University of Reading

Microencapsulation of probiotic bacteria

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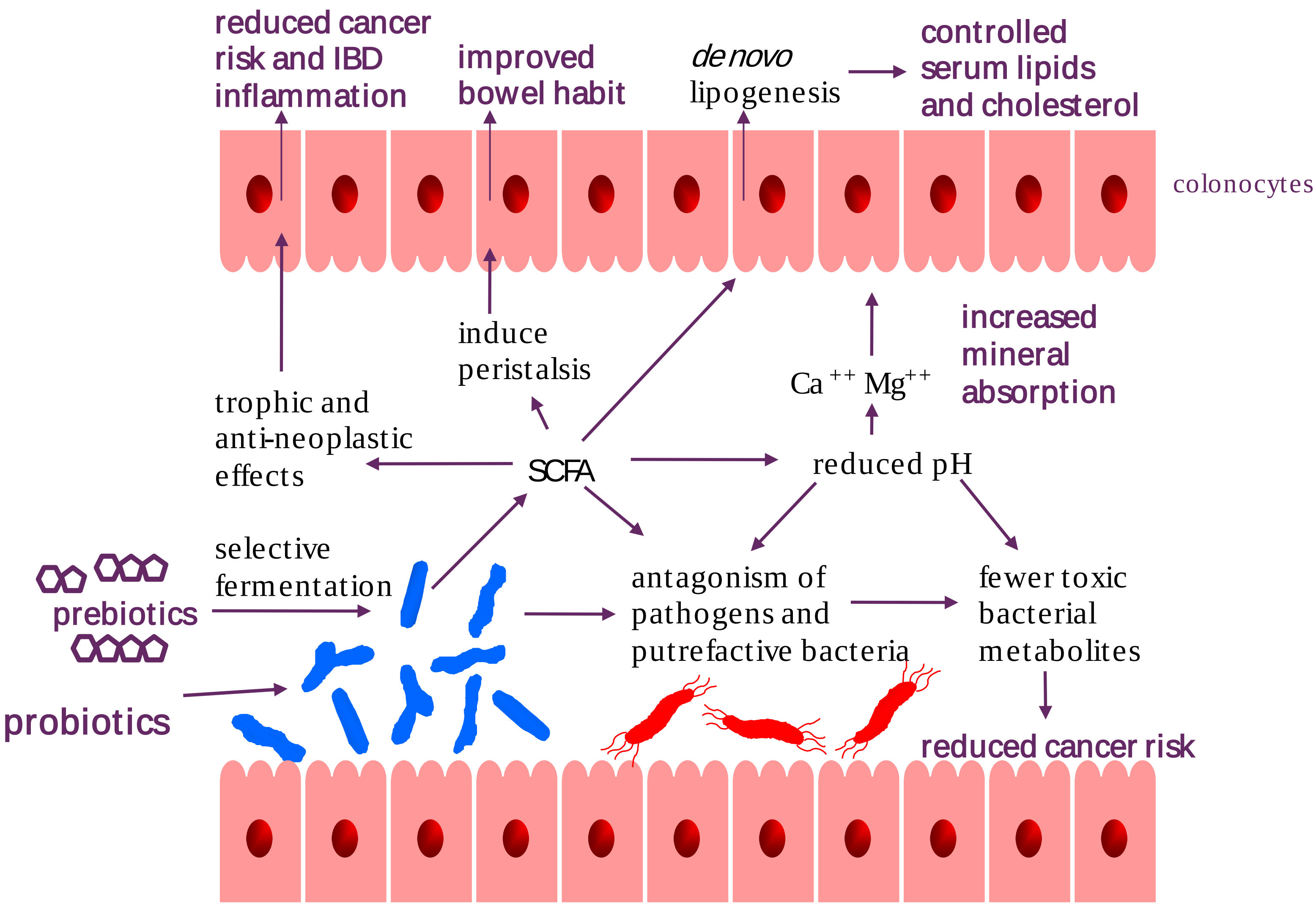
The concept of probiotics and prebiotics

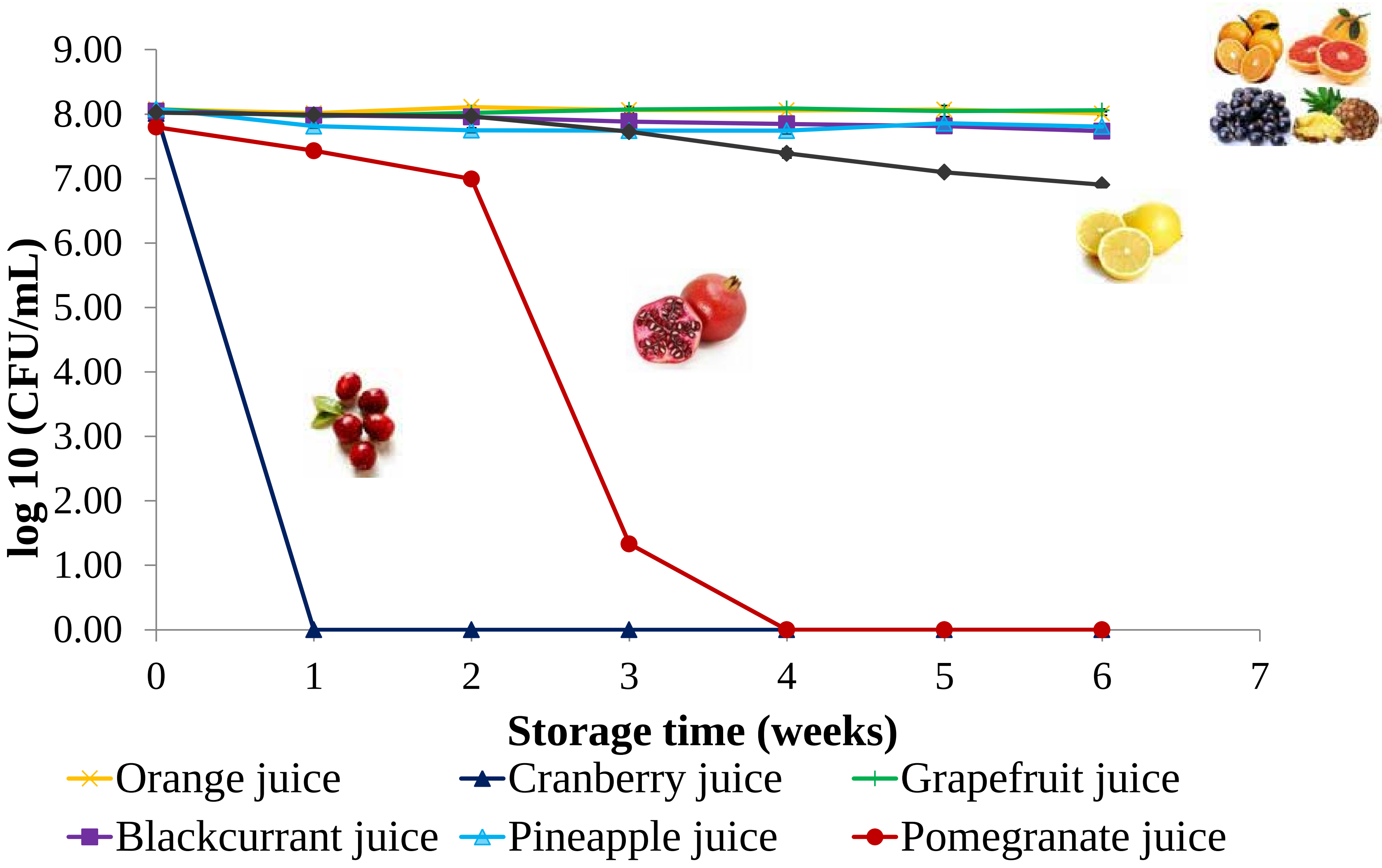


Modified from Crittenden, In: "Prebiotics: Development and Application" (2006)

Potential of encapsulation and challenges

- Prolong survival during long term storage of probiotics in dried form (refrigerated and ambient temperature)
- Prolong survival during food processing and storage in food products (dairy, juices, chocolate, etc)
- Ability to target delivery / control release in the GIT (e.g. small intestine, large intestine)
- Scalability and costs
- Minimise negative organoleptic effects

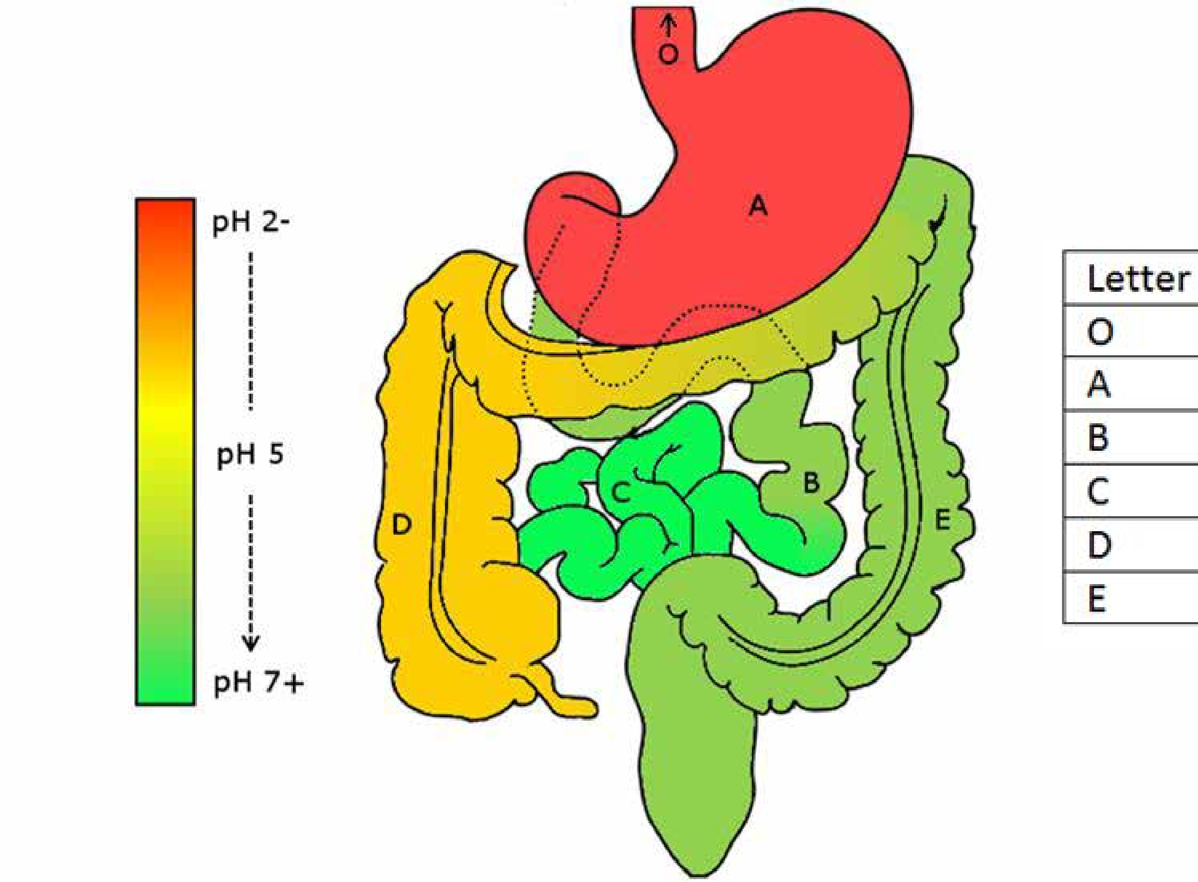
Survival of free probiotic cells in fruit juices



International Journal of Food Microbiology, 146, 111-117 (2011)

Oral administration of live bacteria

- Loss of viability in the stomach before action in intestine



Letter	Region
O	Oesophagus
A	Stomach
B	Proximal Small Intestine
C	Distal Small Intestine
D	Ascending Colon
E	Descending Colon

Materials for encapsulation

- Alginates
- Pectinates
- Xanthan gum
- Gum acacia
- Guar gum
- Carrageenan
- Casein
- Gelatin
- Whey proteins

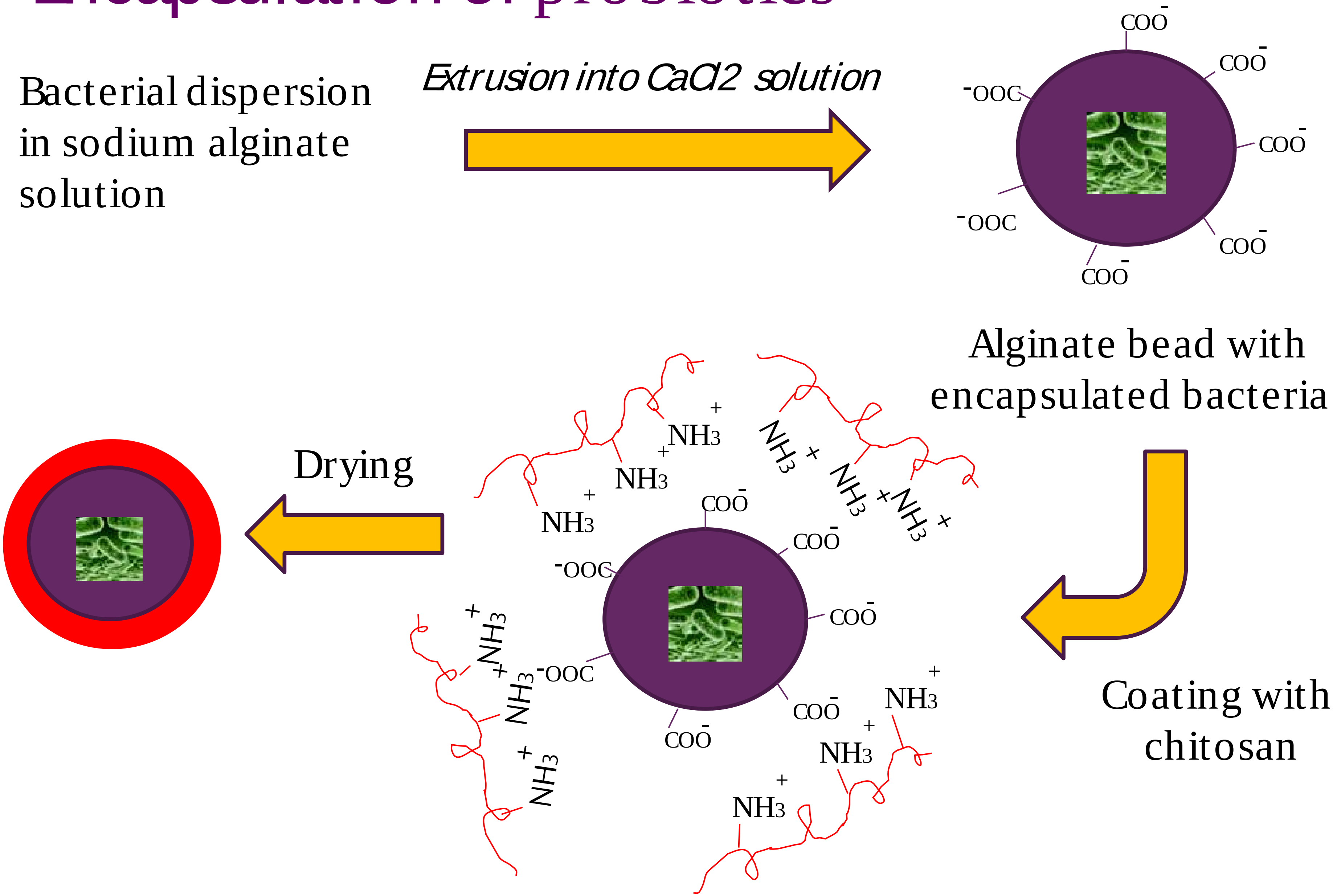
Significant amount of literature

Technologies: Extrusion, Emulsion
Coating technologies

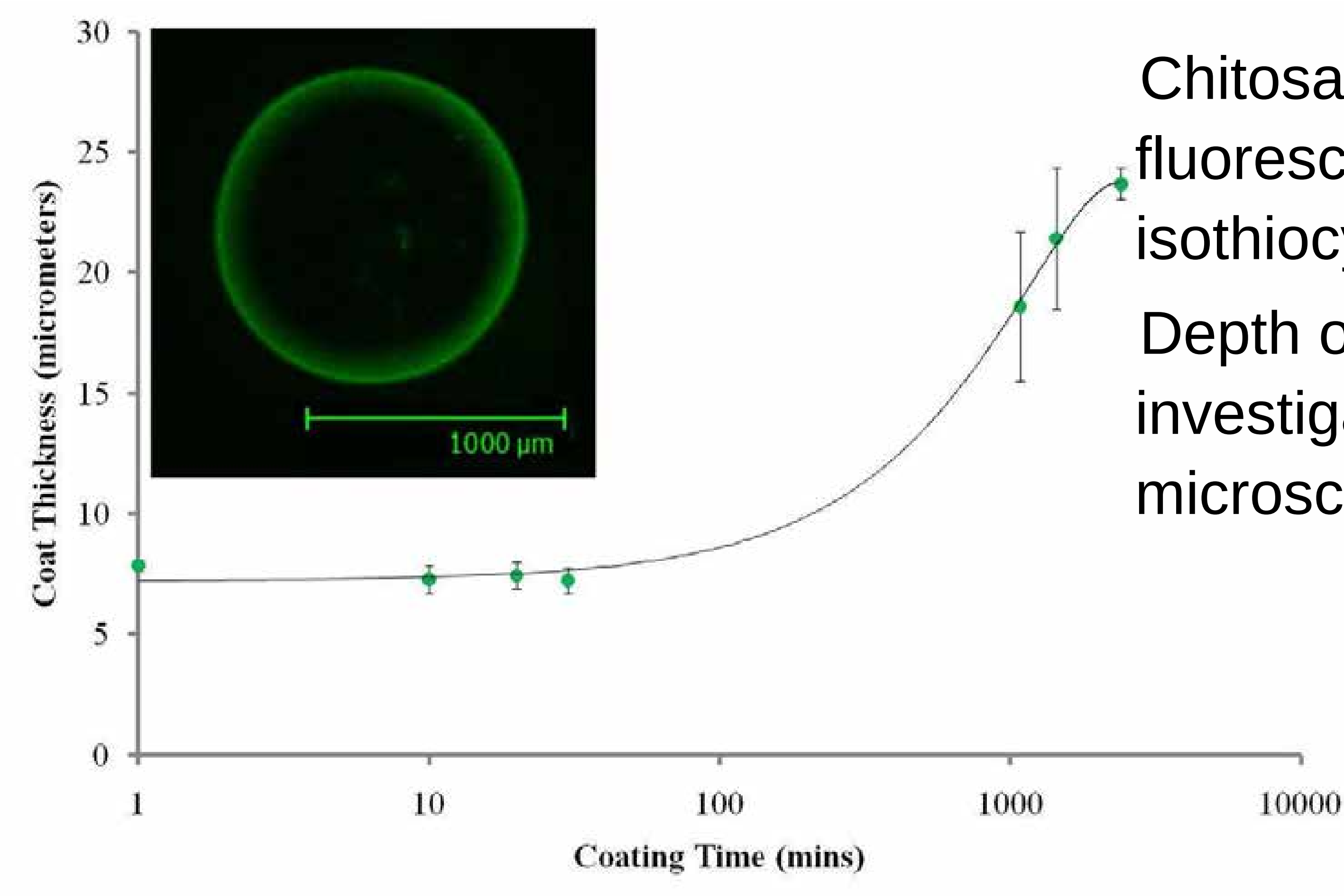
Capsules' characteristics
Size
Porosity
Physical properties

Journal of Controlled Release, 162, 56-67 (2012)

Encapsulation of probiotics



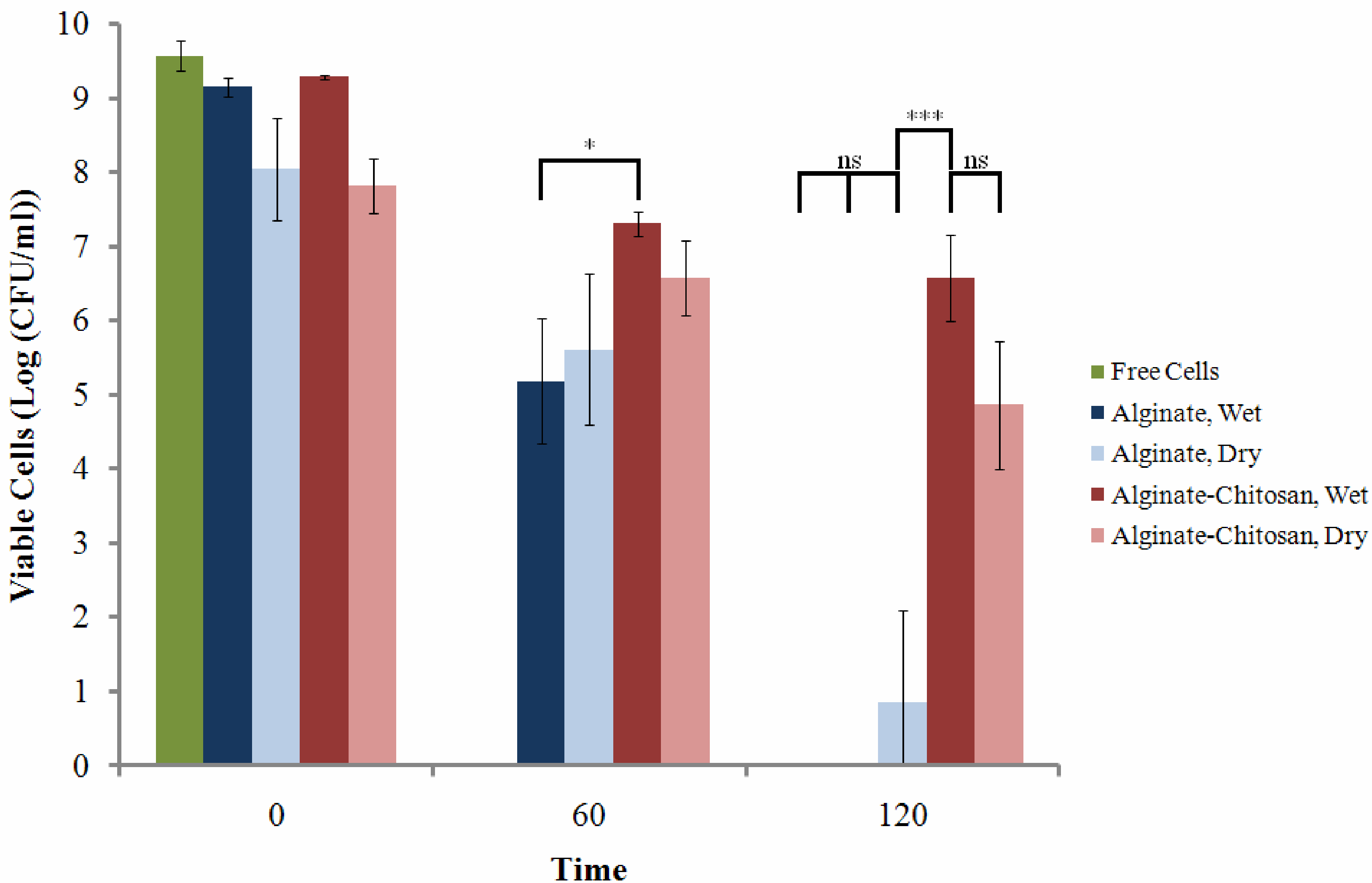
Coat thickness as a function of chitosan exposure time



- Chitosan labelled with fluorescein isothiocyanate
- Depth of penetration investigated by confocal microscopy

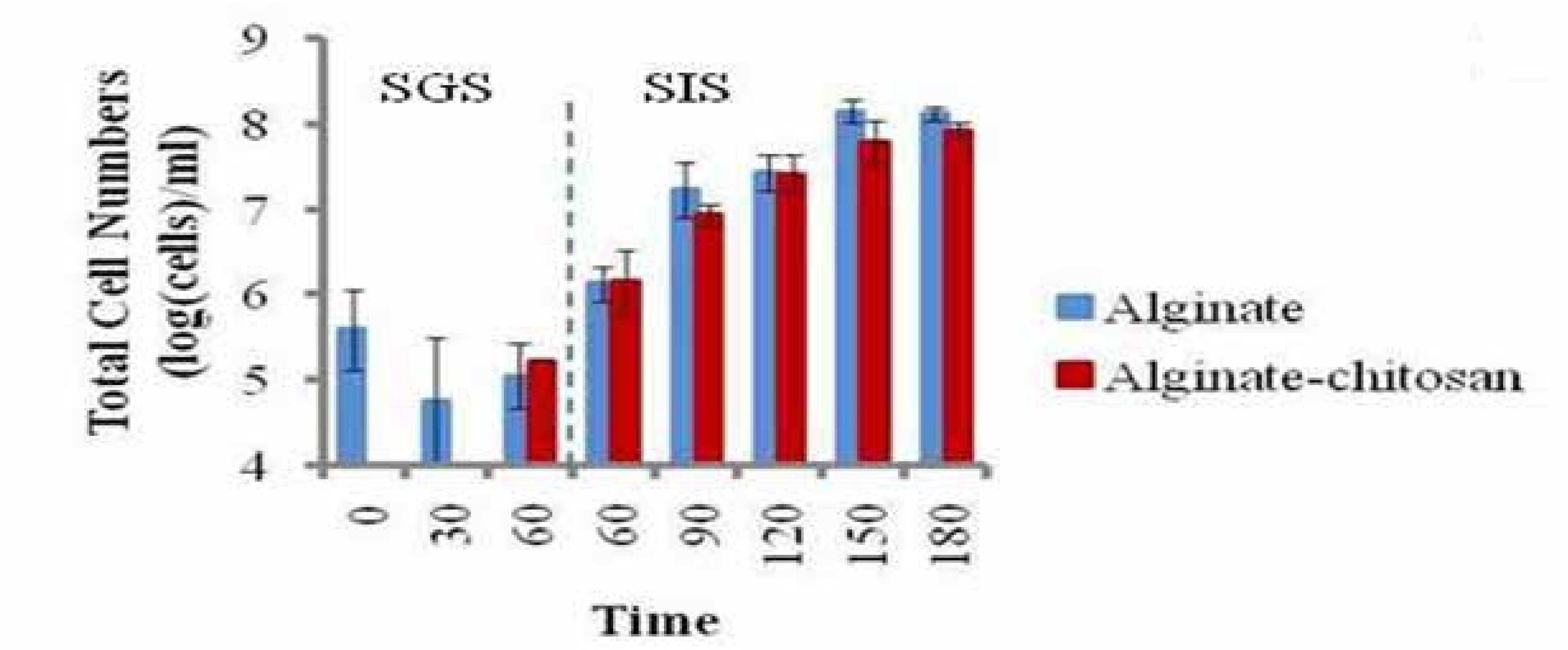
Biomacromolecules, 12, 2834-2840 (2011)

Viability of free and encapsulated *B. breve* in simulated model gastric solution



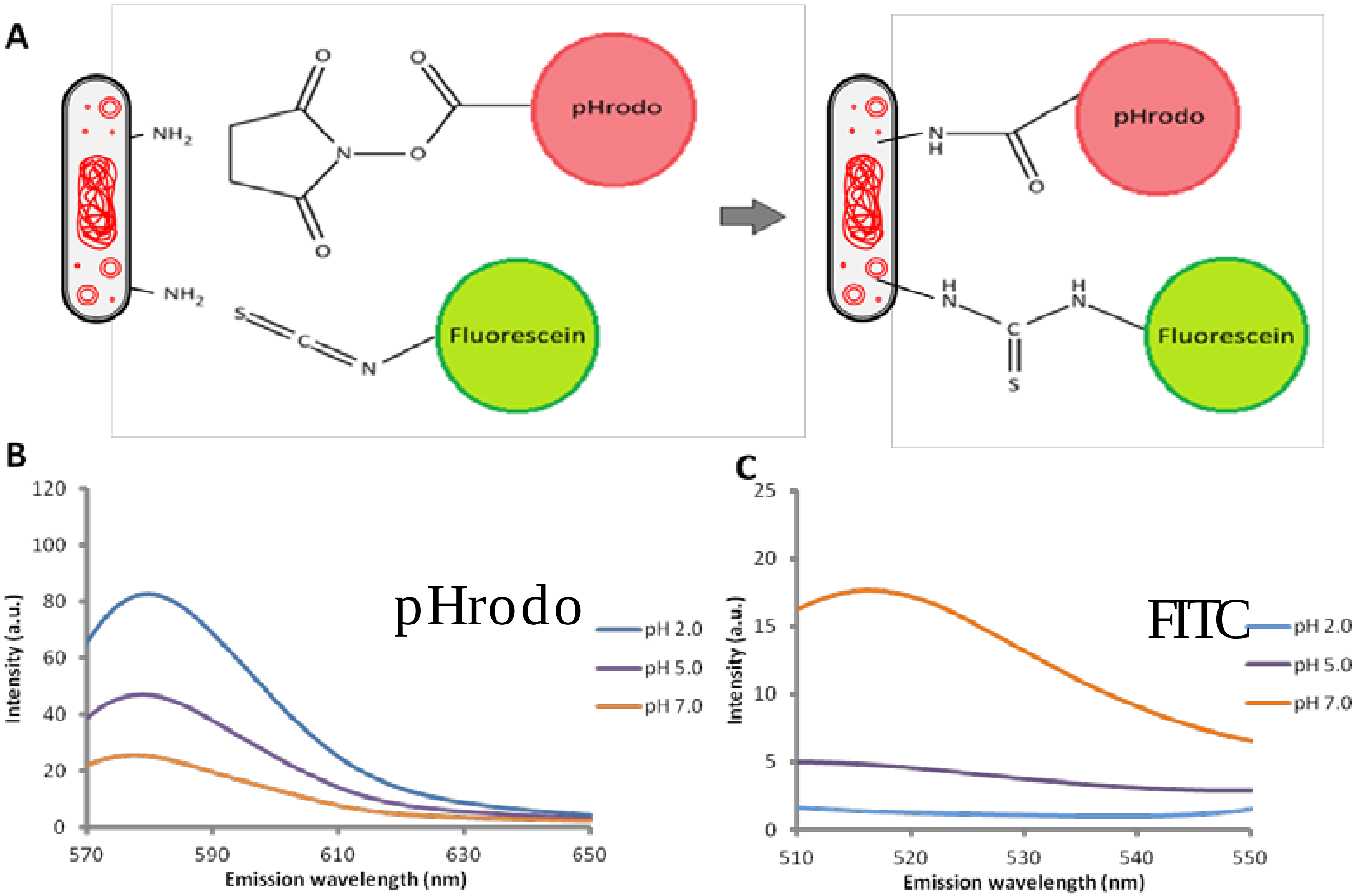
Biomacromolecules, 12, 2834-2840 (2011)

Release of cells during exposure to simulated gastric and intestinal solutions



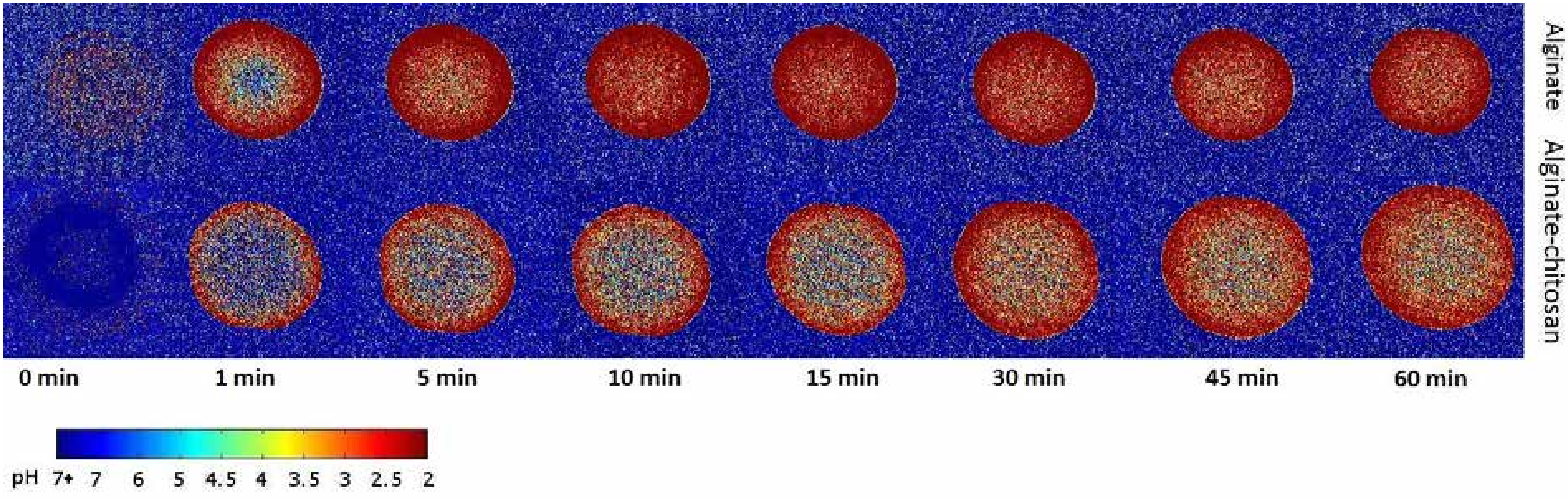
Biomacromolecules, 12, 2834-2840 (2011)

Understanding the mechanism of protection against acid



Biomacromolecules, 14, 387-393 (2013)

Understanding the mechanism of protection against acid



Biomacromolecules, 14, 387-393 (2013)

Methods for drying the microcapsules

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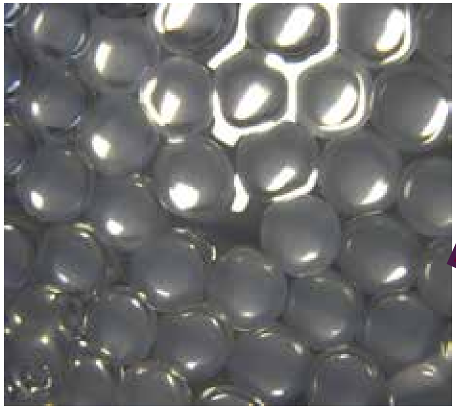
Wet alginate beads



Air drying

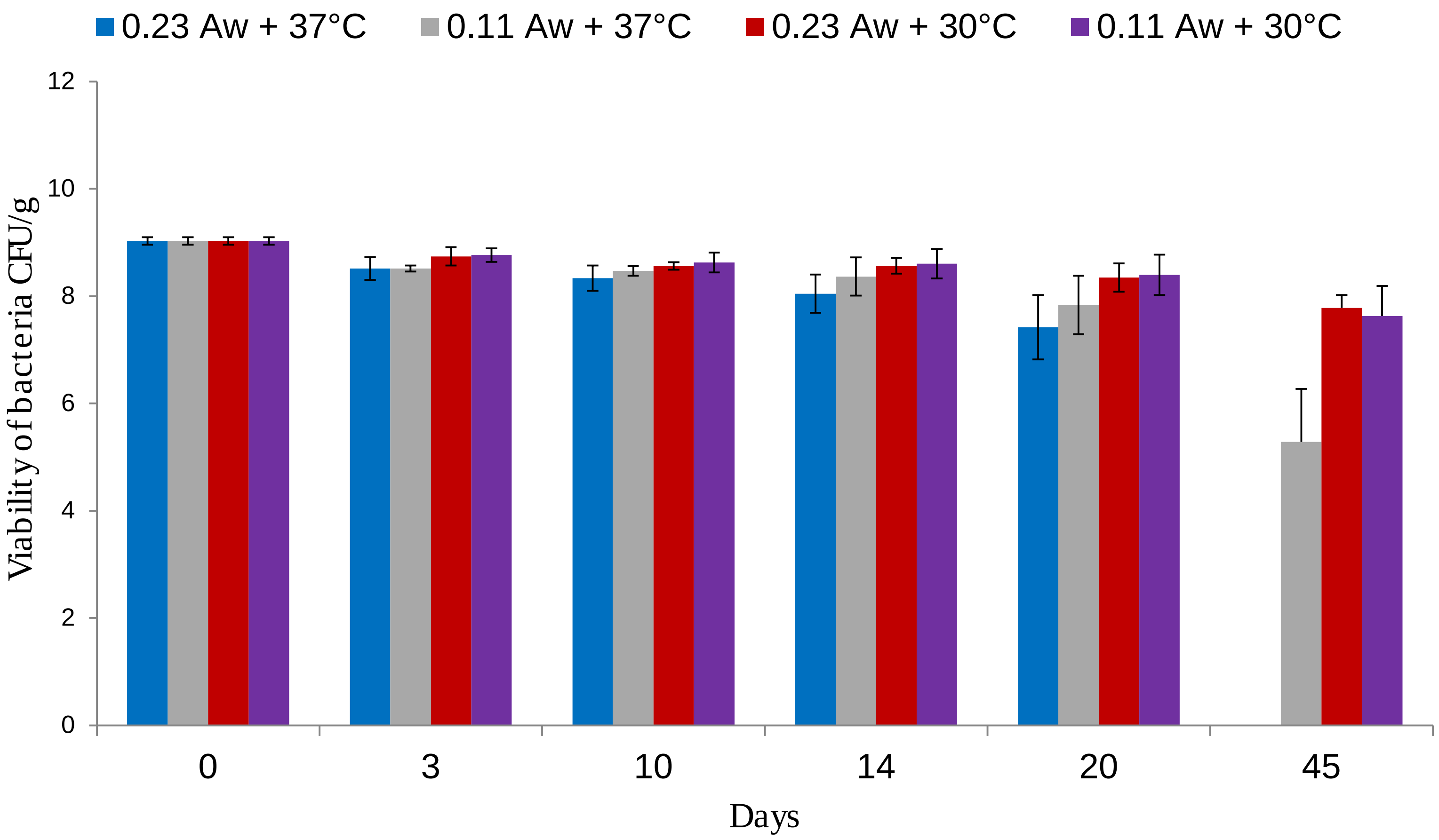
Problems:

- flat beads sticking together;
- slow process;
- not scalable;
- clumping

Fluidised bed drying

Biomacromolecules, 12, 2834-2840 (2011)

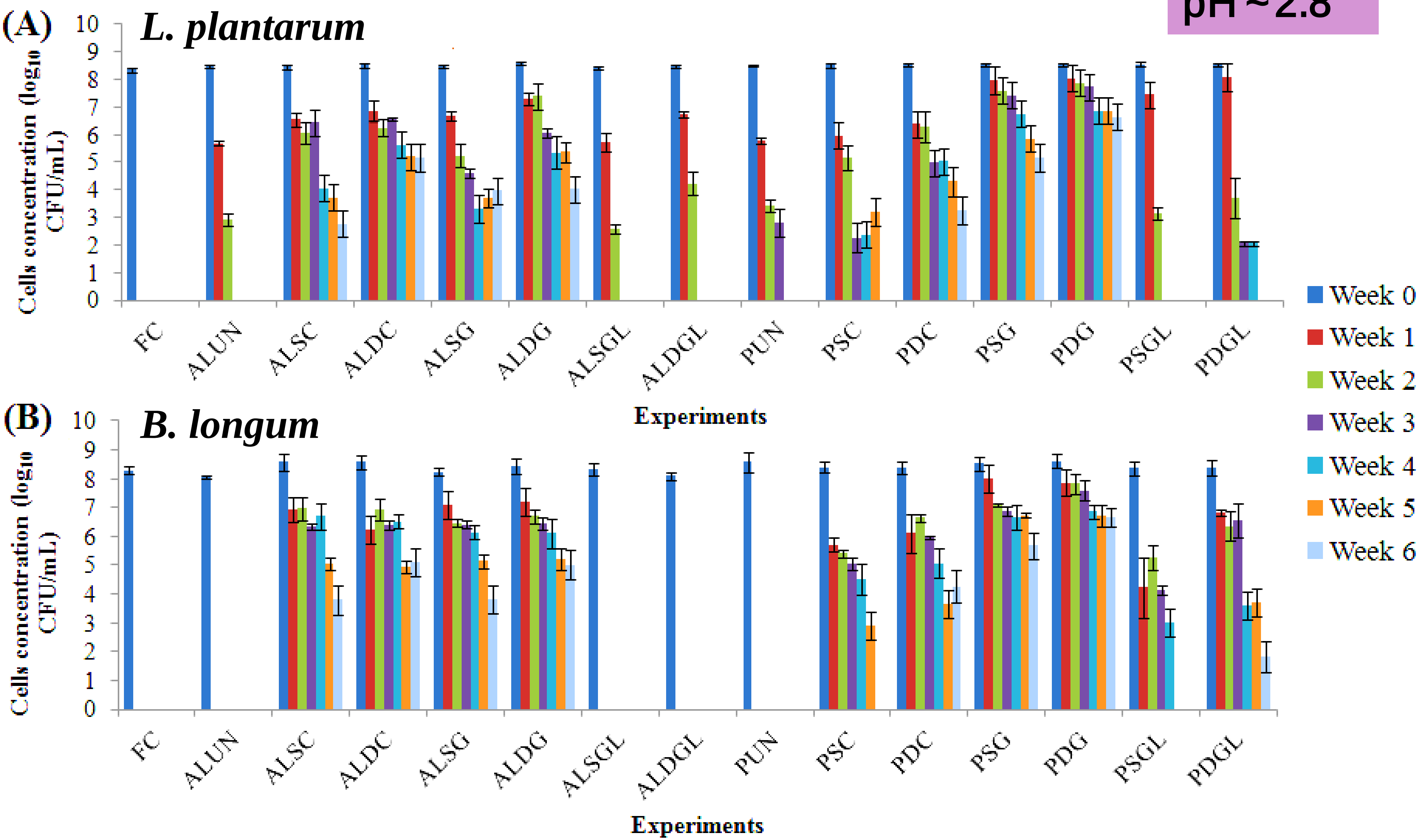
Stability of fluid bed dried encapsulated cells during accelerated storage



Food Research International, 74, 208-216 (2015)

Survival in fruit juices - Cranberry juice

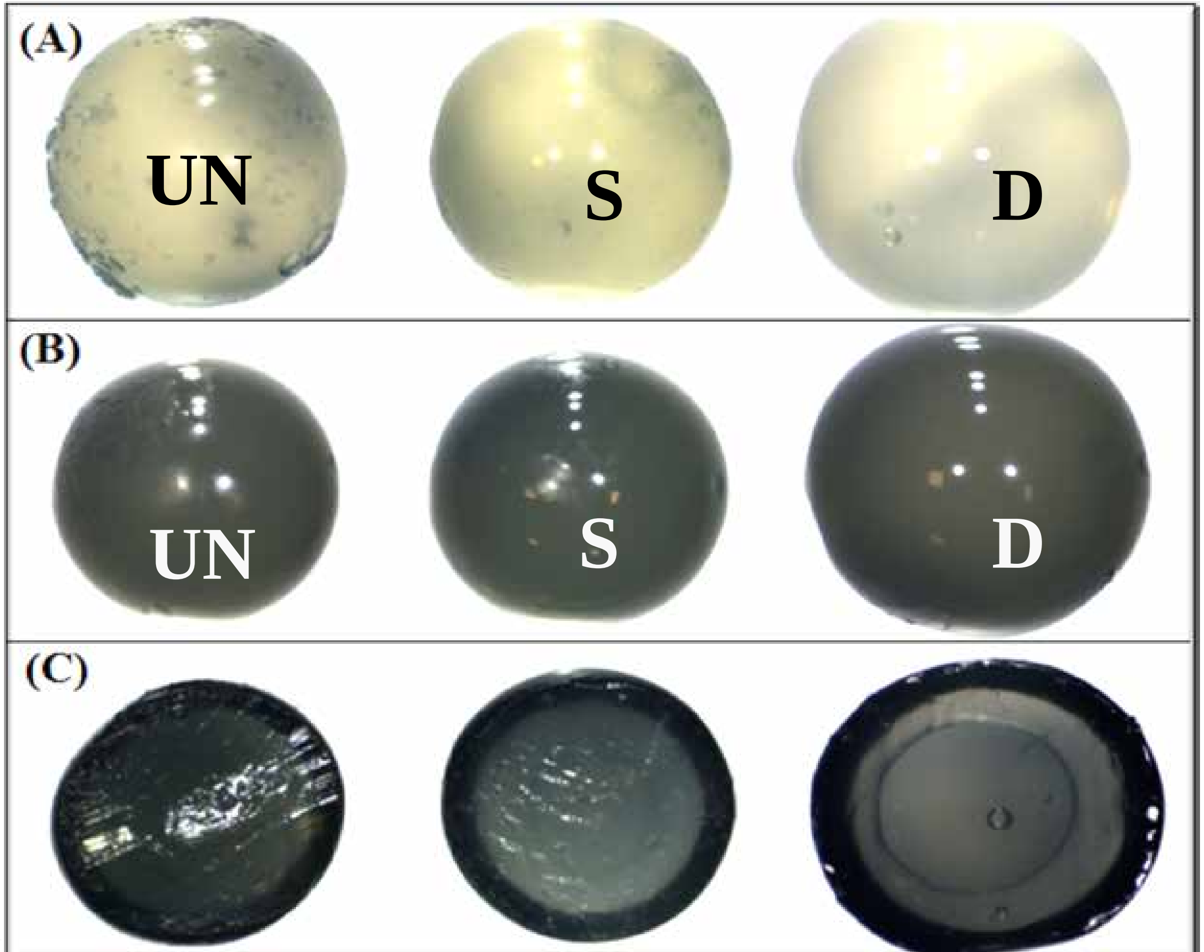
pH ~2.8



Food Research International, 53, 304-311 (2013)

Protection against phenolics

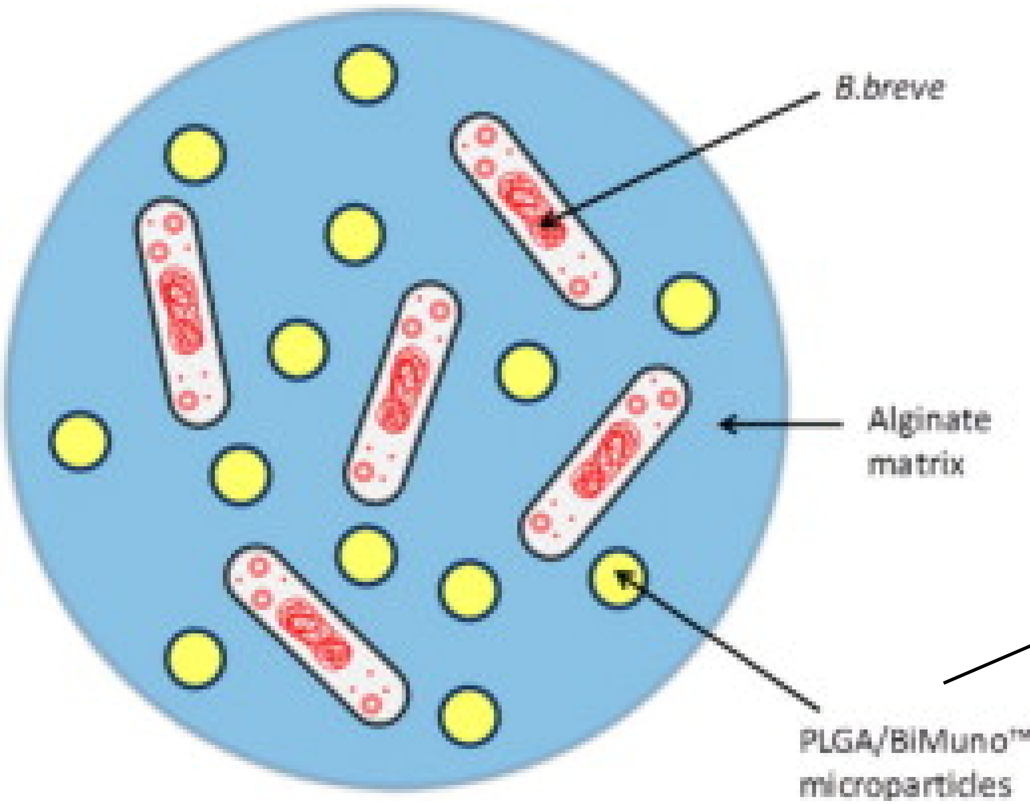
Control



The beads were in 1% gallic acid 1 h (pH = 3) and then Folin–Ciocalteu reagent was added to form the colour

Food Research International, 53, 304-311 (2013)

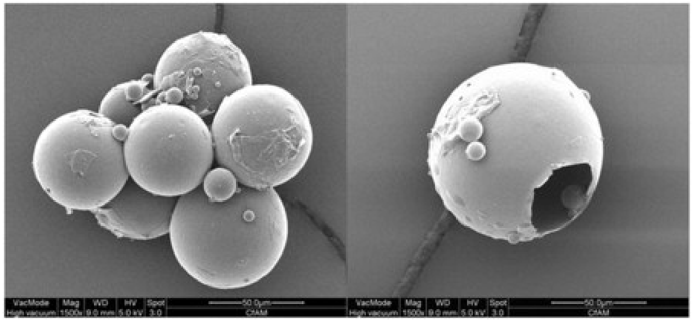
Microencapsulation of a synbiotic (probiotic + prebiotic) into PLGA/alginate multiparticulate gels

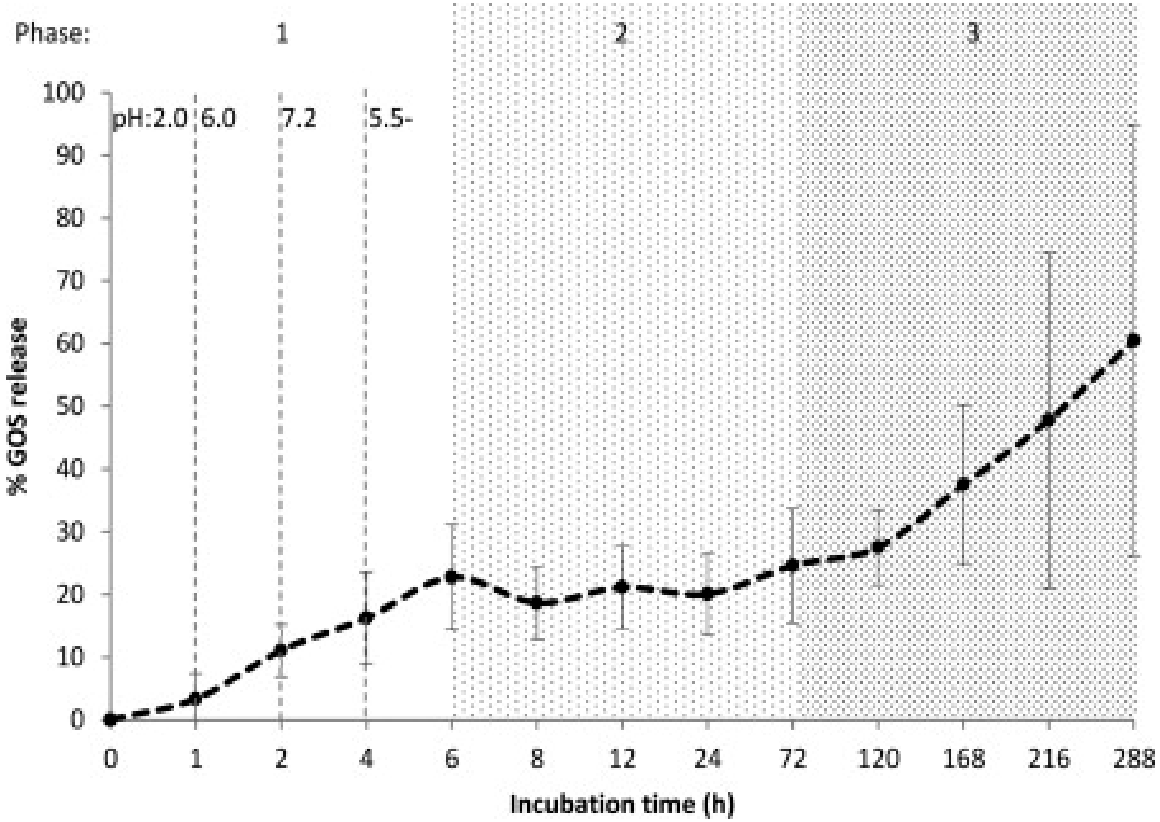


Prebiotic galacto-oligosaccharide (GOS)

International Journal of Pharmaceutics, 466, 400-408 (2014)

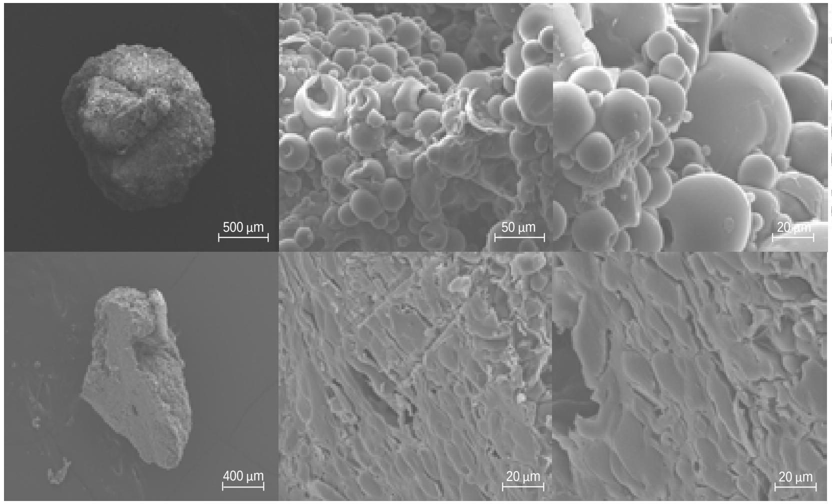
Release of GOS from PLGA microparticles

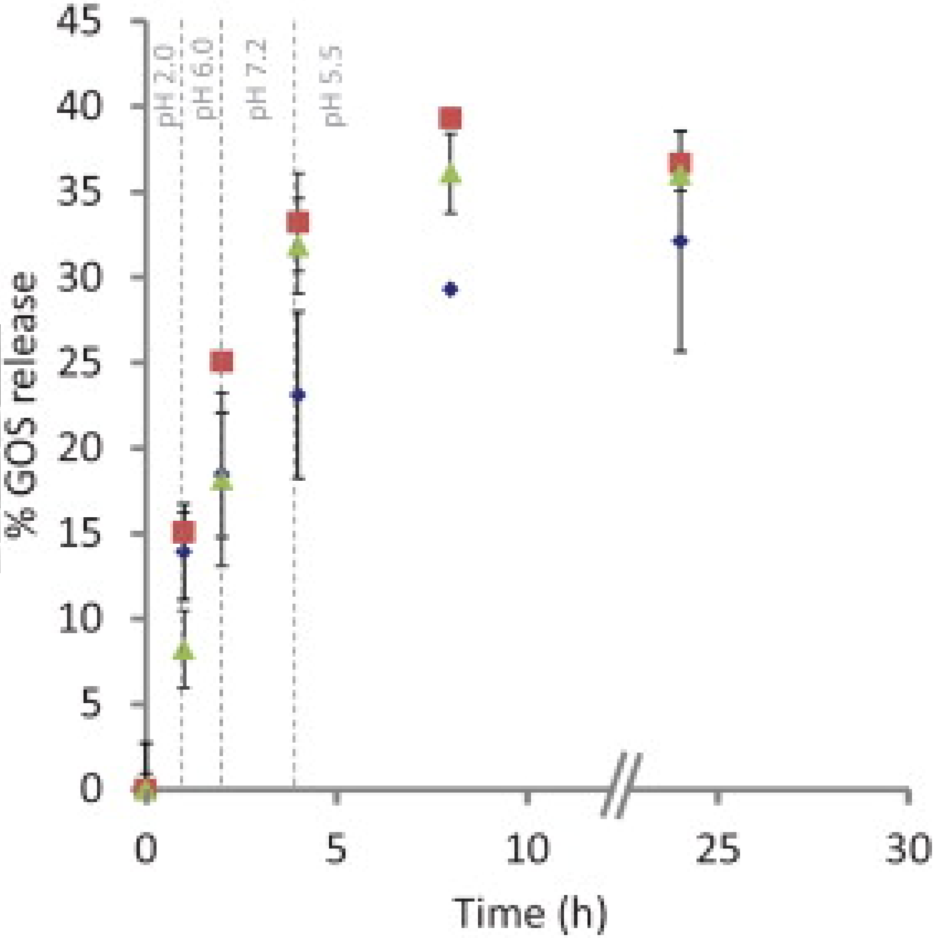




International Journal of Pharmaceutics, 466, 400-408 (2014)

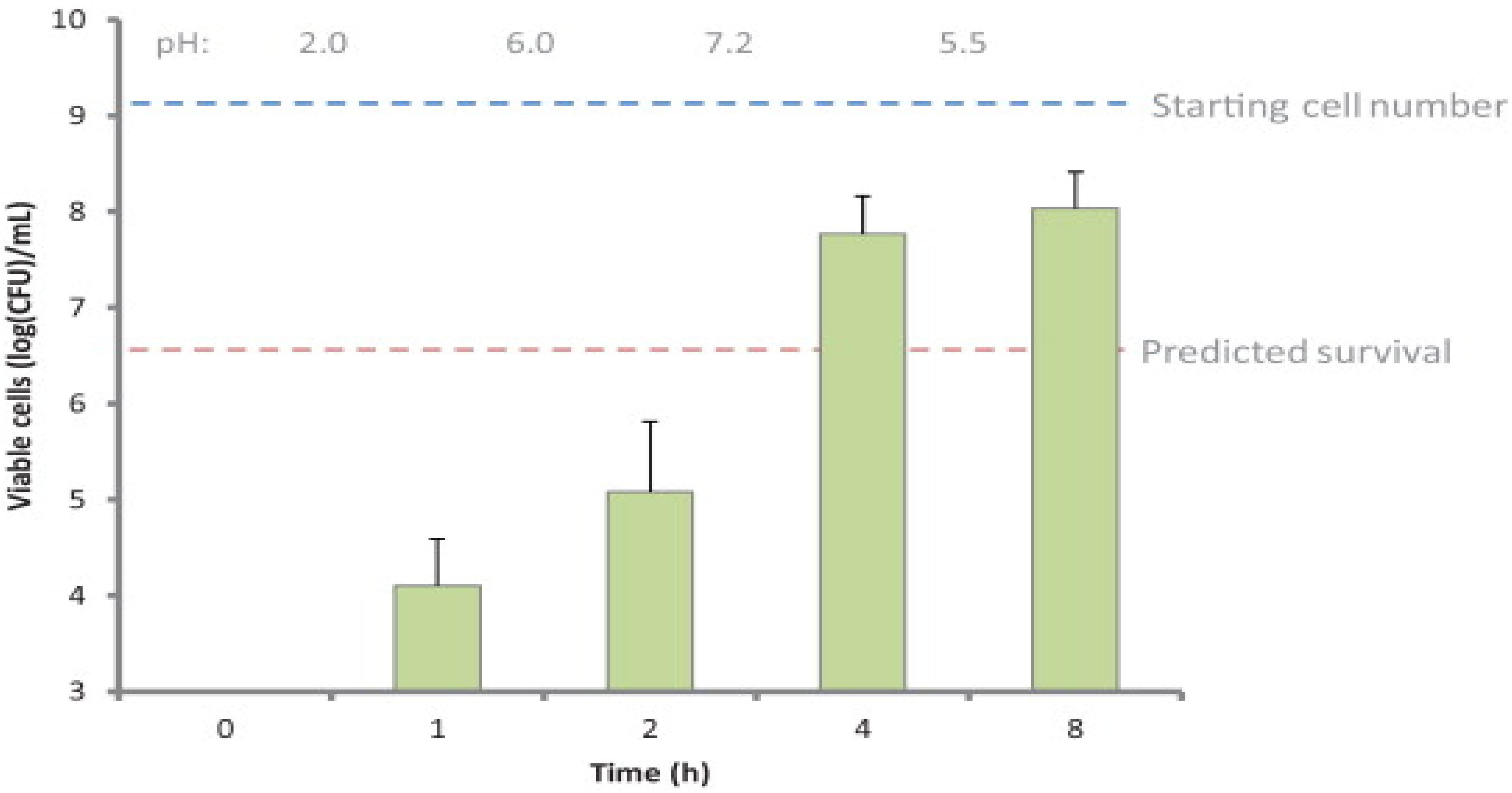
Release of GOS from PLGA/alginate (blue diamonds) and PLGA/alginate–chitosan (red squares) multiparticulates





International Journal of Pharmaceutics, 466, 400-408 (2014)

Release of probiotic from PLGA/alginate multiparticulates



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Future research

- Develop small size microcapsules that offer good protection and understand the influence of size and physiochemical properties on the organoleptic properties of the food
- Develop scalable technologies
- Design and develop encapsulation that can deliver probiotics and prebiotics and specific areas of the GIT
- Study the delivery/release of the microcapsules in animal models of inflammatory bowel disease (e.g. Crohn's disease and ulcerative colitis) and human trials