Polysaccharide and exopolysaccharide utilisation in processed and natural cheese systems

A thesis presented in partial fulfilment of the requirements for the degree of

Doctor of Philosophy

in

Food Technology

at Massey University, Palmerston North,

New Zealand.

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New Zealand

2011

Appendix D

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Abstract

Several polysaccharides are of interest in dairy products because of their ability to bind water and other components of the food systems, often leading to major changes in their functional properties. This work aimed to measure and understand the effects of specific polysaccharides in cheeses on the rheological properties related to functionality. The following polysaccharide–cheese systems were used: the microbial polysaccharides xanthan gum (xanthan), high acyl gellan gum (Gellan-H) and low acyl gellan gum (Gellan-L) in processed cheese and an exopolysaccharide (EPS) from a lactic acid bacteria (LAB) in very low fat Mozzarella cheese. Locust bean gum (LBG) was also used with xanthan.

Model processed cheese using rennet casein and soya oil was developed on a small scale (30 g) using a controlled temperature, stirrer speed and time of mixing. Initially, lactose content, moisture losses and sample preparation were standardised to lower the variability in rheological measurements. The effects of xanthan, xanthan+LBG, Gellan-H and Gellan-L on the rheology of the processed cheese were studied. As the polysaccharide concentration increased from 0.0 to 2.0% (wt/wt), the fracture stress (firmness) increased whereas the fracture strain (longness) decreased for gellan gum and the effect depended on the polysaccharide. The crossover temperature (where $G' = G''$), an indicator of viscoelasticity, was increased dramatically by these polysaccharides. Confocal laser scanning microscopy showed polysaccharide clusters in the protein matrix for Gellan-H, xanthan and xanthan+LBG but not very distinct clusters for Gellan-L.

The effect of Gellan-H and Gellan-L on the water mobility and spreading properties of model processed cheese was investigated. Spreading properties were measured by elongational viscosity, and water mobility was measured by nuclear magnetic resonance (NMR) relaxometry. The NMR data revealed that both polysaccharides significantly reduced the water mobility in the cheese but that the reduction was greater for Gellan-H. The rheology data showed that the addition of polysaccharide increased the elongational viscosity for processed cheese containing both Gellan-H and Gellan-L.

In situ exopolysaccharide (EPS)-producing cultures are widely used to improve moisture retention and texture in low fat cheese manufacture but are limited by a low level of EPS production. The aim of this study was to develop an "all-dairy" ingredient with an increased content of EPS and greater functionality of the EPS for dairy applications such as Mozzarella cheese. An EPS-producing *Streptococcus thermophilus* was chosen and its growth was optimised for the development of the bioingredient. The fermented biomass was harvested at the end of the exponential phase and freeze dried. The reduced viable cell count and the retention of ropiness of the powder from the drying process enabled a higher level of EPS inoculation in a preliminary Mozzarella cheese manufacturing trial.

Pilot-scale very low fat model Mozzarella cheese was manufactured with and without added EPS powder and in situ EPS culture (EPS-C). Large strain rheology, elongational viscosity, melt and NMR relaxometry were used to determine the effects of the in situ and added EPS on the functionality of the cheeses. Cheeses made with the EPS ingredient (EPS-P) retained the highest moisture content (66.0%) without any visible serum exudation. The cheeses made with non-EPS-producing cultures (CTR) and EPS-C had lower moisture contents of 57.5 and 60.2% respectively. Such higher moisture retention of the cheeses made with EPS-P was reflected in the rheological properties of the final cheeses. The cheeses made with EPS-P exhibited greater meltability, lower elongational viscosity and lower modulus of deformability (stiffness) and fracture stress than those made with EPS-C and CTR.

Future work to develop this area of the functional effects of the addition of polysaccharides to cheese would include protein–polysaccharide interactions and better definition of the water affinity of polysaccharide compared with that of protein.

Acknowledgements

I wish to take this opportunity to express my deep sense of gratitude to my primary supervisor, Mr Rod Bennett, Senior Lecturer, Massey University. I feel proud of having worked under his guidance; without his persistent help and calm and patient understanding, this work would not have been possible.

I also express my sincere thanks to my co-supervisor, Dr Philip Watkinson, for introducing me to this field and for his continuous encouragement and patience in the preparation of this thesis. My work is a reflection of the concrete suggestions and encouragement of my two supervisors.

I am thankful to Dr David Reid and Dr Siew Kim Lee for providing suggestions and valuable advice during the processed cheese investigation work. I also wish to thank Dr Alan Welman for his discussions and guidance on the exopolysaccharide work.

Special thanks to Doug Hopcroft and Liz Nickless for their valuable help in using confocal and transmission electron microscopes. I wish to thank Dr Jason Hindmarsh for his assistance with nuclear magnetic resonance experimentation work.

There are so many people at Fonterra Innovation, Palmerston North, that I would like to thank for their help and assistance. Thanks to you all: Susan, Lisa, Sally and Rama. Also thanks to Barbara Kuhn-Sherlock for her help with the statistical analyses.

Thanks to the postgraduate students in the Institute of Food, Nutrition and Human Health, who helped me to survive the process, especially Sandra, Teresa and Oni.

Finally, I wish to acknowledge the patience, courage and constant encouragement of my wife, Falguni, daughter, Kriti, and son, Harshil. Their moral boosting kept me going in this long endeavour. I certainly could not have done it without their sacrifices and unconditional support.

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