JRIFST

www.journals.rifst.ac.ir
Journal of Research and Innovation
in Food Science and Technology

Research Institute of Food Science and Technology

Volume 7, Issue 1, Spring 2018, Pages 13-28
Document Type: Extended Abstract
DOI: 10.22101/JRIFST.2018.05.19.712

Extended Abstract

The Effect of Wall Material and Encapsulation Method on Physicochemical Properties Micro-encapsulated Fish Oil

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Received: 2016.10.08; **Accepted:** 2017.05.30

Abstract

In this study the physicochemical characteristics of microencapsulated fish oil using various wall materials and drying methods were examined. The fish oil encapsulated by three combinations of matrices (fish gelatin+maltodextrin, κ carrageenan+maltodextrin, fish gelatin+ κ carrageenan +maltodextrin), and 25% fish oil emulsions were dried through three different methods: coacervation (CC), spray drying (SD), and freeze drying (FD). Physicochemical characteristics including moisture content, surface and total oil, encapsulation efficiency, color and morphology of microcapsules were investigated. According to results, the combination of fish gelatin and maltodextrin was the best wall combination and also coacervation was the best method to encapsulation of fish oil. These powders had higher encapsulation efficiency and lower surface oil than the other treatments. The results indicated that microcapsules produced by coacervation actually formed larger microcapsules, which provided maximum protection to the fish oil droplets. Comparison of the CC, SD, and FD processes confirmed that combination of matrices; drying temperature, morphology and processing time were among the most critical factors influencing fish oil powders.

Keywords: Coacervation, Encapsulation, Fish Oil, Microcapsule, Spray Drying

Introduction

In recent years, attention to polyunsaturated fatty acids has been increased. It is well known that omega-3 fatty acids positively influence human health. The main omega-3 are eicosapentaenoic and docosahexaenoic acids (EPA C20:5 and DHA C22:6), and fish and fish oil are rich source of them (Kitessa *et al.*, 2001; Kolanowski *et al.*, 2007). However, the application of fish oils in the food system has some limitations; lipid oxidation during storage and the unpleasant taste and odor of fish oil. These aspects can cause deterioration in the quality of food products (Cho *et al.*, 2003). Encapsulation is one of the protection methods of fish oil. It can increase the oil stability (Gan *et al.*, 2008; Pourashouri *et al*. 2014). Coacervation, spray drying and extrusion are the main and common methods at encapsulation of lipophilic compounds (Drusch and Berg, 2008). One of the most important steps in encapsulation is selecting wall material (Pourashouri *et al*. 2014). There are many studies on the different wall material in microencapsulation. Carrageenan has been used as wall material in encapsulation of probiotic and essence that showed good properties (Hambleton *et al*. 2009; Shi *et al*. 2013). There aren't any studies that investigate the combination of fish gelatin and carrageenan in encapsulation of fish oil. The main objective of this study is to survey the effect of coating materials and encapsulation methods on propertis of fish oil powders.

Material and methods

Wall materials ratio including fish gelatin, carrageenan and maltodextrin (filler matrix and soy lecithin as emulsifier are summarized in Table (1). Coating materials were dissolved in distilled water, followed by gentle stirring with a magnetic stirrer to achieve a homogenous shell solution. To garanty of full hydration the solution of wall materails was allowed to hydrate overnight. Coarse emulsions were prepared using an Ultraturrax IKA T25 homogeniser (Germany) at 12000 rpm for 5 min (Pourashouri *et al*., 2014). These stable emulsions were used for spray (180 and 80 °C input and output temperatures, respectively) and freeze drying (45 h). Coacervated microparticles were produced according to Versic (2003), Dong *et al*. (2007; 2008) and Drusch *et al*. (2006). Fish oil was disssolved in polyvinyl alcohol, then this solution was added to fish gelation and carageenan solutions. Finally the coacervated were dried. Creaming index, moisture content (Zhong *et al*., 2009), surface and total oil of microcapsules (Klinkesorn *et al*., 2006), color, morphology and particle size of powders were determined.

Table 1. Treatments of fish oıl encapsulatıon by fish gelatın and carageenan

Treatment	Wall material			Core	
	FG	KC	MD	lecithin	Fish oil
FG	7.50	-	32.50	-	
KC	-	1	38.50	0.50	10
FG+KC	7.50	1	31.50	0.50	

Results and discussion

The fish gelatin in spray and freeze dried microcapsules were found to higher microencapsulation efficiency (85.2 and 87.6%, respectively) and to those prepared by coacervation. Carrageenan had lower encapsulation efficiency in all three methods of encapsulation. The results showed that the protein coating material had better encapsulation efficiency than combination treatments (Swetank *et al*., 2015). Fish gelatin and coacervation showed lower surface oil than other samples. Eratte *et al*. (2014) reported that coacervation and spray drying are better methods for encapsulation of fish oil. SEM graphs showed that freeze dried samples had more cracks and shrinkages and had porous structure. Coacervated samples had more smooth surfaces, without any shrinkage and showed more particle size than others (Barrow *et al*., 2009). The comparison of three methods of encapsulation showed that core loading in coacervation is higher than other methods and had thicker wall (Barrow *et al*., 2007). Fish gelatin had smaller particle size than carrageenan.

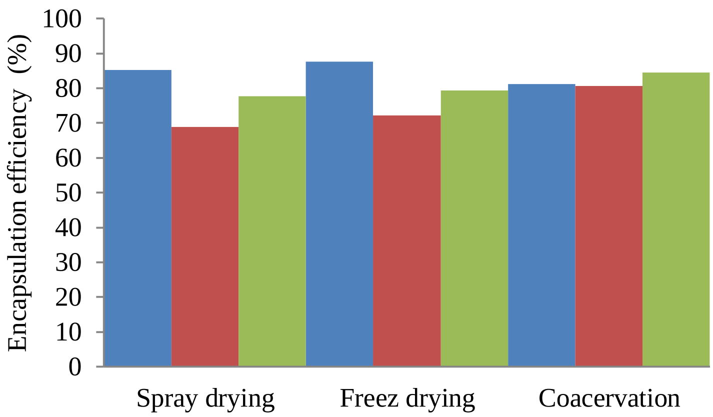

Figure 1. Encapsulation efficiency of fish oil powders in different treatments

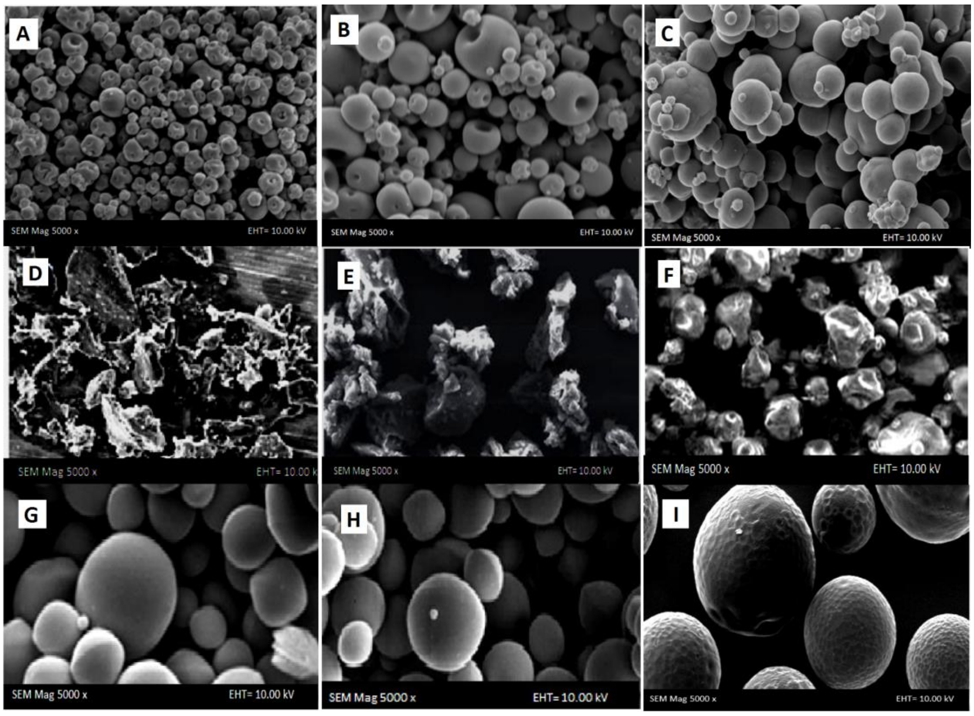

Figure2. SEM micrographs of spray dried microcapsules (A-C) (Fısh gelatin, Carrageenan and combination treatment). Freeze dried microcapsules (D-F) (Fısh gelatin, Carrageenan and combination treatment). Coacervated microcapsules (G-I) (Fısh gelatin, Carrageenan and combination treatment).

Conclusion

The results showed that fish gelatin caused better stability of fish oil and carageenan in combination of gelatin is better coating material of fish oil. The coacervated microcapsules had the advantage oflower surface oil content compared to the freeze and spray dried samples. We conclude that FG and FG–KC complex coacervates can effectively microencapsulate fish oil and the solid microcapsules produced using coacervation will have high encapsulation efficiency and stability against oxidation.

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