GS-519

Investigation on the Performance and Mechanism of Sphingomonas Ferment Extract in Stabilizing Emulsion and Suspension Systems Without Emulsifier or Co-stabilizer

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Introduction:

With a worldwide growing demand for clean beauty and sustainability, natural ingredients are receiving increasing attentions to achieve such claim. Ideally, natural rheology modifiers can offer emulsification capabilities, enabling good stability with limited or without emulsifier, to improve mildness and/or simplify the formulation system. It's well known that polysaccharides such as Xanthan Gum have limited performance in stabilizing many challenging systems (such as higher oil or pigment loading) and when higher dosage of Xanthan Gum is required, an unfavorable sensory may come along. To tackle the formulation challenge with a green, responsible, and sustainable solution, a natural Sphingomonas Ferment Extract (Diutan Gum) was investigated. Different systems such as emulsions, suspensions, and combo systems are developed. Physicochemical characterizations and microscopic analysis, are evaluated at various temperature, and rheology studies are conducted to investigate the flow behavior and stabilizing behavior of Diutan Gum under different conditions. To identify the effectiveness of Diutan Gum, different use levels are tested. A range of loading of oil and/or pigments is tested to understand the capability of Diutan Gum in stabilizing the system. Furthermore, organic UV filters and inorganic UV pigments are tested in Diutan Gum systems to discover its application in sun care.

Materials & Methods:

Materials:
Sphingomonas Ferment Extract (Diutan Gum) was used as supply as sole stabilizer. Emollients tested are Cocoyl Adipic Acid/ Trimethylolpropane Copolymer (CATC), Caprylic/Capric Triglyceride (GTCC), G-66 Guerbet Ester, Triethylhexanoin (GTO), Lauryl Lactate (LL), Isopropyl Isostearate (318), Cetearyl Ethylhexanoate (1818), Macadamia Oil (MADO), Octocrylene (OCR), Ethylhexyl Methoxycinnamate (EHMC), Homosalate (HMS), used as supply. Pigments tested were micro titanium dioxide (15nm) coated with hydrated silica (TiO2-100WP) and uncoated non-nano zinc oxide (ZnO), used as supply.

Table-1 Formulation chart of emulsions and pigment suspension

Ingredient	Concentration curve	Oil loading capacity	Oil compatibility	Organic UV filter combability	Pigment suspension
Deionized water	q.s	q.s	q.s	q.s	q.s
Diutan Gum	0.10 – 1.00	0.30 – 0.50	0.30	0.30	0.3
Glycerin	-	-	-	-	5.00
Butylene Glycol	-	-	-	3.00	-
Propylene Glycol	-	-	-	2.00	-
Phenoxyethanol (and) Chlorphensin	0.50	0.50	0.50	0.50	0.50
Disodium EDTA	0.05	0.05	0.05	0.05	0.05
GTCC	10.00	-	-	-	-
Emollient#	-	2.00 – 50.00	20.00	-	-
Organic UV filters*	-	-	-	10.00	-
Pigments**	-	-	-	-	2.00 – 10.00

Preparation of emulsions: Diutan Gum was first dispersed in water with other water phase ingredients and oil phase was added into the system under stirring. The mixture was then homogenized at 10000 rpm for 5 minutes.
Preparation of pigment suspensions: Diutan Gum was first dispersed in water and pigment particles were added into the system under stirring. The mixture was then homogenized at 10000 rpm for 10 minutes.
Rheology measurement: For all experiments, a Rheometer with vane concentric cylinder geometry was used to investigate the rheological profiles.

Results & Discussion:

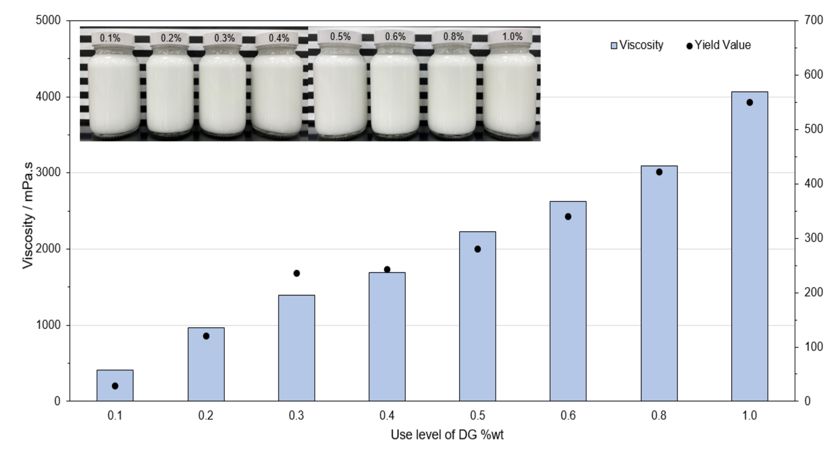

Figure-1 24-hr viscosity and yield value of 10% GTCC O/W emulsion stabilized by 0.1-1.0% Diutan Gum (pH ~5). Photos of emulsion are 1 mon RT samples.

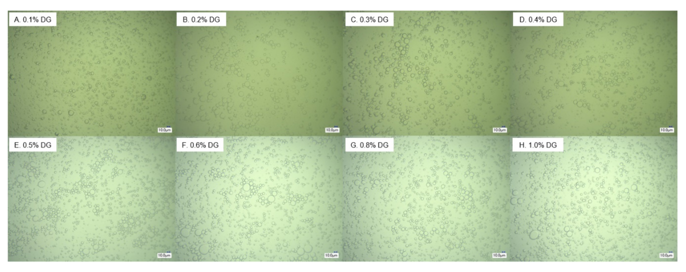

Figure-2 Microscope analysis results of O/W emulsion containing 10% GTCC stabilized by 0.1-1.0% Diutan Gum at RT.

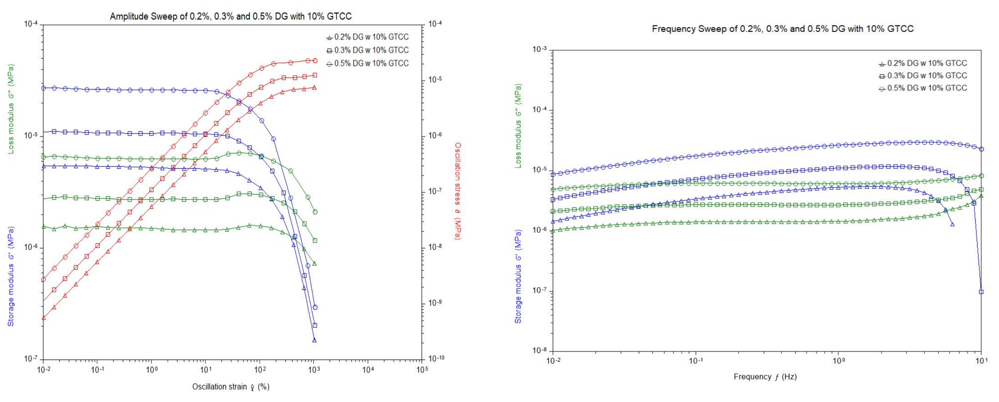

Figure-3 Rheology analysis on Amplitude (0.01-1000%Strain, at 1 Hz) and Frequency (0.01-10 Hz) for 0.2%, 0.3%, 0.5% DG with 10% CCT at 25° C.

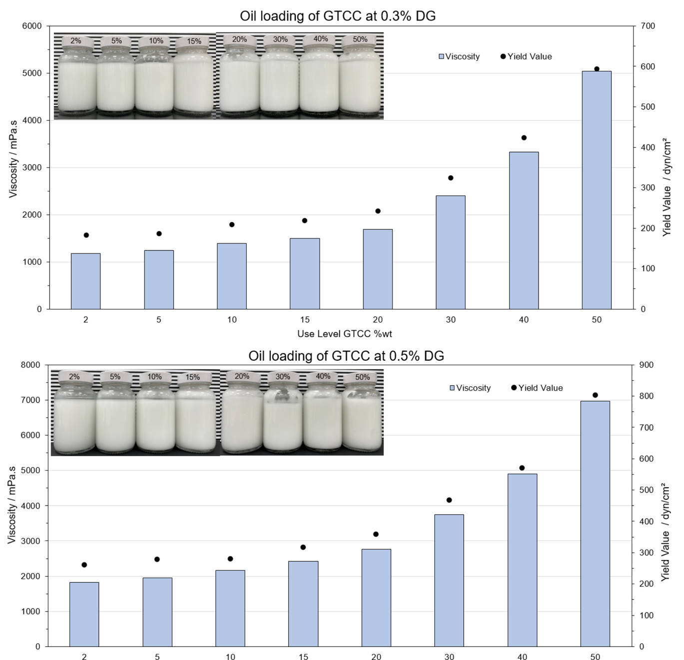

Figure-4 Viscosity and yield value of O/W emulsion containing 2-50% GTCC stabilized by 0.3% and 0.5% Diutan Gum. Photos of emulsion are 1 mon RT samples.

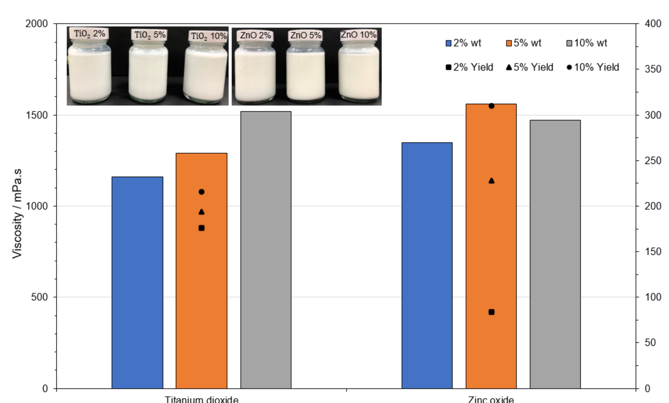

Figure-7 Suspension of 2 – 10% inorganic pigment in 0.3% Diutan Gum mucilage (pH range 5-7 for TiO_2 and ~9 for ZnO)

Diutan Gum showed promising capability to stabilize oil compounds in water upon homogenization and the emulsions made thereafter showed robust stability over storage and under elevated conditions. The high stability of emulsion even at elevated conditions can be attributed to the special structure feature—regular double helices—of Diutan Gum (7-10). Such highly ordered structure enables the aqueous gel formed resistant to high temperature and the high yield provided facilitate the stability of suspension both oil droplets and solid particles.
The response of emulsions, with different DG concentration, to increasing deformation amplitude suggests 0.5% DG based system is more solid than the other lower DG content system and offered higher yield. Higher DG content strengthen the rigid gelling network and thus stronger gel strength. Nonetheless, the effective use level of DG is as low as 0.3% and 0.5% DG can stabilized a wide range of oil components and at various concentration level.

Conclusions:

In this study, Sphingomonas Ferment Extract (Diutan Gum) exhibited outstanding stabilizing properties at low use level (<1%) and low energy level (cold processable and easy dispersion) across all different systems under tested conditions. In a simple emulsion system, Diutan Gum showed its good capability for a wide range of oil loading. Moreover, Diutan Gum displayed good stability profiles, especially at high temperature. The rheology study results demonstrate the high performance of Diutan Gum in terms of stabilization for its efficiency and consistency. Both stability tests and rheology studies reveal its competence in stabilization and suspension. The essential molecular features of Diutan Gum entitle this biopolymer to act as a sole stabilizer for emulsion and suspension. In addition, studies also suggest Diutan Gum is a good candidate in sun care application for its stabilization power for organic UV filter system and suspension power for inorganic UV pigments.
This study offers new insight into the natural polysaccharide in oil-in-water emulsion and high pigment loading suspension systems as a sole stabilizer at low use level and with optimal application performance, thereby meeting the demand of simplicity and sustainability.

Aknowledgments:

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