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Non-aqueous Virgin Coconut Oil Hair Gel

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Abstract. Virgin coconut oil (VCO) is gaining wide popularity in the scientific field and among the public. The purpose of this research was to develop the non-aqueous hair gel by dispersing hydrophilic colloidal silicon dioxide (Aerosil 200) or hydrophobic colloidal silicon dioxide (Aerosil R 972) into virgin coconut oil and to determine the effect of Aerosil type on physical properties of prepared hair gel. Texture analysis and satisfied evaluation of prepared system were also conducted. At a suitable amount of Aerosil 200 and Aerosil R 972, the three-dimensional network led to the immobilization of a dispersing medium. The viscosity of the prepared gel was increased as the amount of Aerosil 200 or Aerosil R 972 was increased. However, the viscosity of gel containing Aerosil 200 was apparently higher than system prepared from Aerosil R 972. The rheological behavior of these gels depended on type and concentration of colloidal silicon dioxide. From texture analysis, the hardness and adhesion of systems comprising Aerosil 200 were higher than that containing Aerosil R 972 with concentration dependence. Satisfied evaluation by a panel consisting of human volunteers demonstrated that the developed non-aqueous virgin coconut oil gel could be used as the hair setting gel.

Introduction

Nowadays, virgin coconut oil (VCO) is gaining wide popularity in the scientific field and among the public. It is believed that VCO is more beneficial than usually obtained copra oil since the mode of extraction retains more biologically active components such as vitamin E and polyphenols [1, 2]. The current emerging major uses of VCO are as: a hair and skin conditioner; an oil base for various cosmetic and skin care products; a carrier oil for aromatherapy and massage oils; a nutraceutical and also functional food. Colloidal silicon dioxide (CSD), Aerosil, is widely used in oral and topical pharmaceutical products. CSD can be divided into two types: hydrophilic and hydrophobic by the groups on its surface [1]. The groups on the surface of different particles of CSD could interact via chemically bond with each other to form connecting bridges led to the immobilization of a dispersing medium and the gel formation [3-7]. Gel can be used as delivery systems for topical administration. In this study, the non-aqueous hair gel was prepared by dispersing hydrophilic CSD (Aerosil 200) or hydrophobic CSD (Aerosil R 972) into hydrophobic dispersing media (VCO) and this study was to determine the effect of Aerosil type on physical properties of hair setting gel.

Experimental

Materials

Virgin coconut oil (VCO) was supplied from Tropicano Oil Co. Ltd., Nakhon Pathom, Thailand. Colloidal silicon dioxides (CSD) (hydrophilic type: Aerosil 200 control no. 1305053 and hydrophobic type: Aerosil R 972 control no. 1274041) were purchased from Wacker-Chemie GmBH, Germany and used as received. Oil soluble blue color and orchid flavor were purchased from SR. Lab Co., Ltd., Bangkok, Thailand.

Methods

Preparation of systems and measurements of viscosity, rheology and texture analysis

VCO was used as hydrophobic dispersing medium. Aerosil 200 at the amount of 2%, 4%, 6%, 8%, 10%, 12% w/w and Aerosil R 972 at the amount of 2%, 4%, 6%, 8%, 10%, 12% 14%, 16% w/w were employed as gelling agent. The gel was prepared by mixing of VCO and CSD (Aerosil® 200 or Aerosil® R972) until the homogenous systems were obtained. The prepared systems were determined their viscosity using Brookfield DV-III Ultra programmable rheometer (Brookfield Engineering Laboratories.Inc., USA) (n=3). The rheological behaviors of the gels were investigated by studying their shear stress as functions of shear rate in a Brookfield DV-III Ultra programmable rheometer (Brookfield viscometer and probe with spindle number 52). Data were expressed as mean $\pm$ SD from the three measurements. The 50 g gel was putted into the 50 mL glass bottles. The upper part of gel was adjusted to obtain the smooth surface and the distance from the top of bottle to gel surface was approximately 0.5 centimeters. The texture of gel was measured using the texture analyzer (Charpa Techcenter, Godalming, Stable micro Systems Ltd., UK). Stainless steel probe was TA-53 3mm diameter punch probe**.** The test condition was: test speed of 10 mm/sec**,** post speed of 20 mm/sec and distance of 10 mm.

Satisfied evaluation for hair setting gel

The obtained hair setting gel was conducted for the satisfied evaluation by a panel consisting the human volunteers (n=6). The characteristics of hair gel (flavor, color, texture) were recorded using a numerical scale. The numerical scale bears the following value: 0 = poor, 1 = obtainable, 2 = good, 3 = very good. Smell and texture, ability of hair gel to set hair, cleaning the hair gel as well as duration of action for hair gel were evaluated after using of this product.

Results and discussion

Viscosity measurement and rheological study

The transparent appearance was obtained after mixing two materials together for all systems in Table 1A and B. Viscosity of the prepared systems containing virgin coconut oil with different amount of Aerosil 200 is shown in Table 1A. The viscosity of VCO containing Aerosil 200 higher than 6% w/w could not be measured since the high viscous gel with sticky was found. The viscosity of system containing 6% w/w Aerosil 200 was higher than that of systems containing 2% and 4%w/w Aerosil 200, significantly ($p \leq 0.05$). The viscosity of the prepared systems containing VCO with different amount of Aerosil R 972 is presented in Table 1B. The viscosity of system containing 16% w/w Aerosil R 972 was higher than that of other systems, significantly ($p \leq 0.05$). The viscosity of the prepared gel was increased as the amount of Aerosil 200 or Aerosil R 972 was increased because the network formation of both type of CSD particles led to the immobilization of the solvents [3-4, 8]. The viscosity modifying property of CSD contributes to the ability of the very small silica particles to form a network structure throughout the medium by interparticular hydrogen bonding via the silanol group (Si-OH) on the surface of silica particles. In addition, besides interparticular interactions, there is possible bonding between the silanol groups and other components that are also capable of hydrogen bond formation. [6-7]. By comparison, the viscosity of system containing Aerosil 200 was higher than that of system containing Aerosil R 972. Because the silanol groups on the surface of Aerosil R 972 are chemically modified with dimethyldichlorosilane [7] whereas Aerosil 200 has more silanol groups (Si-OH) than Aerosil R 972. Therefore, Aerosil 200 surface might have a tendency to form connecting bridges for gel formation greater than that of Aerosil R 972.

Table 1A Viscosity of VCO gel containing Aerosil 200 (n=3)

Aerosil 200	viscosity (mPas)
2%	95.00[a] ±7.07
4%	345.00 [a] ±35.36
6%	12720.00[b] ±3620.39

[a] *P>0.05,* [b] *P≤0.05*

Table 1B Viscosity of VCO gel containing Aerosil R 972 (n=3)

Aerosil R 972	viscosity (mPas)
2%	60.00[a] ±0.00
4%	87.00 [a] ±0.00
6%	195.00 [a] ±7.07
8%	670.00 [a] ±14.14
10%	2665.00 [a] ±1209.15
12%	6035.00 [a] ±1138.44
14%	6885.00 [a] ±4956.82
16%	102040.00[b] ±93903.78

[a] *P>0.05,* [b] *P≤0.05*

The systems containing 4%, 6%, 14% and 16% w/w of Aerosil R 972 represented the rheological behavior as newtonian flow but that containing 8%, 10% and 12% w/w of Aerosil R 972 represented the rheological behavior as pseudoplastic flow (Fig.1). However the systems comprising 2%, 4% w/w of Aerosil 200 represented the rheological behavior as newtonian flow but that comprising 6% w/w of Aerosil 200 represented the rheological behavior as plastic flow. Therefore, the rheological behavior of the developed systems depended on the type and concentration of incorporated CSD.

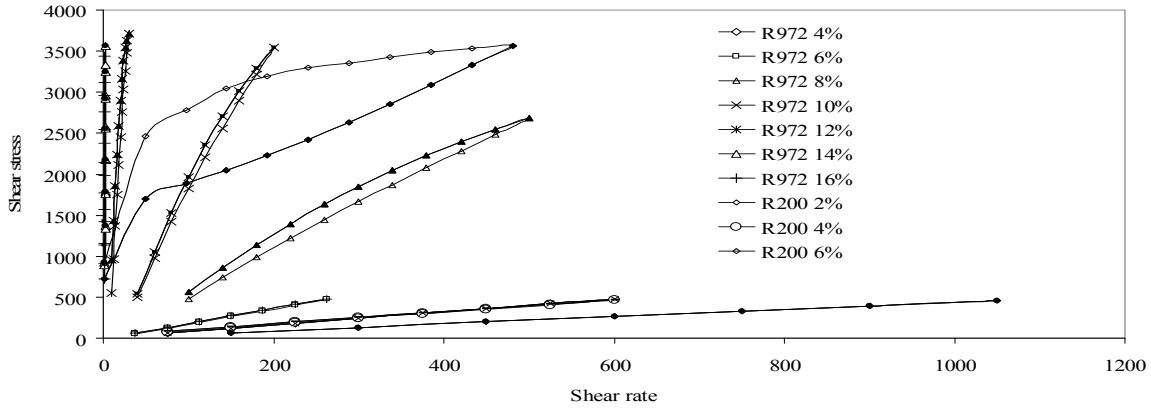

Fig 1 Flow curve of VCO systems containing different amount of CSDs
*solid point showed the increasing shear rate, clear point showed the decreasing shear rate.

Texture analysis. The texture analysis indicated the higher hardness and adhesion of gel prepared from Aerosil 200 than that from Aerosil R 972 (Table 3). Moreover, the more concentration increased, the more hardness and adhesion increased. The network formation from Aerosil 200 particles promoted the immobilization of VCO. However, the obtained systems containing Aerosil 200 greater than 6 % w/w exhibited too viscous and sticky characteristic therefore they were not suitable for further developing into the hair setting gel.

Table 3 Hardness and adhesion force of VCO gel containing CSDs (n=3)

Aerosil 200	Hardness (N)	Adhesion force (N)
8%	74.1915 ± 2.080	58.5275 ± 0.880
10%	195.205 ± 6.558	141.484 ± 9.757
12%	394.255 ± 1.759	274.146 ± 5.278
Aerosil R 972		
14%	12.2145 ± 0.959	43,655 ± 10.236
16%	36.7565 ± 14.554	76.6795 ± 16.154

Hair gel evaluation

The selected non-aqueous VCO gel containing 6% w/w Aerosil 200 was prepared and thereafter mixing with some oil soluble blue color and orchid flavor. The 66.7 % of volunteers accepted the flavor of non-aqueous VCO gel containing 6% w/w Aerosil 200 whereas the 88.3 % of volunteers informed that color of gel was good and the 50 % of volunteers revealed that texture of gel was obtainable. The 66.7 % of volunteers showed that the period of action for hair setting gel was 2-4 hours. Moreover, everybody reported that hair setting gel could be used to set the hair and could be cleaned after used. From satisfied evaluation test, the developed non-aqueous VCO gel could be used as hair setting gel.

Conclusion

Non-aqueous VCO hair setting gel was developed by using CSD as gelling agent. The viscosity of the prepared gel was increased as the amount of Aerosil 200 and Aerosil R 972 were increased due to the network formation of both types of CSD particles leading to the immobilization of the solvents. Aerosil 200 could provide the more viscous environment, hardness and adhesion force for VCO than Aerosil R 972 with concentration dependence. From satisfied evaluation test, the developed non-aqueous VCO gel could be used as hair setting gel.

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