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Short Paper

Sucrose polyesters from poultry fat as non-ionic emulsifiers

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RESUMEN

Poliésteres de sacarosa de grasas de aves de corral como emulsionantes no-iónicos.

Las grasas de aves de corral son ricas en ácidos palmítico y oleico y son producidas como subproductos de las industrias avícolas. Estas grasas pueden ser utilizadas en la preparación de emulsionantes. Los ésteres de sacarosa de grasas de aves de corral fueron preparadas a partir de grasas de bajo coste y sacarosa por esterificación. El rendimiento de los ésteres de sacarosa preparados en este trabajo superó el 85%. El balance hidrofílico-lipofílico (HLB), tensión superficial, tensión interfacial e índice de estabilidad (SI) fueron evaluados y comparados con emulsionantes estandar preparados de ésteres de palmitato y oleato puros. Los valores de tensión interfacial y el HLB fueron más altos en los poliésteres de sacarosa de las grasas de aves de corral.

PALABRAS-CLAVE: Ave de corral - Emulsionante no-iónico - Poliésteres de sacarosa - Propiedades físicas.

SUMMARY

Sucrose polyesters from poultry fat as non-ionic emulsifiers

Poultry fats are rich in palmitic and oleic acids are produced as by-products from poultry industries. These fats can be utilized in the preparation of emulsifiers. Sucrose esters of poultry fat are prepared from low-cost poultry fat and sucrose by esterification. The yield of sucrose esters prepared in this work exceeds than 85%. The hydrophilic-lipophilic balance (HLB), surface tension, interfacial tension and stability index (SI) were evaluated and compared with standard emulsifiers prepared from pure palmitate and oleate esters. Concerning the stability of emulsions, the values of interfacial tension and HLB were higher for the sucrose esters of poultry fat.

KEY-WORDS: Non-ionic emulsifier - Physical properties - Poultry - Sucrose polyesters.

1. INTRODUCTION

Emulsifiers, prepared from polyalcohols and glycosides, can be used, not only for foodstuffs applications, but also in cosmetic and pharmaceutical products. The functions of these emulsifiers, are solubility promoting agents, dispersing agents and wetting agents in creams, shampoos, lotions, tooth paste, medicinal ointments and vitamin oils (12, 15).

It was planned to prepare low-cost emulsifiers from cheaper raw materials such as sucrose and poultry fat. Poultry fat is nearly similar in composition to those materials used in preparation of emulsifiers used for cosmetic and pharmaceutical purposes (13).

Annually about 12.500 tons of poultry fat is produced from poultry industry in Egypt (16). These cheaper sources of fatty material together with sucrose are selected for preparation of non-ionic emulsifier. The prepared emulsifier will be compared with some standard sucrose ester emulsifiers on the basis of hydrophilic-lipophilic balance (HLB), surface and interfacial tension as well as stability index (SI).

2. MATERIALS AND METHODS

2.1. Materials

A sample of poultry fat and pure sucrose were supplied by United Company for Poultry Production and Sugar and Integrated Industries Company (Egypt), respectively. Standard sucrose palmitate and oleate were prepared from high purity chemicals (MERCK, Germany and BDH, England).

2.2. Methods

2.2.1. Fatty acid composition of poultry fat

Poultry fatty acid methyl esters were prepared according to A.O.C.S method (6). Determination of poultry fatty acids composition was performed as previously described (19) using HEWLETT PACKARD HP 6890 gas chromatograph, equipped with flame ionization detector (FID).

2.2.2. Preparation of sucrose fatty acid esters (SFAE)

Sucrose esters of poultry fatty acids as well as pure fatty acids (palmitic and oleic) were prepared

according to the method of Heesen *et al.* (15). Equimolecular of pure sucrose and fatty acids were reacted together in presence of the in-situ prepared sodium soap (catalyst) amounting to 20% of the total weight of sucrose. The mixture was heated at 100°C under nitrogen while the constituents had melted. The temperature was increased to 130°C under reduced pressure (40 mmHg) for 16 hours with continuous stirring. The reaction products were dissolved in an equal quantity of warm butanone and the soap was acidified with 3-5 parts by weight of lactic acid per 100 parts of reaction product. The non-esterified sucrose and excess lactic acid were then eliminated by two successive extractions with distilled water at 70°C. The solvent was then removed under reduced pressure to obtain the final sucrose esters (86.5-88.6% yield) (18).

Mixing of sucrose palmitate with sucrose oleate is accomplished so as to obtain a ratio of saturated: unsaturated (26.8:73.2 w/w) fatty acids similar to that present in the poultry fat.

2.2.3. Evaluation of sucrose ester emulsifiers

1) Infrared spectra (IR)

The infrared spectrum of prepared emulsifiers were performed using infrared spectrophotometer Model Philips PU 9700 (7).

2) Hydrophilic-lipophilic balance (HLB)

Hydrophilic-lipophilic balance of sucrose esters were calculated according to the method of Griffin (14) using the following equation:

$$HLB = 20\left(1 - \frac{\text{saponification value}}{\text{Acid value}}\right)$$

3) Surface and interfacial tension

Surface and interfacial tension of sucrose esters, in xylene at 25°C, were measured as previously described (5) using CSC-DuNouy Interfacial Tensiometer Model 70545 (CSC Scientific Company, Fairfrax, VA).

4) Stability index (SI)

Stability index of sucrose esters was determined by the method of Titus (22). Levels of 1,3 and 5% of each sucrose esters were dissolved in the appropriate soybean oil sample, then 50g oil-water mixtures containing 15, 30, 45, 60, 75 and 90% oil were assembled. These mixtures were warmed to 60°C and homogenized in Edmund Buhler cell homogenizer Model HO4 at 7000 rpm for 15 minutes. A 5 ml portion of the homogenized sample was removed immediately and used to check the oil content of the initial mixture. Another 10 ml was transferred to a test tube and held for 2 hr. in a water bath at 37°C. A 5 ml portion was removed from the bottom of the test tube to check the oil content. Stability index was expressed as a percentage value by dividing the oil percentage in the bottom half of the sample by the oil percentage of the total sample.

3. RESULTS AND DISCUSSION

Fatty acids composition of poultry fat are recorded in Table I indicating that fatty acid contents of poultry fat was rich in palmitic and oleic fatty acids. From the obtained results it can be observed that poultry fat is similar to most animal fats in this respect and can accordingly be used in the preparation of cosmetic and pharmaceutical emulsifiers (13, 17, 20).

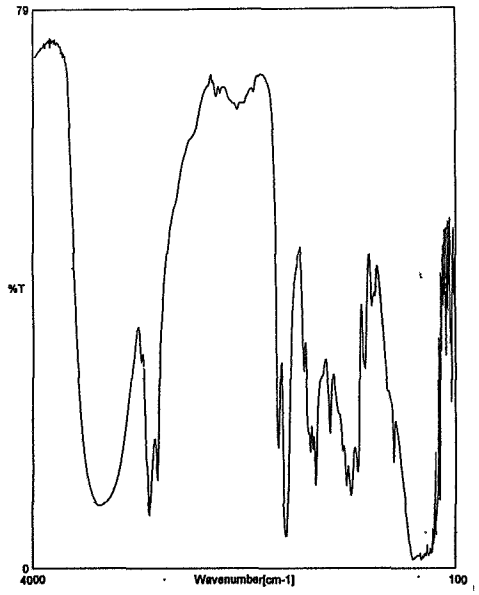

Figure 1
Infrared espectrum of sucrose esters of poultry fat.

Table I
Fatty acids composition of poultry fat

Fatty acids profile (%)							
C_{12}	C_{14}	C_{16}	$C_{16:1}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$	C_{20}
0.99	0.24	24.40	5.45	51.91	15.42	0.47	1.12

C_{12}, Lauric; C_{14}, Myristic; C_{16}, Palmitic; $C_{16:1}$, Palmitoleic; $C_{18.1}$, Oleic; $C_{18:2}$, Linoleic; $C_{18:3}$, Linolenic; C_{20}, Arachidic.

The IR spectrum of the sucrose esters of poultry fatty acids (Fig. 1) and pure fatty acids (palmitic and oleic) showed a strong absorption at 1735 cm^{-1}, and 3350 cm^{-1} indicating the presence of ester linkage and hydroxyl function, respectively (3, 4, 11).

Surface tension, interfacial tension and hydrophilic-lipophilic balance (HLB) are shown in Table II. The results indicated that surface tension of sucrose stearate-oleate mixture and sucrose esters of poultry fat have very similar value (56.1 and 55.7 dynes/cm), respectively, on the other hand, interfacial tension of sucrose ester of poultry fat gave high value of 13.5 dynes / cm. This latter value could be attributed to the presence of different unsaturated fatty acid moieties (palmitoleic and oleic) in the sucrose esters of poultry fat (8, 9, 18). With reference to the HLB values, sucrose stearate-oleate mixture and sucrose esters of poultry fat they amounted to 5.4 and 6.6, respectively. The difference in HLB value may be attributed to the presence of C_{12}, C_{14} and $C_{16:1}$ fatty acids only in the sucrose esters of poultry fat which are somewhat shorter in chain length (10, 18).

Results of the stability index (SI) of soybean oil-water emulsions with the two types of the prepared emulsifiers at different concentrations are presented in Table III. It is clear that both emulsifiers exhibited high SI at 60, 75 and 90% of soybean oil at 1,3 and 5% concentrations, respectively. Thus, SI increased with the increase of the soybean oil percentage in emulsions. The results also indicated that separation of oil from emulsions decreased as interfacial tension and HLB values increased at all concentrations of emulsifiers (1, 18, 22). Therefore, emulsifiers that have low HLB in the ranges of 3-6 will tend to make water-in-oil (W/O) emulsions, while emulsifiers having 8-13 HLB values will tend to make oil-in-water (O/W) emulsions (2, 14, 21).

Table II

Surface active properties of sucrose fatty acid esters (SFAE)

Emulsifier	Surface tension (dynes/cm)	Interfacial tension (dynes/cm)	HLB
Sucrose palmitate-oleate mixture (26.8:73.2 w/w)	56.1	11.3	5.4
Sucrose esters of poultry fat	55.7	13.5	6.6

Table III

Stability index (SI) of soybean oil-water emulsions with SFAE emulsifiers at different concentrations

Emulsifier	SFAE Conc. (%)	% Soybean oil					
		15	30	45	60	75	90
Sucrose palmitate-oleate mixture (26.8:73.2 w/w)	1	14.2	15.0	23.6	71.0	75.4	84.4
	3	37.4	61.6	72.0	80.2	84.2	91.0
	5	44.0	73.0	81.2	84.0	90.0	94.6
Sucrose esters of poultry fat	1	13.0	14.2	21.0	71.4	75.0	84.0
	3	35.6	60.8	70.4	77.0	83.8	88.2
	5	41.4	71.6	80.0	82.6	90.0	92.0

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