Phillips Hydrocolloids Research Ltd. and San-Ei Gen F.F.I., Inc. International Hydrocolloids Forum - Natural Hydrocolloid Emulsifiers Part I

Glyn O. Phillips
Glyn O. Phillips Hydrocolloid Research Centre, North East Wales Institute
Plas Coch, Mold Road, Wrexham, LL11 2AW, UK
Phillips Hydrocolloids Research Ltd.
45 Old Bond Street, London W1S 4QT, UK

Emulsification processes are fundamental in producing acceptable food products in the present era of mass production and long distance transportation. We have all learnt that oil and water do not mix. But the food industry requires that they do not only mix but associate to give an even, stable and homogenous product. It is the task of the emulsifier to achieve this reconciliation of hydrophobic and hydrophilic materials. Additionally, there is a considerable appeal for the general public in the concept of "natural" foods. The food producer, therefore, in the current health conscious climate makes every effort to equate "natural" with fitness and good living to promote a "green" image without those nasty chemicals. The subject of our second International Forum (reference 1 gives details of the First International Forum) was selected to meet both these objectives and deals with natural hydrocolloid emulsifiers. Experts were brought together in Wales to deal with both conceptual and practical aspects of this important subject and now these discussions can reach a wider audience.

A range of physico-chemical processes such as creaming, coalescence, flocculation and gelation can lead to the destabilization of emulsions once formed. What is the structure of such emulsions and what are the processes which lead to their breakdown? These are the fundamental aspects which Eric Dickinson deals with. He shows that by studying the evolution of the microstructure in a phase-separating emulsion system new insights can be obtained about the underlying instability mechanisms.

Using atomic force microscopy (AFM) Victor J. Morris enables us to actually visualise these formation and breakdown of protein - hydrocolloid emulsions by imaging the emulsifiers themselves, or the structures they form at oil-water interfaces. He deals the behaviour of proteins, their interactions with surfactants and the role of proteins in the emulsifying action of certain polysaccharide extracts such as sugar beet pectin. AFM images provide direct evidence for the presence of protein-pectin complexes in sugar beet pectin extracts. It is proposed that these 'tadpole-like' structures are responsible for their emulsifying properties.

Claus Rolin and Jan A. Staunstrup in a "double" presentation, while not rejecting the role of the protein component contributing to the emulsification action of sugar beet pectin describe also a relationship between the content of acetyl ester groups in the pectin and its efficacy for stabilizing

beverages relative to the chosen weighting agent and the sequence of conditions during the beverage manufacturing.

Takahiro Funami takes the sugar beet pectin story one further step because he describes how the role of the protein in sugar beet pectin can be harnessed to improve its emulsification properties. By aggregating the protein using a food friendly process he describes a new product which has great potential.

Ian T. Norton introduces the subject of nano-emulsions, where droplets with diameters below 40nm might be formed. These could provide major advantages if they would allow lower levels of oil into products and so provide improved mouth-feel or to carry micronutrients. He is able to demonstrate that sub-micron emulsion droplets can be produced using decane or triglyceride oils.

Matthias Schultz addresses the challenges of today's dynamically growing beverage market. This paper is a wide ranging review of the application of the major natural emulsifiers available to the beverage technologist. He reviews the competitor emulsifier to gum arabic, namely modified starch, and deals with the relative merits of both. Alternative systems are also discussed, including enhanced gum arabic and chemically modified gum arabic, sugar beet pectin, gum ghatti, corn fibre gum, mesquite gum, Fenugreek gum and protein-polysaccharide complexes. It is valuable experience from a practising producer of flavoured beverages on an industrial scale.

John Flanagan and Harjinder Singh provide an independent assessment of a new improved gum arabic, marketed as SUPER GUM™ which has recently become available on the market. SUPER GUM™ has been modified by an accelerated maturation process, and is characterised by increased molecular weight and greater surface activity compared to unmodified gum arabic. Two different applications of SUPER GUMTM as an encapsulating agent were shown to be very successful. The encapsulation efficiencies of multiple emulsions were increased following the use of SUPER GUM™ as an external emulsifier. A second application, for the micro-encapsulation of a proprietary anti-microbial dairy blend, Glovon was also shown to be successful. Harjinder Singh also gave an beautiful demonstration of the benefits of cross-linking sodium caseinate and gum arabic using the enzyme transgluaminase.

Richard A. Williams offers an alternative industrial method to prepare emulsions using membranes to product the small droplet sizes required. His process is already in full scale production and the traditional beverage industry would do well to look further into the potential of this possible alternative.

Gum arabic received the attention it deserves by the joint group of San-Ei Gen F.F.I., Inc. (SEG) and Phillips Hydrocolloid Research Centre (PHRC) in the Proceedings since it is the most successfully used natural emulsifier in the beverage industry. Saphwan Al-Assaf describes the identification of the molecular parameters which are necessary in gum arabic to provide good emulsification and on this basis how to establish a new physical quality control method. Makoto Sakata reviews the effects of a wide range of factors which influence its emulsification

performance.

The joint research programme between INRA-SEG-PHRC has identified the surface and interfacial properties which underpin a good emulsifier. The paper by Marc Anton demonstrates that the stronger is the elastic interfacial film which can be achieved between the oil droplet and the emulsifier, the better is the emulsification stability.

The paper delivered by Hyoe Hatakeyama examined the interactions which occur when two emulsifiers, methyl cellulose (MC) and gum arabic interact. The narrow pathway between phase separation and integrated systems was negotiated cleverly. Using atomic force microscopy and differential scanning calorimeter, the best conditions for interaction can be identified. New matrices formed this way could be very novel emulsifiers. The results indicate that the gelation of MC can be controlled by selecting gum arabic of specific molecular dimension. At the same time it was found that the molecular equilibration in the sol state is an important factor when the transition behaviour of polysaccharides is investigated.

Pectins are frequently used to stabilise dairy deserts and acidified milk drinks as a result of the interaction of the pectin with the casein (micelles) in milk products. Kees de Kruif investigated the phase behaviour of high methoxy pectin/caseinate dispersions as a function of pH and concentration and found a very sharp borderline between segregative phase separation at pH 5.73 and associative phase separation below the pH 5.73. The interaction between pectin and casein appears to be mainly entropy driven.

The presentation by Nissim Garti describes the emulsion performance of a wide range of whey protein isolates and hydrocolloid complexes and he elegantly demonstrates that such complexes can provide good steric stabilization to the external interface of an emulsion and double emulsion.

A major emphasis in the meeting was the potential of exudates gums in the emulsion market. While gum arabic is well established it is now coming under increasing pressure from synthetic and chemically modified polysaccharides.

Peter A. Williams showed how new gum arabic-protein soluble coascervates could be produced and offering a new route to control and improve the performance of gum arabic itself. The great potential of the old Gum Ghatti has now been fully explored (Takeshi Ogasawara and Yasushi Sasaki) and it is proving to be a remarkably efficient emulsifier which can even out-rival the conventional gum arabic and the enhanced gum arabic products which are now appearing on the market. Mesquite gum is another potential new natural hydrocolloid gum introduced at the meeting (Marguerite Rinaudo).

Overall the Proceedings of the International Forum provide a unique insight into the availability and potential of natural hydrocolloid emulsifiers. We thank San-Ei Gen F.F.I., once again for their support in enabling the Journal to publish these papers. It is testimony to the benefits of an international global partnership in pursuing work of mutual interest.