

Influence of Inulin and β -cyclodextrin on the Properties of Blueberry Nano-emulsion and its Microcapsules

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Received: 28 March 2012; Accepted: 30 May 2012

ABSTRACT

The purpose of this study was to produce oil in water Nano-emulsion by ultrasonication, and investigate the influence of Inulin and β -cyclodextrin on the prosperities of Nano-emulsion and morphology of spray dried microcapsules. The results showed that emulsion droplet size in samples containing β -cyclodextrin (8.28 ± 0.11 nm) was less than Inulin samples (97.12 ± 4.2 nm). Considering SEM photos, β -cyclodextrin had smooth surface and spherical compared with Inulin that emulsion size had profound influence on morphology of particles.

Keyword: Nano-emulsion, Inulin, β -cyclodextrin, microcapsule, blueberry.

1. INTRODUCTION

Encapsulation is the technology of packing solid, liquid or gaseous materials in miniature sealed capsules for releasing at controlled rates using desired release triggers. The simplest microcapsule consists of a core surrounded by a wall or barrier [1]. One of the common techniques to produce encapsulated products is spray drying, that involves conversion of liquid oils and flavours in the form of emulsions into dry powders, as an important application of microencapsulation in the food industry [2]. The choice of a wall material for microencapsulation by spray drying is very

important for microcapsule stability [3]. The microencapsulation of food ingredients is often achieved by biopolymers of various sources, such as natural gums, proteins, dextrans, waxes and their blends [4,5]. In present study Inulin and β -cyclodextrin was used as wall materials. Inulin is a polysaccharide found in many vegetables. It is composed of b-2-1 linked D-fructose molecules. A feature of inulin is that it is difficult to hydrolyze which qualifies Inulin as a matrix molecule for capsules that have to reach the colon and to survive the upper part of the gastrointestinal tract. The

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microorganisms responsible for degradation of Inulin are Bifidobacteria, which are abundantly present in the human gut [6]. Inulin should receive more attention for colon specific delivery of bioactive food components as it is cheap, has many health benefits by itself and can be applied in combination with almost all encapsulation techniques [7].

Cyclodextrins (CDs) are a family of cyclic oligosaccharides that are composed of α -1, 4-linked glucopyranose subunits. Cyclodextrins are produced from starch by enzymatic degradation. These macrocyclic carbohydrates with a polar internal cavity can form complexes and solubilize many normally water-insoluble compounds [8].

For spray drying, emulsification plays an important role that in this study; we used high-energy emulsification such as ultrasonication.

Many emulsion properties such as stability, rheology, appearance, color, texture, and shelf-life depend on emulsion droplet size. Based on the emulsion droplet size, emulsions can be divided into micro (10-100 nm), mini/Nano (100-1000 nm), and macro-emulsion (0.5-100 μ m) [9]. Due to Nano-emulsion characteristic size, they appear transparent or translucent to the naked eye, and possess stability against sedimentation or creaming [10].

2. EXPERIMENTAL

Materials and methods

2.1. Materials

Blueberry essential oil and Tween 80 were purchased from Fermotec Company (Holland) and Merck Company (Germany), respectively. Inulin (Sigma-Aldrich, USA) and β -cyclodextrin were prepared from Sigma-Aldrich Company (USA). Distilled water was used for the preparation of all solutions. All general chemicals used in this study were of analytical grade.

2.2. Methods

Inulin or β -cyclodextrin was dissolved in distilled water by magnetic stirring. They were kept overnight in ambient temperature in order to war-

rant a full saturation of wall materials.

Blueberry essential oil in the ratio of 1:5 (core: wall) and 1% of Tween 80 were added to emulsions. After that, they were stirred by magnetic stirring for pre-emulsion preparation. By using an Ultrasonic Liquid Processor (Model S-4000-010, USA) transformed pre-emulsion to nano-emulsion. It was operated at 24 KHz for 130s. The emulsion droplets size was determined by Stabisizer (Model PMX200C, Germany). Ultimately, the Nano-emulsions were dried by spray drier (Model B-191, Buchi and Switzerland).

2.3. Statistical analysis

One-way ANOVA test was used for determination differences between processes with SPSS 19 package program. A probability level of $p < 0.01$ was considered to be very significant for all statistical procedures. All measurements were done in triple.

3. RESULTS AND DISCUSSION

3.1. Emulsion droplet size

Our results demonstrated that type of wall materials had very significant difference ($p < 0.01$) with emulsion droplets size. When comparing blueberry essential oil encapsulated powders consisting of β -Cyclodextrin with those made with Inulin, it was found that β -Cyclodextrin samples have smaller emulsion size (table 1). In contrast, Inulin samples have bigger emulsion droplets size. It could be related to spatial structure of β -Cyclodextrin that is Nano particle. On the other hand, increasing emulsion size increased encapsulation efficiency. Based on the results, Inulin had better ability to cover blueberry oil due to high encapsulation efficiency.

Table 1:

Wall material	Emulsion size (nm)	Encapsulation efficiency (%)
Inulin	97.12 \pm 4.2	99.45 \pm 0.05
β -Cyclodextrin	8.28 \pm 0.11	98.82 \pm 0.03

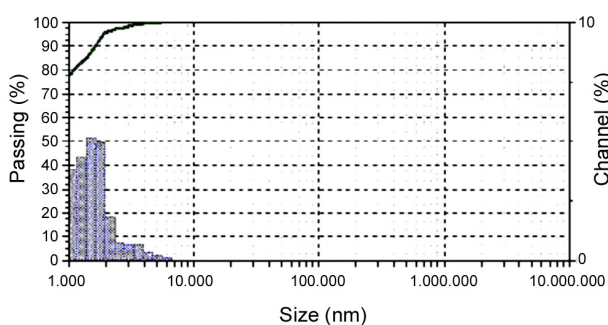


Figure 1: distribution of emulsion droplet size of Inulin.

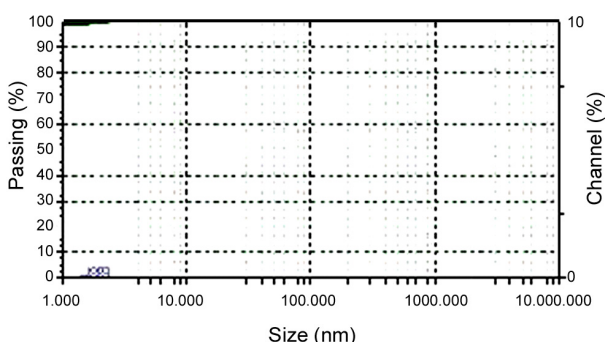


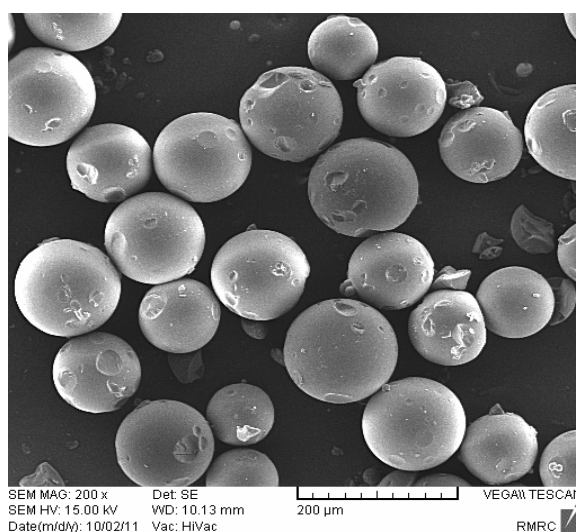
Figure 2: distribution of emulsion droplet size of β -cyclodextrin.

Klaypradit and Huang (2008) encapsulated fish oil with different concentration of wall materials such as Chitosan, maltodextrin and whey protein isolate by ultrasonic atomizer. They found that increasing amount of Chitosan, emulsion droplets size decreased. Our results are in agreement with their results.

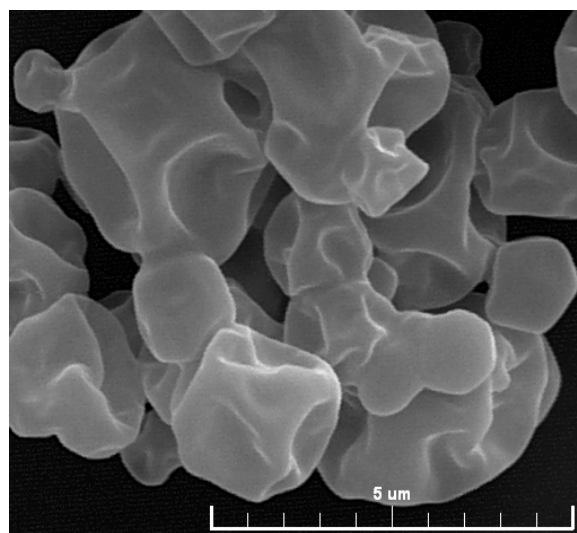
3.2. Scanning electron microscopy

Figure 3 shows morphology of microcapsules. The surface of particles containing β -Cyclodextrin was smooth and free of shrinkage with least the dents. It is clear that dents have direct relationship with emulsion droplet size. Decreasing emulsion size decreased dents in microcapsules. While samples consisting of Inulin had surface with most shrinkage, and indents in comparison with particles containing β -Cyclodextrin.

Also, results indicated that there was a fast crust formation in powders containing Inulin that could



(a)



(b)

Figure 3: Scanning electron microscopic photographs of blueberry encapsulated powders: β -cyclodextrin (A) and Inulin (B).

be related to low levels of surface oil content as there is less opportunity for the blueberry essential oil (core material) to emerge from the surface of particles. While in β -Cyclodextrin samples, crust formation is slower. That it illustrated that more essence droplets could move on the surface.

According to SEM photos, there are different causes for increasing emulsion droplets size during spray drying: size of spray dryer nozzle, decreasing stability of emulsions during spray

drying and type of wall material that it needs to further survey.

4. CONCLUSIONS

This study demonstrated that ultrasonication was the promising alternative method for blueberry essential oil encapsulation, and was able to produce emulsion in Nano range. In fact, emulsion droplet size affected on dents of microcapsules and encapsulation efficiency. Furthermore, while Inulin had better encapsulation efficiency compared with β -Cyclodextrin, on the other hand it produced more dents in microcapsules.

ACKNOWLEDGEMENT

The authors would like to express their gratitude to center of Karaj Agricultural Biotechnology, specially Dr. Davodi and Mrs. Keshavarz for their cooperation throughout this research.

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