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Chemical and physical characteristics of local lecithin in comparison with some other food emulsifiers

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RESUMEN

Características quimicofísicas de lecitina local en comparación con otros emulsionantes alimentarios.

Se estudiaron las características químicas y físicas de lecitina local y otros emulsionantes alimentarios (Emulfuid E, Triodan R 90, Panodan 150 y Monoestearato de glicerol). Las características de estos emulsionantes estudiados fueron solubilidad, balance hidrófilo-lipófilo (HLB), índice de estabilidad (SI), composición en ácidos grasos y espectros de infrarrojo. Los resultados obtenidos mostraron que Emulfuid E y lecitina local fueron mezclas de lecitinas y fosfatidil etanolamina. Por otro lado, Triodan R 90 fue ester poliglicerídico del ácido ricinoleíco, Panodan 150 una mezcla de mono y diglicéridos y G.M.S. un ester monoglicerídico del ácido esteárico.

PALABRAS-CLAVE: Emulsionante alimentario - Lecitina - Propiedades físicas - Propiedades químicas.

SUMMARY

Chemical and physical characteristics of local lecithin in comparison with some other food emulsifiers.

The chemical and physical characteristics of local lecithin and other food emulsifiers (Emulfuid E, Triodan R 90, Panodan 150 and Glycerol mono stearate) were studied. The characteristics of these emulsifiers studied were solubility, hydrophile-lipophile balance (HLB), stability index (SI), fatty acid composition and infrared spectrum. The results obtained showed that Emulfuid E and local lecithin were mixture of lecithins and phosphatidyl ethanol-amine. In addition, Triodan R 90 was a polyglycerol ester of ricinoleic acid, Panodan 150 was a blend of mono and diglycerides, and G.M.S. was a monoglycerol ester of stearic acid.

KEY-WORDS: Chemical properties - Food emulsifier - Lecithin - Physical properties.

1. INTRODUCTION

The industrialization of food production, which has taken place in this century, has created a demand for food processing aids such as food emulsifiers. The function of these minor ingredients in foods is to facilitate large-scale, highly automated production of uniform products with longer stability (shelf-life) which can stand transport and storage until consumption takes place (Krog, 1992). An emulsifier is a substrate with a hydrophobic and a hydrophilic part that has the capacity to form water-in-oil (w/o) or oil-in-water (o/w) emulsions by reducing the interfacial tension. Food products consist not only of water and oil but also of proteins, carbohydrates and other component. Therefore, the term «emulsifier» is to be understood in a much wider sense as surface active agent. The formula for the various phospholipids indicated that the hydrophobic and hydrophilic parts are balanced and that lecithin can be used as an emulsifier (Pearce and Kinsella, 1978). Lecithins, having both polar and non polar groups, have high surface activity and are reactive with both oil and protein, making it an excellent emulsifying agent in food systems (Cherry and Gray, 1981). The objective of the present study were to compare between the chemical and physical properties of local lecithin with some imported emulsifiers.

2. MATERIALS AND METHODS

Emulsifiers

a) Local lecithin (L.Le) was obtained locally from Sandab Factory of Misr Company for Oil and Soap, Egypt.
b) Emulfuid E (E.E.) was obtained from Lucas Mayer Company, Germany.
c) Triodan R 90 (T. R 90) and Panodan 150 (P. 150) were obtained from Grindsted Company, Denmark.
d) Glycerol Mono Stearate (G.M.S.) was obtained from Brimer Food Company, Germany.
e) Other solvents and chemicals used were obtained from British Drug House (BDH).

Hydrophilic-lipophile balance (HLB) of emulsifiers was calculated using the equation of Griffin (1965). Stability index (SI) was determined by the method of Titus *et al.,* (1968). The chromatographic analysis of fatty acids was performed according to Farag *et al.,* (1986). While the infrared spectra of emulsifiers were performed according to Farag *et al.,* (1977).

3. RESULTS AND DISCUSSION

Chemophysical results of local lecithin and other food emulsifiers are tabulated in tables from I to IV. It has shown that:

a) These emulsifiers are nearly soluble in diethyl ether, n-hexane and oil but are not soluble in either water or ethanol, these results agree with that of Akoh and Swanson, (1989), Feuge *et al.,* (1970) and El-Shattory *et al.*, (1993). Table I shows these results.

Table I
Solubility of emulsifiers in different solvents

Solvent	Temp °C	Emulsifiers				
		Emulfuid E	Local lecithin	Triodan R 90	Panodan 150	Glycerol mono stearate
Water						
	25	I	I	I	I	I
	75	PS	SS	I	SS	I
Diethyl ether						
	25	S	S	S	S	S
	75	S	S	S	S	S
P. ether (60/80)						
	25	S	S	S	PS	I
	75	S	S	S	PS	PS
n-hexane						
	25	S	S	S	SS	I
	75	S	S	S	S	S
Oil						
	25	PS	S	PS	I	I
	75	S	S	S	PS	S
Ethanol						
	25	I	I	I	I	I
	75	SS	SS	SS	PS	S

Where:
I = Insoluble
PS = Partially soluble
SS = Springly soluble
S = Soluble

b) HLB of local lecithin and Emulfuid E was almost the same, while, on the other hand Panodan 150 and Triodan R 90 had higher HLB. Meanwhile (G.M.S.) have the lowest HLB. These varied HLB values (from 3.3 to 10.5) depending on emulsifiers chemical composition (Ebeler and Walker, 1984). Table II shows this relation.

c) Stability index increased with the increase of oil percentage. Meanwhile, (G.M.S.), Emulfuid E and local lecithin (strongly lipophilic) are tended to make more stable water-in-oil (w/o) emulsions in comparison with Triodan R 90 and Panodan 150 (strongly hydrophilic). (Akoh and Nwosu, 1992). Increasing the amount of emulsifiers caused an increases in the stability index of the emulsions at all levels of concentration. These actions are attibuted to the reduction of interfacial tension between the two phases of emulsion (Cullum, 1992). Table III shows these actions.

Table II
Hydrophile-lipophile balance (HLB) of emulsifiers

Emulsifier	HLB *
Emulfuid E	6.8
Local Lecithin	7.1
Triodan R 90	8.3
Panodan 150	10.5
Glycerol mono stearate	3.3

* Hydrophile-lipophile balance = 20 (1-S/A)

Where:
S = Saponification value.
A = Acid value of the total fatty acids of the samples after hydrolysis.

Table III
Stability index (S.I.) of soybean oil-water emulsions with emulsifiers at different concentrations

Emulsifier	%	15	30	45	60	75	90
		% soybean oil					
		Stability index					
Emulfuid E	1	13.00	25.50	25.50	85.80	96.20	100.10
	3	60.60	80.40	97.60	90.40	97.20	101.60
	5	55.10	78.90	84.60	92.40	98.30	105.50
Local lecithin	1	12.20	13.50	94.70	101.10	98.50	99.40
	3	18.40	20.20	99.60	99.40	99.90	96.50
	5	19.60	20.90	99.10	99.10	99.50	100.80
Triodan R 90	1	17.90	63.60	94.20	98.70	97.00	98.90
	3	51.70	78.10	95.10	93.70	99.80	98.20
	5	77.10	87.80	92.60	95.20	101.60	99.20
Panodan 150	1	21.20	27.30	36.10	40.90	64.20	83.30
	3	36.10	62.00	92.80	95.30	96.00	97.10
	5	35.20	79.90	96.10	95.90	98.20	100.40
Glycerol mono-stearate	1	13.90	12.20	10.50	18.30	72.00	85.30
	3	59.30	84.10	95.40	99.10	99.60	102.00
	5	78.40	89.20	97.00	99.00	100.80	102.00

Where:
* Stability index (S.I.) = (Fat % in the bottom half of the sample) / (Fat % of the total sample) x 100.

d) Fatty acid contents of local lecithin, Emulfuid E and Triodan R 90 were (55.5%, 64.2% and 76.1%) of unsatured fatty acids, and (44.5%, 35.8% and 23.9%) of satured fatty acids. Stearic acid forms more than 75.0% and 68.0% of the fatty acids of Panodan 150 and (G.M.S.), respectively. These results are in agreement with that Akoh and Swanson (1989) and Calahoro *et al.,* (1992). Table IV shows fatty acids composition of these emulsifiers.

e) The infrared spectrum for lecithin revealed the presence of a peak at 1720 cm^{-1} corresponding to the ester carbonyl of the glicophosphatide. Meanwhile, the presence of a peak at 970 cm^{-1} is an indication for choline containing phospholipids. These peaks have been also reported by Pizzoli *et al.,* (1967) for soybean lecithin. The infrared spectrum also showed peaks at 1500 cm^{-1} for bending (C-H, CH_2 and CH_3) at 1190 cm^{-1} (P = O), at 1160 cm^{-1} for (C-O-C) and at 1090 cm^{-1} for (P - O). On the other hand, a peak at 1080 cm^{-1} was also believed to arise form (P-O-C) vibration and one at 1180 cm^{-1} form a (C-O-C) linkage (Marinette and Stotz, 1953). Meanwhile phosphatidyl ethanol amine and phosphatidyl serine of lecithin posses the fatty ester grouping gives strong C = O bound of peak about 1750 cm^{-1}. These results are in agreement with those reported by Scholfield (1981) and Hurst and Marin (1984).

The infrared spectrum of Triodan R 90 and Panodan 150 showed clearly the alcoholic esters, free OH group and carboxylic acids at peaks 3350 cm^{-1} and 1720 cm^{-1}. In infrared spectrum of (G.M.S.) the peak at 3350 cm^{-1} is attributed to the free OH-stret-ching. While, the peak at 1720 cm^{-1} indicated the presence of carbonyl ester and the peak at 1500 cm^{-1} is characterized for bending (C-H), (CH_2O) and (CH_3) (Dollear, 1959). GLC analyses and I.R. spectra proved that Emulfuid E and local lecithin are mixture of lecithins and phosphatidyl ethanol-amine. While, Triodan R 90 ia a polyglycerol ester of ricinoleic acid, and Panodan 150 is a blend of mono and diglycerides. Meanwhile, (G.M.S.) is a monoglycerol ester of stearic acid.

Table IV
Fatty acids composition of emulsifiers

Emulsifier	Fatty acids %					
	$C_{14:0}$	$C_{16:0}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:1\ (OH)}$
Emulfuid E	0.23	16.06	19.47	44.73	19.51	0.00
Local lecithin	3.47	17.89	23.13	47.82	7.69	0.00
Triodan R 90	12.11	3.03	8.78	31.49	0.00	44.59
Panodan 150	7.00	13.71	75.99	3.30	0.00	0.00
Glycerol mono stearate	29.47	2.45	68.08	0.00	0.00	0.00

Where:
$C_{14:0}$ = Myristic
$C_{16:0}$ = Palmitic
$C_{18:0}$ = Stearic
$C_{18:1}$ = Oleic
$C_{18:2}$ = Linoleic
$C_{18:1\ (OH)}$ = Ricinoleic

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