

Stabilizing Technology of Pure Vitamin A using Triple Matrix Capsulation

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Abstract : In order to get stabilized pure retinol in skin care cosmetics, developing the three layered matrix bead capsules were studied. This study relates to make a cosmetic composition using the three layered matrix capsule that could increase the stability of the active ingredient. A primary encapsulation, vitamin A (pure retinol) of active ingredient was perfectly encapsulated into water-in-oil (Water-in-Oil: W/O) emulsion vesicle using PEG-10 dimethicone copolyol emulsifier. A secondary encapsulation of multiple emulsion of the water-in-oil-in-water (W/O/W) emulsion blending W/O emulsion using sucrose distearate of surfactant was developed using homogenizing emulsifying system. Pure retinol of active ingredient was stably capsulized to inside the W/O/W-multiple emulsion in order to load the triple matrix capsulation. By coating it with a polymer matrix base, encapsulated in the triple layered type, which were developed bead encapsulation of 2~10mm uniformly size. To show beautifully appearance capsulated bead type, these finish particles in this triple matrix layer were developed as a gold, green, dark brown, silver and blue color were encapsulated in the bead types. Structural particle certification of triple matrix layer was observed through SEM analysis. Stability of pure retinol was remained stable more than 99.7% for 30 days at 42° C incubating conditions compared with non-capsule. This technology was applied in different formulations such as various sizes and colors that by applying the skin care cosmetics. In the future, this technology to encapsulate an unstable active ingredient, we expect to be expanded this application in the food and drug as a time delivery system.

Keywords : Capsulation, skin penetration, retinol, stabilization, skin care cosmetics

1. Introduction

In the pharmaceutical industry or cosmetics, the protective barrier of the skin for the

the purpose of the external preparation for skin care, and a technology for supplying the active ingredient has proposed on a different formulation [1]. Recently, to increase the number of extracts obtained from natural stability, encapsulation technology has been widely applied [2]. Until now, in order to

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stabilize the retinol for airless pump it has generally been filled with how often to cut off from the air. In particular, a technique of stabilizing them vitamins since the readily decomposed by light or heat is not so much finding [3~4]. There are several ways such as O/W or W/O type cream, W/O/W type containing retinol in the cosmetic industry [5~7]. However, these methods, there are many problems to get stabilization of pure retinol from using simply dispersing and mixing system. The reason for this is that it is easily oxidized by air and water -OH radical contact [8~10]. Our group tried to find a better stabilization technology inspired by it. Further, to maintain long-term stability stabilizing unstable active ingredient is simply added to a stabilizer [11]. As a way to stabilize the active ingredient, a method of loading a multi-emulsion, a method of encapsulating in a liposome vesicle has been often applied [12]. However, this method does not have a lot of amount of encapsulated active ingredients it is not possible to ensure good stability [13].

Modernizing various methods for making the bead-shaped stable granules containing active ingredient have been proposed. By staining the exterior appearance has been developed in ways that rarely develop to differentiate [14]. Further, while having the form of a polymer matrix has been introduced in the encapsulation method is also a simple form. As a patent, the proposed 3-layered capsule technology is not found.

Also, it has well known in the thermodynamically unstable material, such as pure retinol, polyphenols, vitamin-E and natural extracts [15]. Because the cosmetic products are used for an extended period of time, it is important to stabilize the retinol in the cream in skin care cosmetics. To stabilize the pure retinol but a number of, and the effect is not so effective. In a simple way the stability of retinol, or mixed with the cream,

is a general method for selectively using airless container [16].

Therefore, this study was used a triple matrix capsule technology to stably encapsulated pure retinol. Long-term storage in the incubator at 42° C and the stability of pure retinol were observed for 30 days. To show this look beautifully encapsulated bead types in a variety of colors, and was applied to cosmetic formulations. The second capsule was used to create the W/O/W emulsion. Triple capsules wrapping on the outside surface of matrix droplets were completed in polymer matrix capsule. Overall, we reported the results for the preparation of a triple capsule.

2. Experimental Method

2.1. Materials

Raw materials are used in this study are as follows:

Retinol (Sigma Aldrich USA), retinyl palmitate (Sigma Aldrich USA), PEG-10 dimethicone copolyol (Shinetsu, Japan), cyclopentasiloxane (KCC, Korea), dimethicone (6cs, KCC, Korea), Polyglyceryl-2 stearate (Nikkol, Japan), glyceryl monostearate (Jeongnam, Korea), sucrose distearate (Biobeautech, Korea), Glycerin (LG chemical, Korea), 1,3-butylene glycol (Daicel, USA), polymer matrix mixture (Biobeautech, Korea), calcium sulfate (Daejung Korea), calcium chloride (Daejung Korea). The all materials used this study were used as cosmetics and food grade without further treatment.

2.2. Equipment

Primary, secondary, as a device to create an emulsion homo-mixer (HY-001A, Hansung-ENG, Korea) and dispersing mixer (Hanyang, Korea) was used. To make a bead capsule was used specially prepared Capsule-Mader (Biobeautech, Korea). Quantitative analysis equipment HPLC (Model 1100, Hewlett-

Packard, USA) DMF was used. Other solvents, reagents necessary for analysis was used for analysis of the raw materials of the class.

2.3. Preparing method of triple matrix capsule

2.3.1 Preparing method of 1st capsule W/O emulsion

The primary capsule, to make W/O (water-in-oil) emulsions are shown in Table 1 and Fig. 1. Each weighing a phase A and

phase B to be heated to 50~70° C. Slowly rotate the beaker added to Phase A to Phase B while mixing to 2000rpm. And they were stirred for 5 minutes with 2000rpm it. After cooling to 30° C, it added to phase C and stirred for 5 minutes at 4000rpm.

2.3.2. Manufacturing method of W/O/W emulsion of 2nd capsulation

A second capsule, W/O/W (water-in-oil-in-water) to make the emulsion, it is shown in Table 1. We prepared it as specific mixing

Table 1. Composition of Water-in-Oil (W/O) Emulsion as 1st Capsulation

Phase	Ingredient Name	Wt%	Remarks
A	PEG-10 dimethicone copolyol	3.0	Emulsifier
	Glyceryl monostearate	1.0	Emulsifier
	Polyglyceryl-2 stearate	1.0	Emulsifier
	Cyclopentasiloxane	10.0	Emollient
	Dimethicoen (6cst)	10.0	Emollient
B	Glycerin	5.0	Humectant
	1,3-butylene glycol	5.0	Humectant
	Xanthan gum (2% solution)	10.0	Gelling agent
	Water	54.5	Solvent
C	Retinol (Vitamin-A)	0.5	Additive
Total		100.0	

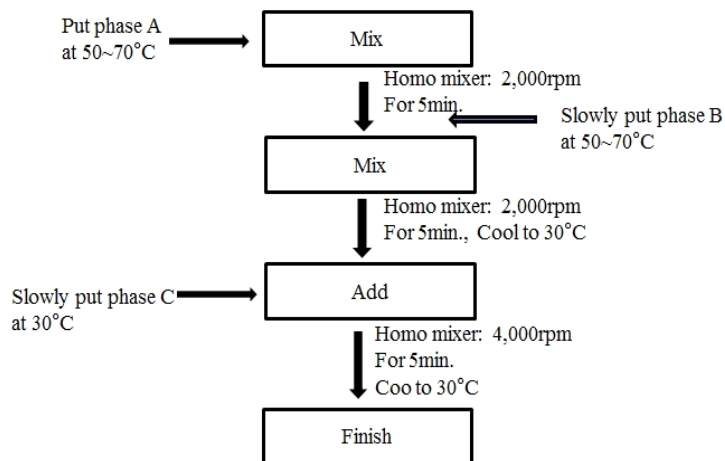


Fig. 1. Manufacturing method of water-in-oil emulsion as a 1st capsulation.

Table 2. Composition of Water-in-Oil-in-Water (W/O/W) Emulsion as 2nd Capsulation

Phase	Ingredient Name	Wt%	Remarks
A	Glycerin	5.0	Moisturizer
	1,3-butylene glycol	5.0	Moisturizer
	Sucrose distearate	3.0	Emulsifier
	Xanthan gum (2% solution)	15.0	Gelling agent
	Hydroxyethylcellulose (2% solution)	10.0	Moisturizer
	Water	22.0	Solvent
B	W/O-Emulsion (Table 1)	40.0	1 st Capsulation Base
Total		100.0	

method: while mixing paddle put in phase-A then put phase-B (Table 1 base), dispersing step was important preparing with without broken multiple emulsion vesicles. Mixing condition of paddle mixer was 15rpm for 3 minutes with Homo-mixer was 2000rpm to make a W/O/W emulsion.

2.3.3. Manufacturing method of triple matrix capsulation

A manufacturing method of the triple matrix capsule, by incorporating a polymer matrix base of 0.1~1wt% in the second capsule passing through the small nozzles, we could make tertiary matrix capsule. The size of the nozzle was suitable for a 0.1~2mm. In this study, the stability of vitamin A was put into the center of the first capsule.

2.4. Retinol A measure of stability test

In order to stabilizing ability of triple capsule incorporated with pure retinol, Cream of tertiary encapsulated bead was determined by HPLC. The mobile phase was methanol and acetonitrile. Flow rate was 1 mL per minute. Stationary phase was used for C-18 column. Samples were compared by analysis of the two samples which are non-coated retinol and triple matrix capsule cream.

3. Results and Discussions

3.1. Preparation of 1st capsule

Preparing method of primary capsule showed in Table 1, Fig. 1 and Fig. 2. As you can see in Fig. 2, it was W/O emulsion system. Inside is water phase. Outside is oil phase. It was first step to make triple capsule. This is the basis for making the capsule through the third step. Retinols of 5000 IU/g were loaded in the interior of the capsule. Unstable pure retinol from outside was sealed to protect from air and light. Retinol should be careful because it is easy to decompose in light materials. If the primary capsule of W/O type is fine, smooth W/O/W capsule was also able to make good.

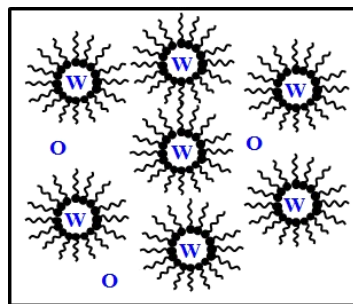


Fig. 2. Schematic design of 1st capsulation as water-in-oil emulsifying system; (W: water, O: oil)

3.2. Preparation of 2nd capsule

The second capsule is made of the W/O/W emulsion as shown in Table 2 a method of sealing by the primary particles in the inside part. It shows a schematic diagram of the secondary capsule in Fig. 3. Internal phase is a water-in-oil has existed, outer phase was present the water-phase. Pure retinol could be encapsulated in the inside of the capsule. This can be considered as reliable because of the formed W/O emulsion was used in addition to sucrose distearate hydrophilic dispersant emulsifier.

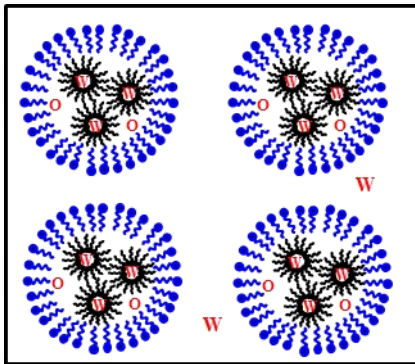


Fig. 3. Schematic design of 2nd capsulation as water-in-oil-in-oil (W/O/W) emulsifying system:
(W: water, O: oil)

The structure of the secondary of W/O/W emulsion was showed in Fig. 4. The structure of the emulsion was observed with a CCD camera equipped with an optical microscope. Magnification was observed by 1000 times magnification. W/O/W-emulsion of Fig. 4 showed almost similar to the schematic diagram shown in Fig. 3 we first designed. Emulsion type in this study was consistent with the similar structure.

In particular, we could make it because we found sucrose distearate having HLB value 7. Therefore, we could develop the second capsule showed to be stably maintained without any break.

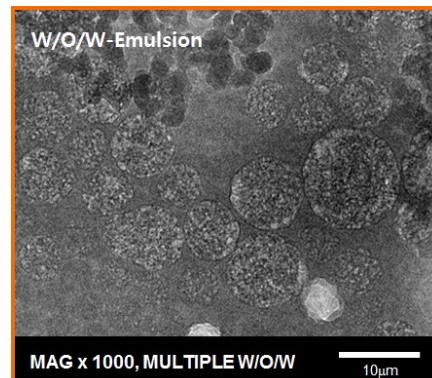


Fig. 4. Microscopic analysis of water-in-oil-in-oil (W/O/W) emulsifying system for 2nd capsule: magnification x 1000 times with CCD camera and with soft ware program.

3.3. Preparation of 3rd matrix capsule

A schematic diagram of the third matrix capsule is shown in Fig. 5. W/O/W emulsion is made of the granule is filled with polymer matrix stability, as shown in Fig. 5. The purpose of inclusion of the triple capsule is sealed to stabilize the pure retinol. The third capsule is isolated from the oxygen to prevent rancidity and oxidation from outside condition, as well as to protect the retinol from UV light of sun. Retinol is also known as the best ingredient for anti-aging.

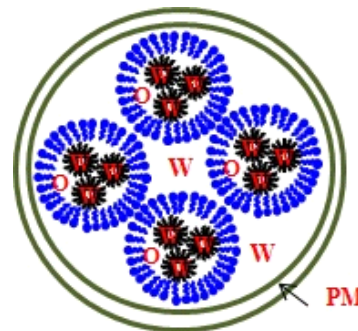


Fig. 5. Microscopic analysis of water-in-oil-in-oil (W/O/W) emulsifying system for 2nd capsule: magnification x 1000 times with CCD camera and soft ware program. (W: water, O: oil, PM: polymer matrix)

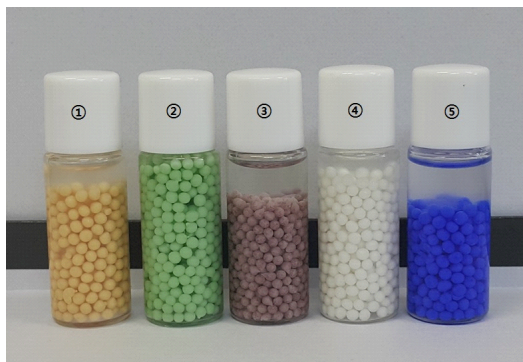


Fig. 6. Various triple matrix capsules containing pure retinol each 5000IU/g; ① gold, ② green, ③ dark brown, ④ silver, ⑤ blue color capsule

In cosmetics, it is important above all that the active ingredients remain stable for an extended period of time with finished product. Finally, we showed in Fig. 6 regarding 5 kinds of triple matrix capsules. Their capsules showed real matrix capsule having gold, green, brown, silver, blue colors to be composed of triple layer. Their particle sizes were $2 \pm 0.2 \mu\text{m}$. These could see beautifully as an appearance of clear cosmetic bottles in skin care cosmetics. The three layered of microcapsule incorporated into retinol could certify stably at 42°C incubators for storing 30 days.

Fig. 7 is to develop the various sizes of triple capsulation. Sizes of their capsules are 2mm, 5mm, 8mm, 10mm with red, yellow, white, black as granules. Developing different size, it was dependent on the nozzle inner size. They could create a beautiful cosmetic due to

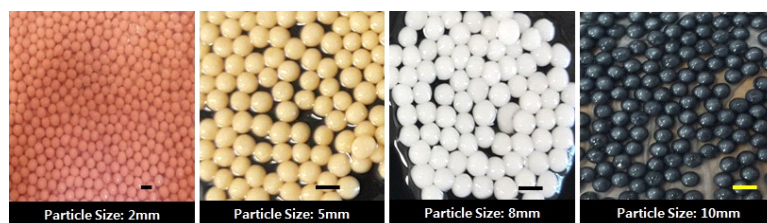


Fig. 7. Microscopic analysis of triple matrix capsule forming in water-in-oil-in-oil (W/O/W) emulsifying system for 2nd capsule; from left red, yellow, white, and black colors.

the different color capsule. In addition, it could increase the stability to load the various active ingredients within the capsule.

3.4. SEM Analysis of Matrix Capsule Surface

Retinol to analyze the particles in the capsule is enclosed 3 were observed by TEM analysis. The TEM analysis results are shown in Fig. 8. Cut the center surface of one granule particles were observed inside formative shape. As shown in Fig. 8 showed cross-section of the particle formed with cross-linked to the matrix was found to form a stable matrix wall. Dispersed pearl particles could be seen that the appearance was a gold-colored loaded in multi-capsule.

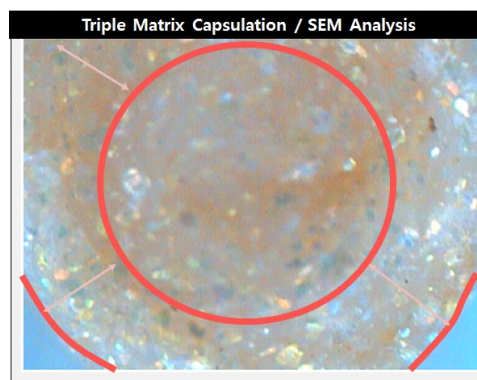


Fig. 8. Electron microscopic SEM analysis of triple matrix capsule; automatically cut cross section then observed into SEM microscop, magnification $\times 10,000$ times with CCD camera and soft ware program.

3.5. Retinol stability of triple matrix capsule

In order to test the stability of retinol, not encapsulated sample and the triple matrix capsule was quantitatively analyzed by HPLC. The results are shown in Fig. 7. The content of the initial retinol, as shown in Fig. 7 was 5,000IU/g. However, 42 degrees for 30 days in the incubator, and the content of the stored samples to 2170IU/g, 56.6%, was reduced. However, the triple matrix capsules, to 4978IU/g seen that contained 99.56% it was found that the stability is excellent.

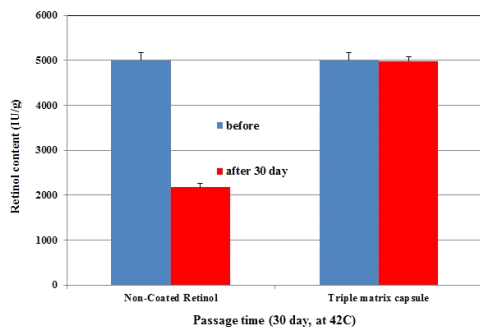


Fig. 9. Stability of triple matrix capsulized pure retinol (5000iu/g) compared with non-capsuled cream; blue bar is before, red bar is after 30 days in 42° C incubations.

4. Conclusions

This study was used a triple matrix capsule technology in order to stably encapsulate the pure retinol of unstable material. Matrix capsule of Long-term storage in the incubator and the stability of pure retinol were observed. To show this look beautifully encapsulated bead types in a variety of colors, and was applied to cosmetic skin care formulations. The second capsule was used to create the W/O/W emulsion. Triple capsules wrapping on the outside surface of matrix droplets were completed in polymer matrix capsule. You can make a pure retinol containing capsule in a variety of colors can develop a beautiful and

gentle cosmetics. Those technologies are significantly expected to apply at cosmetic industry as well as are widely available in pharmaceutical and food industry applications.

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