

Encapsulation of nutraceuticals: from fermentation to biological effect



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The aim of the research project is the development of capsules, which can trap probiotic microorganisms and allow their fermentation, to obtain a semi-finished product potentially usable in the formulation of new functional foods. Probiotics are “live microorganisms which when administered in adequate amounts confer a health benefit on the host”[1] and fermentation is the key biotechnological process, ensuring the growth of microorganisms and the production of metabolites, such as lactic acid and SCFA which may participate to the healthy effect promoted by probiotics.

Recent scientific evidences [2], [3] also suggest the importance of postbiotics, defined as “preparation of inanimate microorganisms and/or their components that confers a health benefit on the host”[4]. Postbiotics are therefore the results of a probiotic inactivation phase, which lead to a safer and more stable product.

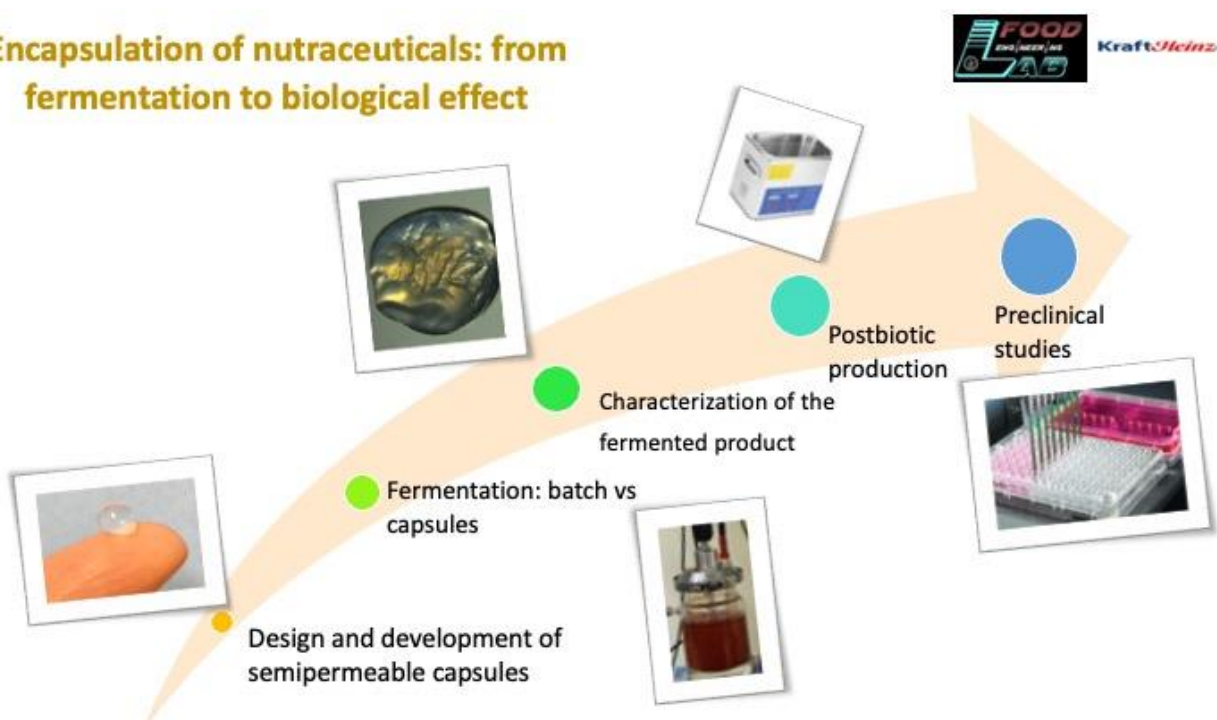
Both probiotics and postbiotics can be enclosed in capsules, suitably designed to protect these nutraceuticals during the production process, storage or gastrointestinal transit [5], [6].

Immobilization of probiotics through encapsulation may also allow for high cell density to be achieved [7] and could improve the fermentation process. For instance, capsules can be imagined as bioreactors in which the immobilized probiotic carries out fermentation: the very small fermentation volume into capsules avoids spatial inhomogeneities, which would lead to significant inefficiencies in the fermentation process.

Therefore, in the present work semipermeable capsules will be developed, capable of segregating the probiotic cell, allowing its fermentation and, at the same time, allowing the metabolites produced to escape.

The probiotic will be inactivated through an appropriate mild method, such as mild thermal treatment or sonication, and the postbiotic produced will be tested through pre-clinical studies for its potential health effect.

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Bibliography

- [1] C. Hill *et al.*, "The International Scientific Association for Probiotics and Prebiotics consensus statement on the scope and appropriate use of the term probiotic," *Nat. Rev. Gastroenterol. Hepatol.* 2014 118, vol. 11, no. 8, pp. 506–514, Jun. 2014, doi: 10.1038/nrgastro.2014.66.
- [2] D. Morniroli, G. Vizzari, A. Consales, F. Mosca, and M. Gianni, "Postbiotic Supplementation for Children and Newborn's Health," *Nutrients*, vol. 13, no. 3, pp. 1–11, Mar. 2021, doi: 10.3390/NU13030781.
- [3] A. Rad, A. Abbasi, H. Kafil, and K. Ganbarov, "Potential Pharmaceutical and Food Applications of Postbiotics: A Review," *Curr. Pharm. Biotechnol.*, vol. 21, no. 15, pp. 1576–1587, May 2020, doi: 10.2174/1389201021666200516154833.
- [4] S. Salminen *et al.*, "The International Scientific Association of Probiotics and Prebiotics (ISAPP) consensus statement on the definition and scope of postbiotics," *Nat. Rev. Gastroenterol. Hepatol.*, vol. 18, no. 9, pp. 649–667, Sep. 2021, doi: 10.1038/S41575-021-00440-6.
- [5] S. Sáez-Orviz *et al.*, "Lactic Acid Bacteria Co-Encapsulated with Lactobionic Acid: Probiotic Viability during In Vitro Digestion," *Appl. Sci.* 2021, Vol. 11, Page 11404, vol. 11, no. 23, p. 11404, Dec. 2021, doi: 10.3390/APP112311404.
- [6] K. Oberoi, A. Tolun, Z. Altintas, and S. Sharma, "Effect of Alginate-Microencapsulated Hydrogels on the Survival of *Lactobacillus rhamnosus* under Simulated Gastrointestinal Conditions," *Foods* 2021, Vol. 10, Page 1999, vol. 10, no. 9, p. 1999, Aug. 2021, doi: 10.3390/FOODS10091999.
- [7] C. Champagne, C. Lacroix, and I. Sodini-Gallot, "Immobilized cell technologies for the dairy industry," *Crit. Rev. Biotechnol.*, vol. 14, no. 2, pp. 109–134, 1994, doi: 10.3109/07388559409086964.

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