Effect of Lower Fatty Acids on the Solubilization of Butanol-1 in Aqueous Solutions of Sodium Salts of Fatty Acids. II

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Inhaltsübersicht

Es wird über Arbeiten berichtet, die das Studium der Löslichkeitsbeeinflussung von Fettsäuren auf Butanol-1 in Gegenwart von fettsauren Salzen beinhalten. Viskositätsmessungen an den Systemen sollen einen Hinweis auf die Flüssigkeitsstruktur geben.

Summary

From the results it has been concluded that the addition of free acids lowers the tendency of the soap solution to form Hydrophilic Oleomicelles but it has no effect on the formation of Lipophilic Hydromicelles.

The tendency to form viscous solutions or gels increases with the increase in the length of the acid chain of the soap and decreases with the amount of free acid added. The sol gel transformation temperature increases with the increase in the length of the acid chain in the soap as well as with the increase of the chain length of the free acid added.

It may also be pointed out that the capacity for solubilization of the soap in presence of same amount of free acid decreases as the length of the acid chain in the soap increases and it is in the order:

Myristate > Palmitate > Stearate.

From the viscosity measurements it has been confirmed that two types of micelles are formed in the solutions.

Introduction

In this part of the communication, the effect of n-propionic, n-butyric, n-caproic and n-caprylic acids on the solubilization of Butanol-1 in aqueous solutions of sodium myristate, sodium palmitate and sodium stearate has been studied.

The viscosity of the solubilized solutions has been determined with a view to finding out the nature of the micelles formed in the solutions.

Materials used

Myristic acid (L. Light & Co.) and Stearic acid (Thomas Tyrer & Co.) have been purified by distilling under reduced pressure.

Palmitic (E. Merck) was used without further purification. All the lower acids were purified by the method given in part I of this communication. Butanol-1 and Sodium Hydroxide were of the same grade as used in the previous work.

Experimental

The method used for preparing the solutions was the same as given in part I. The viscosity of the solutions has also been measured by the same method and the results obtained are given in tables I, II and III.

Results and Discussion

From the results it is observed that it has been possible to prepare the solutions of 80% Butanol-1 concentration in presence of free Propionic acid in case of all the soaps. In the palmitate and stearate systems, free acids separates out at room temperature even in 80% Butanol-1 solutions. In the solutions of 90% Butanol-1 concentration, gel has been obtained in presence of 1% free Propionic acid in case of all the soaps. In the case of Myristate system the gel transforms into clear solution below 35° C whereas in case of palmitate and stearate system the gels transform into clear solutions at a temperature higher than 35° C. In the myristate system, the solution of 5% Butanol-1 containing 1% free Propionic acid remains clear at a temperature higher than 35° C. It has not been possible to prepare the solutions for 10% to 70% Butanol-1 concentrations in presence of even 1% Propionic acid in case of any of the soaps, whereas it has been possible to prepare the solutions of these concentrations of Butanol-1 in neutral soaps. This shows that free acid lowers the solubility of Butanol-1 in Aqueous solutions of soaps. The behaviour of all the soaps in presence of free Butyric acid is similar to that in presence of Propionic acid. The difference being that in the solutions of 10% Butanol-1 in presence of 1% Butyric acid in the Myristate system, free acid separates out at room temperature and the solution remains clear at 35° C and the gel obtained in 90% Butanol-1 solutions transform into clear solution above 35° C whereas in presence of Propionic acid that gel transforms into clear solution below 35° C. This shows that the temperature of Sol gel transformation in presence of Butyric acid is higher than in presence of Propionic acid. In the case of Palmitate and stearate systems, the solution of 10% Butanol-1 in presence of 1% Butyric acid remains clear at a temperature higher than 35° C whereas in the case of Myristate system the solution remains clear below 35° C. This shows that Myristate is a better solubilizer than the palmitate and stearate even in presence of free acids.

In presence of 1% and 2% Caproic acid, it has been possible to prepare the solutions for 30% to 80% Butanol-1 concentration in case of all the soaps. In the palmitate and the stearate systems free acid separates out in the solutions of 20% Butanol-1 concentration at room temperature but the solutions remain clear above 35° C. In the myristate system free acid separates out at room temperature in 10% Butanol-1 solutions but the solution remains clear at 35° C whereas in the case of palmitate and stearate systems the solutions remain clear above 35° C. In 90% Butanol-1 solutions in presence of 1% Caproic acid gel has been obtained in case of all the soaps. In the case of Myristate this gel transforms into clear solution below 35° C whereas in case of Palmitate and stearate systems the gel transforms into clear solutions above 50° C.

In presence of 3% Caproic acid, it has not been possible to prepare the solutions for 10%, 20% and 30% Butanol-1 concentrations in case of any of the soaps, whereas it has been possible to prepare the solutions of higher concentrations of Butanol-1 in presence of 3% Caproic acid. The solutions of 50% to 80% Butanol-1 concentrations in presence of 4% Caproic acid have also been prepared in case of all the soaps but it has not been possible to prepare the solutions of 10% to 40% Butanol-1 concentrations in case of any of the soaps. It has been possible to prepare the solutions of 60% to 80% Butanol-1 in presence of any amount of Caproic acid.

From the results it has been concluded that even in presence of Caproic acid, Myristate is a better solubilizer than Palmitate and stearate. The free acid lowers the solubility of Butanol-1 in Aqueous solutions of soaps.

In presence of even 1% free Caprylic acid, it has not been possible to prepare the solutions of 5% Butanol-1 in case of any of the soaps. In the presence of Caprylic acid upto 6%, it has been possible to prepare the solutions for 10% to 80% Butanol-1 concentrations. In the case of Palmitate system, free acid separates out at room temperature and the solutions remain clear at 35° C.

It has been possible to prepare the solutions of 20%, 30% and 40% Butanol-1 concentrations in presence of Caprylic acid upto 11%, 13% and 19% respectively whereas for 50% to 80% Butanol-1 concentration it has been possible to prepare the solutions in presence of any amount of Caprylic acid.

From the results it has been concluded that the solubility of Butanol-1 below 50% concentration in Aqueous soap solution decreases as the amount of free acid in solution increases whereas the addition of free acid in the solutions containing Butanol-1 above 50% has no effect.

The comparision of the results show that the effectiveness of the acids in lowering the solubility of Butanol-1 is in the order.

Propionic acid > Butyric acid > Caproic acid > Caprylic acid.

It may also be pointed out that Myristate acts as a better solubilizer than Palmitate and Stearate even in presence of free acids.

Viscosity

Propionic acid in different soaps. From the results given in table I, it has been observed that the viscosity of 80% Butanol-1 solutions decreases as the amount of free Propionic acid in the solution increases. This is due to the fact that the addition of free acid in presence of 80% Butanol-1 does not increases the size of the micelles as it is not incorporated in the micelles.

Table I

Viscosity of the systems: water-sodium salts of the fatty acids-Butanol-1 and Propionic acid

Viscosity in milli poise — Temperature 35° C

Con. of Butanol-1 in volume %	Con. of free acid in volume %	Sodium salts of the acids		
		Myristate	Palmitate	Stearate
80%	1%	26.70	27.44	27.93
	4%	25.82	26.28	26.55
	8%	24.50	25.05	25.33
	10%	24.03	24.61	24.82
90%	1%	24.90	gel	gel

Table II

Viscosity of the systems: water-sodium salts of the fatty acids-Butanol-1 and Butyric acid

Viscosity in milli poise — Temperature 35° C

Con. of Butanol-1 in volume %	Con. of free acid in volume %	Sodium salts of the acids		
		Myristate	Palmitate	Stearate
10%	1%	36.35		
80%	1%	26.93	27.24	27.57
	2%	26.43	26.75	27.12
	4%	26.11	26.44	26.86
	8%	25.31	25.61	25.97
	11%	24.68	25.04	25.52
90%	1%	gel	gel	gel

Table III

Viscosity of the systems: water-sodium salts of the fatty acids-Butanol-1 and Caproic acid

Viscosity in milli poise — Temperature 35° C

Con. of Butanol-1 in volume %	Con. of free acid in volume %	Sodium salts of the acids		
		Myristate	Palmitate	Stearate
10%	1%	19.04		
	2%	22.78		
20%	1%	22.49	23.90	25.47
	2%	22.95	24.19	25.43
30%	1%	26.88	28.07	30.10
	2%	27.49	28.90	30.34
40%	1%	29.53	31.23	32.66
	2%	30.68	32.06	33.47
	3%	34.18	34.28	34.31
50%	1%	30.62	31.93	32.75
	2%	31.65	32.92	34.30
	3%	32.85	33.82	34.79
	4%	34.19	34.71	35.18
60%	1%	30.26	31.46	32.03
	2%	30.47	31.46	32.17
	3%	30.59	31.47	32.31
	8%	30.69	31.49	32.95
	16%	30.89	31.54	33.03
70%	1%	28.72	29.47	30.32
	3%	28.59	29.42	30.28
	8%	28.47	29.38	30.25
	16%	28.15	29.46	29.65
80%	1%	27.86	27.82	28.85
	4%	26.98	27.64	28.63
	8%	26.64	27.36	28.41
90%	1%	gel	gel	gel

In Myristate system the viscosity of 80% Butanol-1 solution in presence of 1% free acid is higher than 90% Butanol-1 solution which may be due to the larger size of the micelles in the former than in the latter. It may also be pointed out that the viscosity of the solutions increases as the length of the acid chain in the soap increases.

Butyric acid in different soaps. The effect of the Butyric acid on the viscosity is similar to that of the Propionic acid except that

viscosity of the solutions in presence of Butyric acid is higher than those of the solutions containing same amount of Propionic acid. This is due to the larger chain of the Butyric acid as compared to Propionic acid.

Caproic acid in different soaps. From the results given in table III it is observed that the viscosity of the solutions upto 60% Butanol-1 concentration increases with the increase in the amount of free acid whereas above 60% Butanol-1 concentration, it decreases with the increase in the amount of free acid. The explanation given for this difference is the same as suggested in the previous work.

It may also be pointed out that the viscosity of the solutions containing free acid upto 2% increases as the concentration of Butanol-1 increases upto 50% and then decreases with further increase in the Butanol-1 concentration.

From the results it has been concluded that in the case of Caproic acid also, the viscosity increases as the length of acid chain in the soap increases. The viscosity of the solutions also increases with the increase of the length of the chain of the free acids.

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