Article

Microencapsulation of Riboflavin (Vitamine B_2) using Alginate and Chitosan : Effect of Surfactant Span 80 upon Microcapsule Diameter

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Abstract. Riboflavin (vitamin B2) plays an important role in the growth and maintenance of human metabolism. Riboflavin is the highly sensitive and unstable to environmental influences such as light, reducing agents and pH. Riboflavin is protected by forming it into microcapsules with sodium alginate as a matrix and coated with chitosan reinforced with glutraldehid crosslinking. This study aims to study the process of microencapsulation of riboflavin with sodium alginate and chitosan and is emphasized to study the effect surfactant span 80 upon the size of the microcapsules formed. Based on microcapsule size and its distribution, it can be concluded that more span 80 added to paraffin oil will reduce the size of microcapsule that is formed

Keywords : riboflavin, chitosan-alginate, crosslinking, span 80

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1. Introduction

Riboflavin (vitamin B2) plays an important role in the growth and maintenance of human metabolism. Riboflavin is soluble in water, present in animal cells and plants. The human body needs a certain amount of riboflavin and the rest is removed through the urine system, therefore riboflavin is needed every day and is supplied from outside the human body.

One of the obstacles for supplying riboflavin to the human body is the highly sensitive and unstable nature of riboflavin to environmental influences such as light, reducing agents and pH. One way to maintain the riboflavin stability is by encapsulation technology composed of a matrix of polymers containing active compounds of rivoflavin

The material selection as a polymer matrix must be considered because the material must be biodegradable, edible, and non-toxic. Alginate is a biopolymer extracted from brown algae and is composed of two basic units (blocks), α-L-guluronic acid (G) and β-D-mannuronic acid (M) which are linearly connected to connections 1-4. The presence of carboxylate groups makes the alginate negatively charged (polyanionic). Alginate is non-toxic, biocompatible and biodegradable. The solubility of alginate in water depends on the cation that binds to it. Sodium alginate dissolves in water but may form water-insoluble tissue when cross-linked with divalent or polyvalent cations such as Ca^{2+} and Zn^{2+} [1] but Ca^{2+} is more commonly used because it can bind to guluronic acid groups to form tissues with an egg-box structure [2]. These properties make sodium alginate has a great ability as a carrier of active compounds such as riboflavin [3]. Despite its advantages, sodium alginate matrix has a weakness that is easy to release the active compound so it is not suitable to be used as a control release of active compounds [4].

To overcome these constraints, the alginate matrix needs an additional coatings. Materials as additional coatings should also be biodegradable, biocompatible and non-toxic. One of the biopolymers suitable for this coating is chitosan. Chitosan is a linear polymer composed of units of N-acetyl D-glucosamine and D-glucosamine units. Strong electrostatic interactions between amino groups in chitosan and carboxylate groups in alginates will form a chitosan / alginate complex which is able to keep the release of an active compound. This chitosan / alginate complex is used to protect microcapsules in the encapsulation process and regulate the release of an active compound [5], [6].

Chitosan has three active groups, namely amino groups, primary hydroxyl groups, and secondary hydroxyl groups. The groups are in the C-2, C-3, and C-6 positions. The presence of the above clusters facilitate modification of chitosan. One of the chitosan modifications is the crosslinking process to form a 3-dimensional network. The crosslinking process will make chitosan stronger and resistant to alkaline atmosphere.

This study aims to study the process of microencapsulation of riboflavin with sodium alginate and chitose and is emphasized to study the effect of emulsification media and the amount of emulsifier on the size of the microcapsules formed.

2. Materials and Methods

Riboflavin was obtained Sigma-Aldrich. Chitosan and sodium alginate were obtained from local store. Chitosan was dissolved in 1% acetic acid solution for making chitosan solutions. Sodium alginate was dissolved in aqueous solutions for making sodium alginate solutions. Another chemicals were used, namely glutaraldehyde as crosslinking agent for chitosan, $CaCl_2$ as crosslinking agent for sodium alginate, and span 80 as surfactant agent. There were emulsification medium namely parafin oil, sunflower oil, canola oil, corn oil and palm oil. All were obtained from local store.

Riboflavin was mixed in 30 mL 2.5% alginate solutions. This mixed solution was then dripped slowly into 75 mL paraffin oil (earlier span 80 was dissolved in this oil at various volumes) and was dispersed using magnetic stirrer for 20 minutes.

The dispersed solutions was then dripped slowly into 125 mL 1% $CaCl_2$ solutions and stirred using magnetic stirer for 60 minutes. The microcapsules were formed in this process. The microcapsules were filtered and washed. The microcapsules were added into 80 mL 1% chitosan solutions and stirred for 15 minutes for coating process. The microcapsules were filtered and added into 80 mL 2% glutaraldehyde solutions for 60 minutes. The microcapsuled were then filtered, washed, and dried in the oven.

The microcapsules size were determined using digital microscopic

3. Results and Discussion

There was crosslinking reaction when sodium alginate solution was added into $CaCl_2$ solution formed egg-box structure. Figure 1 shows this reaction

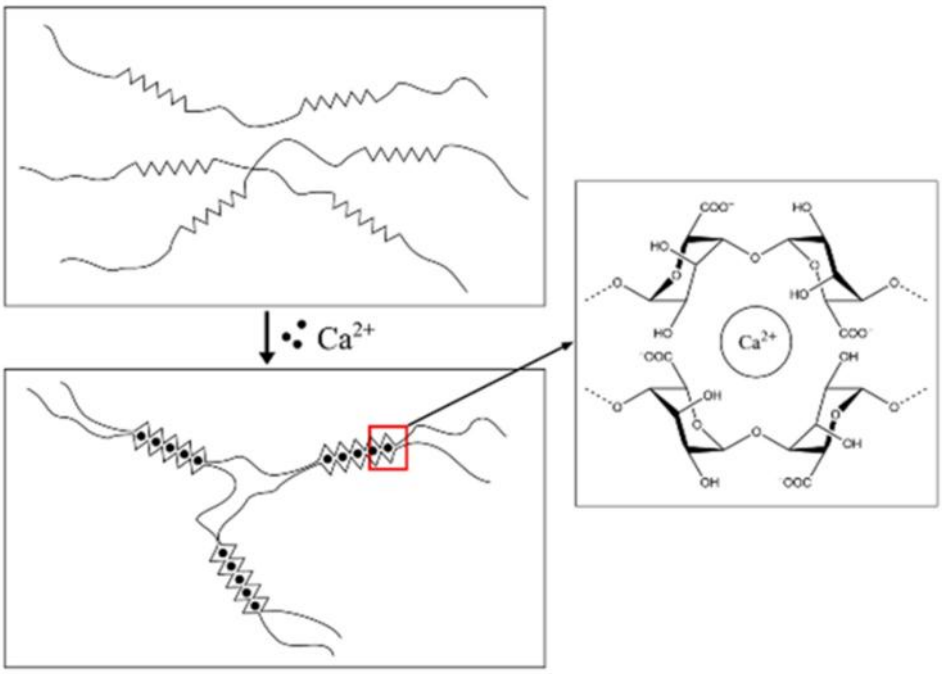

Fig. 1. The ionic crosslinking reaction of sodium alginate using Ca^{2+}

There was crosslinking reaction when chitosan-coated microcapsules was added into glutaraldehyde solution. Aldehyde group in glutaraldehyde reacted with amino group in chitosan. Figure 2 shows this reaction

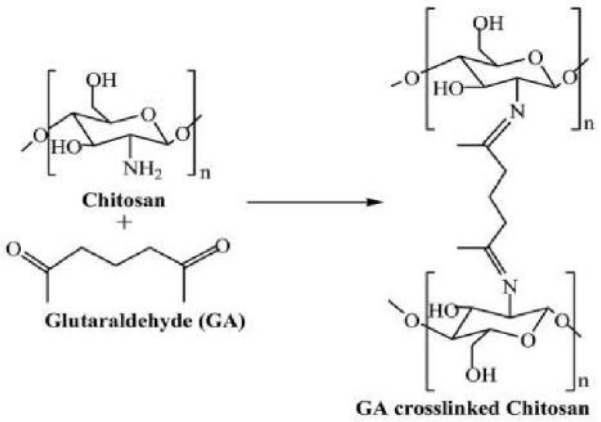

Fig.2. The crosslinking reaction between chitosan and glutaraldehyde

Figure 3 shows the image of microcapsule at various process stage.

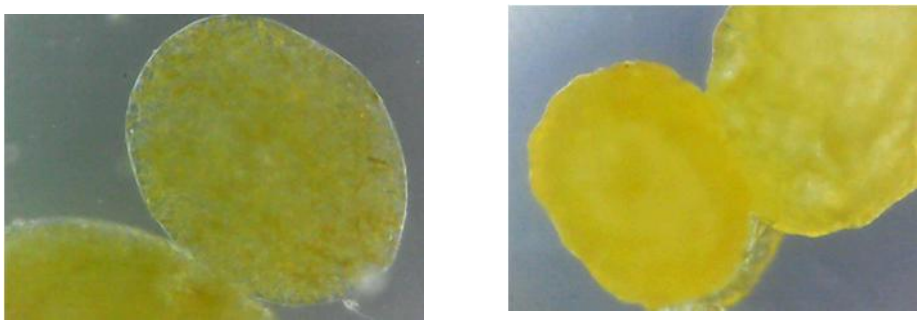

Fig. 3. The image of microcapsule.
a. Alginat microcapsule before coated with chitosan
b. Alginat microcapsule after coated with chitosan and dried

Figure 3a shows alginate microcapsule before coated by chitosan and still in wet condition. After coating with chitosan and dried (figure 3b), the microcapsule surface becomes not smooth and wrinkled. This condition due the water reducing in microcapsule.

The effect of span 80 upon microcapsules size is showed at figure 4.

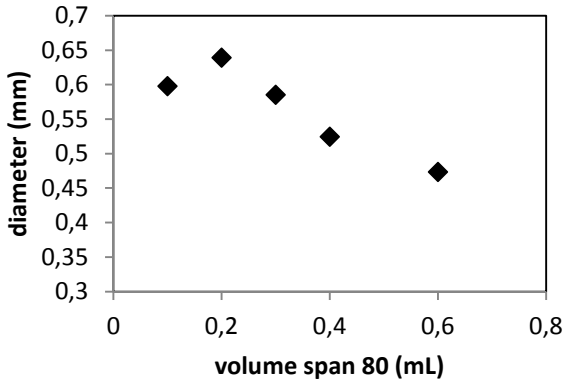

Fig. 4. Diameter of microcapsule at various span 80

Figure 4 shows that the more span 80 added to the paraffin oil the smaller the size of the microcapsules. This is caused by span 80 as surfactant will reduce the surface tension between alginate with paraffin oil so that the size of microcapsules is getting smaller. This statement is supported by the microcapsule size distribution as shown in figure 5.

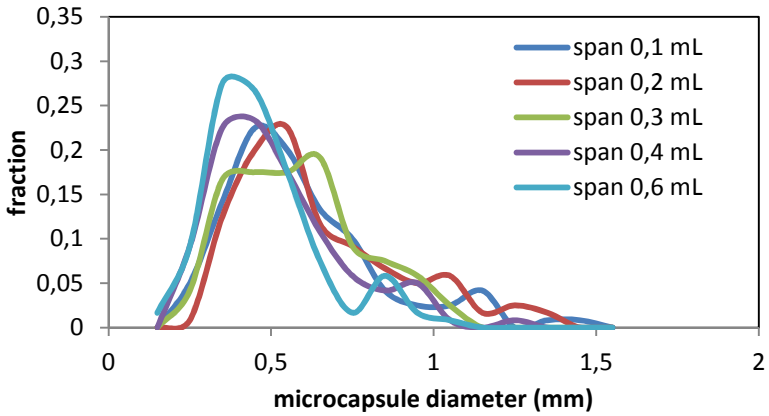

Fig. 5. Size distribution of microcapsule at various span 80 volume

4. Conclusion

Riboflavin can be formed into microcapsules with sodium aginate as a matrix and coated with chitosan reinforced with glutaraldehyde crosslinking. Based on microcapsule size and microcapsule size distribution it can be concluded that more span 80 added to paraffin oil will reduce the size of microcapsule that is formed

5. Acknowledgement

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