POLYGLYCEROLS AND POLYGLYCEROL ESTERS AS POTENTIAL WATER ACTIVITY REDUCING AGENTS. CHEMISTRY AND SENSORY ANALYSIS

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1. INTRODUCTION

The development of commercially acceptable intermediate moisture foods for human consumption depends on the use of efficient, safe, and palatable water vapor pressure reducing compounds. Many of these humectant substances act through different mechanisms of "binding" water, thus and restricting the availability of water for microbial growth. In general, the materials used today belong in the categories of salts, sugars, and polyols, with the latter offering particular promise (12, 26). In practice, considerable use has been made of glycerol and propylene glycol, which in general, have a deleterious effect on taste characteristics (burning sensation, etc.) of the food product. Other compounds, such as sucrose, corn syrup, sorbitol and dextrose, are restricted to formulations where sweetness is desirable.

An examination of the published literature (7, 17) reveals both a continuing interest in intermediate moisture foods and a persisting problem due to the lack of suitable substances to reduce water activity. A successful water vapor pressure reducing agent should meet the following criteria:

1. safety (approval by the appropriate national health agency);
2. efficiency in lowering water activity without any adverse effects on the host product;
3. quantitative prediction of water activity lowering effect;
4. low chemical reactivity;
5. ease of incorporation;
6. low cost.

As is the case with other research centers, especially in industry, our laboratories have maintained a long, though fluctuating, interest in intermediate moisture foods, both through in-house and contract work (11).

During the last two years our attention has focused on certain groups of non-ionic surface active agents, known as polyglycerols and polyglycerol esters, as possible water activity reducing substances. The polyglycerols are formed by intermolecular dehydration of glycerol heated in the presence of either alkaline or acidic catalysts (22). Most often alkaline catalysts such as sodium hydroxide or sodium acetate, at 250-275°C are used in an inert atmosphere of nitrogen or carbon dioxide. Esterification with fatty acids is often accomplished at 190-220°C resulting in a mixture of linear and cyclic esters. In commercial preparation, the complexity of the mixture of the esters is due to the composition of the starting fatty acids, the position and extent of esterification, and the number of ether linkages present. By changing the degree of polymerisation of the glycerol and the extent of esterification the hydrophylic-lipophylic balance (HLB) can vary from about 4 to about 13 (3, 21), and therefore the physical properties and functionality of these compounds in foods.

Table I shows some of the main functional properties and examples of foods in which the polyglycerol ester compounds are used. In earlier years the usefulness of these agents in foods was severely limited due to the presence of undesirable colors and flavors. Subsequent improvements to the manufacturing process resulted in a better control of composition and in refinements which reduced the presence of objectionable impurities. An extensive patent and other literature exist on the synthesis, chemistry, and physical properties and uses of these compounds (2, 8, 10, 14, 19, 24, 25, 27, 28).

Garti and Aserin (18), using HPLC, showed that any theoretical calculation of the product composition of polyglycerol esters could not be correct since the fatty acid radicals are not distributed at random among all available hydroxyl groups, the internal positions (secondary hydroxyls) of the glycerol polymer being esterified with greater difficulty than the primary hydroxyl groups.

Neissner (23) reported that two-dimensional TLC on boric acid-impregnated silica gel 60 precoated plates was a simple, useful method for separating fatty acid polyglycerol esters into a larger number of compounds, providing an insight into their complex character and allowing identification of the individual compounds. Babayan and McIntyre (3) reported on the physical and chemical properties of mono- and diesters of short and medium chain acids of polyglycerols. Polyglycerol esters become more hydrophilic as the molecular weight of the polyol increases; they become less hydrophilic as the length