WATER BINDING CAPACITY OF STARCHES, THEIR DERIVED PRODUCTS AND OTHER CEREAL COMPONENTS

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ABSTRACT

This thesis describes the moisture binding capacities and gelatinization characteristics of several commercial native starches and some of their derivatives. The main techniques used in the investigation were Differential Scanning Calorimetry and Scanning Electron Microscopy.

The introduction presents a general review of starch-water relations and the significance of these relations to food systems. A brief discussion of the aim of the project is also presented to show the relevance of the research. The literature review attempts to introduce the nature of water, its involvement in certain forms of food spoilage, the concept of bound water and the common methods used in the determination of bound water. The chemistry, structure and properties of the starch substance are also considered, with brief references to outstanding contributions to the understanding of the behaviour of this industrially useful commodity. The process of starch gelatinization and the usual methods of its estimation are also described, and in doing so brief discussion of water behaviour in dough has been included.

The starch samples used in the study were analysed for their moisture, protein, fat and ash contents. Each starch was analysed for eight metals using atomic observation spectrometry. Calcium, potassium and magnesium were present in all samples. A few of the starches contained

traces of zinc and copper. Aluminium was present in the aluminium octinyl derivatives of both wheat and maize starches. This metal was also found in the canna and maize starches.

Calorimetric studies investigating the moisture binding capacities of the starches showed native starches to have different moisture binding capacities. Substitution, cross-linking, oxidation, dextrinization, and acid hydrolysis of starches resulted in lower levels of moisture binding capacities compared with the parent starch. The only exception was the pre-gelatinized form which could bind more water than the parent starch. The time of mixing of wheat flour doughs was found to have no effect on the level of moisture bound in doughs. Sucrose was found to increase the level of bound water in starch-water system whereas salt had no effect on the moisture binding level of the starches.

Using the D.S.C. procedure, each native and derivatised starch had a characteristic gelatinization endotherm from which an enthalpy of gelatinization as well as a gelatinization range for which temperatures of onset, peak and conclusion were measurable. In all cases, modification reduced the gelatinization energy. A minimum level of water in the available or free state was needed to initiate gelatinization. Sucrose reduced the gelatinization energy with increasing concentration, however with salt the effect was complex. The gelatinization energy decreased initially and then began to rise slowly with increased salt

concentration. The extent of gelatinization was found to be dependent on both temperature and time of exposure.

Studies using scanning electron microscopy showed marked differences of granular disruption and solubilisation between the native starches. The processes of cross-linking were seen to retard granular disruption and dispersion of the starch materials. Substitution increased ease of dispersion and the dried out gel appeared as a strandular network. Starches which had been dextrinized or oxidized or hydrolysed showed different behaviour again except for the oxidized tapioca form which gave a gel structure similar to a substituted starch. Conditions such as temperature of heating and also time of heating were seen to affect each modification type differently.

In general, the substituted forms were found to be disrupted and dispersed after lower heat treatment than the cross-linked forms with the cross-linked form being most resistant of all to dispersion. Studies using a sedimentation procedure indicated the same situation with substituted forms swelling greatly and dispersing easily, while the cross-linked forms showed limited swelling. Electron microscopy showed that dextrinized, hydrolysed and the oxidized forms swelled and dispersed but may have undergone some degree of retrogradation compared to the substituted forms.

TABLE OF CONTENTS