

## SOME RESULTS OF THE STUDY OF LIPIDS AND FATTY ACIDS OF ALGAE FROM THE CASPIAN SEA

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**Abstract:** by means of a method of infra-red spectroscopy quality, quantity and a structure of the difficult fatty acids which are a part lipids of four versions of red seaweeds and two versions of green seaweeds growing in Caspian sea have been established. Have besides established that under the influence of valence fluctuations carbonyl and hydroxyl groups, acids in a solution contain in a kind acetylated macromolecules. The primary increase in quantity of connections of a part acids reduces frequency of valence fluctuations carbonyl groups, and it extends according to the acids which are not keeping primary connection. The received results allow to explain interrelation between a structure and biological activity of acids.

**Keywords:** infra-red spectroscopy, Caspian sea, difficult fatty acids, red and green seaweeds, the effect of valence vibrations of carbonyl and hydroxyl groups.

## НЕКОТОРЫЕ РЕЗУЛЬТАТЫ ИССЛЕДОВАНИЯ ЛИПИДОВ И ЖИРНЫХ КИСЛОТ ВОДОРОСЛЕЙ КАСПИЙСКОГО МОРЯ

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**Аннотация:** с помощью метода инфракрасной спектроскопии было установлено качество, количество и строение сложных жирных кислот, входящих в состав липидов четырех разновидностей красных водорослей и двух разновидностей зеленых водорослей, произрастающих в Каспийском море. Кроме этого установили, что под воздействием валентных колебаний карбонильных и гидроксильных групп, кислоты в растворе содержатся в виде ацетилированных макромолекул. Первичное увеличение количества соединений, входящих в состав кислот, снижает частоту валентных колебаний карбонильных групп и оно расширяется в соответствии с кислотами, не сохраняющими первичное соединение. Полученные результаты позволяют объяснить взаимосвязь между строением и биологической активностью кислот.

**Ключевые слова:** инфракрасная спектроскопия, Каспийское море, сложные жирные кислоты, красные и зеленые водоросли, воздействие валентных колебаний карбонильных и гидроксильных групп.

Currently, more than 200 fatty acids are known, differing in the degree and character of carbon chain branching, the number and position of double bonds, the nature and number of functional groups, and the length of the carbon chain [6-8]. Despite the significant successes achieved in the synthesis and study of properties and structure of fatty acids, interest in these biologically important compounds is increasing.

Along with other physicochemical methods, infrared (IR) spectroscopy is widely used to identify the composition of complex mixtures of natural compounds, including mixtures of fatty acids [1-3, 5].

In the Caspian Sea there are 187 species of algae - macrophytes [4], the fatty acid composition of lipids of which has not been studied so far. Biological activity of algal lipids is determined by their fatty acid composition and structure.

In this connection, the purpose of the present work is to determine the structure of the carbon skeleton of fatty acids of lipids of 4 red (*Lourensia sacpica* A. Zin et Zaberzh - I, *Polysiphonia caspica* Kütz - II, *Polysiphonia deaudata* (Dillw) Kütz - III, *Polysiphonia violaceae* (Roth) Grev - IV) and 2 green (*Cladophora vagabunda* (L.) Hoek - V, *Enteromorpha linza* (L.) I.Ag - VI) algae of the Caspian Sea by IR spectroscopy.

Absorption of mixtures of saturated and unsaturated higher fatty acids of water-roses lipids (I-VI) consists of absorption of their double bonds ( $\text{-NS=CH-}$ ,  $\text{C=O}$ ) and saturated part ( $\text{-C-H}$ ,  $\text{-C-}$ ,  $\text{-C-C-}$ ,  $\text{-O-H}$ ,  $\text{-C-O-}$ ) of the molecule. Therefore, the region from 4000 to 650  $\text{cm}^{-1}$  (2.5-15.3  $\mu\text{m}$ ), which covers the absorption due to fluctuations of all characteristic groups and bonds of fatty acids, attracted our attention.

The absorption band corresponding to the valence vibrations of the  $\text{C=O}$  bond of fatty acids of algal lipids (I) was detected in the spectrum without difficulty - 1900-1580  $\text{cm}^{-1}$  (Fig.1). However, the interactions of valence vibrations of  $\text{C=O}$  and  $\text{O-H}$  bonds (3300-2500  $\text{cm}^{-1}$ ) lead to the appearance of 2 new bands at 1440-1395 and 1320-1210  $\text{cm}^{-1}$ . In the IR spectrum of lipids of algae (I), the bands of valence vibrations of the  $\text{C=O}$  bond with  $\text{-O-H}$  are dominant. Often this band is very wide, which is probably due to a large variation in the energy of such vibrations due to the large number of different variants of the formation of hydrogen bonds between fatty acid molecules.

It is known that intermolecular hydrogen bonds are destroyed as the solution is diluted [4]. However, by registering the spectrum of fatty acid mixtures of algal lipids (I-VI) at different concentrations it was not possible to obtain information on the breakage of hydrogen bonds. In all cases, dimers of saturated and unsaturated fatty acids are very strong and exist only as dimers.

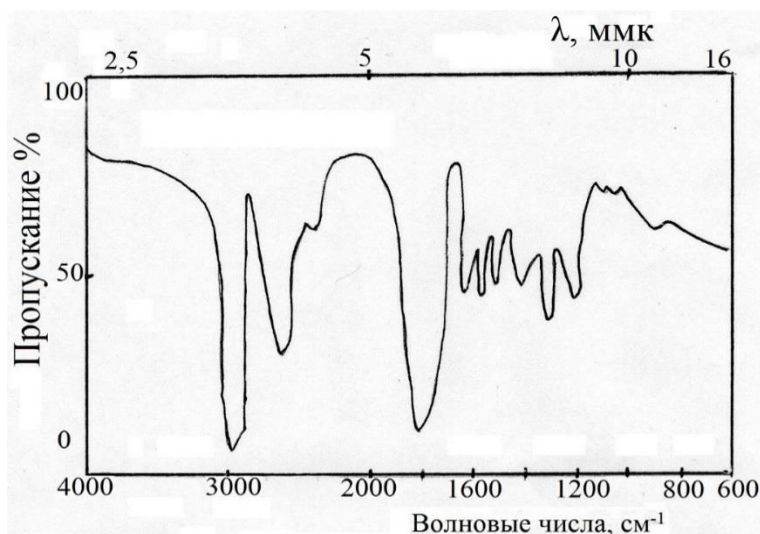


Fig.1. IR spectra of fatty lipid mixtures of the alga *Lourensia caspica* (in liquid film).

It was noted that the frequency of  $\text{C=O}$  vibrations decreases by about 30  $\text{cm}^{-1}$  at conjugation with one bond  $\text{-C=C-}$  by 15  $\text{cm}^{-1}$  at conjugation with one bond  $\text{-C=C-}$  and not yet 15  $\text{cm}^{-1}$  at conjugation with 2 double bonds. Further conjugations almost do not lead to frequency shifts. In these cases, the intensity of the  $\text{C=O}$  vibrational band increases and it expands compared to the bands of fatty acids in which there is no conjugation.

The absorption band corresponding to the carboxyl group appears at 1715-1700  $\text{cm}^{-1}$ .

Although IR spectra are used to identify *trans*-double bonds, the absorption bands at 968  $\text{cm}^{-1}$ , caused by out-of-plane deformation vibrations of hydrogen atoms at the double bond, do not appear well (Fig.1)

This is probably explained by the local symmetry of the double bond environment.

The studied mixtures of higher fatty acids of lipids also show intense absorption in the region 1420-1200  $\text{cm}^{-1}$  caused by deformation vibrations of  $\text{-C-O-}$  bonds.

In the region 1625-1585  $\text{cm}^{-1}$  several bands appear, sometimes merging into one broad band (Fig.2), caused by conjugation of 2 and more  $\text{-C=C-}$  bonds. The intensity of absorption bands corresponding to valence vibrations of conjugated  $\text{-C=C-}$  bonds is usually small.

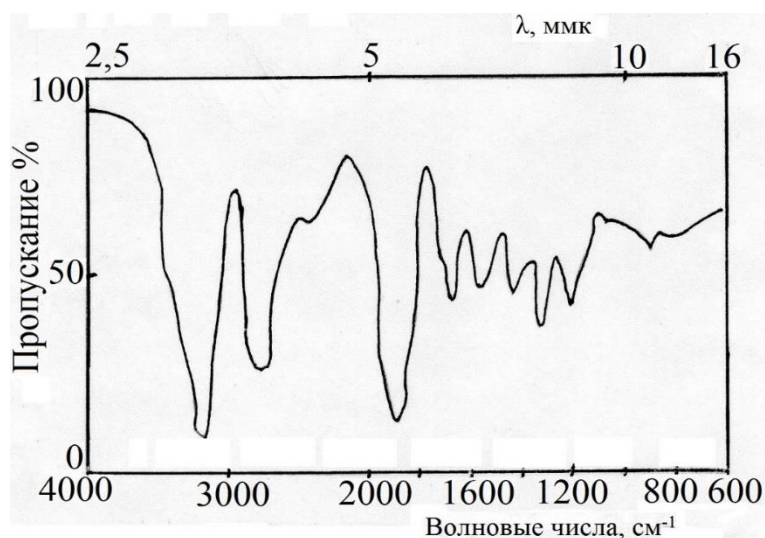


Fig.2. IR spectra of fatty acid mixtures of lipids of *Polysiphonia caspica* (in liquid film).

Absorption in the region 3000-2800  $\text{cm}^{-1}$  is caused by valence vibrations of methane groups ( $=\text{C-H}$ ), which is overlapped by intense absorption bands of  $-\text{C}-$  and  $-\text{C-H}$  groups and is practically not used for identification.

The expected merging and increase in absorption of valence vibrations of  $-\text{C}-$  and  $-\text{C-H}$  groups in the region 2940-2850  $\text{cm}^{-1}$  are observed, which corresponds to the higher content of these groups in the lipid composition of the studied algae (I-VI).

The IR spectra of fatty acids of lipids of algae III, VI are similar to the spectra of fatty acids of lipids of algae I, II.

Based on the obtained data of IR spectra, it was possible to determine the type of carbon skeleton of fatty acids included in algal lipids (I-VI) and the ratio of the carboxyl group of fatty acids to saturated and unsaturated groups located in the linear unbranched chain. These data are of great interest for establishing the relationship between the pharmacological activity of algal lipids and their fatty acid composition and structure, which makes it possible to create highly effective and rational dosage forms based on them.

IR spectra of higher fatty acids of algal lipids (I-VI) of the Caspian Sea were obtained on a spectrophotometer of the company 'Carl Zeiss Jena' in a wide frequency range of 4000-650  $\text{cm}^{-1}$  on the fourth slit programme at a sweep speed of 12  $\text{mm}/100 \text{ cm}^{-1}$  and a paper pulling speed of 150  $\text{cm}^{-1}/\text{min}$ .

The objects for the study were prepared as thin capillary film on potassium bromide windows. The film thickness of the samples was selected so that the maximum of the absorption bands was between 20 and 80% transmittance.

#### Conclusion.

1. As a result of interaction of valence vibrations  $\text{C}=\text{O}$  and  $\text{O-H}$ , fatty acids of lipids form associated macromolecules.
2. With an increase in the number of  $\text{C}=\text{C}$  bonds, the frequency of valence vibrations of the carbonyl group decreases and the intensity of the band increases, and this band broadens compared to the bands of fatty acids lacking a double bond.
3. The results obtained on the composition and structure of fatty acids of algal lipids can allow to create highly effective and rational drugs on their basis.

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