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INTRODUCTION

Emulsion formulations are one of hard tasks since there are a lot of emulsifiers which can be selected. To save time in emulsifier selection, the hydrophile-lipohile balance (HLB) system has been used for choosing proper emulsifiers. Lipophilic compounds (oils, fats, and waxes) have an individual value called "required HLB". An emulsifier or blend of emulsifiers, having an HLB equal to the required HLB of the lipophilic phase will make a more stable emulsion than emulsifiers of any other HLB values.[1] Generally, blends of emulsifiers can provide much higher effective as emulsifiers than any single chemical composition would be because their resulted complex interfacial films can protect the internal droplets from coalescence, leading to more stability.[1-3] Nevertheless, "right chemical type" is also as important as "right HLB". It was reported that the properties of emulsifier mixtures, i.e. HLB and carbon number of alkyl chain length, affected the stability of asphalt emulsions.[4] Moreover, only total HLB of an emulsifier pair was found to be not enough to formulate a physically stable coconut oil emulsions.[5] Besides normal emulsions, the stability of multiple emulsions was also depended on emulsifier chemistry.[6] Therefore, it is interesting to investigate the influence of few differences in HLB values but large differences in chemical structures of an emulsifier in the emulsifier blends on feasibility of emulsion formation. In this study, isopropyl palmitate (IPP) was formulated in form of lotion using four pairs of different blends of non-ionic emulsifiers and evaluate for feasibility of emulsion formation. The required HLB for IPP is 11.5.[7] Four pairs of emulsifier blends with the identical total HLB of 11.5 prepared from different components were investigated.

MATERIALS AND METHODS

Materials Fou r non-ionic emulsifiers, i.e. polyethylene [20] sorbitan monooleate (PSMO, HLB = 15.0), polyethylene [20] sorbitan monostearate (PSMS, HLB = 14.9), sorbitan monooleate (SMO, HLB = 4.3) and sorbitan monostearate (SMS, HLB = 4.7) were purchased from P.C. Drug Center Co., Ltd. (Bangkok, Thailand). Isopropyl palmitate (IPP) was purchased from East Asiatic (Bangkok, Thailand). Distilled water was used throughout the experiments. All chemicals were of pharmaceutical grade and used as received without further purification.

Preparation of isopropyl palmitate lotions Amount of each emulsifier in each emulsifier blend was calculated according the HLB system.[1-3] Four formulations of IPP lotions containing 40% w/w IPP, 10% w/w emulsifier blend, and 50% w/w water, as exhibited in Table 1, were prepared by an emulsification process.[5] The oil phase (IPP and an oil-soluble [low HLB] emulsifier) and the water phase (water and a water-soluble [high HLB] emulsifier) were separately heated in a water bath to 70°C. Afterwards, the water phase was slowly added to the oil phase with continuous stirring until the mixture was cooled to ambient temperature.

Observation for feasibility of lotion formation All prepared samples were optically observed for their appearance such as color and homogeneity to determine the feasibility of lotion formation. The feasibility of lotion formation was decided from non-separated milky liquid performance of the obtained products within 3 days after preparation, arbitrary criteria duration.

Table 1 Formulations of IPP Lotions

Formulation	IPP (% w/w)	PSMO (% w/w)	PSMS (% w/w)	SMO (% w/w)	SMS (% w/w)	Water (% w/w)
L-1	40	6.73	-	3.27	-	50
L-2	40	6.60	-	-	3.40	50
L-3	40	-	6.79	3.21	-	50
L-4	40	-	6.67	-	3.33	50

RESULTS

After immediate preparation, all samples were seen as milky liquids. However, only L-4 could provide the feasibility of lotion formation while other formulations could not as shown in Figure 1. The products of L-1, L-2 and L-3 exhibited upward creaming and subsequently breaking within very short duration.

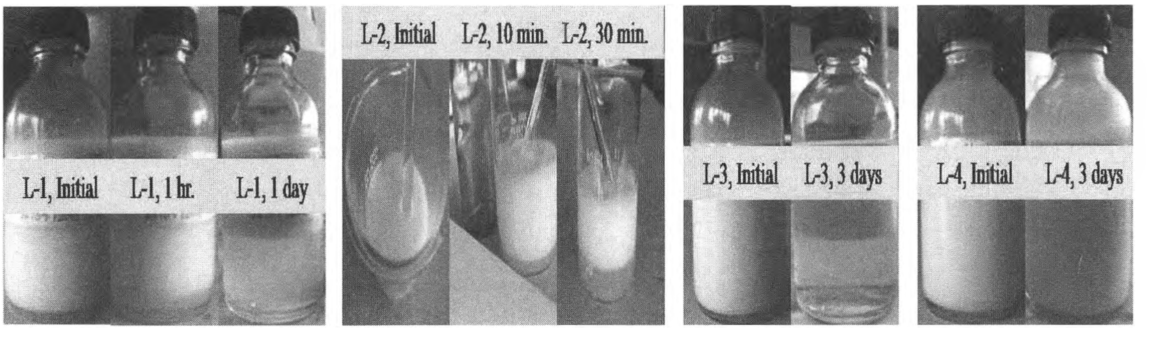

Figure 1 Appearance of the investigated IPP lotions

DISCUSSION

The results indicated that only formulation L-4 could provide feasibility for physical stable IPP lotion while other formulations (L-1, L-2, and L-3) could not. Upward creaming was seen in Formulations L-1, L-2, and L-3 since the instable dispersed oil droplets were less dense than the water continuous phase, resulting in a tendency to raise. Afterwards, the instable oil droplets could coalesce and phase separation could be occurred. This physical instability also indicated an oil-in-water type of the obtained IPP lotion which was in coincidence to HLB of emulsifier system of higher than 8.[1-3]

The difference in HLB value between SMO and SMS is 0.4; obviously showing that SMO is more lipophilic.[1-3] In previous study, SMO was found that it could not form strong interfacial films around droplets of coconut oil since its very low HLB caused SMO to prefer to migrate into the oil phase rather than to settle at the oil/water interface.[5] In this study, it was also noted that SMO in formulations L-1 and L-3 could not provide feasibility for physical stable IPP lotion. This phenomenon was due to high lipophilicity of SMO.

The difference in HLB value between PSMO and PSMS is only 0.1; however, the stability of the obtained IPP lotions was contrast. PSMO when combined with either SMO or SMS could not feasibly provide physical stable IPP lotions while PSMS when combined with SMS could do. Hence, chemical structures of emulsifiers can influence on feasibility of emulsion formation by attraction with the oil phase.[1] As illustrated in Figure 2, the unsaturated lipophilic oleate tail of PSMO could attract to IPP having saturated bonds less than the saturated lipophilic stearate tail of PSMS.

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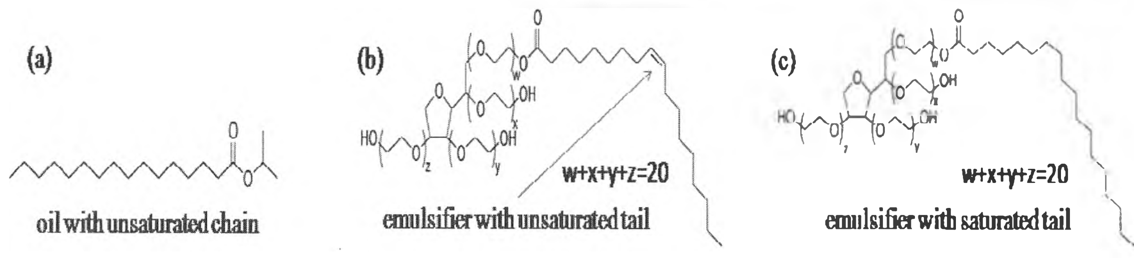

Figure 2 Chemical structures of (a) IPP, (b) PSMO, and (c) PSMS.

It could be obviously seen in this study that the application of the HLB system could not provide the perfect answer for emulsifier selection. Chemical compatibility resulted from chemical structure was also a critical factor. However, the physicochemical reasons were not investigated in the current study.

In this study, it was found that proper emulsifier blend (PSMS/SMS) could provide a stable IPP lotion. It is well-known that more the emulsion interface is strengthened by the presence of the emulsifier system results in higher stability of the resultant emulsion. Therefore, an emulsifier blend is possible to reach a greater packing density of emulsifier material at the oil/water interface rather than a single material, leading to an intrinsically more stable emulsion.[1-3] To illustrate this point, the packing of PSMS/SMS at the interface between IPP and water in order to for an oil-in-water emulsion was proposed and exhibited in Figure 3.

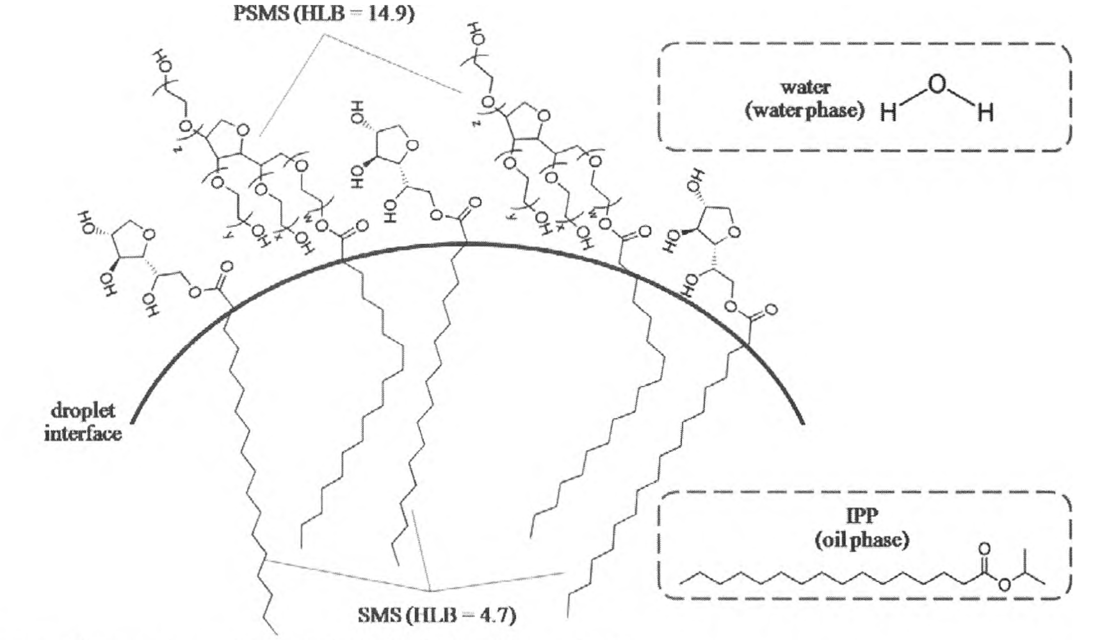

Figure 3 Packing of an emulsifier blend (PSMS/SMS) at IPP/water interface.

CONCLUSION

It could be concluded that among studied emulsifier pairs (PSMO/SMO, PSMO/SMS, PSMS/SMO, and PSMS/SMS), only the PSMS/SMS blend was suitable to emulsify IPP in water, although all pairs had the identical total HLB value. Thus, besides HLB values, the chemical structures of emulsifiers were proved to be another important parameter in feasibility of emulsion formation.

ACKNOWLEDGEMENTS

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