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Figure 1: Alginate microcapsules

Alginate microencapsulation is a useful and accessible method with which to entrap a variety of products, both chemical and biological, which provides a platform upon which to provide controlled release properties. Alginate is of great interest industrially due to its GRAS (generally recognised as safe) status, low cost and its acquisition from renewable sources. In addition to these, alginate microencapsulation is easily applied to produce large numbers of uniform polymer beads (Fig. 1).

Alginate itself is a linear polysaccharide composed of 1-4 linked β -D-mannuronic acid (M) and α -L-guluronic acid (G) monomers derived from brown algae. Along the polymer chain there are homopolymeric (GG or MM) and alternating (GM or MG) regions. The homopolymeric G regions can bind to divalent ions to form an 'egg-box' structure, forming alginate monolith (Fig. 2). Dependent upon the relative concentration and distribution of these G and M residues alginate

can show slightly varying physical properties, for example alginate with a high proportion of homopolymeric GG moieties give gels which are stronger than those with a larger amount of mannuronic residues¹. The carboxyl groups on the saccharide monomers have a pKa between 3.3 and 3.5, as a result of which, in solution, the majority of these are non-ionic below around pH 3.3. This change in chemistry results in insolubility and aggregation of the polymer. With respect to controlled release this is a very desirable property, it means that at low pHs (for example those found in the stomach) alginate is insoluble; retaining load. At higher pHs (pH >3.5) the alginate monolith breaks down, releasing encapsulated material.

Alginate microcapsules are most commonly produced by extrusion or emulsion². Extrusion involves external gelation by dripping a solution of alginate into a cross linking solution and allowing it to harden over

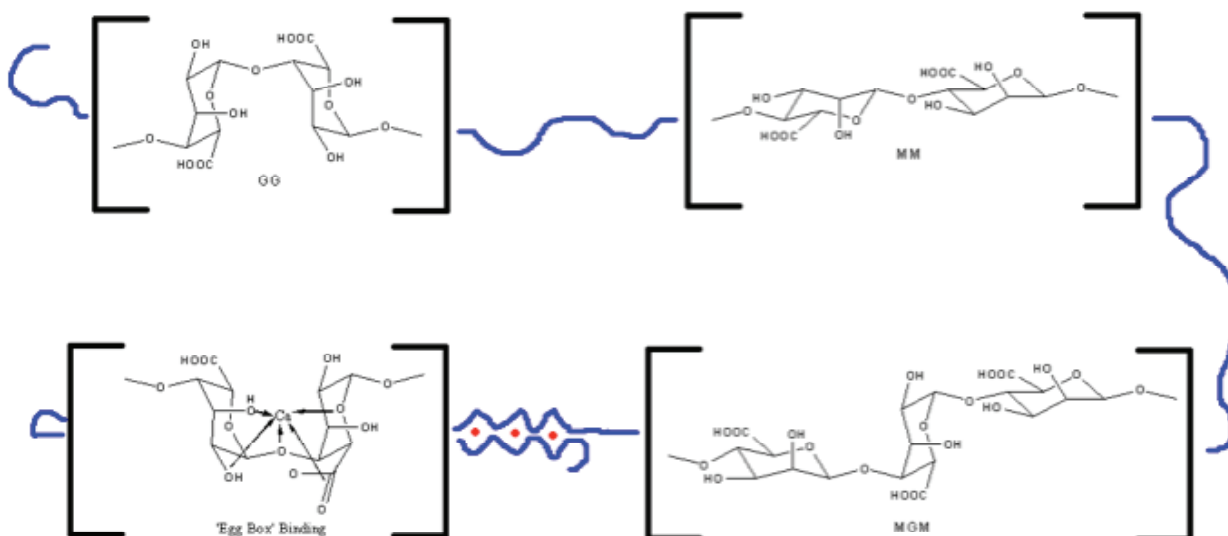


Figure 2: Various structural arrangements of alginate

Encapsulation: Technology and application

time. Emulsion, using internal gelation involves the production of a stable emulsion of alginate containing calcium carbonate in oil. An organic acid is added to the mixture which liberates carbonic acid and cross links the alginate with the remaining divalent calcium ions. Other technologies have been applied to the production of alginate microcapsules such as spinning disk atomization³, spray drying⁴ and microfluidics⁵ though these are considerably less common.

The application of these alginate microcapsules to drug delivery usually involves further formulation in the form of coating or the incorporation of other polymers. For example Moebus et al produced alginate/poloxamer microcapsules loaded with terbutaline sulphate and bovine serum albumin for the controlled delivery to mucosal surfaces⁶. Another example is that of Elzatahry et al whose research entailed the coating of alginate microcapsules with the polycation chitosan⁷. This produced a coated microcapsule which exhibited "excellent" mucoadhesive properties as well as controlled delivery of theophylline to the colon. Alginate microencapsulation has also been applied to the more unusual fields of protein, cell and DNA encapsulation. The previous examples typify the wide range of applications to which alginate microencapsulation can be applied with easily made modifications and therefore the scope for use in research for controlled release.

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The Science of Medicines

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UKICRS are hosting three sessions at this year's UK PharmSci 2010 Conference in Nottingham.

Session 1 : Thursday 2 Sept / 08.30 - 10.30

Prof Tony D'Emanuele (UCLan) : Crossing cellular barriers using dendrimer nanocarriers

Dr Lea Ann Dailey (King's College London) : Emerging nanotechnologies for inhalation drug delivery: What is the cutting Edge?

Session 2 : Thursday 2 Sept / 13.15 - 15.00

Dr Catherine Tuleu (University of London) : Integrated aspects of formulation issues associated with children's medicines: from regulation to practice via research (MCRN) and industrial initiatives (EuPFI)

Mr Carl Mroz (Colorcon) : Excipients - suitability of their use in Paediatrics and ways forward

Dr John Hempenstall (GSK) & Dr Jenny Walsh (Astra Zeneca) : Formulation strategies for paediatric clinical studies and for market

Session 3 : Thursday 2 Sept / 15.30 - 17.30

Dr Andreas Schatzlein (University of London) : Anti-cancer nanomedicines

Dr Helen McCarthy (Queen's University Belfast) : Bio-inspired vectors for gene therapy

Dr Giuseppe Battaglia (University of Sheffield) : Polymersomes in drug delivery