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Food Physical Chemistry Applications to Processing and Nutrition

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Editorial

Food Physical Chemistry is considered as a branch of Food Chemistry [1-5] concerned with the study of structure- functionality relationships, as well as the underlying physical and chemical interactions [6] in foods in terms of physical and chemical principles applied to food systems. This includes, of course, the applications of physical/chemical techniques [7-24], instrumentation and methodology for the study of foods [2-4,6-9], thus partially overlapping also with Food Analytical Chemistry. One may also consider Food Physical Chemistry from the viewpoint of "physiochemical principles of the reactions and conversions that occur during the manufacture, handling, and storage of foods" [25], but this is a somewhat restrictive view because food physicochemical applications are also encountered in the fields of Human Nutrition, biomedical, biotechnology and crop sciences.

Understanding food processes and the properties of foods requires both a basic knowledge of physical chemistry and of how it applies to specific foods and food processes. Therefore, Food Physical Chemistry is essential for improving the quality of foods, their stability and food product development. Because Food Science and Human Nutrition are multi-disciplinary fields, specific areas of Food Physical Chemistry are being developed through interactions with other areas of Food Chemistry, and more generally, Food Science, such as: food analytical chemistry, food process engineering/food processing, food and bioprocess technology, food extrusion, food quality control, food packaging, food biotechnology and food microbiology. Thus, two rapidly growing, related areas to Food Physical Chemistry are Food Biotechnology and Food Biophysical Chemistry [6], where the emphasis is, respectively, on agricultural, biological and biomedical applications. Food physical chemistry concepts are often drawn from rheology, theories of transport phenomena, physical and chemical thermodynamics, chemical bonds and interaction forces, quantum mechanics and reaction kinetics, biopolymer science, colloidal interactions, nucleation, glass transitions and freezing [25] in disordered/non-crystalline solids. The techniques utilized range widely from dynamic rheometry, optical microscopy, electron microscopy, AFM, light scattering, X-ray diffraction/neutron diffraction [2] to MRI/ spectroscopy (NMR, [13], FT-NIR/IR, NIRS, Raman, ESR and EPR, [1-4,7-24] CD/Vibrational Circular Dichroism (VCD) [2], Fluorescence/FCS [4,12,15], HPLC, GC-MS [2,4] and other related analytical techniques.

Food systems are often derived from biological ones that have a high-level of both structural and dynamic complexity. The structural complexity of food systems stems from their multi-component, and often multi-phase, nature, as well as the presence of structural disorder [26] in foods. In a series of previously published articles and books, several attempts were made to consider certain types of food systems (such as hydrated dough and frozen foods) as glasses ([25] and relevant references cited therein), although few food systems can be indeed considered as 'typical' glasses, that is, with only short-range, atomic level order being present. A much more general, structural approach to systems with partial disorder, or only partial ordering [26,27], was introduced only recently in [28] in terms of *paracrystalline* models of systems with partial disorder that are applicable also to highly ordered systems and glasses (meta-stable systems that possess only short-range order). Because high levels of hydration and/or salts are often present in processed foods, techniques that are capable of monitoring the interactions of water and ions with major components of foods such as proteins, carbohydrates and lipids, starch granules, gels, and so on, have been employed with success to determine the non-ideal interactions of the latter with water and ions [2-4,29-32]. Among such techniques are Nuclear Magnetic Resonance/Magnetic Resonance Imaging (NMR/NMRI), Near Infrared (NIR) and Environmental Scanning Electron Microscopy (ESEM) [19-22,27,32-38]. The results obtained by such techniques for hydrated maltodextrins, corn syrups [38], corn, wheat [27] and potato starches [27,32,33,35], muscle, milk and soybean proteins [17,35-37,39-41] have revealed the presence of a fraction of trapped water in intermediate moisture foods of lowered water vapor pressure that is inaccessible for microorganism growth, and thus has important applications for increasing food stability and shelf-life. The trapped water fraction is particularly noticeable and also readily observed in raw potato starch by Deuterium NMR [27,35]. Related, structural studies of such food systems, as well as their model two- or three- component model systems, are usually carried out by Carbon-13 [6,13-14,33,42,43], and two-dimensional (2D) NMR [2].

On the other hand, NIR techniques [11-22], when combined with suitable primary techniques [8-11] for calibration purposes provide the means for rapid, inexpensive analysis and improvements of the quality of crop seeds, such as soybeans and corn, for foods with improved nutritional quality. As an example, a recently debated issue is that of the health benefits of soybean isoflavones in foods at levels exceeding 20 to 30 mg; relevant NIR calibrations and studies of the levels of isoflavones

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in soybean seeds were recently reported [23-24] that could be employed in further nutritional studies. Such nutritional applications of Food Physical Chemistry are too numerous to be discussed in any detail in this concise report.

A novel area of Food Physical Chemistry related to food processing and extrusion- which is also relevant to biomedical/ pharmaceutical applications- is that of microencapsulation. A number of microencapsulation results and applications were reviewed in [44].

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