Application of Microencapsulation on Probiotic cheddar cheese ripening

Amin Seyed Yaghoubi
Department of Food science and Technology of Ferdowsi university of Mashhad, International Branch, Mashhad, IRAN
Email:amin.yagoubi@stu.um.ac.ir

Seyed Ali Mortazavi
Department of Food sience and Technology,
Ferdowsi University of Mashhad
Mashhad – IRAN

Taravat Ghanbarzadeh
Department of Food Science and Technology,
Quchan Branch, Islamic Azad University,
Quchan, Iran.
taravat_ghanbarzadeh@yahoo.com

Abstract— Micro and Nanoencapsulation are most practical and effective techniques for functional foods as probiotics, Prebiotics and Synbiotics. In order to increase of shelf life of probiotics and also improving of some physico-chemical properties of Cheddar cheese, microencapsulation technique can be used effectively in this field. Due to the importance of Cheddar cheese ripening, it is necessary to maintain the favorable conditions for survival of probiotics and also enhance of ripening time via controlled release.

Keywords: Probiotic, Microencapsulation, Cheddar Cheese, Ripening.

INTRODUCTION

Encapsulation may be defined as a process to entrap one substance within another substance, thereby producing particles with diameters of a few nm to a few mm. Controlled release of food ingredients at the right place and the right time is a key functionality that can be provided by microencapsulation[20].

Encapsulation describes different processes to cover an active compound with a protective wall material and it can be employed to treat flavours so as to impart some degree of protection against evaporation, reaction, or migration in a food. Three main types of encapsulates might be distinguished, i.e., the reservoir type, matrix type and coated matrix type [14]. The Development of microencapsulation products started in 1950s in the research into pressure-sensitive coatings for the manufacture of carbonless copying paper Encapsulation technology is now well developed and accepted within the pharmaceutical, chemical, cosmetic, foods and printing industries. In food products, fats and oils, aroma compounds and oleoresins, vitamins, minerals, colorants, and enzymes have been encapsulated [2].

Benefits of Microencapsulation

Microcapsules have a number of interesting advantages, and the main reasons for microencapsulation can be summarized as follows: Protection of unstable, sensitive materials from their environments prior to use. Better processability (improving solubility, dispersibility, flowability). To decrease the transfer rate of the core material to the outside environment. Shelf-life enhancement by preventing degradative reactions (oxidation, dehydration). Controlled, sustained, or timed release. Safe and convenient handling of toxic materials. Masking of odor or taste. Enzyme and microorganism immobilization. Controlled and targeted drug delivery. Handling liquids as solids [23].

PROBIOTICS

Probiotics is defined as ‘‘live microorganisms, which when consumed in adequate amounts, confer a health effect on the host [6]. Most probiotics in the food supply are used in fermented milks and dairy products. The bacteria in a product should remain metabolically stable and active, surviving passage through the upper digestive tract in large numbers sufficient enough to produce beneficial effects when in the host intestines [21]. Survival of these bacteria during the product shelf life until being consumed is therefore an important consideration. Suggested beneficial minimum level for probiotics in yogurt is 10^6 cfu/mL and daily intake should be about 10^8 cfu. Encapsulation has been investigated for improving the viability of microorganisms in both dairy products and the intestinal tract[19]. For dairy and food applications, probiotic encapsulation in food grade, porous matrices has been most widely used [5].

The probiotic effects

Competition with pathogens. preventing intestinal infection. ease of digestion of food. lowering of serum cholesterol levels. possessing anticarcinogenic activity. enhancement of the immune system. production of acid and/or bacteriocins. improving lactose utilization in persons who are lactose intolerant [18].

Techniques for Probiotic Encapsulation

Physicomechanically (Spray drying technique) and Chemically (extrusion and emulsion techniques). All these techniques have been proven to increase the survival of probiotics by up to 90% [11].

Among the well-known microencapsulation methods, spray-drying is most widely used in the chemical, pharmaceutical, and food industries due to its inherent attributes such as high production rates and relatively low operational cost [3].

The principle of spray-drying technique involves dissolving a polymer, in the continuous phase, which surrounds the core material particles (encapsulant such as probiotics) inside the sprayed droplets. However, exposure to high air temperatures required to facilitate water evaporation during the passage of the bacteria in the spray-drying chamber exerts a negative impact on their viability and hampers their activity in the spray-dried product [7].

Probiotic viability in dairy products

A number of factors may affect the loss of viability of probiotics in fermented milks. They include acidity, post acidification, level of oxygen and oxygen permeation through the package, sensitivity to antimicrobial substances synthesized by starter bacteria, and lack of nutrients[15]. Two main options are pursued to increase the viability—enhancing the probiotic stress response and the use of other vehicles for probiotic delivery.

Cheese

Cheese is the generic name for a group of fermented milk-based food products produced throughout the world in a great diversity of flavours, textures, and forms [22]. An essential part of the cheese-making process is the conversion of a liquid, milk, into a solid material, the curd, that contains casein and fat of the milk, but has expelled the main part of the water, and usually, the whey proteins. This is achieved by the addition of rennet to coagulate the casein gel [17]. The cheese curd thus forms the basis of the cheese, which is later modified by processes such as pressing, salting and ripening [1].

A production of 17,778 million tonnes (t) in 2004 was reported, which corresponds to a growth of almost 3272 t in the last decade. Cheese from cow's milk represents 95%-96% of the total cheese production (8). In 2006, an increase of 550,000 t (or 2.3%) in relation to 2005 was reported. European countries, including Ireland, Belgium, Germany, the Netherlands, and France registered the main production increase, with a similar tendency observed in the USA. [9].

Effects of microencapsulation on cheese quality

Traditional cheese maturation involves a series of complex biochemical and microbiological process that occur at a very slow rate. Though most varieties of cheese ripen fast, certain varieties, especially low moisture varieties such as Cheddar, require longer ripening to develop the flavour, texture, taste and aroma characteristics of mature cheese [16]. Introducing encapsulated probiotics in cheese not only enhances the storage viability of probiotics but also improves the flavor of cheese. Due to a relative high pH (pH 5.5), Cheddar cheese presents the advantage of being a good carrier of probiotic microorganisms.

Cheese Ripening

The ripening process of cheese is very complex and involves microbiological and biochemical changes in the curd, resulting in the flavour and texture characteristic of a particular variety [4].

spray dried Advantages are the cost-effectiveness and the applicability to large scale production compared to traditional methods like freezing or freeze-drying. it seems that the ME is not necessary for increasing the probiotic viability in Cheddar cheese but in the case of fresh cheese [10]. For example, the ME is a good way of enhancing probiotic viability because of the low pH value of the product [6].

The presence of ripening stages during cheese processing is an additional problem for the stability of a probiotic culture, as its survival through this period cannot be predicted with accuracy.

Biochemical changes occurring inside the cheese environment, as water activity decreases, sometimes together with a decrease in pH, create a hostile and stressful environment for the adjunct cultures[21].

An additional problem is the proliferation of a population of non-pathogenic adventitious bacteria, usually lactobacilli and pediococci, which often become the dominant microbiota in cheese. They are also called non-starter lactic acid bacteria (NSLAB) [13].

Some results shown that Increasing the cheese ripening temperature from 4 °C to 8 °C did not affect the viability of the probiotic microorganisms, the salt, fat and protein contents of the cheeses during ripening of 24 wk [12].

the spray dried culture was stable for 7 weeks while it was kept at room temperature and during refrigeration as well.

Conclusions

Shell materials and Technologies have been developed and an extremely wide variety of functionalities can now be achieved through microencapsulation. Any type of factors can be used to prompt the release of the encapsulated ingredients, such as: pH changes, mechanical stress, temperature, enzymatic activity, time ,osmotic force. Encapsulated probiotic bacteria can be used in many fermented dairy products, such as yoghurt, cheese, cultured cream and frozen dairy desserts, and for biomass production. Another major challenge is to improve the viability of probiotics during the manufacturing processes, particularly heat processing. Keeping in view the importance of producing thermoresistant probiotic microorganisms, as well as the interests of food and pharmaceutical Companies. There are at least two options: discovering new strains of probiotic bacteria that are naturally heat stable or that have been genetically modified. developing an encapsulation system that effectively acts like an ''insulation material''.

Coating of capsules with some lipids, with high melting points, may also Provide low moisture conditions and an anaerobic environment for probiotic bacteria and may possibly improve thermal stability.

References

[1] A. G. D. Cruza, F. C. A. Buritib, C. H. B. de Souzab, J. A. F. Faria,1 and S. M. I. Saad. “Probiotic cheese: health benefits, technological and stability aspects”, Trends in Food Science & Technology 20 , 2009, 344-354.

[2] A. Madene, M. Jacquot, J. Scher & S. Desobry, “Flavour encapsulation and controlled release – a review” International Journal of Food Science and Technology, 41, 2006, 1–21.

[3] B. F. Gibbs, S. Kermasha, I. Alli, & C.N. Mulligran, “Pressure-and heat-induced gelation of mixed beta-lactoglobulin/polysaccharide solutions: scanning electron microscopy of gels”. Food Hydrocolloids, 13, 1999, 339–351.

[4] B. Ozer, Y. S. Uzun, H. A. Kirmaci, “Effect of microencapsulation on viability of Lactobacillus acidophilus La-5 and Bifidobacterium bifidum Bb-12 during kasar cheese ripening” International Journal of Dairy Technology, 61(3), 2008, 237-244.

[5] C. P. Champagne, C. Lacroix, & S. Gallot,” Immobilized cell technologies for the dairy industry. Critical Reviews in Biotechnology, 14(2), 1994, 109–134.

[6] D. Semyonov, O. Ramon, A. Kovacs, L. Friedlander, and E. Shimoni, “Air-Suspension Fluidized-Bed Microencapsulation of Probiotics,” Drying Technology, 30, 2012, 1918–1930.

[7] E. Ananta, M, Volkert, & D. Knorr, “Cellular injuries and storage stability of spray-dried Lactobacillus rhamnosus GG”, International Dairy Journal, 15(4), 2005, 399–409.

[8] International Dairy Federation, “The world market for cheese “ Bulletin IDF, 402, 2005, 5-18.

[9] International Dairy Federation, “The world dairy situation”, Bulletin IDF, 423, 2007, 5-18.

[10] K. Kailasapathy, & S. H. Lam, ”Application of encapsulated enzymes to accelerate cheese ripening”. International Dairy Journal, 15(6-9) , 2005, 929–939.

[11] K. M. K. Kebary, S. A.. Hussein, & R. M. Badawi, “Improving viability of Bifidobacteria and their effect on frozen ice milk. Egyptian Journal of Dairy Science, 26(2), 1998, 319–337.

[12] L. Ong, N.P. Shah, “Probiotic Cheddar cheese: Influence of ripening temperatures on survival of probiotic microorganisms, cheese composition and organic acid profiles,” LWT- Food Science and Technology 42 ,2009, 1260–1268.

[13] M. Hayes, M. Coakley, L. O’Sullivan, C. Stanton, C. Hill, G. F., Fitzgerald, “Cheese as a delivery vehicle for probiotics and biogenic substances”. Australian Journal of Dairy Technology, 61(2), 2006, 132-141.

[14] N. J. Zuidam, E. Shimoni, “Overview of microencapsulates for use in food products or processes and methods to take them,” Springer-Verlag, New York Inc, 2009, pp. 3–29.

[15] N. P. Shah, “Functional cultures and health benefits,” *Intern. Dairy* J, 17, 2007, 1262–1277.

[16] P. L. H. McSweeney, “Biochemistry of cheese ripening”, International Journal of Dairy Technology, 57(2-3), 2004, 127-144.

[17] Phillips M., Kailasapathy K., Tran L., Viability of commercial probiotic cultures (L. acidophilus, Bifidobacterium sp., L. paracasei and L. rhamnosus) in Cheddar cheese, Int. J. Food Microbiol. 108 (2006) 276–280.

[18] P. L. Teoha , H. Mirhosseini , S. Mustafa, A. S. M. Hussin & M. Y. Abdul Manap, "Recent Approaches in the Development of Encapsulated Delivery Systems for Probiotics," Food Biotechnology, 25, 2011, 77–101.

[19] R. Fuller, "Probiotics: the scientific basis. London: Chapman & Hall. 1992.

[20] S. Gouin, "Microencapsulation: industrial appraisal of existing technologies and trends," Trends in Food Science & Technology 15 ,2004, 330–347.

[21] S. Rokka, P. Rantamäki, "Protecting probiotic bacteria by microencapsulation: challenges for industrial applications", Eur Food Res Technol , 231 , 2010, 1–12

[22] T. M. Brennan, M. Cogan, M. Loessner, S. Scherer, "Bacterial surface-ripened cheeses, in: Fox P.F., Mc Sweeney P.L.H, Cogan T.M., Guinee T.P. (Eds.), Cheese: Major Cheese Groups, Elsevier, Oxford, UK, pp, 2004, 199–225.

[23] W. Krasaekoopt, B. Bhandari, & H. Deeth, "Evaluation of encapsulation techniques of probiotics for yoghurt". International Dairy Journal, 13(1), 2003, 3–13.