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Cream Prepared from Emulsifying Polymer: Effect of Oil Content, Stirring Intensity & Mixing Temperature

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ABSTRACT

This study investigated the factors affecting physical properties of cream prepared from emulsifying polymers. The systems containing ammonium acrylate/Acrylamide copolymer & Polyisobutene & Polysorbate 20, distilled water and isopropyl isostearate were prepared. Formula and process variables including amount of oil, stirring intensity and mixing temperature on physical properties of cream base were evaluated. Viscosity of emulsions was increased as amount of oil was increased. Viscosity of formulation did not change as stirring intensity and mixing temperature were increased. The amount of oil affected viscosity of cream base whereas the stirring intensity and temperature did not affect the viscosity of cream base prepared from emulsifying polymers.

Keywords: Emulsifying polymer, Oil content, Stirring intensity, Mixing temperature, Cream

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INTRODUCTION

Emulsifying polymer could be used in low energy emulsification [1-4]. It is a pre-neutralized polymer having the non-ionic surfactant catching around it and being dispersed in oil phase which it can invert and the polymer network expands instantly during contact with aqueous system. Therefore it can be used in cold processing and ideal for use in case of the presence of heat-sensitive ingredients. However it is interesting for investigation the effect of temperature on the properties of the systems prepared with this polymer since it will apply for products prepared using process with higher temperature. Additionally, this emulsifier is the polymer therefore it should be study the effect of stirring intensity on the physical properties of system. One main component of emulsion system is oil therefore it is interesting to study the effect of oil on the physical properties of system prepared with the emulsifying polymer. Isopropyl isostearate is the non-ionic liquid fatty acid esters. It is the ester of isopropyl alcohol and isostearic acid, is used as a skin conditioning agent-emollient in cosmetic products. The advantage of isopropyl isostearate was non-greasy, good solvent and good spreadability [5].

This aim of this study was to study the effect of oil, stirring intensity and mixing temperature on physical properties of cream prepared from ammonium acrylate/Acrylamide copolymer & polyisobutene & polysorbate.

MATERIALS AND METHODS

Materials

Sepiplus 265® (Se 265) (Ammonium acrylate/Acrylamide copolymer & Polyisobutene & Polysorbate 20) (batch no. T44031), was purchased from Seppic, Paris, France. Isopropyl isostearate (Prisorine 2021®) (batch no. 1129023, Uniqema, U.K.) was used as received. Methyl hydroxyl benzoate (batch no. A16/18), propyl hydroxyl benzoate (batch no.000130), polyethylene glycol 400 (PEG 400) (batch no.P077241) were supplied by P.C. Drug Center Co., Ltd., Thailand.

Methods

Preparation of Cream Base and Study of Physical Properties

Preparation of Cream Base

The oil phase (phase A : Isopropyl isostearate (Prisorine®2021) and aqueous phase (phase B : water and emulsifying polymer (Se 265)) were weighed and filled into separate containers. Phase A was gradually added to phase B (A to B) at room temperature with appropriate manual agitation for 5 min to form the emulsion. Finally, the remaining ingredients of phase C (Concentrated paraben) and/or drug were added to the bulk. The emulsion was mixed for 3 min until it was homogenous.

Study of Physical Properties

The viscosity of prepared systems was measured using brookfield helipath viscometer (Brookfield Engineering Laboratories Inc., Stoughton, USA). The sample of 200 g was prepared and was filled into a glass bottle before test. The pH of formula was measured using a pH meter (Professional Meter PP-15 Sartorius, Goettingen, Germany). All measurements were performed at room temperature in triplicate for each sample. The physical stability of prepared creams was also tested after 6 cycles temperature cycling. For one cycle, all formulations were kept at 10°C for 24 h in the refrigerator and then at 40 °C for 24 h in the hot air oven (FED 720, Scientific promotion, Bangkok, Thailand). Viscosity alteration and phase separation were used to indicate the physical stability. The stable formulation should not have the phase separation or apparent viscosity change. Human volunteer skin was applied with cream and measured the skin glossiness and moisturizing value using skin analyzer (Skin Diagnostic Model SD 27, CK Electronic GmbH, Koln Germany) (n=3).

Factors Affecting Physical Properties of Cream Base Formulation

Effect of oil content

The oil used in this study was isopropyl isostearate (Prisorine® 2021). Amount of oil in each formulation was varied as 5, 15, 25, 35, 45, 55 and 65 % v/w. The methods for preparing the cream base and the study of the physical properties were conducted as mentioned previously. The percent compositions of the formulations are shown in Table 1. Se 265 was used as an emulsifying polymer.

Effect of mixing temperature

Selected system comprising 15% w/w Prisorine®2021, 3% Se 265, 1% paraben concentrate and water was exposed under different mixing temperatures; room temperature, 50°C, 70°C and 100°C. The oil phase and water phase were separately heated to the above mentioned temperatures. Both phases (the oil phase was added to the water phase) were mixed then the emulsion was stirred at room temperature for 5 min. The methods for preparing the cream base and the study the physical properties were performed as mentioned previously.

Effect of Stirring Intensity

Above selected system was exposed under several stirring intensity for 5 min using homogenizer: level 7 (17,500 rpm), level 8 (20,000 rpm), level 9 (22,500 rpm), level 10 (25,000 rpm) and manual mixing with stirring rod. The methods for preparing the cream base and the methods for studying the physical properties were performed as mentioned previously.

Data Evaluation

The significance of the differences between mean values (where $p < 0.05$) was tested using ANOVA and pair *t*-test from SPSS for window version 11.0. Each data point represents the average of three determinations.

RESULTS AND DISCUSSION

Emulsifying polymers are useful component for production of creamy emulsion products. In this study, the viscosity of cream bases was evaluated under several factors such as amount of oil, mixing temperature and stirring intensity.

Effect of oil content

The viscosity of the prepared cream bases was in the range of 159,111 ± 5,048 to 472,000 ± 25,438 cps as shown in Fig. 1. Amount of oil affected viscosity of cream base prepared from emulsifying polymer. The viscosity of cream base was increased as oil concentration increased from 5 to 35 % w/w. This was due to an increasing in phase volume of internal phase in emulsion [6]. High oil concentration often led to an increase in particle size and viscosity of the system [7, 8]. However, this emulsifying polymer at concentration of 3 % w/w could not accommodate oil phase more than 35 % v/w because the emulsion cracked and separated into two phases. The pH of the prepared cream bases was in the range of 5.88 ± 0.03 to 7.33 ± 0.04. The viscosity of all cream bases after 6 cycles of temperature cycling showed no significant difference from freshly prepared cream base. Cream bases prepared using 5 and 15% oil exhibited the good appearance with a homogeneous texture, smoothness and colorless. However cream bases using oil at 25 and 35 % was more translucent, less smoothness and homogeneity. Almost cream bases were absent of phase separation and color change. However cream base containing oil more than 35 % was cracked and separated into two phases. The phase volume of oil at 15 % w/w was used for further step since it provided the cream base with appropriate appearance and physical properties. The effect of oil content on cream viscosity was significantly different ($p<0.05$).

Figure 1: The viscosity of cream base both containing different oil content

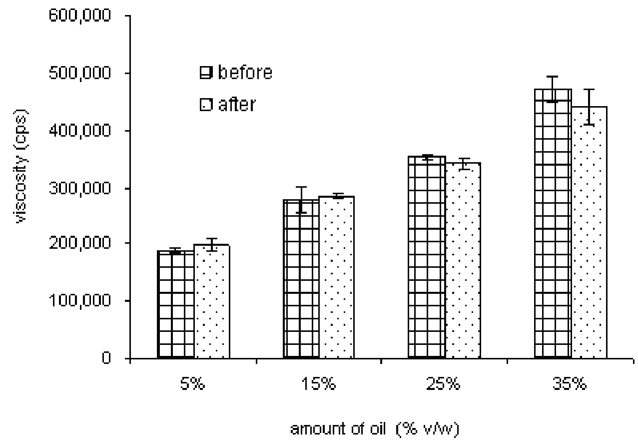

Figure 2: Glossiness value of cream containing different amount of oil

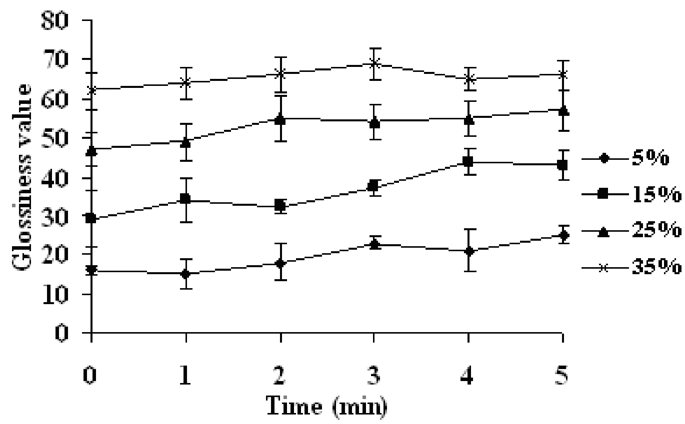

Figure 3: Moisturizing value of cream containing different amount of oil

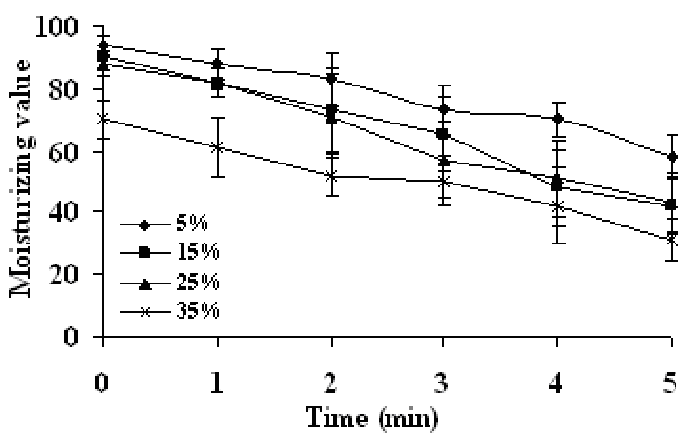

Figure 4: The viscosity of cream base prepared using different mixing temperature

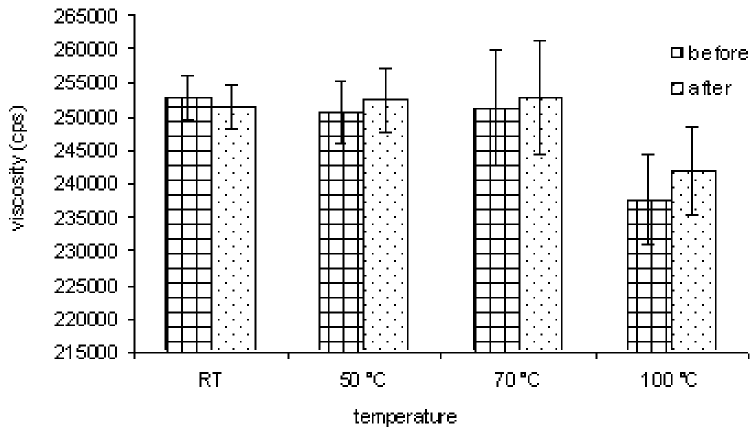

Figure 5: The viscosity of cream bases prepared using different stirring intensity

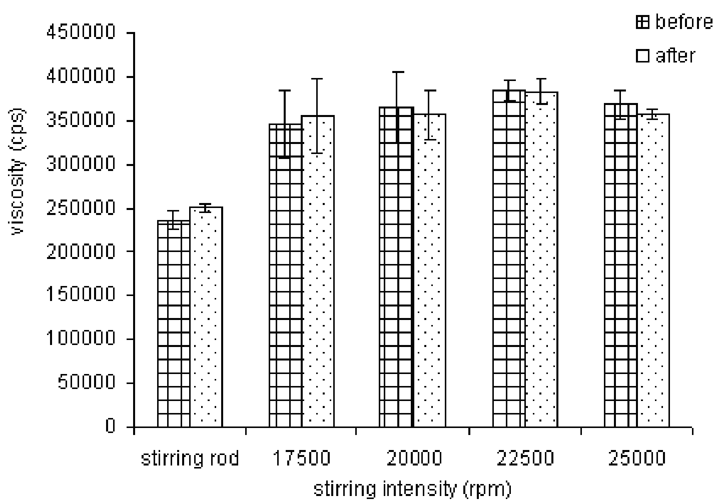

Table 1: Composition of the cream base using different oil content

Compositions	Formulation (% v/w)
Emulsifying polymers	3
Prisorine®2021	5 , 15 , 25 , 35, 45, 55, 65
Paraben conc.	1
Water	q.s.

The skin glossiness was higher when the cream base containing higher amount of oil was applied on the volunteer skin as presented in Fig. 2. The moisturizing value tended to decrease with time (Fig. 3) indicating the absorption of cream into the skin (Fig. 3).

Effect of Mixing Temperature

The viscosity of the cream bases prepared using different temperature (RT-100°C) was in the range of 237,778 ± 6,577 to 252,889 ± 3,355 cps as shown in Fig. 4. The viscosity of all cream bases after 6 temperature cycling was not significantly different from freshly prepared cream base. The pH of the prepared cream bases was in the range of 7.44 ± 0.02 to 7.46 ± 0.04. All cream bases before and after passing 6 temperature cycling presented the good appearance and it was absent of phase separation and color change. The effect of mixing temperature on cream viscosity was insignificantly different ($p<0.05$). Generally, temperature was one of the most important factors for the system stability [9]. Almost cream bases prepared using emulsifying polymer (Se 265) in this study was stable under different mixing however, an abnormal increase in temperature (100◦C) was to be avoided because it tended to coagulate the particles, thereby causing a deterioration of the emulsion [10]. It could practically affect formulations through an alteration of changes in viscosity and solubility, partitioning of molecules between the two phases, melting of waxes, and hydration of polymers, and can also facilitate creaming and coalescence [11]. This result suggested that almost emulsifying polymers used in this study could tolerate to high temperature, which might be also suitable to use in the preparation requiring the heating process.

Effect of Stirring Intensity

The viscosity of the cream bases prepared using different stirring intensity was in the range of 236,889 ± 11,496 to 384,889 ± 11,340 cps as shown in Fig. 5. The viscosity of cream base prepared using different stirring intensity could be ranked in the following: homogenizer (22,500 rpm > 25,000 rpm > 20,000 rpm > 17,500 rpm) > manual mixing. The pH of the prepared cream bases was in the range of 7.33 ± 0.03 to 7.35 ± 0.04. The viscosity of all cream bases after 6 temperature cycling was not significantly different from freshly prepared cream base. All cream bases before and after 6 temperature cycling presented the good appearance with a homogeneous texture and it was absent of phase separation and color change. However, the smoothness of formulations prepared using homogenizer was greater than the formulation prepared using stirring rod. Manual mixing with stirring rod was selected to prepare the cream base in following step because cream base prepared from manual mixing with stirring rod still exhibited conveniently and good physical appearance. The effect of stirring intensity on cream viscosity was significantly different ($p<0.05$) between using stirring rod and homogenizer. However, these was no significant different between various stirring intensity by homogenizer. Emulsification is usually achieved by the application of mechanical energy [10]. Generally, the increased viscosity of emulsion was achieved with higher stirring speed. Decreasing particle size led to an increase in the interfacial surface. Hence utilization of high stirring intensity could stabilize the system.

CONCLUSION

Several factors affected physical properties of cream base prepared using emulsifying polymer. The amount of oil affected viscosity of cream base whereas the stirring intensity and temperature did not affect viscosity of this cream base.

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REFERENCES

[1] Claude D, Daniele C. 1995; US Patent 5470551.
[2] Anchisi C, Maccioni AM, Sinico C, Valenti D. Il Farmoco 2001; 56:427-31.
[3] Anna RB, Maria CB, Giovanni M, Franco FV. J Pharm Biomed Anal 2006; 41:449–54.
[4] Thais G, Mirela D. Inter J Pharm 2006; 327:12–16.
[5] Cosmet P. J Am Coll Toxicol 1992; 11 (1):43-9.
[6] Becher P. Emulsions: Theory and Practice. 2nd edi., Reinhold Publishing Co., New York, U.S.A., 1965.
[7] Benita S, Levy MY. Int J Pharm 1989; 54:103-112.
[8] Ishii F, Sasaki I, Ogata H. J Pharm Pharmacol 1990;42:513-5.
[9] Soriano MM, Contreras MJ, Flores ES. Boll Chim Farm 1996; 135(6):364-373.
[10] Chen G, Tao D. Fuel Process Technol 2005; 86:499-508.
[11] Idson B. Drug Cosmet Ind 1993;152:27-30, 38-43,72.