Hydrocolloids

Part 2

Fundamentals and Applications in Food, Biology, and Medicine

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Preface to Part 2

This volume is based on the presentations given at Osaka City University International Symposium 98 - Joint meeting with the 4th International Conference on Hydrocolloids - held on 4-10 October 1998 in Osaka.

The first article in Section 1, a masterly review by Professor Phillips shows the wonderful rich world of hydrocolloids, how they are useful in various fields with many potential future developments especially in processing of foods and in biomedical fields. This contribution is based on a lecture given to the general public.

Section 2 includes the articles treating the fundamental aspects and industrial applications of dispersions, emulsions, suspensions, and surfaces. Although it is frequently said that this is the world of mystery and art rather than science, the articles in Section 2 show the steady advance in the understanding of this world.

Section 3 covers the mixtures of biopolymers which have been the subjects of hot debate these ten years. Our understanding of the interaction of different biopolymers is certain to be interesting and important from the view point of not only science but also industry.

Section 4 consists of articles concerning processing. The effects of shear on the gelation is an important problem, and the recent marvellous achievements are described by Professor Djabourov and Professor Norton. Many interesting problems in food processing are discussed in this section.

Section 5 gathers the articles in biomedical fields. Although only two articles closely related with pharmaceuticals, these articles show the important relation between hydrocolloids and pharmaceuticals. Since hyaluronan plays an important role in the field of orthopaedics, ophthalmology, and cosmetics, six articles together with some other articles related with biorheology are included in this section.

Although most articles in this volume treat the hydrocolloids as functional materials which modify the texture of foods, control the rheological properties of foods, biofluids and pharmaceuticals, most hydrocolloids are at the same time dietary fibres. Section 6 includes contributions to this aspect.

Section 7 gathers the articles describing the problems of sensory evaluation, texture measurements and mastication which are very important to improve the quality of life.

I am sure that this volume provides valuable information and stimulating problems based on the enthusiastic discussions, questions, comments and answers during the conference. All the articles included in this volume have been reviewed and rewritten carefully according to comments and criticisms. I hope that the readers will share the pleasure to get the experience on many exciting aspects and infinite possibility of hydrocolloids.

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Colloids: a partnership with nature

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1. NATURAL FIBRE FOR HEALTH AND LIVING

Throughout the world there is a growing belief that natural foods are an integral part of a healthy life style. It is inevitable, therefore that food producers source an increasing proportion of their raw materials from nature itself. The most significant growth demonstrated in the last European Food Ingredient Exhibition was in preparing healthier foods, particularly to replace animal fat and to introduce more nutritional fibre. A well researched market analysis " Prospect for Food and Drink Ingredients in the European Union (EU)" predicts that the use of fat replacers in the EU will increase by 113.8% from 202,504 tons to 433,038 tons from now until the year 2000. The sectors showing the largest fat substitution potential are yellow fats, biscuits and soups, sauces and dressings. The greatest percentage changes will occur in savoury snacks, cheese and drinking milk cream and condensed milk. However, there will certainly be an increased demand by an increasingly health-conscious consumer for reduced fat and enhanced fibre foods of all types. If this can be achieved using materials which have low calorific value, further health benefits will result. Foods containing such ingredients will need to match the quality of the original product and without adverse dietary effects. This target, cannot be achieved without the scientific use of thickeners, stabilisers and emulsifiers, particularly of the "natural type". This calls for colloids, which can interact with water to form new textures and perform specific functions, and as such can be classed as "hydrocolloids". In 1997 the world market for such hydrocolloids was 2,621 million US dollars and is set to grow significantly to meet the health aspirations of the consumer in the next millennium.

Most of the main hydrocolloids used in the food industry are carbohydrate. There is a growing interest in carbohydrate and its components throughout the world and recommendations have been made to encourage increased carbohydrate consumption. The main sources are cereals, sweeteners, root crops, pulses, vegetables, fruit and milk products. These are the main source of food energy, and as a per cent of energy, total carbohydrate ranges from about 40% to over 80%, with the developed countries such as those in North America, Western Europe and Australia at the low end of the range and developing countries in Asia and Africa at the high end. Starch accounts for 20 - 50% or more of energy where the total carbohydrate is in the high range.

The McGovern Report " Dietary goals for the United States " in 1977 first introduced the term " complex carbohydrates " to distinguish sugars from other carbohydrates. It was used to encourage consumption of what were considered to be healthy foods, such as whole grain cereals etc. Later came the use of the terms " available and unavailable carbohydrates " in order to draw attention that some carbohydrates are not digested and absorbed in the small intestine but rather reaches the large bowel where it is fermented. Subsequently was added the concept of " resistant starch " to describe starch or starch degradation products not absorbed in the small intestine of healthy humans. Now we prefer to refer to these materials in terms

of "dietary fibre", the main components of which were first thought to come from the cell walls of plant material in the diet and comprise cellulose, hemicellulose and pectin (the non-starch polysaccharides). We now also draw a distinction between soluble and insoluble nutritional fibre.

The physical properties of fibre allow it to perform both in a physical role to assist laxation, by increasing bowel bulk and speeding up of intestinal transit time. There is also a metabolic function by fermenting through colonic microflora to give short-chain fatty acids (SCFA), mainly acetate, propionate and butyrate. These have a very beneficial effect on colon health through stimulating blood flow, enhancing electrolyte and fluid absorption, enhancing muscular activity and reducing cholesterol levels.

Now that these effects are known, it is the task of the food scientist to provide the hydrocolloids in the most appropriate form for inclusion in the food product. This requires an understanding of their structure and the way in which they act to produce the desired function in the food. Many of the contributions in this book are devoted to achieve this objective.

2. THE WORLD MARKET FOR FOOD HYDROCOLLOIDS

An indication of the size of the market for natural hydrocolloids is shown in Table 1. In 1997 the value was 2,621 million US $.

Table 1 **WORLD MARKET OF HYDROCOLLOIDS 1997**

HYDROCOLLOID	$ MILLION	%	COMMENT
Starches	646	25	Cost effective and label friendly
Gelatin	538	21	achieved despite BSE
Carrageenan	263	10	politics almost over
Pectin	260	10	user recognition and label friendly
Xanthan	205	8	first one tried
Arabic	147	6	still surviving + +
Agar	130	5	dominated by Japan
LBG	97	4	an old favourite
Alginate	87	3	speciality role
Guar	77	3	Most cost effective
CMC	67	3	too chemical sounding others now
MMC	46	2	opened process technology
Konjac	11	0	suprising advance
Tara	5	0	
Gellan	6	0	on the way, but too costly now
Cassia Tora	5	0	
TOTAL	2,621		

Source : Third International Business Conference on Food Hydrocolloids, Nice France 1997

The starches from a variety of natural sources, such as corn and potato remain the leading hydrocolloid, followed closely by gelatin. Now concern about diseases which may be transferred from animal sources has raised some query about this useful material.

Carrageenan, a product from seaweed has been a centre of controversy because of a presumed adverse effect on health, and because of a commercial battle with a new cheaper form of carrageenan from the Philippines, now called "Processed Eucheuma Seaweed" for regulatory purposes. Pectin from apples is still a friendly and useful product. Xanthan is the first of the biosynthetic hydrocolloids to break through into the top five, and leads the way for other bacterial polysaccharides such as gellan to come into regular use. At present it is their price that holds them back. Gum arabic, an exudate from trees in Africa, continues to be used for a multitude of food uses and is favoured as an emulsifier particularly in beverages and as a source of natural fibre in health drinks. It is also a valuable encapsulator of flavours and it remains a food approved adhesive as it has been for more than 2000 years. The traditional thickeners, locust bean gum and guar gum remain competitive and find their way into most sauces, salad dressings and food fillings. The alginates from seaweed can perform a variety of speciality functions and have great flexibility within their structure, and as such are used in a range of applications varying from toothpaste to ice cream and wound dressings. Carboxymethyl cellulose and microcrystalline cellulose represent a different category since they are produced from wood pulp by a variety of physical and chemical processing methods. Since these are a good source of fibre and have a variety of functionalities in food, they seek to competed with the traditional natural hydrocolloids by offering security of supply, quality and price.

Essentially the function of such hydrcolloids is to improve the texture of foods and to assist in presenting various processed food products in a healthy and attractive ready to use form. Table 2 shows how the hydrocolloids form the dominant sector of the texturising agents now in use An important new development is to be able now to form foods which have the mouthfeel of a fat without the presence of fat itself. The fat replacers usually form small gel particles which simulate the behaviour of natural fats in food and so assist to reduce harmful fats in the diet.

Table 2

HYDROCOLLOIDS ARE THE DOMINANT SECTOR AMONG TEXTURISING AGENTS