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THE STABILITY OF ALL-*TRANS*-RETINOL IN NOVEL LIQUID CRYSTALLINE O/W EMULSION

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Abstract

We investigated the stability of all-*trans*-retinol on the liquid crystalline O/W emulsion composed of mainly alkyl polyglycerine, alkyl polyglucose and glycerine, and compared the activity of all-*trans*-retinol in the various forms of liquid crystal.

Under certain conditions, novel liquid crystalline gel was formed around oil droplets, and layers of this liquid crystalline gel were very wide and rigid. (SWLC; Super Wide Liquid Crystal)

SWLC was very helpful to stabilize retinol in O/W emulsion. After storage at 45 C for 4 weeks, all-*trans*-retinol in O/W emulsion composed of SWLC retained above 85% of the activity upon HPLC analysis, whereas those within no liquid crystalline emulsion gave 47% and normal liquid crystalline emulsion composed of fatty alcohols gave 40 60%.

Retinol in oil phase is nealy insoluble in pure water, but in cosmetic emulsion systems can be slightly solubilized into water because emulsifiers and polyols in emulsion systems function as solubilizers. In this case, water in outer phase acts as a media for oxygen transporation and thus destabilizes retinol. As a result, retinol in O/W emulsion has a tendency to become unstable. SWLC surrounding oil droplet which contains retinol is wide and rigid, therefore reduces contact between inner phase and outer phase.

To make SWLC, properties of emulsifiers are very important phase transition temperature should be high, and the structure of surfactants should be bulky, and their ratio should be suitable to make rigid and wide liquid crystalline gel layer in order to reduce contact between retinol in inner phase and water in outer phase.

Introduction

Many researches have been studied to stabilize oil soluble active ingredients; W/O, W/O/W, encapsulation, bead, double capsule, microsponge, etc. It is well known that retinoids can be easily destabilized through UV, heat and oxygen. Especially oxygen in aqueous phase accelerates destabilization of retinoids.

We investigated the effect of liquid crystalline gel layer (SWLC) on the stability of all-*trans*-retinol in O/W emulsion system, by reducing contact between retinol in inner oil phase and outer water phase. To make rigid and wide liquid crystalline gel layer, surfactants which have high phase transition temperature and bulky structure were used and optimal formulation ratio of the surfactants was also discussed.

Materials and Methods

Preparation and characterization of SWLC

PGPS (polyglycerin10-pentastearate) and CPG (cetostearyl polyglucoside) as primary surfactant, BA (behenyl alcohol) and CA (cetostearyl alcohol) as cosurfactant were used to prepare SWLC emulsion. CCT (Caprylic/capric triglyceride) was also used as oil component and glycerin was used for water phase as well as deionized water. All ingredients used in these experiments are cosmetic grade and the state of oil droplet and formation of liquid crystalline gel layer were observed with polarized microscope (Nikon Optiphot-2).

Stability of all-trans retinol

SWLC emulsion containing all-*trans*-retinol (BASF) was prepared and analyzed through HPLC and compared to other emulsion systems; non-liquid crystalline O/W emulsion and thin-liquid crystalline O/W emulsion which is formulated with polysorbate 60 and cetostearyl alcohol. All samples were stored at 45 C for 40 days in order to detect remained retinol content and determine how SWLC is helpful to stabilize oil soluble active ingredient.

SWLC systems were analyzed with absorbance at 325nm and converted to IU (International Unit) to estimate their activities. Methanol of HPLC grade as extracting solvent and all-trans-retinol at Sigma as standard material were used in this analysis. The activity of standard retinol during storage was also compensated.

Solvents, instruments and conditions used in HPLC analysis are as follows:
Mobile phase : methanol (HPLC grade, Fischer)
Pump : Waters 510, Detector : Waters 996 photodiode array detector
Column : CAPSELL PAK (C18), type-UG 120 , 5 μ, size-4.6mΦ*250mm
Flow rate : 0.8ml/min

Results and Discussion

Formation of SWLC

To prepare SWLC emulsion, the ingredients divided into water phase and oil phase were heated to 70 C. They were mixed and homogenized for 5 minutes. And then they were colled down to room temperature.

As results of various ingredient compositions, the best formation of SWLC was the ratio (1 : 3.5 : 1.5) of oil, water and surfactants. In this case, the ratio of PGPS to CPG was 10 : 3 in the surfactant and that of BA to CA was 2 : 1 in cosurfactant. The results are shown in Figure 1.

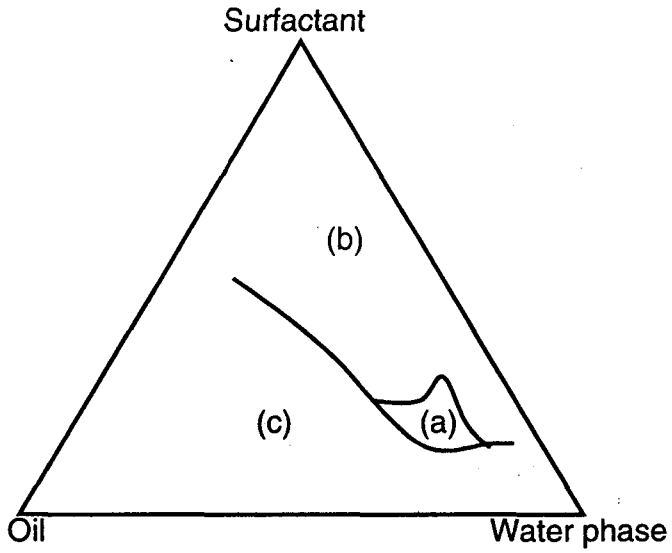

Fig.1 Phase diagrams of formation of SWLC.

In the emulsion system, the oxidation of oil phase can be prevented by suppressing mass transfer between the interior and exterior if the rigid and wide liquid crystalline gel is formed around oil droplet. To form this kind of liquid crystalline gel, surfactant with bulky structure and high phase transition temperature should be appropriated.

It seems that PGPS and CPG would form strong lamellar structure since their structure as bulky and has multi-chained hydrocarbon with leading the hydrophobic bonding, and their phase transition temperatures (about 60 C) are high. Also, when BA and CA are used with PGPS and CPG, carbon chains are prevented from being packed too much and the solidifying is limited. In addition, the formation of a tight liquid crystalline layer could happen.

As shown in Figure 1. a, it is observed that the optimal rigid and liquid crystalline gel is formed at the amount of surfactant is one and half of oil used. When the higher ratio of surfactant was used solidified crystal appeared in the interface (Figure 1. b). In addition, if the lower ratio of surfactant was used, a little thin O/W emulsion was formed in liquid crystalline gel (Figure 1. c). Under the constant contents of water, the optimal formation of SWLC occurred if the ratio of PGPS to CPG was 10 : 3. The cosurfactant, fatty alcohol has critical function in formation of SWLC as the ratio of BA to CA was 2 : 1.

It seems that the carbon chains of those surfactant and cosurfactant are packed by hydrophobic interaction and assist the formation of optimal structure of crystalline gel by mixing different hydrocarbon chain lengths. Also, it is assumed that they prevent the formation of solidified crystal in the interface and the effect is maximized at this ratio.

The phase of SWLC depends on the kinds of oil. In triglycerides, better formation was observed compared to in hydrocarbon or branched ester oil. The reason seemed that liquid crystal phase formation around oil droplet was affected by compatibility with surfactants in structure although hydrocarbons have high solubility. When glycerin was half of the amount of water, the best SWLC formation occurred. It seems that glycerin helps the structuring of water and contributes to the lamella structure. The average thickness of liquid crystalline gel layer in SWLC was 2.0μm at 10μm diameter oil droplet. Figure 2 shows the microscope picture of SWLC.

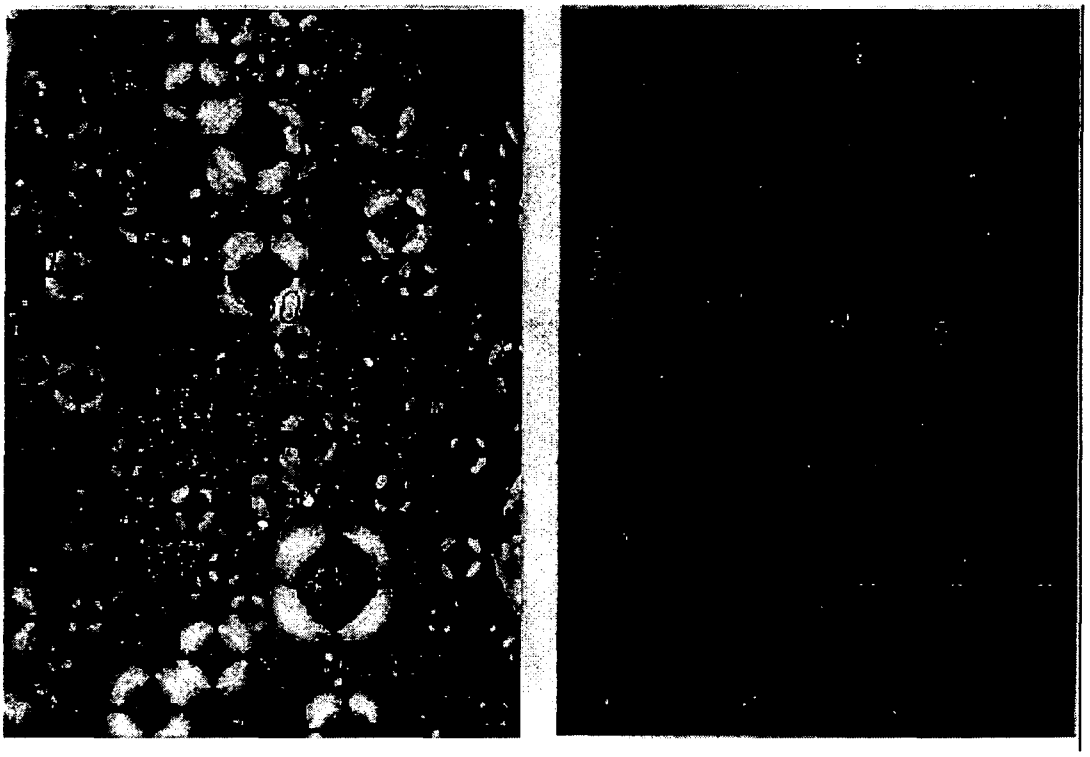

Fig. 2 Microscope pictures of SWLC. (500)

In spite of the excellent efficacy for skin, retinol is oxidized easily by air, water, light and limited in cosmetic applications. But, the SWLC could be applied to cosmetic use in unstable active material since the rigid and wide crystalline gel limits the mass transfer of interior and exterior. Table 1 shows the changes of the amount of retinol in HPLC analysis as compared to the general emulsification systems.

[Table 1] HPLC analysis of retinol remained in liquid crystalline system

Sample	after 20 days at 45 C	after 40 days at 45 C
A	68 %	28 %
B	92 %	79 %
C	78 %	51 %

(A : no liquid crystalline emulsion, B : SWLC, C : thin liquid crystalline emulsion)

As a result, retinol in SWLC shows better stability as compared to other samples and could sustain 80% of the activity. Therefore, it seems that SWLC system could be used in the stabilization of unstable active material for cosmetic applications.

In addition, more investigation will follow to reveal SWLC application in cosmetics, that is, the long-lasting water holding capacity, skin absorption and the increasing of stability of emulsion, etc.

Conclusion

As results of above experiments, we could get optimal and stable SWLC system with the ratio (1 : 3.5 : 1.5) of oil, water and surfactants. In this case the ratio of PGPS to CPG was 10 : 3 in the surfactant and that of BA to CA was 2 : 1 in cosurfactant.

Activity of retinol in SWLC system matained 80% after 40 days storage at 45 C by HPLC analysis; therefore SWLC is expected to be used for application of cosmetic emulsions especially to stabilize oil soluble active ingredients.

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