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Features of Technical Phospholipid Surfaces Obtained from Cotton Oils

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ABSTRACT: This article studies the main features of cottonseed oil phospholipids and the advantageous qualities of their use as a natural plant surfactant (surfactant). Also, information is given on methods for producing phospholipids from cottonseed oils and the table shows the results of laboratory studies on the fatty acid composition of cotton phospholipid, which determine the advantages of their use as a natural surfactant in clay drilling fluids.

KEY WORDS: Phospholipid, surfactant, hydration, emulsifier, antioxidant, cottonseed oil, refining, oil-fat industry, gossypol, phosphatide.

I. INTRODUCTION

With the expansion of the areas of application of surface-active substances (surfactants) in chemical, pharmaceutical, oil and other industries, interest in natural plant phospholipids, especially for technical purposes, has been increased.

Previously, phospholipid surfactants were obtained by hydration of light (sunflower, soybean, etc.) oils and the precipitate was used in food products (chocolates, baked goods, etc.) as emulsifiers and antioxidants [1-4]. Moreover, technical phospholipids are practically not used as an independent product of isolation from cotton, etc. dark vegetable oils.

Today, many studies confirm the advantages of natural plant-based surfactants over synthetic ones and therefore, expand research work on the use of technical phospholipids in various sectors of the economy. In addition, according to the requirements of the technical regulation, phospholipids should be maximally excreted from crude vegetable oils before their alkaline refining. they have a negative effect on the subsequent processes of oil processing, their neutralization, hydrogenation, separation of the catalyst from salomas, etc.

Therefore, the study of the composition, structure and properties of plant phospholipids allows us to determine the areas and conditions of their use, which mainly depends on the nature and type of raw materials i.e. vegetable oil. In the oil and fat industry, the separation of phospholipids from light (soybean, sunflower, safflower, etc.) oils has become an obligatory operation in the general technological scheme of their complex refining to produce an independent product-phosphatide concentrates for various purposes [5-7].

II.OBJECT AND RESEARCHING METHODS.

It is known that phospholipids are asymmetric diesters of phosphoric acid (Fig. 1), for which there is no unified classification [8, 9].

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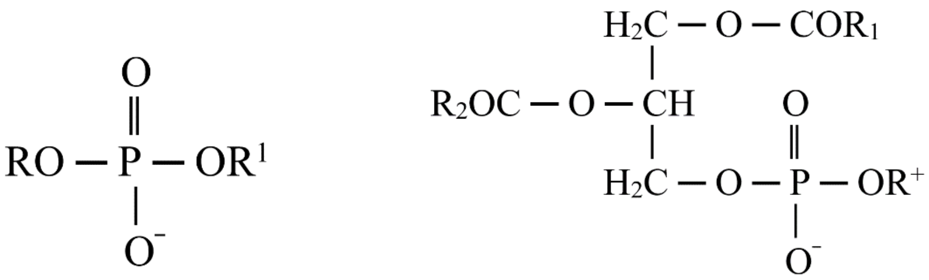

a) b)

Pic. 1. The structure of asymmetric diesters of phosphoric acid and its derivatives

where: a - asymmetric diesters of phosphoric acid;

b - derivatives of 1,2 diacyl-Sn-glycero-3-phosphate;

R - acyl, alkyl, alkenyl ether derivatives of glycerol, diols and aminodiols;

R^1 - nitrogenous bases, amino acids, myoinositol, glycerin, etc .;

R_1 and R_2 are saturated or unsaturated hydrocarbon residues of fatty acids;

R^+ - nitrogenous bases (ethanolamine, diethanolamine, trimethylethanolamine), amino acids (serine), the remainder of the polyol (glycerol, inositol).

Vegetable oils mainly contain glycerophosphatides, which in turn are divided into: nitrogen-containing bases (acids) and polyol-containing. The former include phosphatidylserine, phosphatidyl-N-methylethanolamine, phosphatidyl-N, N-dimethylethanolamine and phosphatidylcholine, and the second - the rest [10,11].

Plant phospholipids are highly soluble in aliphatic and aromatic hydrocarbons and their halogen derivatives. The presence of nonpolar (hydrophobic) and polar (hydrophobic) sites in phospholipid determines their behavior in aqueous solutions [12].

It is known that phospholipids isolated from vegetable oils are capable of changing phase and energy interactions on the interfaces between the polar and nonpolar phases. Phospholipids are organic compounds containing hydrocarbon radicals in the molecule, one or more polar (active) groups that are present in surface-active substances (surfactants). Moreover, the surface activity of phospholipids in nonpolar solvents appears brightly at the interface between them and water. This feature of phospholipid surfactants allows us to attribute them to micellar solutions forming in oils. Therefore, a phospholipid surfactant in a non-polar solvent can be indirectly characterized by the ratio of the hydrocarbon (hydrophobic) and active (hydrophilic) parts of the molecules — hydrophilic-lipophilic balance (HLB), which is calculated by the following formula[13]:

$$HLB = \sum N_{hydroph} - nN_{CH_2} + 7;$$

where: $\sum N_{hydroph}$ – the sum of the group numbers of hydrophilic groups;

n – the number of groups CH_2 in the molecule or the number of hydrocarbon atoms in the hydrophobic group;

N_{CH_2} – group number for CH_2.

This formula can be described by the following equation:

$$HLB - 7 = 0{,}36\ln\left(C_w/C_o\right);$$

where: C_w and C_o – the equilibrium concentration at which surfactants dissolve in water and oil, respectively.

According to published data [14, 15], of all plant phospholipids, phosphatidylcholines have the highest surface activity and vice versa, phosphatidic acids have the least surface activity.

Therefore, the hydratability of phospholipids from vegetable oils is primarily due to the surface activity of their molecules at the interface with water.

Despite the «mild» mode of phospholipid isolation from vegetable oils by hydration, undesired (toxic, carcinogenic, etc.) substances that do not allow the use of surfactants for food purposes also pass into the composition of the resulting product. So, phospholipids isolated from cottonseed (press or extraction) oils contain toxic gossypol, chlorophyll and their derivatives, which gives grounds for their use for technical purposes [16-18].

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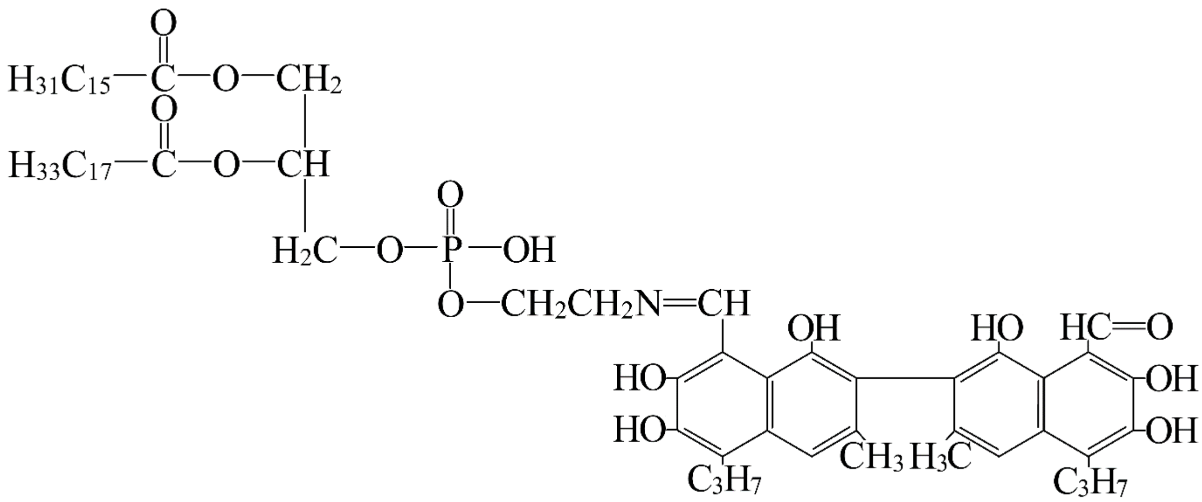
Gossypol and its derivatives have high reactivity and quickly interact with phospholipids, forming various surfactants [19, 20].

Gossyphosphatidylethanolamines are formed here in the form of monophosphatide (a) and phosphatide (b) complexes (Pic. 2.), Which have toxic properties.

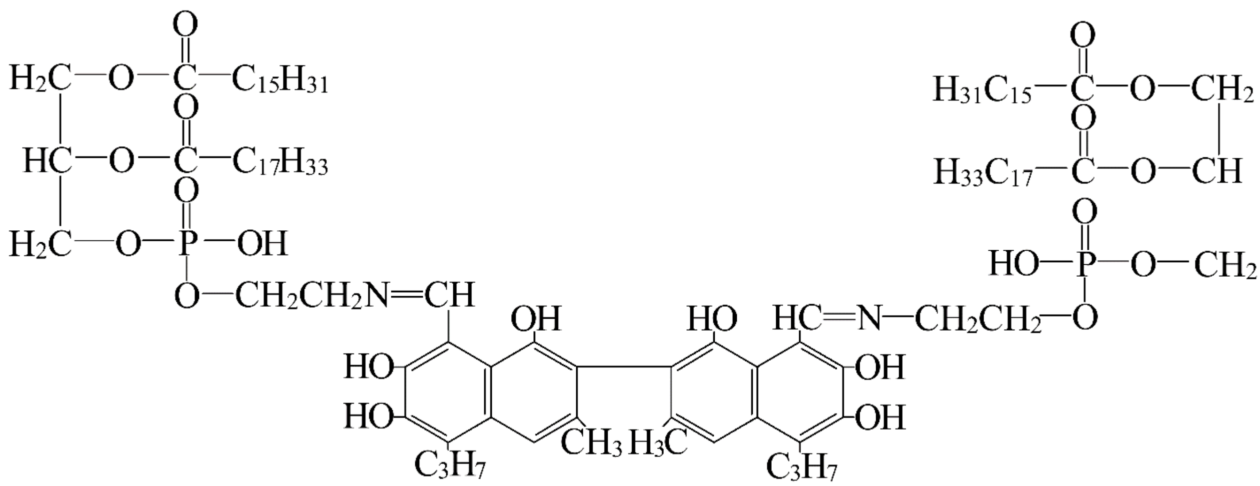
Moreover, monosubstitutedgossyphospholipids (a), in which a free aldehyde group is stored, can further interact with phospholipids. The resulting gossyphospholipids are subdivided into hydrolyzable (acids and alkalis) and non-hydrolyzable, which are readily soluble in warm oil, gasoline miscells, ethyl ether and halogenated hydrocarbons, but not soluble in acetone.

III. RESULTS AND DISCUSSION.

Cotton oils of hydratable gossifosfatidov contain up to 3.1%, free fatty acids up to 7.5%, ash up to 3.2%, nitrogen up to 1.2%, carbohydrates up to 4.1% and unsaponifiable lipids up to 4.9%. At the same time, the content of non-hydratable phospholipids in cottonseed oil ranges from 0.2 to 0.5% by weight of the oil.



a)



b)

Pic. 2. The structure of gossyphosphatidylethanolamines in the form of monophosphatide (*a*) and phosphatide (*b*) complexes

We, using GLC, studied the fatty acid composition of hydratable phospholipids of cotton oils obtained by pressing and extraction.

In the table 1 fatty acid composition of hydratable phospholipids of cotton oils obtained in various ways.

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Table 1
Fatty acid composition of cotton phospholipids

Hydratablephospholipids	Fatty acid content, %				
	$C_{16:0}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$
Cottonseed oils:					
press	22,1-24,8	3,1-3,3	17,1-17,3	55,4-57,9	0,1-0,5
extraction	23,2-25,3	3,4-3,7	17,4-17,7	55,8-58,3	0,2-0,7

As can be seen from the table. 1, the content of saturated fatty acids in hydratable phospholipids of cottonseed oil ranges from 25.5 to 28.1%, and unsaturated from 72.6 to 75.3%. This suggests that cotton oil phospholipids as well as triacylglycerides at a low temperature (below 7 ° C) have a buttery appearance.

A distinctive feature of hydrated phospholipids of cotton oils from non-hydrated oils is the presence of choline-containing compounds in them, which limit their surface-active properties. In technical phospholipids, unlike food ones, they contain more choline-containing compounds, which give them enhanced emulsifying properties. Therefore, the demand for the first is great, especially in the oil and gas industry.

Today, analysis of consumer indicators for technical phospholipids shows that they are several times more than for food. This is due to the scale and areas of widespread use of technical phospholipids as surfactants in various sectors of the economy. So, for example, in the oil and gas industry alone, technical emulsifiers (lecithin) annually require more than 10.0 thousand tons.

IV. CONCLUSION

Thus, studies of technical phospholipid surfactants obtained from cottonseed oils showed that they contain gossypol, chlorophyll and their derivatives, which have toxic properties and therefore are rational for use in non-food objects. The formed gossyphosphatides have various complex species and are difficult to separate from phospholipids. Technical phospholipids, unlike food ones, contain more saturated fatty acids and therefore, often have a buttery structure.

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