

Structure and Properties of Food Hydrocolloids - Gels, Emulsions and Foams

Katsuyoshi Nishinari

Department of Food and Human Health Sciences, Graduate School of Human Life, Osaka City University

3-3-138, Sugimoto, Sumiyoshi-ku, Osaka 558-8585, Japan

Summary

Food hydrocolloids have been widely used in the food industry for their gelling, thickening, emulsifying, dispersing, and stabilizing functions. Recently they have attracted much attention for controlling food texture for elderly people having difficulty in mastication and deglutition, and also in their function as dietary fiber which are expected to lower cholesterol and blood pressure thus preventing lifestyle related diseases. Food hydrocolloids control the texture and at the same time they control flavor and aroma release which has also been studied extensively. Methods of investigation are very diverse ranging from physics to biological chemistry, and it is necessary for workers in this field to learn various methods. The Japanese Society of Food Hydrocolloids organizes an introductory seminar on the day before the hydrocolloids symposium.

This special issue of FFI Journal includes lecture notes, including answers to questions in the seminar and symposium, which were held in Osaka on May 22nd and 23rd in 2007, respectively. Identification of the chemical structure of polysaccharides is fundamental to understanding their functions and properties. Prof. Yoji Kato explains how to determine the structure of xyloglucan isolated from various vegetables and fruits combining anion exchange chromatography, maldi-tof, and enzymatic degradation. This study gives clues to finding a new polysaccharide having a similar function to a known polysaccharide, and also to understanding what kind of structural feature is effective for a specific function.

AFM was found to be useful to directly observe the microscopic structure of biopolymers and some monographs and review papers have been published. The application of AFM in meat science is introduced by a lecture by Dr. Tomohito Iwasaki who tries to understand the relationship between the AFM observations and mechanical properties of muscle proteins.

Syneresis in hydrogels is an important problem but is not well understood because of the lack of fundamental study, Prof. Toshikazu Takigawa applied an ultracentrifugal method to a hydrogel, poly (vinyl alcohol) gel, which is useful to understand the interaction between the gel network and water. This method seems to be very promising to understand syneresis in hydrogels and is expected to be applied to various food hydrogels.

Molecular diffusion in gels is an important problem to understand the mesh structure of the gel network. Dr. Shingo Matsukawa explains how to use NMR to understand the gelation of gelatin

and carrageenan, and to determine the diffusion coefficient of pullulan chains in gellan gels.

Prof. Masayuki Tokita showed clearly that gelation can be analyzed by percolation theory using some model gelling biopolymers such as casein micelles, carrageenans and gelatin in the 1980s, and wrote an excellent introduction on percolation treatment of gelation in *Food Hydrocolloids*, Vol.3, 263-274 (1989). Now, he discusses the fundamental problem of gelation especially emphasizing spinodal decomposition in agarose. Work on emulsions has been said to be an art rather than a science mainly because of their extremely non-equilibrium nature and also due to the polydispersity of droplets. Prof. Mitsutoshi Nakajima succeeded recently in producing emulsions with a well controlled droplet size using a microchannel emulsification. It is expected that this method will be useful to much better understand complicated emulsion behavior and also to produce new types of emulsions.

Many research groups are involved in the study of bubbles and foams, and Dr. Masahiko Mizukoshi explains the fundamentals and applications in bread and sponge cakes based on his long experience in the industry.

Pectins have been used mainly as a gelling and thickening agent in the food industry, but recently sugar beet pectin (SBP) has been exploited especially in Europe for its emulsifying function. Dr. Makoto Nakauma explains the relationship between the structural characterization of SBP and the emulsifying behavior.

Collaboration between academia and industry is necessary to further develop understanding and application of food hydrocolloids. The viewpoints of both unity and diversity are necessary for the study of food hydrocolloids. In the preface of "Science of Food Hydrocolloids", (Eds. K. Nishinari and T. Yano, Asakura Shoten Publ. 1990) the importance of unified study of food hydrocolloids was emphasized.

Many food engineers have been working in different areas, as in "Every man for his own trade" in the processing of fish, meat, dairy products, soybeans, cereals, vegetables, fruits, and seaweed, and there has not been much exchange of information between engineers treating different foods. The food hydrocolloids approach proposes that different workers in different product areas interact with each other taking into account that these hydrocolloids can be studied from a unified viewpoint: all these dispersed systems are colloidal systems consisting of water, polysaccharides, proteins, lipids and other ingredients. The Wrexham international conference, Gums and Stabilisers for the Food Industry, has been organized every two years for thirty years, and the International Hydrocolloids Conference first organized in Japan in 1992 is now also organized every two years one after another. The 9th IHC will be held in June 2008 in Singapore and the 10th IHC will be held in Shanghai in 2010. The impact factor of the journal *Food Hydrocolloids* exceeds 2.0, and is becoming a vital source of information for researchers in this field.

Diversity is essential for human life. If we are forced to eat exactly the same food everyday, we will

curse that food just as the Israelites cursed the manna. Even astronauts need different foods, and the Japanese Society of Food Science and Technology (JSFST) is now collaborating with the Japan Aerospace Exploration Agency (JAXA) to develop space food for Japanese astronauts. Good foods are necessary for all healthy workers and also for hospitalized patients. Food hydrocolloids are expected to be further developed in all the areas of human life. The realization of diversity is based on respect for individual characteristics. Gels may be hard or soft, some gels tend to cause syneresis while others not, some gels show good flavor release, both emulsions and foams may differ if their sizes of droplets, bubbles are different ...etc, and the combination of these diverse food materials can create a wide spectrum of palatable dishes. Every material has its own "raison d'être", which cannot be replaced by other ingredients, and at the same time various new materials have been created to mimic other materials.

Last year, in Japan, the word *nise or gi* relating to adulteration in food unfortunately penetrated widely through various food sectors, but I am sure that most workers are sincerely reflecting on the issue, and can overcome the problem in cooperation with consumers. I hope that this special issue is useful for all the engineers and technologists in the food sectors.

Finally, I would like to thank contributors for rewriting their lecture notes, and I wish readers to enjoy all of these "palatable" and "functional" papers! Bon appétit!