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Investigation of Formation of Cold Liver Oil/Water Microemulsion in the Presence of Cetyltrimethylammonium Bromide (CTAB) and Lauryl Alcohol (LA)

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Abstract:- The physical characteristics of the O/W microemulsion made from the surfactant cetyltrimethylammonium bromide (CTAB), cold liver oil, water, and lauryl alcohol (LA) as a non-ionic cosurfactant were investigated using Electrical conductivity and hydrodynamic viscosities at various temperature and different oil additions. The range of concentration CTAB ranged from 1× 10^{-3} M to 2 × 10^{-2} M. Through the aid of the level of the critical micelle concentration (CMC) and the typical free energy of micellar (G^{o}_{m}) dissociation (α) micellization was assessed. Also discovered is that the growth of the CMC of CTAB is gradually accompanied by a starting at 25 °C to 55 °C. It is obvious to see that the CMC of CTAB continues to rise when more cold is introduced. increased by liver oil. In light of the findings from this study, it can the usage of CTAB is advised for micellization in watery medium and the creation of optical or water emulsions or microemulsions would have many applications in the future, especially in the production of pharmaceuticals and cosmetics.

Keywords:- *Surfactants, Microemulsions, Cetyl Trimethyl Ammonium Bromide, Cold Liver Oil, Lauryl Alcohol, CMC, Electrical Conductivity.*

I. INTRODUCTION

Surfactants are surface-active substances made up of molecules that a non-polar hydrophobic component, typically a lengthy or 8–18 carbon atoms long, branching hydrocarbon chain linked to a loving polar or ionic component. Polar or ionic water chains that are hydrophobic interfere with water only slightly. Major ionic or polar groups greatly interfere with molecules through dipole or ion-dipole equilibrium, with water molecules. among the hydrophilic and hydrophobic components (a Hydrophilic) are providing these particle-surfactant systems with specialized characteristics like accumulation at various limits and Union (Genesis micellate) solutions [1-5]. A surfactant depending on the type, can be categorized into four broad categories. among the hydrophilic groups, which include cationic, anionic, amphoteric, and nonionic. Along with the surface vibratory characteristics of besides being a surfactant, it also has the amazing capacity to self-assemble in water-based solution. The solution's characteristics with regard to surfactants Figure (1), which displays the ability to do so, demonstrates how this

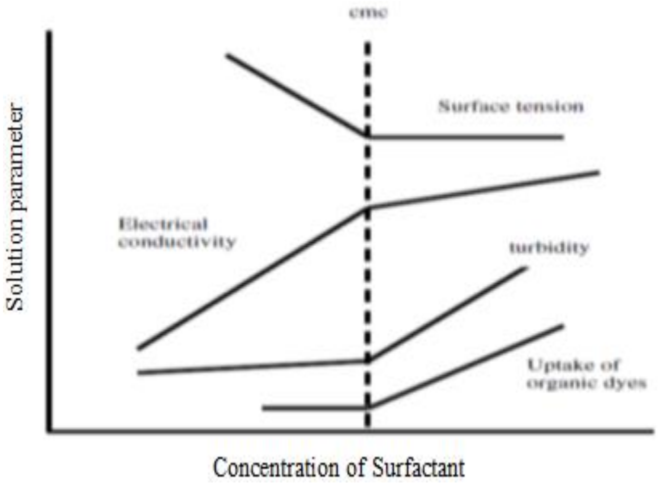

Fig 1 Diagram Illustrating the Sharp Change in a Range of Solution Properties at the CMC

A sharp transition occurs in most of the physical properties of the solution, which corresponds to self-assembling structures called micelles and the concentration at which

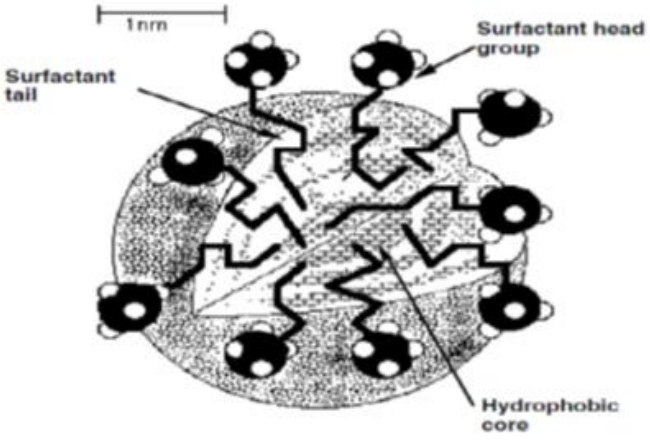

Fig 2 Schematic Diagram of a Surfactant Micelle

These micellates form is characteristic of each servant and is called the critical micelles concentration (CMC).The clip can be seen through the softener as shown in Figure (2) [6-7].

The CMC sharply declines as the water hydrophobic component of surface tension rises, and it does so more quickly for non-ion substances than for ion substances that lower surface tension by one methylene group and by increasing the hydrophobic part of the surface tension in the case of ion substances. The hydrocarbon chain's length is extended, and a second group also reduces the CMC to one-third of its initial value, making it evident that the various surface tension congeners of the CMC are being monitored with the alkyl chain by using the following formula:

$$\log \text{CMC} = A + Bn \qquad (1)$$

Where A and B are constants, and n is the alkyl chain[9]. measuring hydrodynamic viscosity Calculate the flow time of the solution relative to the flow time of the water using Ostwald's viscometer. Where η_r is the relative viscosity, t_s is the flow time of solution, and t_o is the flow time of water the formula is:

$$\eta_r = t_s / t_o \qquad (2)$$

Micelle formation Gibb's micellization free energy, ΔG_m is calculated by:

$$\Delta G_m = RT \ln \text{CMC} \qquad (3)$$

$\Delta \mathring{S}_m$ is the slope calculated from the ΔG_m *vs* T. ΔH_m is determined by applying the relationship:

$$\Delta G_m = \Delta H_m - T\,\Delta S_m \qquad (4)$$

The surfactant sits at the water-oil interface when water, oil, and it are combined. Either emulsions or microemulsions are terms used to describe these systems based on their stability (thermodynamically stable). The four components of the microemulsion are created by emulsifying oil in water with the aid of co-surfactants and surfactants. The ratio of surfactant to cosurfactant, the chain length of the cosurfactant, the kind of hydrocarbon in the oil phase, as well as the temperature during preparation and phase inversion, have all been shown to have an impact on the generation of microemulsions. Through molecular orientation at the interface and dramatically reduced interfacial free energy, the surfactants can be used to stabilize oil in water dispersions [7]. In the meantime, the interfacial free energy declines as When near zero interfacial tension is attained, thermodynamic stability is obtained. The co-surfactants are typically alcohols with intermediately long chains [19]. Because of their capacity to improve the penetration of drugs across diffusion layers, good appearance, and drug solubilization, microemulsion technology is used in the cosmetic and pharmaceutical industries in the creation of transdermal drug delivery systems and some topical medicines. We haven't yet done any research on the physical properties of the O/W.

Microemulsion generated from cold liver oil, water, the cosurfactant LA, and the surfactant cetyltrimethylammonium bromide (CTAB). Cetyltrimethylammonium bromide (CTAB), a quaternary ammonium salt, is a surfactant has a 16-carbon long tail and an ammonium head group with three methyl groups attached. It was first synthesized in the mid-twentieth century and it can be used as bacterial and fungal antiseptic, as a component in buffer solutions used for the extraction of DNA, and to help condition hair [23, 24].

Cetyltrimethylammonium bromide (CTAB) is a highly effective cationic surfactant in daily life. As with any surfactant, CTAB forms micelles in solution. These micelles have an aggregation number around 80, and a critical micelle concentration of 1 mM when in water and at 25°C [25]. The presence research work aims to Investigation of formation of cold liver oil/water microemulsion in the presence of cetyltrimethylammonium bromide (CTAB) and lauryl alcohol (LA).

II. MATERIALS AND METHOD

Cetyltrimethylammonium bromide (CTAB) was purchased from Aldrich with a purity of 99.5 w/w%. Lauryl alcohol (LA) was obtained from Aldrich with a purity of 99 w/w%. Cold liver oil was obtained from local market with a high purity.

By dilution of 0.1 M CTAB stock solution with precise portion of distilled water, a series of aqueous CTAB surfactant solutions (series A) in concentration range of 1×10^{-3} - 2×10^{-2} M were created. Each as-prepared CTAB surfactant solution of series A received a 0.2 ml cosurfactant (LA) addition. The resulting solutions were shaken immediately for 15 minutes to achieve equilibrium stabilization, and then various volumes of cold liver oil (oil) were added at diverse weight percent ranges between 0.99 and 1.50%. A 15-minute instantaneous shaking makes up series B. Using a conductivity bridge (METRIC model) and a temperature range of 25 to 55 ºC, the specific conductivity (K) of each solution of series A and B was determined. By plotting K vs. surfactant concentration, values for CMC were obtained, where CMC stands for the intersection of two lines. However, the thermodynamic parameters of the micellization were computed using equations (3) and (4), and the estimated value of the degree of the micelle ionization (α) is obtained from the absolute ratio of two-line slopes. All solutions' relative viscosities (η_r) at CMC were calculated using an Ostwald viscometer. Data presentation and line-regression fitting were performed using Origin Pro. version 6.1.

III. THE DISCUSSION OF RESULTS

Figure 3 shows a typical curve of specific conductivity vs. surfactant concentration at 25 ºC without the addition of LA or oil. Well-defined zones with two distinct line slopes can be found. This can be explained by the divergence in conductivity trend between measurements made before and after the critical micelle concentration (CMC). The best straight lines demonstrating the linear relationships between the specific conductivity and concentration before and after the micellization of CTAB at a certain temperature are represented by the two red-hued lines. Applying line regression fitting to the experimental data produced these straight lines.

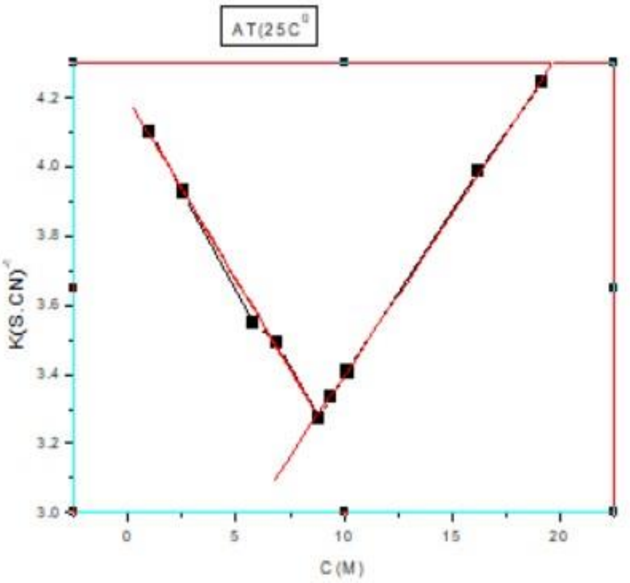

Fig 3 K vs. Surfactant Concentration at 25 ^{O}C Without Addition of LA and Oil

The estimated values of CMC and of CTAB measured at various temperatures (ranging from 25 to 55 °C) are listed in Table 1 together with the relevant statistical characteristics (where R^2 denotes the squared correlation coefficient or variance and SD the standard deviation). The CMC of CTAB steadily decreases with rising temperature, as can be seen. This suggests that when the temperature increases, CTAB micelles' aggregation number—or the number of surfactant molecules per micelle—decreases. The degree of micelle ionization does, however, vary with temperature, with a maximum and minimum being found at 35 °C and 50 °C, respectively.

Table 1 Values of CMC and α of CTAB at Different Temperatures

T (°C)	CMC(M)	α	SD	R^2
25	8.87	1.11	0.09	0.94
35	7.87	0.8	0.08	0.92
40	6.81	2.46	0.15	0.84
45	5.75	1.33	0.12	0.74
50	4.27	4.4	0.07	0.99
55	3.79	0.31	0.05	0.99

The Gibbs free energy of CTAB micellization varies as a function of temperature, as seen in Table 1 and Figure 4. The slope of the G^o_m vs. T curve in Figure 4 was used to calculate the standard entropy of micellization (ΔS^{o}_{m}). The CTAB micellization in aqueous environments is a spontaneous process that is thermodynamically advantageous, according to Table 1 negative sign of G^o_m and positive sign of ΔS^{o}_{m}.

Table 2 Thermodynamic Parameters of Micellization of CTAB Surfactants in Aqueous Solutions

T(K)	lnCMC	ΔG^o_m	ΔS^o_m	ΔH^o_m	R^2	SD
298	2.18	-8398.5	155.127	155.127	0.9311.5	733.595
308	2.	-50100.8				
313	1.9	-4941.9				
318	1.7	-4492.3				
323	1.4	-3496.7				
328	1.3	-3543.3				

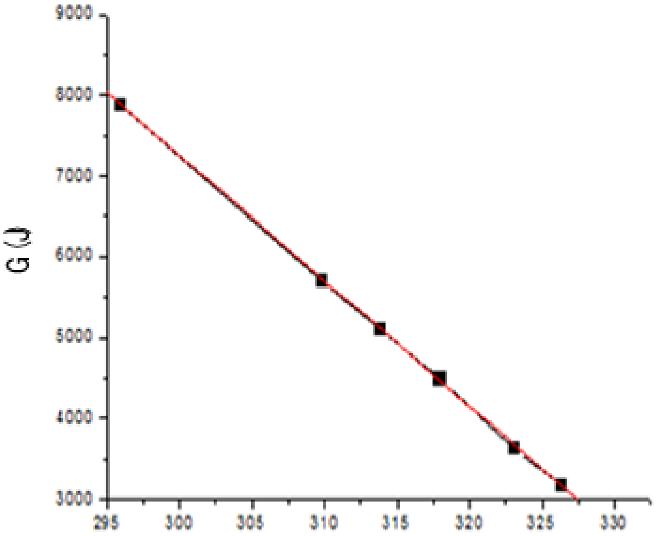

Fig 4 ΔG°_{m} vs. T plot of CTAB Micellization

Table 3 lists the fluctuation of CMC, the level of micelleionization, and the relative viscosity of CTAB corresponding to the CMC, and Figure 5(a), (b), and (c) also show these values, respectively. As seen in Figure 5(a), it is obvious that adding cold liver oil causes the CMC of CTAB to continue rising. This is also demonstrated by the gradual decrease in relative viscosity that occurs as oil percentage rises. This might be because the hydrophobic cores of CTAB micelles are where oil droplets fractionate and then emulsify. The size of the CTAB micelle tends to increase as a result of this emulsification, hence larger concentrations of CTAB would be needed to establish an equilibrium micellization with the addition of more oil as a disperse phase.

Table 3 Variation of $CMC_K^{\times}$ and η_r at CMC for CTAB as a Function of Weight % of Cold Liver Oil Added

Cold liver oil %	CMC×10^{-3} M	α	η_r@CMC
0.99	2.80	0.77	0.001
1.09	4.06	0.12	0.004
1.09	5.74	0.04	0.009
1.19	6.79	0.27	0.012
1.49	10.95	0.32	0.015
1.50	11.12	1.4	0.018

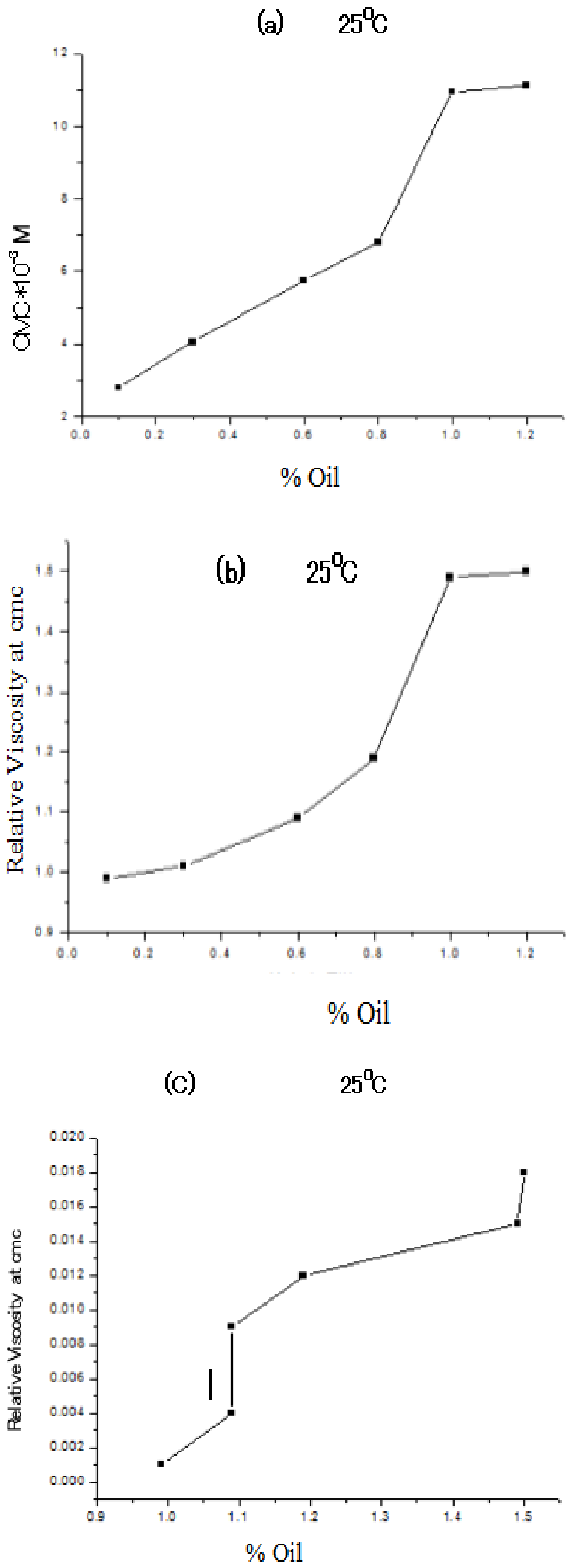

Fig 5 The Variation of CMC (a), α (b) and ηr at CMC (c) as a Function of wt % Cold Liver Oil Added

IV. CONCLUSION

In many different industries, including those that deal with food, medicine, cosmetics, and fragrances, surfactants perform crucial functions. The micellization of surfactant molecules is a prerequisite for the creation of either o/w or w/o emulsions because of the variety of configurations they possess (polar head groups and hydrophobic long chains, for example). In this study, we tried to learn more about the physiochemical characteristics of CTAB surfactant and its o/w emulsion made from cold liver oil and water in the presence of LA as a non-ionic cosurfactant. Measurements of electrical conductivity and hydrodynamic viscosity were made at various temperatures and with various amounts of oil addition. At room temperature, 10.75 $\times 10^{-3}$ M was determined to be the CMC of CTAB in aqueous media, which is in excellent agreement with the value reported in the literature. Further research has revealed that as temperature increases from 25 °C to 55 °C, the CMC of CTAB steadily falls. Using cold liver oil in the presence of LA, the emulsifying capacity of CTAB has also been studied. A CTAB surfactant's capacity to create microemulsions was demonstrated by microscopic pictures.

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