Microencapsulación de algunos compuestos bioactivos mediante secado por aspersión

Microencapsulation of some bioactive compounds through spray drying

A microencapsulação de alguns compostos bioactivos por secagem por aspersão

Juan José Luna Guevara
Benemérita Universidad Autónoma de Puebla, México
juanj.luna@correo.buap.mx

José Mariano López Fuentes
Benemérita Universidad Autónoma de Puebla, México
lombriculturapepe_buap@yahoo.com.mx

Oscar Jiménez González
Benemérita Universidad Autónoma de Puebla, México
oscar_j123@hotmail.com

Lorena Luna Guevara
Benemérita Universidad Autónoma de Puebla, México
lunaguevara@yahoo.com.mx

Resumen

La microencapsulación (ME) permite la incorporación de ingredientes alimentarios en pequeñas cápsulas. Asimismo, favorece la conservación de sabores, aromas y compuestos como acidulantes, antioxidantes y vitaminas, así como algunos alimentos y materiales incluyendo aceites y microorganismos. La ME es una tecnología que puede contribuir al procesamiento de los alimentos al preservar su contenido nutricional, coadyuvar con una liberación controlada en la formulación y facilitar su manipulación. La liberación oportuna de los microencapsulados mejora la eficacia de los aditivos, amplía el campo de aplicación de los ingredientes alimentarios y asegura la dosis óptima, mejorando así la rentabilidad para el fabricante de alimentos. Por lo tanto, en esta revisión se describen brevemente algunos aspectos relacionados con la ME mediante el secado por aspersión, materiales encapsulados y encapsulantes, algunas experiencias exitosas de la ME y su uso en la tecnología de los alimentos.

Palabras clave: microencapsulation, compuestos bioactivos, secado por aspersión.

Abstract

Microencapsulation (ME) allows the incorporation of food ingredients in small capsules. Also, promotes the conservation of flavours, aromata and compounds such as acidulants, antioxidants and vitamins, as well as some food and materials including oils and micro-organisms. The ME is a technology that may contribute to food processing to preserve their nutritional content, contribute with a controlled release in the formulation and facilitate its handling. The release timely of the microencapsulations improves the efficacy of the additives, expands the scope of food ingredients and ensures the optimal dose, thus improving the profitability for the food manufacturer. Therefore, this review briefly describes some aspects related to the ME by spray drying, encapsulated materials and encapsulating materials, some successful ME experiences and its food technology usage.

Key words: microencapsulation, bioactive compounds, spray drying.

Resumo

A microencapsulação (ME) permite a incorporação de ingredientes de alimentos em pequenas cápsulas. Além disso, favorece a preservação de sabores, aromas e compostos como acidulantes, antioxidantes e vitaminas, e alguns alimentos e materiais, incluindo óleos e microorganismos. O ME é uma tecnologia que pode contribuir para a transformação de alimentos para preservar o seu conteúdo nutricional, ajudar com uma formulação de liberação controlada e facilitar o manuseio. A libertação atempada do microencapsulado melhora a eficácia de aditivos, alarga o âmbito de ingredientes alimentícios e assegura a dose ideal, melhorando assim a rentabilidade para o fabricante de alimentos. Portanto, esta revisão descreve resumidamente alguns aspectos da ME por spray drying, encapsulados e materiais de encapsulação, algumas experiências bem sucedidas de ME e seu uso em tecnologia de alimentos.

Palavras-chave: microencapsulação, compostos bioactivos, secagem por atomização.

Fecha recepción: Diciembre 2015 **Fecha aceptación:** Junio 2016

Introduction

Microencapsulation (ME) is the isolation of the Active Ingredient (liquid, solid or gaseous state) to obtain products with a spherical form and micron size, in which the active ingredient (AI) or core, is protected from the media by a membrane, facilitating its handling (Ko et al., 2002) and allowing his release when very small amounts are required (Kirby, 1991). In this sense these capsules can release their contents at speeds controlled under specific conditions (Chen et al., 2003; Kim et al., 2002; Lee et al., 2003; Ko et al., 2002; Cho et al., 2000; 2003; Parra, 2010; Nesterenko et al., 2013).

The technique of ME can be applied to promote the strength of food materials used in the conditions of processing and packaging, improving the taste, aroma, stability, nutritional value and appearance of their products, and in that way protect environmentally sensitive substances. The release properties of the microencapsulations may depend on the content, breaking, solubilization, warming, pH, or enzymatic action, of the particles. On the other hand, help to mask flavors and unpleasant odors of the substances (i.e., let you control the release of material up to to the adequate stimulus) (Lee, 2003).

The ME has different applications in the industry food with the aim of improving the properties and characteristics of food ingredients, an example is the immobilization of the ingredients or the addition of antimicrobial agents (Cha et al., 2003; Cha et al., 2002; Choi et al., 2002; Dubey et al., 2009).

There are several processes for producing microencapsulations, among which are the spray drying, the spray cooling, fluidized bed combustion (FBC), coacervation / separation of phase, gelation, solvent evaporation, supercritical fluid (SCF) expansion, interfacial polymerization (polycondensation), emulsion polymerization and extrusion (Nesterenko et al., 2013). Choosing the technique from ME for a particular process depends on size, biocompatibility and biodegradation that the particle needs (Montes, De Paula, and Ortega, 2007). Spray drying is currently one of the methods most used in the food industry (Augustin and Hemar, 2009; Desai and Park, 2005; Gibbs et al., 1999).

Microencapsulation and its applications

The ME has been used by the food industry for more than 60 years and, in a broad sense, into food processing, including the covering of tiny particles. The size of these microcapsules can vary, from submicron to several millimeters particles and maintain a wide variety of forms, depending on the materials and methods used (Desai and Park, 2005). Some ingredients that can be encapsulated are: acidulants, fats, flavorings, antioxidants, polyunsaturated oils, vitamins, drugs, microorganisms, minerals, etc. (Dubey et al., 2009; Yañez et al., 2002; Kirby, 1991). Within the most important parameters to control during the spray drying are: temperature of inlet and outlet of the drying air, the feed flow of product to dry, residence time and the preparation of the raw material (Parra, 2010).

Design of microcapsules

A wide variety of natural or synthetic polymers can be selected depending on the material to be coated and the characteristics desired in the final microcapsules. The correct choice of the wall material is very important, since it influences the efficiency of encapsulation and stability of the microcapsule. The composition of the coating material is the main determinant of the functional properties of microcapsule and the way in which can be used. The ideal encapsulant must provide to the film emulsifying properties, be biodegradable, resistant to the intestinal tract, have low viscosity and a high content of solids, low hygroscopicity, not be reactive with the core, have ability to seal and keep the core inside the capsule, have capacity to provide the maximum protection to the core against adverse conditions, lacking of a unpleasant taste for their applicability in food and have economic viability (Barros and Stringheta, 2006).

Most of the wall materials do not have all the desired properties. A common practice is the mixing of two or more materials. Such materials can be carbohydrates: starches, modified starches, dextrins, sucrose, cellulose and chitosan; gums: Arabic gum, alginate and Carrageenans (carrageenins); lipids: wax, paraffin, monoglycerides and diglycerides, hydrogenated oils and fats; inorganic materials: silicates and calcium sulphate; gluten proteins, casein, gelatin, albumin, among others (Shahidi and Han, 1993; Silva et al, 2014.).

Uses and applications in the food industry

The ME spray drying is used primarily in the food industry in order to protect ingredients that are sensitive to light and oxygen and reduce the formation of free radicals (Ahmed et al, 2010;. Bąkowska-Barczak and Kolodziejczyk, 2011 ; Barros and Stringheta, 2006). According to Desai and Park (2005) and Kirby (1991), the proper use of microencapsulated industry depends on the relationship established between the active substance or polymer core and serves as a wall. Factors that limit or favor this relationship are: release kinetics, the ratio of the copolymer, the polymer molecular weight, cost, particle size, etc. (Bakan, 1973; Desai and Park, 2005).

The ME is a viable alternative that can be applied to a wide variety of products. Recent studies have shown enormous potential to protect the core material, resulting in superior quality products for the food industry; however, the use of this technology in heat sensitive products, such as microorganisms and essential oils can be limited due to the required high temperature causes volatilization and / or destruction of the product (Silva et al., 2014).

ME applications on plant products

The ME helps protect and preserve different nutrients or antioxidants bioactive compounds in fruits and vegetables (Dubey et al., 2009), so there have been numerous studies that use this technique for the conservation of the compounds mentioned. This becomes important because there is currently an increase in the consumption of foods that contribute to improving the health of the consumer, including a variety of fruits and vegetables, which are an important source of antioxidant compounds.

Among the studies on the implementation of the ME in plant they are developed by Larroza and Zerlotti (2007) and Fabra et al. (2009), who evaluated the stability of carotenoid compounds during drying, the ME and its possible application in hydrophilic environments. Another investigation was conducted with the "astaxanthin" and xanthophyll carotenoid pigment to obtain nanospheres encapsulated ethyl cellulose type, achieving good characteristics of encapsulation efficiency of 98% (Tachaprutinuna et al., 2009 and Parra, 2010). It is worth mentioning that astaxanthin is a pigment used in the aquaculture industry; recently it proposed the application as a nutraceutical product.

Rutz et al. (2013), they were encapsulated juice Brazilian cherry (Eugenia uniflora L.) in matrices of xanthan-hydrogel rubber and assessed the stability of carotenoids, phenolics and antioxidant activity after 84 days at 4 and 25 ° C, obtaining better results 4 ° C. They also analyzed açaí juices (with different agents MD 10DE, 20DE MD, GA, tapioca starch) at 25 and 35 ° C. Furthermore, Tonon et al. (2010), achieved by encapsulating assess the stability of anthocyanins and antioxidant activity, the results were different in microencapsulated as they depend on conditions such as storage temperature and water activity of the powders.

Encapsulation of phenolic compounds from myrica bayberry or by Zheng et al. (2011) and Fang and Bhandari (2011), allowed to determine that the contents of antioxidant compounds not only depended on the type of encapsulant (ethyl cellulose or MD 10DE), but the process conditions during the ME as inlet temperatures and exit (150 ° C and 80 ° C), water activity of the powders and pH of the encapsulated emulsions. Meanwhile, Kuck and Zapata (2016) encapsulated phenolic extracts from grape skin (Vitis labrusca var. Bordo) using gum arabic and an inlet temperature of 140 ° C, ensuring retention of phenols (81.4 to 95.3%) , anthocyanins (80.8 to 99.6%) and antioxidant activity (45.4 to 83.7%).

Krishnan et al. (2005), they achieved an oleoresin cardamom microencapsulated by spray drying using gum arabic, maltodextrin and modified starch. The results showed an increase in the protection of the oleoresin.

Furthermore, Arrazola et al. (2014), evaluated pigments microencapsulated anthocyanins by spray drying 30% maltodextrin and 180 ° C, which showed good physicochemical properties with lower moisture contents (3.43%) and water activity (0.26) and higher percentages of solubility (93.61%). According to the retention times (1,012 min) and spectral analysis shown by the samples and the standard delphinidin-3-rutinoside, anthocyanin quantified in the extract and microencapsulated powders could be Delphinidin-3-rutinoside. Microencapsulated powders presented color settings ° H between 2 and 7 °, indicating a red color with high tonality, being the treatment with 15% maltodextrin which presented the highest values of hue.

Conclusion

Microencapsulation has allowed food materials to better withstand the processing conditions and packaging as they maintain the flavor, aroma, stability, nutritional value and appearance of their products. Have carried out recent research using new carriers or encapsulants, however, still you need further study alternatives of new wall materials and encapsulated materials, and to improve and optimize existing methods of encapsulation, which increase shelf life of microcapsules and their potential applications.

Bibliography

Ahmed, M., Akter, M.S., Lee, J. C., Eun, J. B. (2010). Encapsulation by spray drying of bioactive components, physicochemical and morphological properties from purple sweet potato. LWT – Food Science and Technology 43 (9), 1307-1312.

Arrazola, G., Herazo, I., & Alvis, A. (2014). Microencapsulación de Antocianinas de Berenjena (Solanum melongena L.) mediante secado por aspersión y evaluación de la estabilidad de su color y capacidad antioxidante. Información tecnológica, 25(3), 31-42.

Augustin, M. A., & Hemar, Y. (2009). Nano- and micro-structured assemblies for encapsulation of food ingredients. Chemical Society Reviews, 38, 902-912.

Bakan, J.A. (1973). Microencapsulation of food and related products. Food Technology, 27 (11), 34-38.

Bakowska-Barczak, A. & Kolodziejczyk, P. (2011). Black currant polyphenols: their storage stability and microencapsulation. Industrial Crops and Products 34 (2), 1301-1309.

Barros, D., & Stringheta, C. (2006). Microencapsulamento de antocianinas: Uma alternativa para o aumento de sua aplicabilidade como ingrediente alimentício. Biotecnologia ciência e desenvolvimento, 36(36), 18-24.

Cha, D., Cooksey, K., Chinnan, S., Park, H. (2003). Release of nisin from various heat-pressed and cast films. Lebensm.-Wiss. U.-Technol. 36, 209-213. 16.

Cha, D., Choi, J., Chinnan, M., & Park, H. (2002). Antimicrobial films based on Na-alginate and j-carrageenan. Lebensm.-Wiss. U.-Technology. 35, 715-719. 17.

Chen, X., Lee, C., & Park, H. (2003). O=w emulsification for the self-aggregation and nanoparticle formation of linolenic acid modified chitosan in the aqueous system. Journal of Agricultural and Food Chemistry, 51, 3135-31.

Cho, H., Shin, D. & Park, J. (2000). Optimization of emulsification and spray drying processes for the microencapsulation of flavor compounds. Korean Journal of Food Science and Technology, 32, 132-139.

Choi, W., Park, H., Ahn, D., Lee, J. & Lee, C. (2002). Wettability of chitosan coating solution on 'Fuji' apple skin. Journal of Food Science. 67, 2668-2672.

Desai, K., & Park, J. (2005). Recent developments in microencapsulation of food ingredients. Drying Technology, 23, 1361-1394.

Dubey, R., Shami, T. & Bhasker R. (2009). Microencapsulation technology and application. Defence Science Journal. 59, 82-95.

Fabra, A., Hambleton, P. Talens, F. Debeaufort & A. Voilley (2009). Influence of interactions on wáter and aroma permeabilities of i-carrageenan–oleic acid–beeswax films used for flavour encapsulation. Carbohydrate Polymers 76(2): 325-332.

Fang, Z. & Bhandari, B. (2011). Effect of spray drying and storage on the stability of bayberry polyphenols. Food Chemistry, 129, 1139-1147.

Gibbs, B., Kermasha, S., Alli, I., & Mulligan, C. (1999). Encapsulation in the food industry: A review. International Journal of Food Sciences and Nutrition, 50, 213–224.

Kim, B., Hwang, S., Park, J., Park, H. (2002). Preparation and characterization of drug-loaded microspheres by an emulsion solvent evaporation method. Journal of Microencapsulation, 19, 811-822.

Kirby, C.J. (1991). Microencapsulation and controlled delivery of food ingredients. Food Science and Technology Today. 5 (2), 74-80.

Ko, J., Park, H., Hwang, S., Park, J., Lee, J. (2002). Preparation and characterization of chitosan microparticles intended for controlled drug delivery. International Journal of Pharmaceutics. 249, 165-174.

Krishnan, S., Bhosale, R., & Singhal, R. (2005). Microencapsulation of cardamom oleoresin: Evaluation of blends of gum arabic, maltodextrin and a modified starch as wall materials. Carbohydrate Polymers, 61(1), 95-102.

Kuck, L., & Zapata, N. (2016). Microencapsulation of grape (Vitis labrusca var. Bordo) skin phenolic extract using gum Arabic, polydextrose, and partially hydrolyzed guar gum as encapsulating agents. Food Chemistry, 194, 569-576.

Laohasongkram, K., Mahamaktudsanee, T. & Chaiwanichsiri, S. (2011). Microencapsulation of Macadamia oil by spray drying. Procedia Food Science, 1, 1660-1665.

Larroza, I. & A. Zerlotti (2007). Encapsulation of Lycopene using spray-drying and molecular inclusion processes. Brazilian Archives of Biology and Technology 50(5): 893-900.

Lee, D., Hwang, S., Park, J.B. & Park, H. (2003). Preparation and release characteristics of polymer-coated and blended alginate microspheres. Journal of Microencapsulation, 20, 179-192.

Lee, J., Park, H., Lee, C., Choi, W. (2003). Extending shelf life of minimally processed apples with edible coatings and antibrowning agents. Lebensm.-Wiss. U.-Technology. 36, 323-329.

Montes, E., De Paula, C. y Ortega, F. (2007). Determinación de las condiciones óptimas de encapsulado por co-cristalización de jugo de maracuyá (Pasiflora edulis).Temas Agrarios, 12,5-12.

Nesterenko, A., Alric, I., Silvestre, F., & Durrieu, V. (2013). Vegetable proteins in microencapsulation: A review of recent interventions and their effectiveness. Industrial Crops and Products, 42, 469-379.

Parra Huertas, R. (2010). Food microencapsulation: a review. Revista Facultad Nacional de Agronomía, Medellín, 63(2), 5669-5684.

Rutz, J., Zambiazi, R., Borges. C., Krumreich, F., Da Luz, S., Hartwig, N., Da Rosa, C. (2013). Microencapsulation of purple Brazilian cherry juice in xanthan, taragums and xanthan-tara hydrogel matrixes. Carbohydrate Polymers, 98, 1256-1265.

Shahidi, F. & Han, X. (1993). Encapsulation of food ingredients. Critical Reviews in Food Science and Nutrition 33, 501–547.

Silva, P. T. D., Fries, L. L. M., Menezes, C. R. D., Holkem, A. T., Schwan, C. L., Wigmann, É. F., ... & Silva, C. D. (2014). Microencapsulation: concepts, mechanisms, methods and some applications in food technology.Ciência Rural, 44(7), 1304-1311.

Tachaprutinuna, A., Udomsup, T., Luadthong C., & Wanichwecharungruang, S. (2009). Preventing the thermal degradation of astaxanthin through nanoencapsulation. International Journal of Pharmaceutics 374:119-124.

Tonon, R., Brabet, C. & Rubinger, M. (2010). Anthocyanin stability and antioxidant activity of spray-dried açai (Euterpe oleracea Mart.) juice produced with different carrier agents. Food Research International 43, 907-914.

Yañez, J., Salazar, L., Chaires, J., Jiménez, M., Márquez y Ramos E. (2002). Aplicaciones biotecnológicas de la microencapsulación. *Revista Avance y Perspectiva* 21: 313-319.

Zheng, L., Ding, Z., Zhang, M. & Sun, J. (2011). Microencapsulation of bayberry polyphenols by ethyl cellulose: Preparation and characterization. Journal of Food Engineering, 104, 89-95.