Microencapsulation of Gac oil in chitosan microcapsules

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INTRODUCTION AND OBJECTIVE

Gac oil is a Vietnamese traditional product which contents a high concentration of interesting carotenoids like β-carotene and lycopene which are very useful in cancer treatment and anti-aged protection due to their strong antioxidant activity (Nguyễn 1993). However, its hydrophobicity restrains its uses in food applications which are normally aqueous systems.

Chitosan is a biopolymer that now attract attention of researchers as it is non-toxic, biodegradable, and biocompatible which provide potential for many biotechnological applications (Peniche 2003).

In this study, we encapsulated Gac oil in chitosan microcapsules using coacervation/ precipitation method. Encapsulation yield, encapsulation efficiency and protection effect of chitosan were analysed.

MATERIALS AND METHODS

Materials

Chitosan was produced in Nha Trang University from shrimp shell. Gac oil was kindly given by Food industry and research institute of Vietnam.

Preparation of Gac oil emulsion

Gac oil emulsion was prepared in polymer's solutions with ratio of 3ml Gac oil for 100ml solution of 2% chitosan in acetic acid 1%. The mixture was homogenized at 4 bars for 10 minutes using the homogenizer IKA T18 Basic, ULTRA_TURRAX (Tran 2012).

Preparation of microcapsules

Microcapsules were formed by drop the emulsion into NaOH solution with stirring at room temperature. Microcapsules were then harvested and analyzed for encapsulation yield and encapsulation efficiency.

Protection effect of chitosan microcapsules

Capsule after dried was bottled and placed in oven at 45°C. The carotenoids retention was determined in times by UV – VIS spectrometry. Reaction coefficient rate was calculated follow Vant'Hoff equation.

RESULTS AND DISCUSSION

Influence of NaOH concentration

Microcapsules were formed in different NaOH concentrations from 0,1N to 2N. At low concentrations (<0,5N), the drops were broken immediately when touching solution even without stirring. At high concentrations (2N), capsules were hardened rapidly within seconds so that we could not measure its mass reduction. At moderate concentration of NaOH (0,5 – 1N), capsule's weight loss was observed (Fig. 1). This loss was rapid in the first 5 minutes and attainted to balance after 30 minutes. It seems have no significant different between two tested NaOH concentrations. The weight loss was about 30% after 60 minutes.

Hardening of capsule was obtained by de-protonated of amino groups in chitosan molecule structure in basic solution (Agnihotri 2004). The loss in weight of microcapsule corresponds to water go-out into solution which reduces its pH (Fig. 2). A same trend in reduction of pH in compare with the reduction of capsule's weight confirms this argument.

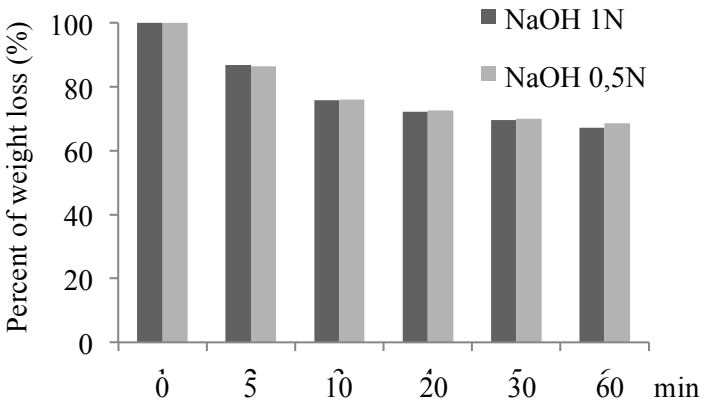

Figure 1. Capsule's weight loss in time

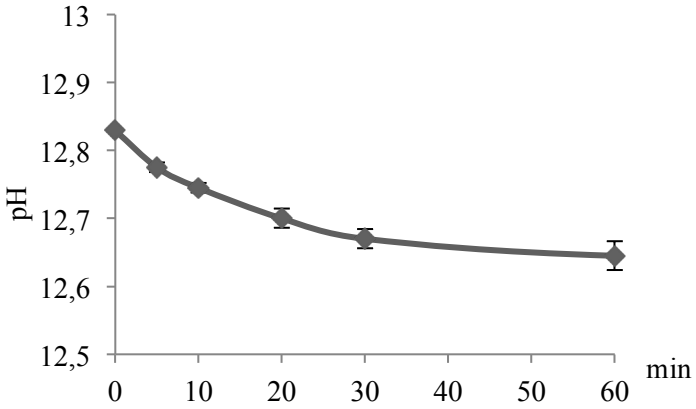

Figure 2. Reduction of pH during precipitation

Encapsulation yield and encapsulation efficiency

Encapsulation yield was determined as percent of beta-carotene encapsulated while encapsulation efficiency was determined as ratio of beta-carotene

inside capsule to total carotene encapsulated (Tab. 1). Encapsulation efficiency was about 80,5% which means there was non-encapsulated carotenoids on the surface of microcapsules. TEM images showed that it seemed to have oil precipitated on the surface of capsules (Fig. 3).

Table 1. Encapsulation yield and encapsulation efficiency

Encapsulation yield (%)	Encapsulation efficiency (%)
96,4	80,5

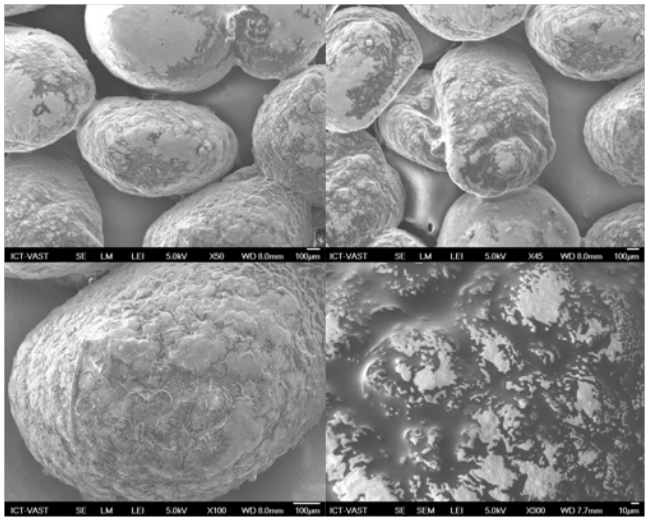

Figure 3. Microcapsules of Gac oil by TEM

Protection effect of chitosan microcapsules on beta-carotene of Gac oil The protection effect of chitosan microcapsules to carotenoids in Gac oil was tested under accelerated condition. A slight decrease in beta-carotene concentration was observed (Tab. 2). Water content of microcapsules was also slightly increased but there was no effect of capsule's agglomeration. After 45 days stored at 45°C, lost of content of beta-carotene was about 5 – 6 %.

Table 2. Carotenoids retention in chitosan microspheres conserved at 45°C

	Concentration of beta-carotene (µg/g)	Beta-carotene retention (%)	Water content (%)
Initial	118,06	100	4,63
After 20 days	114,73	97,2	5,79
After 45 days	111,49	94,4	6,11

We have also calculated the reaction coefficient rate of the Vant'Hoff equation to estimate the haft-life of beta-carotene in microcapsule at 25°C (Tab. 3). The result showed that the capsules could retain up to 92% of beta-carotene after 3 months of storage at room temperature. It needs about 2 years to loss 50% of beta-carotene in these capsules. Normally, Gac oil stored at room temperature losses rapidly its carotenoids content. After Nguyễn et al., (Nguyễn 2010), Gac oil stored without nitrogen treatment lost up to 63,7% of its content in beta-carotene and 47% if treated with nitrogen after 3 months at room temperature.

Table 3. Calculated haft-time of beta-carotene in chitosan microcapsules

Reaction coefficient rate at 25°C (1/ day)	Calculated concentration of beta-carotene after 3 months (µg/g)	Beta-carotene retention (%)	Calculated haft-time (days)
0,001	108,86	92,2	769

CONCLUSIONS

We have successfully encapsulated Gac oil in chitosan microcapsules. Despite the surface of microcapsules was still rough, a high load was obtained. A good protection was also observed with haft-time up to 2 years.

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