant exudates.[83,109] The sap exudate from a tree was the Italian commercial source of mannitol for many years.[21,150,151] Mannitol is also present in seaweed[21] and grasses.[74]

The seven-carbon heptitols are considerably less prevalent in nature. Volemitol is found in algae,[105] lichen,[104] mushrooms,[25] and plants of the primrose family.[24] Perseitol is found in avocados.[112,113]

Definition

The term *polyols* in this discussion will be restricted to those molecules that have two or more hydroxyl groups and have only hydroxyl groups. This will exclude sugars, although they have many hydroxyl groups and, in some instances, exhibit similar properties.[17] The chief difference noted between polyols and sugars is related to the aldehyde linkage present in the sugars.

As a class polyols are more stable chemically and thermally than sugars. They are usually more expensive than sugars; hence, the food industry demands that a polyol contribute a notable desired property to the final product. For these reasons we shall not treat sugars as polyhydric alcohols.

Polyhydric alcohols for our use then are defined as derivatives of aliphatic hydrocarbons formed by the replacement of two or more hydrogen atoms with two or more monovalent hydroxyl groups, each being attached to a different carbon atom.

Both glycols that we shall consider—propylene glycol and butylene glycol—have a longer carbon-chain length than the number of hydroxyl groups. The balance of the polyhydric alcohols to be discussed—triols to heptitols—have an equal number of hydroxyl groups and carbon atoms.

While the polyhydric alcohol family continues to challenge the curiosity of the scientist, only a few polyols are of actual commercial importance in the food industry—propylene glycol, glycerol, sorbitol, and mannitol.

Properties of Polyhydric Alcohols

The properties of polyhydric alcohols may be summed up quite briefly by stating that they are generally water-soluble, hygroscopic materials that exhibit a moderate viscosity at high concentrations in water. For the most part polyols exhibit a sweet taste ranging in sweetness from less than half that of sugar to slightly higher. These properties are shown schematically in Figure 1.

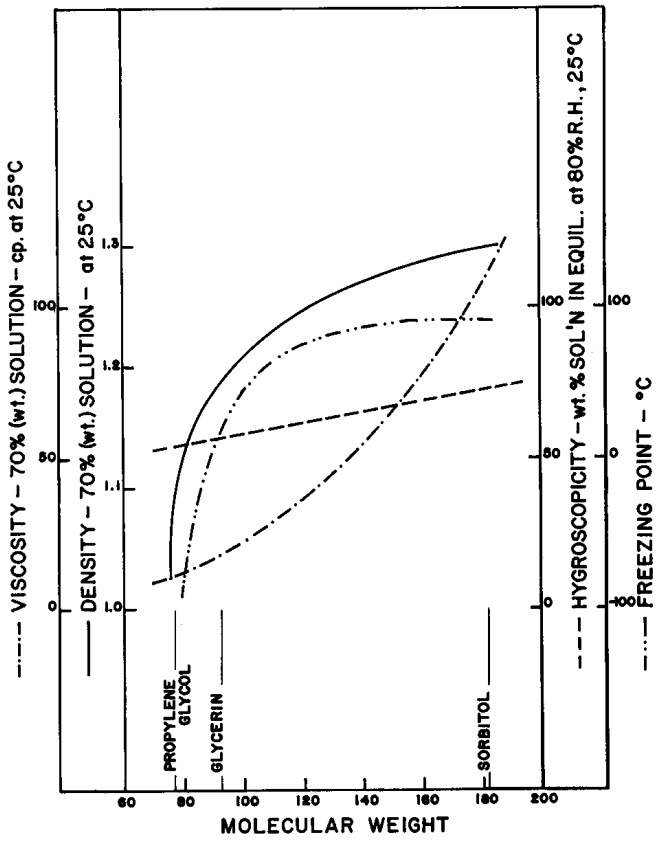

Fig. 1. Polyhydric alcohol behavior vs. molecular weight.

Table 1 shows a comparison of the properties of the four commercial polyhydric alcohols approved for use in foods.* They are all permitted in unstandardized foods, provided the amount used does not exceed that reasonably required to accomplish the intended physical or technical effect. Of course, they are not permitted in standardized foods, unless the standard of identity permits their use. Each case for a standardized food must be investigated separately.

Data in Table 1 show that as the molecular weight increases, the melting points, boiling points and viscosities generally increase. It has also been observed that with increasing molecular weight solvent properties for non-polar

* In addition (A) §121.1057: Polyethylene glycol 6000 is permitted (1) as a binder in plasticizing agents, (2) as an adjuvant in tablet coatings, and (3) as an adjuvant to improve flavor and body work with non-nutritive sweeteners; (B) §121.1114: Xylitol is permitted in some special dietary uses.

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