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RESEARCH ARTICLE OPEN ACCESS

Determination of required hydrophilic-lipophilic balance of *Amesiodendron chinense* (Merr.) Hu oil and development of stable cream formulation☆

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Abstract – *Amesiodendron chinense* (Merr.) Hu oil is reported to use for the treatment of skin disease by Thai folk medicine. Its hydrophilic-lipophilic balance (HLB) value is very important for developing a stable cream formulation. This study aimed to determine the required hydrophilic-lipophilic balance (rHLB) value of *Amesiodendron chinense* (Merr.) Hu oil and to develop a stable cream formulation. Herbal cream containing *Amesiodendron chinense* (Merr.) Hu oil was prepared by phase inversion temperature technique using water, Tween80, and Span60. The first series of 11 emulsions with HLB values ranging from 5.0 to 15.0 and the second series of eight emulsions with a smaller interval in HLB values from 5.0 to 7.8 were prepared. rHLB of coconut oil was also determined for validation of methodology. Creaming index is the established parameter to determine rHLB and to develop stable emulsion. Emulsions with optimum emulsifier concentration resulted in less percentage-creaming index. Utilizing determined rHLB, *Amesiodendron chinense* (Merr.) Hu cream was formulated and evaluated for different physical parameters including viscosity, color, odor, texture, and pH. Finally, the results showed the rHLB value of coconut oil and *Amesiodendron chinense* (Merr.) Hu oil was 5.4 and 6.2, respectively. The stable creams were developed with a 3% emulsifier. Physical parameters were found to be consistent over 6 cycles of accelerated stability test under 4 and 45°C. Physical properties of cream evaluation ensure the stability of the developed cream. rHLB value of *Amesiodendron chinense* (Merr.) Hu oil was exhibited, and the stable creams were successfully formulated by utilizing determined rHLB.

Keywords: O/W cream / *Amesiodendron chinense* (Merr.) Hu / rHLB / cosmeceuticals / stability test

Résumé – Détermination de la balance hydrophile-lipophile requise de l'huile d'*Amesiodendron chinense* (Merr.) Hu et développement d'une formulation de crème stable. L'huile d'*Amesiodendron chinense* (Merr.) Hu est utilisée pour le traitement des maladies de la peau par la médecine populaire thaïlandaise. Sa valeur de balance hydrophile-lipophile (HLB) est très importante pour le développement d'une formulation de crème stable. Cette étude vise à déterminer la valeur de balance hydrophile-lipophile requise (rHLB) de l'huile d'*Amesiodendron chinense* (Merr.) Hu et à développer une formulation de crème stable. Une crème à base de plantes contenant de l'huile d'*Amesiodendron chinense* (Merr.) Hu a été préparée selon la technique de température d'inversion de phase en mélange avec de l'eau, du Tween80 et du Span60. Deux séries ont été préparées : une première série de 11 émulsions avec des valeurs HLB allant de 5,0 à 15,0 et une seconde de 8 émulsions avec un intervalle plus petit entre les valeurs HLB allant de 5,0 à 7,8. Le rHLB de l'huile de noix de coco a également été déterminé pour valider la méthodologie. L'indice de crémage est le paramètre établi pour déterminer à la fois le rHLB et pour développer une émulsion stable. Les émulsions avec une concentration optimale d'émulsifiants ont donné lieu à un indice de crémage inférieur en

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pourcentage. En utilisant le rHLB déterminé, la crème à base d'*Amesiodendron chinense* (Merr.) Hu a été formulée. Des caractérisations physicochimiques incluant la viscosité, la couleur, l'odeur, la texture et le pH ont été réalisées. Finalement, les résultats ont montré que la valeur rHLB de l'huile de noix de coco et de l'huile d'*Amesiodendron chinense* (Merr.) Hu était respectivement de 5,4 et 6,2. Des crèmes stables à base d'huile d'*Amesiodendron chinense* (Merr.) Hu ont été développées avec un émulsifiant à 3 %. Les tests de stabilité accélérée menés entre 4 et 45 °C répétés sur 6 cycles ont confirmé la robustesse de la formule ainsi que les caractérisations physico-chimiques. La valeur rHLB de l'huile d'*Amesiodendron chinense* (Merr.) Hu a été déterminée, et les crèmes stables ont été formulées avec succès en utilisant la rHLB déterminée.

Mots clés : crème H/E / *Amesiodendron chinense* (Merr.) Hu / rHLB / cosméceutiques / test de stabilité

Highlights

This study aims to determine the rHLB of *Amesiodendron chinense* (Merr.) Hu oil which is the natural oil that has not to reported before, therefore the exact rHLB of Hu oil lead to the development of further stable formulation or another grateful benefit of this oil that can apply in the future. In this study, the rHLB of Hu oil was found at 6.2. The rHLB value was applied to calculate the required quantity of the emulsifier blend for the successful development of stable cream containing Hu oil. The cream containing Hu oil was developed with 3% of an emulsifier; the combination of Tween80 and Span60. The rHLB of the oil phase used was between 9.33 and 10.33. The stable creams were successfully formulated by utilizing determined rHLB.

1 Introduction

Most of the pharmaceutical as well as cosmetic, semisolid formulations are biphasic systems (emulsion, cream, and lotion), where hydrophilic-lipophilic balance (HLB) plays a vital role by managing the tension between two immiscible liquids at their interface (Alam *et al.*, 2020). The exact knowledge of the required HLB (rHLB) value of different ingredients in the emulsion guides the determination of rHLB of the system (oil phase of formulation), which ultimately helps in the development of a stable in the final formulation (Meher *et al.*, 2013). Fortunately, rHLB of almost all of the ingredients including emulsifiers used in emulsions such as cetyl/stearyl alcohol, stearic acid, white beeswax, Tween series, Span series, glycerol stearates, and many more are already reported in the literature, whereas aromatic oils are still not properly investigated and reported. *Amesiodendron chinense* (Merr.) Hu oil is an aromatic oil from SAPINDACEAE. It is reported to be used for the treatment of skin disease by Thai folk medicine. Unfortunately, the simple cream preparation using *Amesiodendron chinense* (Merr.) Hu oil was instability (Tiptiwa, 2008).

In the present study, a pharmaceutically and cosmetically elegant cream formulation of *Amesiodendron chinense* (Merr.) Hu oil with different cream bases was attempted to develop. During the formulation process, difficulty was experienced in the step of selecting the suitable emulsifiers to produce a stable emulsion. These complications further guided to determine the rHLB value of *Amesiodendron chinense* (Merr.) Hu oil, which is not reported in the literature. Therefore, currently, there is an attempt to determine the rHLB value of *Amesiodendron chinense* (Merr.) Hu oil. To ensure the correctness of the applied method, the rHLB value of coconut oil was also determined simultaneously. Utilizing the determined rHLB of *Amesiodendron chinense* (Merr.) Hu oil, the formulation of cream containing *Amesiodendron chinense* (Merr.) Hu oil was developed and also the evaluation was assessed for different physical parameters such as consistency, color, pH, viscosity, homogeneity, and phase behavior during the accelerated stability test. These parameters possibly ensure the reproducible quality of a specific product.

2 Materials and methods

2.1 Materials

Amesiodendron chinense (Merr.) Hu oil was collected from a local healer in Phatthalung province, Thailand. Botanical identification was performed by Asst. Prof. Dr. Katesarin Maneenoon, an ethnobotanist at the Faculty of Traditional Thai Medicine, Prince of Songkla University. Chemical ingredients used in formula development include, coconut oil, Tween80, Span60, stearic acid, white beeswax, glycerol monostearate (GMS), isopropyl myristate, propylparaben were purchased from L.B. science, Thailand. All were cosmetic/pharmaceutical grade.

2.2 Preparation and evaluation of emulsion

To determine the rHLB of *Amesiodendron chinense* (Merr.) Hu oil/coconut oil, the formulation was developed by the formula composed of 3 main parts; 3% was an emulsifier, 5% was an oil phase, and 92% was the aqueous phase. In the 3% emulsifier, Tween80 (HLB = 15) and Span60 (HLB = 4.7) were chosen and blended in the different ratios. 5% of oil phase consist of *Amesiodendron chinense* (Merr.) Hu oil and coconut oil while 92% water was taken as the aqueous phase. The emulsion was prepared using the phase inversion temperature technique. An emulsion was prepared by mixed of the required amount of Tween80 was dissolved in the aqueous phase and Span60 was dissolved in the oil phase. Till the equal temperature of the two phases, the aqueous phase was poured into the oil phase with continuously gentle stirring for 10 min or until becomes homogenously. The blended emulsion of *Amesiodendron chinense* (Merr.) Hu oil and coconut oil by different ratios of a chosen emulsifier could produce the HLB value range from 5 to 15 shown in Table 1 (first series emulsion). The first series of emulsions were physically evaluated for any changes in appearance, color, and instabilities for 30 days, the most stable emulsion was identified by the determination of the creaming index (CI) of

Table 1. Hydrophilic-lipophilic balance spreadsheet of emulsion preparation.

Formulation (*Amesiodendron chinense* (Merr.) Hu oil)	HLB	Tween80 (%)	Span60 (%)	Formulation (Coconut oil)
First series emulsions				
AC1	5.0	2.91	97.09	CC1
AC2	6.0	12.62	87.38	CC2
AC3	7.0	23.33	76.67	CC3
AC4	8.0	32.04	67.96	CC4
AC5	9.0	41.75	58.25	CC5
AC6	10.0	51.46	48.54	CC6
AC7	11.0	61.17	38.83	CC7
AC8	12.0	70.87	29.13	CC8
AC9	13.0	80.58	19.42	CC9
AC10	14.0	90.29	9.71	CC10
AC11	15.0	100	0	CC11
Second series emulsion				
AC12	5.0	2.91	97.09	CC12
AC13	5.4	6.80	93.20	CC13
AC14	5.8	10.68	89.32	CC14
AC15	6.2	14.56	85.44	CC15
AC16	6.6	18.46	81.55	CC16
AC17	7.0	23.33	76.77	CC17
AC18	7.4	26.21	73.79	–
AC19	7.8	30.10	69.90	–

AC: *Amesiodendron chinense* (Merr.) Hu oil emulsion; CC: coconut emulsion; HLB: hydrophilic-lipophilic balance.

Table 2. *Amesiodendron chinense* (Merr.) Hu oil cream formulation.

Ingredients (%)	Formulation				
	F1	F2	F3	F4	F5
White beeswax	1.5	1.5	1.5	1.5	1.5
Isopropyl myristate	7.5	7.5	7.5	7.5	10
Stearic acid	12.5	10.5	8.5	6.5	10.5
Glyceryl monostearate	7.5	7.5	7.5	7.5	10
Tween80	1.64	1.56	1.46	1.35	1.46
Span60	1.36	1.44	1.54	1.65	1.54
Amesiodendron chinense (Merr.) Hu oil	5	5	5	5	5
Propyl paraben	0.3	0.3	0.3	0.3	0.3
Water (up to 100 mL)	q.s.	q.s.	q.s.	q.s.	q.s.

all formulas. The most stable emulsion from the first series emulsion (HLB5-8) was selected to generate the second series by configuring the HLB to be more detailed. The emulsions in the HLB range of 5.0–7.8 were formulated as a second series emulsion and subjected to other evaluation parameters.

2.3 Creaming index

CI was recorded on the 3rd, 7th, 15th, 30th days. CI was calculated by taking the ratio of the total height of the cream (H_C) layer and the total height of emulsion (H_E) as follows:

$$\%\,\mathrm{CI} = (H_C/H_E) \times 100 \qquad (1)$$

2.4 Formulation of cream containing *Amesiodendron chinense* (Merr.) Hu oil

The determined rHLB value of *Amesiodendron chinense* (Merr.) Hu oil from the previous investigation. The further utilization of the rHLB was to develop the cream formulation, as shown in Table 2. The cream was prepared as an oil-in-water disperse system by heating the oil phase and aqueous phase separately. Then, two phases of an emulsion were mixed and continuously stirred for 30 min to result in a cream. After the preparations, the physical parameters including physical appearance, pH, viscosity, homogeneity, and phase separation were characterized. In addition, the visual appearance of the

formulation, such as consistency, color, and the odor was observed. The pH was measured by using ColorpHast^{TM} pH-indicator strips (Merck, Darmstadt, Germany). Rotational rheometer DV-III Ultra equipped with a TC spindle was used to measure the viscosity of an emulsion at a rotation rate of 20 rpm at 25 °C ± 2 °C.

2.5 Microscopic analysis of the cream structure

The cream containing *Amesiodendron chinense* (Merr.) Hu oil was stained with water-soluble dye (Amaranth), and their morphology was analyzed using a light microscope (AxioLab. A1, Carl Zeiss, Germany) connected to an EOS 80D camera (Canon, Japan). All images were captured using a Zeiss Axiovision LE software (Carl Zeiss, Germany).

2.6 Stability test

The stability test was performed with the heating and cooling method for 6 cycles at 4 °C and 45 °C. The physical parameters of the cream were carried out before and after 6 cycles of the accelerated stability test.

2.7 Statistical analysis

Data were presented as mean ± SD with n = 3. Data were analyzed using Student's t-test on SPSS software and considered statistically different at $p < 0.05$.

3 Results and discussion

This study aims to determine the rHLB of Hu oil, which is the natural oil that has not to reported before, therefore the exact rHLB of Hu oil lead to the development of further stable formulation or another grateful benefit of this oil that can apply in the future. The method performed is the reliable method to determine the rHLB of newly discovered oil based on a previous study (Meher *et al.*, 2013). In addition, this study uses coconut oil as a standard to confirm the correctness of the rHLB value. For the stability test was assessed by heating and cooling method (Petchsomrit *et al.*, 2020), which is the reliable method for testing the stability of the formula. The picture of all stable formulations was shown in Figure 1.

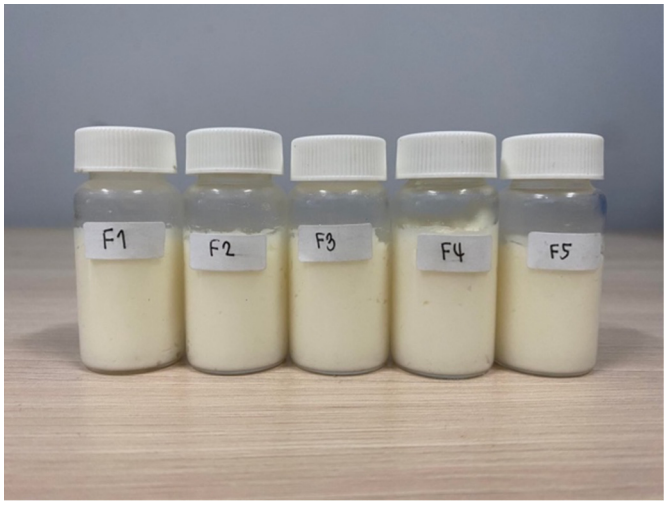

Fig. 1. Stable cream containing *Amesiodendron chinense* (Merr.) Hu oil after 6 cycles of accelerated stability test under 4 and 45 °C.

3.1 Creaming index

An emulsion is simply defined as "a system comprised of two immiscible liquids, one of which is dispersed as droplets (the dispersed or internal phase) throughout the other (the continuous or external phase)" (Jafari *et al.*, 2008). Thermodynamically unstable is one of the properties of emulsions; over time, an emulsion tends to break down into an oil phase and aqueous phase (Hosseini *et al.*, 2015). Various physicochemical mechanisms can indicate the instability of an emulsion, such as gravitational separation or creaming, coalescence, flocculation (partial) coalescence, and Ostwald ripening (Birdi, 2008, Hosseini *et al.*, 2015). In biphasic systems, creaming is a natural phenomenon to indicate the destabilization of an emulsion (Robins *et al.*, 2002). The creaming index is a value used to define the stability of an emulsion, by the emulsion with a low creaming index displays good creaming behavior and represents the stability of an emulsion. The low creaming index value of 0–20% indicates the low serum separation and higher emulsion stability (Zungur *et al.*, 2015). It provides an initial idea of the nearest stable emulsion range that may be useful for defining rHLB (Meher *et al.*, 2013). For 30 days, all the emulsions contain *Amesiodendron chinense* (Merr.) Hu oil (AC) and coconut oil (CC) were studied for creaming behavior and their percent CI was determined. The percent CI of *Amesiodendron chinense* (Merr.) Hu oil (AC) and coconut oil (CC) emulsions, which are stored at room temperature, are shown as follows in Table 3. The phase separation of aqueous and oil was observed in formula AC5–AC11 and CC5–CC11 with the HLB value ranging from 9 to 15 within 30 days of study. While the emulsion with HLB 5–7 has no phase separation (AC1–AC3), as shown in Table 3. As in the previous report, the best emulsion formulated was prepared with a surfactant or a mixture of surfactant with the HLB values which is close to the desired HLB value (rHLB) oil phase used in the formula (Orafidiya and Oladimeji 2002, Schmidts *et al.*, 2010). Therefore, in the second series emulsions of *Amesiodendron chinense* (Merr.) Hu oil and coconut oil with selected HLB ranges from 5–7 were re-formulated with a more precise HLB value to determine the rHLB of *Amesiodendron chinense* (Merr.) Hu oil. The creaming index can provide indirect information about the extent of aggregation of the droplet occurring in an emulsion; the higher the creaming index, the faster the droplets move, and therefore more droplet aggregation has occurred that ensures the instability of an emulsion (Zarena *et al.*, 2012). Thus, to monitor the most stable formula, the lowest percent CI was found in the formulations AC15 and CC13 with HLB 6.2 and 5.4. Therefore, the rHLB value of the *Amesiodendron chinense* (Merr.) Hu oil was 6.2, While the rHLB value of coconut oil is 5.4 close to Nattinee and Tanita's study, which reported an rHLB value of coconut oil as 5.8 (Nattinee and Tanita, 2011).

Table 3. Percent creaming index of *Amesiodendron chinense* (Merr.) Hu oil and coconut oil emulsions stored at room temperature.

Formulation	Percent creaming index at			
	Day 3	Day 7	Day 15	Day 30
AC1	21.67	25.00	31.67	33.00
AC2	0.20	1.30	1.30	2.20
AC3	1.30	1.67	2.20	5.43
AC4	61.33	61.33	61.67	62.33
AC5	82.00	82.00	82.00	82.00
AC6	88.33	88.33	90.00	90.00
AC7	94.33	77.33	94.00	94.00
AC8	92.33	92.33	92.33	92.33
AC9	95.00	98.00	98.00	98.00
AC10	PS	PS	PS	PS
AC11	PS	PS	PS	PS
AC12	34.33	37.33	37.33	39.33
AC13	26.33	29.67	33.67	35.67
AC14	18.67	19.33	21.67	24.00
AC15	3.20	3.20	4.10	9.67
AC16	11.87	13.53	15.90	19.00
AC17	16.43	18.33	19.43	24.67
AC18	56.33	43.67	45.33	47.00
AC19	55.33	55.33	57.00	58.00
CC1	0.43	0.43	0.66	3.33
CC2	0.00	0.00	0.00	1.32
CC3	0.00	0.00	0.22	2.67
CC4	0.00	4.43	6.00	8.90
CC5	0.00	61.33	62.67	66.00
CC6	86.67	88.67	88.67	88.67
CC7	90.00	90.00	90.00	90.00
CC8	92.00	94.00	94.00	94.00
CC9	98.33	99.00	99.00	PS
CC10	97.67	97.67	97.67	99.00
CC11	PS	PS	PS	PS
CC12	0.00	1.33	1.76	2.67
CC13	0.00	0.00	0.22	0.66
CC14	0.00	0.00	0.22	0.89
CC15	0.00	0.00	2.46	3.10
CC16	0.00	0.43	0.67	1.56
CC17	0.00	1.77	2.00	2.67

AC: *Amesiodendron chinense* (Merr.) Hu oil emulsion; CC: coconut oil emulsion; PS: phase separation.

3.2 rHLB and cream formulation

All selected ingredients for formulation development are acceptable grades for cosmeceutical/pharmaceuticals. The chosen emulsifier in the formulation included Tween80 and Span60, while the stiffening agent was also added into the formula composed of stearic acid and glyceryl monostearate. To preserve the best condition; propylparaben was used as a preservative because exhibits a broad spectrum of antimicrobial activity and could prevent the contamination of bacteria that possibly occurs from the natural oil in the formula. Even some studies indicated that paraben is possibly toxic but in a population with normal skin, the paraben is practically non-irritating and non-sensitizing (Soni *et al.*, 2002). While the *Amesiodendron chinense* (Merr.) Hu oil was used as a skin-conditioning agent in the formulation development. According to the previous reports, the best stable emulsions are formulated with emulsifiers or the mixer of emulsifiers, which possess HLB values close to the required HLB of the oil phase in the formula. Therefore, to the complete emulsification process of two immiscible phases, the suitable emulsifier with an rHLB value is very important to formulate the emulsion system with different proportions of oil and water phases (Schmidts *et al.*, 2010, Alam *et al.*, 2020). Consequently, the HLB of the ingredient needs to be known before proceeding with the emulsification process. Based on the theory that

Table 4. HLB contribution by the oil phase of different formulations (F1-F5) to determine the rHLB of the emulsifier.

Oil phase		Formulations				
		F1	F2	F3	F4	F5
White beeswax (HLB = 12)	%w/w	1.5	1.5	1.5	1.5	1.5
	HLB contribution	0.53	0.56	0.6	0.64	0.49
Isopropyl myristate (HLB = 11.5)	%w/w	7.5	7.5	7.5	7.5	10
	HLB contribution	2.54	2.70	2.88	3.08	3.11
glyceryl monostearate (HLB = 3.8)	%w/w	7.5	7.5	7.5	7.5	10.0
	HLB contribution	0.84	0.89	0.95	1.02	1.03
Stearic acid (HLB = 15)	%w/w	12.5	10.5	8.5	6.5	10.5
	HLB contribution	5.51	4.92	4.25	3.48	4.26
Amesiodendron chinense (Merr.) Hu oil (HLB = 6.2)	%w/w	5	5	5	5	5
	HLB contribution	0.91	0.97	1.03	1.11	0.84
Total oil phase		34	32	30	28	37
rHLB value of formulation		10.33	10.04	9.71	9.33	9.72

Table 5. The hydrophilic-lipophilic balance (HLB) contribution by individual emulsifiers of different formulations to achieve the required hydrophilic-lipophilic balance (rHLB).

Emulsifiers		Formulations				
		F1	F2	F3	F4	F5
Tween80 (HLB = 15)	%w/w	1.64	1.56	1.46	1.35	1.46
	HLB contribution	8.2	7.8	7.3	6.75	7.3
Span60 (HLB = 4.7)	%w/w	1.36	1.44	1.54	1.65	1.54
	HLB contribution	2.13	2.26	2.41	2.58	2.41
Final HLB value of the formulation		10.33	10.06	9.71	9.33	9.71
rHLB value of formulation		10.33	10.04	9.71	9.33	9.72

emulsions with an optimum emulsifier concentration will result in less percent CI (Orafidiya and Oladimeji, 2002) thus, the required HLB of *Amesiodendron chinense* (Merr.) Hu oil was determined in the previous step. The HLB value of the oil and emulsifier was determined according to the reported method. Finally, the rHLB for the oil phase is the sum of the HLB in combination with an emulsifier, as shown in Table 4. To develop the stable system of cream containing *Amesiodendron chinense* (Merr.) Hu oil, the quantity of emulsifier (Tween80) required to blend with another emulsifier (Span60) to reach the rHLB for the oil phase were calculated and shown in Table 5.

The concept of rHLB was used to design emulsion-based stable formulations. After the homogenization of the oil and aqueous phase, all formulation F1-F5 containing the ingredients at different proportions of stearic acid and emulsifiers (shown in Tab. 1) were able to form the stable emulsion system. The formulations had a suitable combination of emulsifiers with rHLB values that equal the oil phase. The results showed the overall rHLB value contributed by the oil phase of formulations F1-F5 was 10.33, 10.04, 9.71, 9.33, and 9.73, respectively (Tab. 4), and the overall HLB value contributed by the emulsifier combination of formulations F1-F5 was 10.33, 10.06, 9.71, 9.33, and 9.71, respectively (Tab. 5). This suitable in the contributed HLB of the oil phase and rHLB achieved by the combination of an emulsifier is the reason for the stability observed in the formulations, F1-F5. Therefore, it can be inferred that the specific ratio and percentage of an emulsifier blend is unique in the formulation development. If using the emulsifiers with different HLB values, maybe vary in the concentration of emulsifiers to stabilize the same emulsion (Meher *et al.*, 2013).

3.3 Physical stability

Cream containing *Amesiodendron chinense* (Merr.) Hu oil was stained with a water-soluble dye and analyzed by light microscopy to confirm that the cream was an oil-in-water emulsion because the aqueous color solution was stained outside an oil droplet as shown in Figure 2. The optimized formulation of the cream containing *Amesiodendron chinense* (Merr.) Hu oil based on the HLB system study was subjected to an accelerated stability test, including centrifugation and heating-cooling cycles. The optimized cream did not exhibit any sign of instability under the given stress conditions. The parameters observed for physical stability were the visual appearance (consistency, color, and odor), pH, viscosity, homogeneity, and phase behavior. These parameters remain unchanged after 6 cycles of the heating-cooling of stability test. The pH values of the formulations were ranged from 4–5 that good as skin pH (Mishra *et al.*, 2014). All formulations of

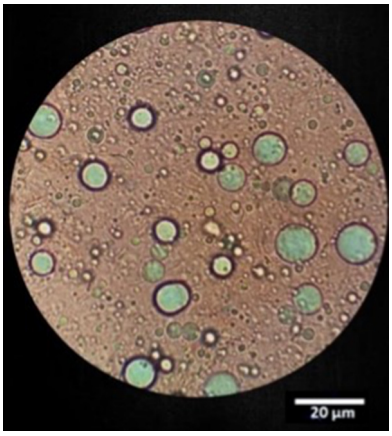

Fig. 2. The morphology of cream containing *Amesiodendron chinense* (Merr.) Hu oil as stained as stained by water-soluble dye and imaged by light microscopy. The scale bar indicates 20 µm.

Table 6. Physical stability of the cream containing *Amesiodendron chinense* (Merr.) Hu oil under accelerated conditions for 6 cycles.

Parameters	Condition	Formulations				
		F1	F2	F3	F4	F5
Appearance	Before	Thick cream	Thick cream	Thick cream	Thick cream	Thick cream
	After	Thick cream	Thick cream	Thick cream	Thick cream	Thick cream
Color	Before	White	White	White	White	White
	After	White	White	White	White	White
pH	Before	5	5	5	5	5
	After	5	5	5	5	5
Viscosity (cPs)	Before	32 536 ± 1400	30 103 ± 1129	22 836 ± 2114	20 847 ± 1778	32 149 ± 338
	After	29 419 ± 1187	26 124 ± 658	26 414 ± 770	27 650 ± 968	25 675 ± 1023
Homogeneity	Before	Homogeneous	Homogeneous	Homogeneous	Homogeneous	Homogeneous
	After	Homogeneous	Homogeneous	Homogeneous	Homogeneous	Homogeneous
Phase separation	Before	No	No	No	No	No
	After	No	No	No	No	No

cream containing *Amesiodendron chinense* (Merr.) Hu oil showed a pH quite similar to the pH of human skin. The viscosity of the cream formulations was found to be between 20 847 ± 1778 and 32 536 ± 1400 cPs; The value of this viscosity is included in the range of quality requirements of cream preparations ranging from 2000–50 000 cPs (Ermawati *et al.*, 2017). The results demonstrated that the formulations were able to retain their integrity without showing any signs of instability (Tab. 6).

4 Conclusions

In this study, the rHLB of *Amesiodendron chinense* (Merr.) Hu oil was found at 6.2 while the rHLB of the coconut oil is 5.4 as in a standard report. The cream containing *Amesiodendron chinense* (Merr.) Hu oil was developed with 3% of an emulsifier; the combination of Tween80 and Span60. The rHLB of the oil phase used was between 9.33 and 10.33. The blended emulsifier used in the O/W formulations could achieve the rHLB and result in the stability of the formulation system. The rHLB concept was applied to calculate the required quantity of the emulsifier blend for the successful development of stable cream containing *Amesiodendron chinense* (Merr.) Hu oil. The developed cream represents the favorable physicochemical properties for dermal use. However, efficacy evaluation of the developed cream should be further conducted to elucidate *in-vitro* and *in-vivo* studies in further study.

Conflict of interest

The authors declare the absence of any conflicts of interest.

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