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Colloidal characteristics in gradual binary associated systems of new "homogeneous" polyoxyethylene structured lipids

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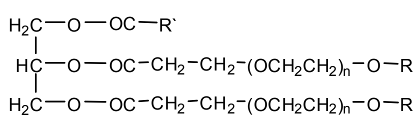
Abstract

In series of structurated lipids (SL) (I), conjugates PEG_n-L (2R'; R) (R'; 2R), previously characterized by primary colloidal parameters: surface tensions (σ), critical micellar concentrations (CCM) and hydrophile/hidrophobe values (HLB) representatives with high lipophily ("colloidally disadvantaged") as a result they have limited use in horticultural and agroalimentary processing due belonging to HLB = 1-8. The objective of the paper is to ameliorates in a controlled manner of this colloidal parameters through gradual binary monitorized association "homogeneous" (n = 9,18) polyoxyethylene (structured by Williamson procedure) conjugates PEG_n-L (2R';1R) (R'; 2R) in series HLB_1/HLB_2 = 4/10; HLB_1/HLB_2 = 4/13; HLB_1/HLB_2 = 6/10; HLB_1/HLB_2 = 6/13 and ratios 10/90; 30/70; 50/50; 70/30; 90/10. Experimental results interpreted in correlation structures-HLB systems have imposed two new cumulated colloidal parameters: "homogeneous" cumulated oligomerisation degree (n_{CB}), respectively hydrophile/hidrophobe cumulated value (HLB_{CB}) "colloidally advantaged". Performance of gradual binary association in this systems confirmed advantages and limits the premise for start-up and adopted work strategies.

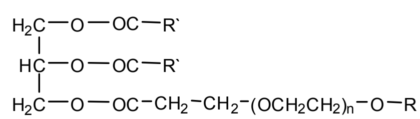
Keywords: "homogeneous" polyoxyethylene conjugates, structurated lipids, binary colloidal systems, cumulated colloidal competences

1. Introduction

The conjugates PEG_n-L (2R';1R) (R';2R) (SL) (I) "colloidaly disadvantaged" synthetized, purified and characterized in previous work [1,2], biodegradable biopolymers with highly lipophily, financially accessible and remarkable capacity of derivatization and conditioning potential with adjustable solubility in typical environments to encapsulation, dispersion, processing allow the dosage limitation of the bioactive product introduced related to mass unit of the biopolymer [1,2,3-11].



PEG_n-L (R`;2R)



PEG_n-L (2R`;R)

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We can present some of the major fields of other application for lipophyl structures:

- coated films for fresh horticultural products (storage, vegetables and fruits preservation). In this fields polyethyleneglycols (PEG_n) and their fatty acids esters (E-430/431/433) can be accessed in agroalimentary processing receivers as emulsifiers, dispersing agents, binders or carriers by seclusion of active principles [12-16];
- wax coated films (E-907) have been elaborated to imitate the natural cover of fruits and vegetables. "Waxing" (cutin and suberine) (dewaxing) of fresh citric harvesting is done since XII[th] and XIII[th] century in China [17], but the pellicles limit the transfer of respiratory gases and induced fermentation. Gelatine pellicles have been proposed in the XIX[th] century and for the preservation of meat and other foods. Between 1930-1940 were sold as additivation products paraffin waxes which in melting were applied as a protector to the fruits and vegetables, and afterwards were elaborated carnauba wax emulsions (E-903) [3,12,18,20,21]; to fight off degradation and simultaneously with the administration of fungicides [13,22,23,29]. Other additivation products include protectors against frosting, color additives, growth regulators or biological combatants [10,13,15-17,30-32] lipidic layer (monoglicerides acetates/E-472a associated with surfaceactive compounds) for the blocking of water transfer, fighting off "burnts", MacIntosh apple decay and stains at Jonathan apples [10,11,17,19,33,34].

2.Materials and methods

2.1. Materials

- "homogeneous" polyoxyethylene conjugates PEG_n-L (2R';1R) (R'; 2R) (n = 3-9) with HLB_1 = 1-8, „colloidally disadvantaged"
- conjugates PEG_n-L(2R'; 1R) (R'; 2R) with HLB_2 = 4-14 (Table 2) colloidally advantaged" [5];

Table 1. Physico-chemical (colloidal) parameters (HLB) of "colloidally disadvantaged" (HLB = 2,4-7,3) (selective list) conjugates series PEG_n-L (2R'; 1R) (R';2R) (n = 3, 6, 9) (R' = R'_s; R'_{ca}; R'_m; R'_{co}) R(NF; EH) accessed in evaluation HLB_{CB} by binary systems gradually associated

No	Structure of conjugates PEG_n-L (2R'; 1R)	"Homogeneous" degree of oligomerisation	HLB_1[1]
1	PEG_3-L (2R'$_s$; 1 EH)	3	2,75
2	PEG_3L (2R'$_s$; 1NF)		2,54
3	PEG_3L (2R'$_{ca}$; 1 EH)		2,90
4	PEG_3-L (2R'$_{ca}$; 1 NF)		2,43
5	PEG_3-L (R'$_m$; 1 EH)		3,28
6	PEG_3-L (2R'$_m$; 1 NF)		2,95
7	PEG_3-L (R'$_{co}$; 1 EH)		2,93
8	PEG_3-L R'$_{co}$; 1 NF)		2,48
9	PEG_3-L (2R'$_s$; 1 EH)	6	5,33
10	PEG_3-L (2R'$_s$; 1 NF)		4,50
11	PEG_3-L (2R'$_{ca}$; 1 EH)		5,39
12	PEG_3-L (2R'$_{ca}$; 1 NF)		4,37
13	PEG_3-L (R'$_m$; 1 EH)		5,70
14	PEG_3-L (R'$_m$; 1 NF)		4,79
15	PEG_3-L (2R'$_{co}$; 1 EH)		5,27
16	PEG_3-L (2R'$_{co}$; 1 NF)		4,48
17	PEG_9-L (2R'$_s$; 1 EH)	9	6,64
18	PEG_9L (R'$_s$;1 NF)		6,32
19	PEG_9 L (R'$_{ca}$; 1 EH)		6,64
20	PEG_9 L (R'$_{ca}$; 1 NF)		6,25
21	PEG_9L (R'$_m$; 1 EH)		7,32
22	PEG_9 L (R'$_m$; 1 NF)		6,74
23	PEG_9 L (R'$_{co}$; 1 EH)		6,50
24	PEG_9 L (R'$_{co}$; 1 NF)		6,35

Table 2. Conjugates PEG$_n$-L (2R'; 1R) (R'; 2R) accessed in binary systems for optimization of "colloidaly disadvantaged" structurated lipids

No	Structure of association for some with hydrophile/hidrophobe values "colloidally disadvantaged" conjugates (HLB$_1$) and "colloidally advantaged" conjugates (HLB$_2$)		
	HLB$_1$	HLB$_2$	
1	4.00±0.5 PEG$_3$-L(R'$_{ca}$; 2NF) PEG$_3$-L(R'$_{ca}$; 2NF) PEG$_3$-L(R'$_{ca}$; 2NF)	10.00±0.5	PEG$_9$-L(R'$_{ca}$; 2EH) PEG$_9$-L(R'$_{co}$; 2 EH) PEG$_9$-L(R'$_s$; 1NF) PEG$_{18}$-L(2R'$_m$; 1NF) PEG$_{18}$-L(2R'$_m$; 1EH) PEG$_{18}$-L(2R'$_{co}$; 1EH)
		13.00±0.5	PEG$_{18}$-L(R'$_{ca}$; 2NF) PEG$_{18}$-L(R'$_s$; 2NF) PEG$_{18}$-L(R'$_m$; 2NF) PEG$_{18}$-L(R'$_{co}$; 2NF) PEG$_{18}$-L(R'$_{ca}$; 2EH) PEG$_{18}$-L(R'$_s$; 2EH) PEG$_{18}$-L(R'$_{co}$; 2EH)
2	6.00±0.5 PEG$_9$-L(2R'$_{ca}$; 1NF) PEG$_9$-L(2R'$_s$; 1NF) PEG$_9$-L(2R'$_{co}$; 1NF) PEG$_9$-L(2R'$_{co}$; 1EH)	10.00±0.5	PEG$_{18}$-L(R'$_{ca}$; 2NF) PEG$_{18}$-L(R'$_m$; 2NF) PEG$_{18}$-L(R'$_s$; 2NF) PEG$_{18}$-L(R'$_{co}$; 2NF) PEG$_{18}$-L(R'$_{ca}$; 2EH) PEG$_{18}$-L(R'$_s$; 2EH) PEG$_{18}$-L(R'$_{co}$; 2EH)
		13.00±0.5	PEG$_{18}$-L(R'$_{ca}$; 2NF) PEG$_{18}$-L(R'$_s$; 2NF) PEG$_{18}$-L(R'$_m$; 2NF) PEG$_{18}$-L(R'$_{co}$; 2NF) PEG$_{18}$-L(R'$_{ca}$; 2EH) PEG$_{18}$-L(R'$_s$; 2EH) PEG$_{18}$-L(R'$_{co}$; 2EH)

propionic acid (Merck) (CAS 79-09-4); ethanol 98% (Merck) (CAS 64-17-5); phenol (Merck) (CAS 108-95-2).

Table 3. Dependence of cumulated "homogeneous" degrees of oligomerisation (n_{CB}) for some conjugates PEG$_n$-L(2R'; 1R) (R'; 2R) "colloidally disadvantaged" (n_2) in various binary gradually associated systems

No	Binary systems		Binary gradually associated ratios				
	n_1	n_2	10/90	30/70	50/50	70/30	90/10
1	3	9	8,40	7,20	6,00	4,80	3,60
2	3	18	16,50	13,50	10,50	7,50	4,50
3	3	36	32,70	26,10	19,50	12,90	6,30
4	6	9	8,70	8,10	7,50	6,90	6,30
5	6	18	16,80	14,40	12,00	9,60	7,20
6	6	36	33,00	27,00	21,00	15,00	9,00
7	9	18	17,10	15,30	13,50	11,70	9,90
8	9	36	33,30	27,90	22,50	17,10	11,70
9	18	36	34,20	30,60	27,00	23,40	19,80

2.2. Methods

Evaluation of water number (A) for polyoxyethylene chains (PEO) "homogeneous" (n = 3-18) per se and/or derivatized [1,41]: Water number defined as the volume of aqueous phenol solution 2 % added until the appearance a 1 % solution of polyoxyethylene chains (PEO) "homogeneous" (n = 3-18) per se and/or derivatized chains, conjugates PEG$_n$-L(2R';R), (R';2R), (ethyl alcohol solution 96 % at 25°C), opalescence determined by the clevage of "hydrogen linkages" of the of polyoxyethylene chains (PEO) with water molecules in a process of double exchange (equilibrium) that existes the solution. It is accepted where:

$$HLB = 0.89A + 1.11$$

A = water number (mL solutions 2 % phenol/ mL solution 10 % of polyoxyethylene chains PEO in ethyl alcohol 96 % at 25°C);

HLB = hydrophyle/hydrophobe values "homogeneous" (n = 3-18) polyoxyethylene chains

(PEO), conjugates PEG_n-L (2R'; R), (R'; 2R), studied.

Weigh 0,5 g conjugates PEG_n-L(2R';R) (R';2R) to be studied in Jukov apparatus at 25 ± 0.5°C, dissolve in 5 mL ethyl alcohol 96 % and titrate it with aqueous phenol solutions 2 % from a biuret with double walls (at the same temperature as the Jukov apparatus).

Results are estimated with the relation:

$$A = \frac{\text{aqueous phenol solution 2 \%(mL)}}{\text{ethyl alcohol solution of } PEG_n - L(2R';R),(R';2R)(mL)}$$

Evaluation of HLB values after adapted Karabinos method [1,41]: In 200-250 mL Erlenmeyer vessel weigh (analytical precision) 0.5 g conjugate PEG_n-L(2R'; R), (R'; 2R), dissolve by stirring under controlled heating in 10-15 mL propionic acid (or 5-10 mL ethyl alcohol 98 % depending on the solubility of the studied product. Cooled by thermostatic bath at 25°C is titrated with aqueous phenol solution 2 % up to a permanent opalescence.

A is estimated with the relation:

$$A = \frac{\text{aqueous phenol solution 2 \%(mL)}}{\text{ethyl alcohol solution of } PEG_n - L(2R';R),(R';2R)(mL)}$$

$$B = \frac{\text{aqueous phenol solution 2 \%(mL)}}{\text{propionic acid solution of } PEG_n - L(2R';R),(R';2R)(mL)}$$

$$HLB = 0.89\,(A)B + 1.11$$

3. Results. Discussions

In order to quantify as good as/possible the effects of the binary gradual association (n = 3, 6, 9) with that of the "colloidal disadvantaged" (HLB_1=4-6) conjugates PEG_n-L (2R';1R) (R';2R) and with the "colloidally advantaged" (HLB_2 = 10-13) (n_2 = 9, 18, 36) conjugates PEG_n-L (2R';1R) (R';2R), there have been introduced in the paper two cumulated colloidal parameters [10,11].

- the cumulated "homogeneous" degree of oligomerisation by binary association (n_{CB}) [24-26]:

$n_{CB} = n_1 + n_2$ [for PEG_n-L (R'; 2R)];
$n_{CB} = n_1 + n_2 = n_2$ [for PEG_n-L (2R'; 1R)];

PEG_3-L (R'$_{co}$; 2NF); $n_{CB} = n_1 + n_2 = 3 + 3 = 6$;
PEG_{18}-L (2R'$_m$; 1EH); $n_{CB} = n_1 + n_2 = 0 + 18 = 18$;
PEG_9-L (R'$_{co}$; 2EH); $n_{CB} = n_1 + n_2 = 9 + 9 = 18$;
PEG_{18}-L (R'$_m$; 2EH); $n_{CB} = n_1 + n_2 = 18 + 18 = 36$

- the hydrophile/hydrophobe cumulated value by gradual binary association (HLB_{CB}) [27,28].

There have been selected two groups of „colloidally disadvantaged" conjugates PEG_n-L (2R'; 1R) (R'; 2R) with the hydrophile/hydrophobe value (HLB_1 = 4.00 ± 0.5) belonging to the series PEG_3-L(R'; 2NF) with three representants, respectively the series PEG_9-L(2R';NF;EH) with the hydrophile/hydrophobe value HLB_2 = 6.00 ± 0.5 with four representants. In both groups of conjugates the "homogeneous" cumulated oligomerisation degree is n_c = 6 and n_c = 9 and the hydrocarbonated polyunsaturated chains la (R') belongs to the vegetal lipidic fractions, isolated, purified and characterized by the seeds (kernels) of the wildnut tree (R'$_{ca}$) (*Aesculus hippocastanum*), grapes (R'$_s$) (*Vitis vinifera*), coriander (R'$_{co}$) (*Coriandri fructus*) and wied rose (R'$_m$) (*Rosa canina*) [1,6-9].

The conjugated structures selected belong to both series of ratios R'/R (1l/2; 2/1) and to both types of hydro carbonated chains R(EH;NF).

We have also simultaneously decided to use two categories of "colloidally advantaged" conjugates PEG_1-L (2R'; 1R) (R'; 2R) having the hydrophile/hydrophobe values HLB_2 = 10.00 ± 0.5 and belonging to the series PEG_{18}-L (R'; 2EH/2NF) respectively to PEG_{18}-L(2R'; EH/NF) (HLB_2 = 13.00 ± 0.5) with three representants conjugates series PEG_{18}-L(2R'; EH) respectively ten representants.

In both cases of conjugates, the "homogeneous" cumulated oligomerisation degree is (n_c = 18; n_c = 36):

PEG_9-L (R'; 2EH/2NF) with $n_c = 9 + 9 = 18$;
PEG_{18}-L (2R'; EH/NF) with $n_c = 9$;
PEG_{18}-L (R'; 2EH/2NF) with $n_c = 18 + 18 = 36$

In order to optimize the HLB_1 "colloidally disadvantaged" values there has been done their gradual association in the series 10/90; 30/70; 50/50; 70/30; 90/10 with "colloidally advantaged" conjugates PEG_n-L (2R';R) (R';2R) (HLB_2). The consequences have been evaluated by correlation and by experimentally determining the values n_{CB} (Table 3) and HLB_{CB} (Tables 4, 5, 6).

Table 4. Dependence of cumulated "homogeneous" hydrophile/hidrophobe values for some conjugates PEG_n-L(2R'; R) (R'; 2R) "colloidally disadvantaged" (HLB_2) in various binary gradually associated systems

No	Binary systems		"Homogeneous" cumulated degree oligomerisation HLB_{CB} in various binary gradually associated systems				
	HLB_1	HLB_2		HLB_1	HLB_2		HLB_1
1	4	10	9,40	8,20	7	5,80	4,60
2	4	13	12,10	10,30	8,50	6,70	4,90
3	6	10	9,60	8,80	8,00	7,20	6,40
4	6	13	12,30	10,90	9,50	8,10	6,70

No	10/90 (HLB_1=4)		30/70 (HLB_1=4)		50/50 (HLB_1=4)		70/30 (HLB_1=4)		90/10 (HLB_1=4)	
	HLB_{CB}	HLB_2	HLB_{CB}	HLB_2	HLB_{CB}	HLB_2	HLB_{CB}	HLB_2	HLB_{CB}	HLB_2
Series 1	9,40	10	8,20	10	7,00	10	5,80	10	4,60	10
	12,10	13	10,30	13	8,50	13	6,70	13	4,90	13
	10/90 (HLB_1=6)		30/70 (HLB_1=6)		50/50 (HLB_1=6)		70/30 (HLB_1=6)		90/10 (HLB_1=6)	
Series 2	HLB_{CB}	HLB_2	HLB_{CB}	HLB_2	HLB_{CB}	HLBj	HLB_{CB}	HLB_2	HLB_{CB}	HLB_2
	9,60	10	8,80	10	8,00	10	7,20	10	6,40	10
	12,30	13	10,90	13	9,50	13	8,10	13	6,70	13

No	10/90 (n_1=3)		30/70 (n_1=3)		50/50 (n_1=3)		70/30 ((n_1=3)		90/10 (n_1=3)	
	n_{CB}	n_2	n_{CB}	n_2	n_{CB}		n_{CB}	n_2	n_{CB}	n_2
Series 1	8,40	9	7,20	9	6,00	9	4,80	9	3,60	9
	16,50	18	13,50	18	10,50	18	7,50	18	4,50	18
	32,70	36	26,10	36	19,50	36	12,90	36	630	36
	8,40	9	7,20	9	6,00	9	4,80	9	3,60	9
Series 2	8,70	9	8,10	9	7,50	9	6,90	9	6,30	9
	16,80	18	14,40	18	12,00	18	9,60	18	7,20	18
	33,00	36	27,00	36	21,00	36	15,00	36	9,00	36
	n_{CB}	$n_2(n_1=9)$	n_{CB}	$n_2(n_1=9)$	n_{CB}	$n_2(n_1=9)$	n_{CB}	$n_2(n_1=9)$	n_{CB}	$n_2(n_1=9)$
Series 3	17,10	18	15,30	18	13,50	18	11,70	18	9,90	18
	33,30	36	27,90	36	22,50	36	17,10	36	11,70	36
Limited series	n_{CB}	$n_2(n_1=18)$								
	34,20	36								

4. Conclusions

The It is through that the major objectives of paper, to optimize in a controlled way the colloidal parameters of any "colloidally disadvantaged" conjugates PEGn-L (2R';R) (R';2R) through monitorised gradual binary association (10/ 90; 30/70; 50/50; 70/30; 90/10) with "colloidally advantaged" conjugates PEGn-L(2R';R) (R;2R) (HLB_2=4-14) is a benefit technological option. Experimental dates interpreted correlate with two new cumulated colloidal indicators (n_{CB}; HLB_{CB}) confirmed the premises for start-up and adopted work strategies.

Table 5. Dependence of binary "homogeneous" oligomerisation degrees cumulated n_{CB} and binary cumulated hydrophile/hidrophobe values HLB_{CB} in the series of conjugates PEG_3-L($2R_s$'; EH) (R_s'; 2EH)binary gradually associated (1-70 %) with "homogeneous" polyoxyethylene chains high oligomerised (n=30, 40, 50)

No	Conjugates	Colloidal parameter	Amount of "homogeneous" polyoxyethylene chain high oligomerised for binary graduall associated														
			EH_{30}					EH_{40}					EH_{50}				
			1	10	20	50	70	1	10	20	50	70	1	10	20	50	70
1	PEG_3-L($2R_s$'; EH)	n_{CB}	3.27	5.70	8.40	16.50	21.90	3.37	6.70	10.40	21.50	28.90	3.47	7.70	12.40	26.50	35.90
		HLB_{CB} 1)	2.90	4.28	5.82	10.42	13.49	2.90	4.29	5.83	10.46	13.54	2.91	4.36	5.97	10.81	14.04
2	PEG_3-L(R_s'; 2 EH) 2,3)	n_{CB}	6.24	8.40	10.80	18.00	22.80	6.34	9.40	12.80	23.00	29.80	6.44	10.40	14.80	28.00	36.80
		HLB_{CB} 1)	5.41	6.61	7.88	11.71	14.26	5.46	6.61	7.90	11.75	14.31	5.47	6.69	8.04	12.10	14.82

1) determined after Kambinos, J., (1955) [30], adapted Jianu C. Ph.D. 2006 [15];
2) cumulated "homogeneous" partial oligomerisation degree (n = 3);
3) cumulated hydrophile/hidrophobe values for conjugates "colloidaly disadvantaged" PEG_3-L($2R_s$'; EH) (HLB = 2.75); PEG_3-L(R_s'; 2EH) (HLB = 5.33)

Table 6. Dependence of cumulated "homogeneous" hydrophile/hidrophobe values HLB_{CB} for some conjugates PEG_n-L(2R'; R) (R'; 2R) "colloidally disadvantaged" in various binary gradually association with conjugates "colloidally advantaged" (HLB_2)

No	Binary systems		Cumulated binary hydrophile/hydrophobe values for HLB_{CB} PEG_n-L(2R';R) (R';2R)				
	HLB_1	HLB_2	HLB_1/HLB_2 10/90	HLB_1/HLB_2 30/70	HLB_1/HLB_2 50/50	HLB_1/HLB_2 70/30	HLB_1/HLB_2 90/10
1	4.00±0.5	10.00±0.5	9.4(±0.5) (8.90 - 9.90) PEG_9-L(R'_s; 2NF) 9.17 PEG_9-L(R'_{cs}; 2NF) 9.19 PEG_9-L($2R'_m$; 2NF) 9.34 PEG_9-L($2R'_{cc}$; 2NF) 9.37 PEG_{18}-L($2R'_s$; 1EH) 9.88 PEG_{18}-L($2R'_s$; 1EH) 9.58 PEG_{18}-L($2R'_{cs}$; 1EH) 9.44 PEG_{18}-L($2R'_{cc}$; 1EH) 9.82 PEG_{18}-L($2R'_{cc}$; 1NF) 9.39	8.20(±0.5) (8.15 - 8.25)	7.00 (±0.5) (6.50 - 7.50) Binary associated colloidal systems with HLB < 8	5.80(±0.5) (5.30 - 6.30)	4.60(±0.5) 4.10 - 5.10)
2	4.00±0.5	13.00±0.5	12.10(±0.5) (11.60 - 12.60) PEG_9-L(R'_m; 2EH) 12.63	10.30(±0.5) (9.80 - 10.80) PEG_9-L(R'_s; 2EH) 10.54 PEG_9-L(R'_{cs}; 2EH) 10.44 PEG_9-L(R'_m; 2EH) 10.88 PEG_9-L($2R'_{cc}$; 2EH) 10.11 PEG_{18}-L($2R_s$; 1EH) 9.88 PEG_{18}-L($2R'_s$; 1EH) 9.45 PEG_{18}-L($2R'_{cs}$; 1EH) 10.30 PEG_{18}-L($2R'_{cc}$; 1NF) 10.22 PEG_{18}-L($2R'_{cc}$; 1EH) 9.82	8.00 (±0.5) (8.00 - 9.00)	Binary associated colloidal systems with HLB > 8	
3	6.00±0.5	10.00±0.5	10.60(±0.5) (9.10 - 10.10) PEG_9-L(R'_s; 2NF) 9.17 PEG_9-L(R'_{cs}; 2NF) 9.19 PEG_9-L(R'_m; 2NF) 9.34 PEG_9-L($2R'_{cc}$; 2EH) 10.11 PEG_9-L($2R'_{cc}$; 2NF) 9.37	8.28 (±0.5) (8.30 - 9.13)	8.00(±0.5) (7.50 - 8.50)	Binary associated colloidal systems with HLB ≤ 8	
4	6.00±0.5	13.00±0.5	12.30(±0.5) (11.80 - 12.80) PEG_{18}-L(R'_s; 2NF) 12.75 PEG_{18}-L(R'_{cs}; 2NF) 11.71 PEG_9-L(R'_m; 2NF) 12.63	10.90(±0.5) (10.40 - 11.40) PEG_9-L(R'_s; 2EH) 10.54 PEG_9-L(R'_{cs}; 2EH) 10.4 PEG_9-L(R_m; 2EH)10.88 PEG_9-L($2R'_{cc}$; 2EH) 10.11	9.50(±0.5) (9.00 - 10.00) PEG_9-L(R'_s; 2NF) 9.17 PEG_9-L(R'_{cs}; 2NF) 9.19 PEG_9-L($2R'_m$; 2NF) 9.34 PEG_9-L($2R'_{cc}$; 2NF) 9.37 PEG_{18}-L($2R'_s$; 1EH) 9.88 PEG_{18}-L($2R'_s$; 1NF) 9.58 PEG_{18}-L($2R'_{cs}$; 1EH) 9.95 PEG_{18}-L($2R'_{cs}$; 1EH) 9.55 PEG_{18}-L($2R'_{cc}$; 1NF) 9.44 PEG_{18}-L($2R'_{cc}$; 1EH) 9.82 PEG_{18}-L($2R'_{cc}$; 1NF) 9.39	8.10(±0.5) (7.60 - 8.60) Binary associated colloidal systems with HLB ≥ 8	

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

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