# COMPOSITION OF SURFACE LIPIDS OF LEAVES OF CONIFEROUS UNDER INFLUENCE OF INDUSTRIAL CONTAMINANTS

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**Abstract**.
Surface lipids (SL) of some types of Coniferous have esters and free fatty acids in essential quantities. Carbonyl absorbtion area in UR-spectra of SL of investigated plants was represented by two bands 1705-1710 $sm^{-1}$ (I) and 1725-1740 $sm^{-1}$ (II) that is relevant to absorbtion of carbonyl groups of esters and free fatty acids. The band II is more intensive in young leaves and its intensity changes with age. We found that fatty acid composition of SL of Pinus sylvestris had such changes with age: quantity of odd-carbon fatty acids decreased but $C_{22:0}$ – behenic acid – increased. SL of leaves of Pinus sylvestris grown on the territory of a chemical plant with significant atmospheric contamination of the same age had another UR-spectra then control plants. Especially significant shift was found for the youngest leaves. As free fatty acids and bound fatty acids are the only carbonyl-containing components of SL, it is reasonable to suggest, that biosynthesis of bound (in esters) and free fatty acids both are sensitive to atmospheric contamination and this sensitivity is different. One of the aspects of these investigations may be elaboration of methods of spectral control of SL of plants during the processes of phytoremediation.

**Introduction**
Our previous investigations [1-3] showed that SL of some types of Coniferous had esters and hydrocarbons as the main classes and free fatty acids with odd numbers of carbon chain in essential quantities. We found that fatty acid composition of SL of Pinus sylvestris changes with age: quantity of odd-carbon fatty acids decreased but $C_{22:0}$ – behenic acid – increased. Two elongation-decarboxylation (ED) systems in surface tissues of plants work independently: EDI – lead to hydrocarbons, alcohols, free fatty acids with odd-carbon chain (free components of SL) and EDII – lead to esters where only pair-carbon fatty acids occurred (bound components of SL). The conclusion was made: EDI-pathway is more sensitive than EDII one but they both make impact to adaptation mechanisms of plants. In this work we present data received by detailed spectral (UR) analysis of SL from leaves of Coniferous of first year old and content of their main components.

**Materials and methods**
Surface lipids were extracted from leaves of Coniferous (Picea abies L. Karst., Picea pungens Engelm., Pinus pallasiana D. Don., Pinus sylvestris L., Pinus nigra Arnold., Larix sibirica Ledeb.,) grown on control area – Botanic University Garden and on industrial region (Chemical Plant region). Procedures of extraction and investigation of surface lipids are described in [1].

**Results**

The main hydrocarbons of SL of Coniferous are $C_{26}$ - $C_{29}$ (table 1).

Table 1: Main hydrocarbons in SL of Coniferous of 1 year old, %

| Quantity of carbon | Type of plant | | | | | |
|---|---|---|---|---|---|---|
| | Picea pungens | Picea abies | Pinus pallasiana. | Pinus sylvestris. | Pinus nigra | Larix sibirica |
| $C_{26}$ | 0,61± 0,02 | 0,33± 0,01 | 7,62± 0,08 | 4,18± 0,04 | 10,19± 0,31 | 16,45± 0,33 |
| $C_{27}$ | 0,30± 0,01 | 3,20± 0,05 | 3,96± 0,06 | 3,95± 0,06 | 9,50± 0,21 | 10,20± 0,28 |
| $C_{28}$ | 2,62± 0,05 | 12,79± 0,31 | 1,30± 0,03 | 10,25± 0,11 | 8,47± 0,17 | 14,38± 0,28 |
| $C_{29}$ | 88,68± 0,89 | 75,59± 0,76 | 34,55± 0,38 | 47,76± 0,49 | 18,87± 0,37 | 19,24± 0,29 |

If hydrocarbons are represented by odd-numbered carbon substances, main fatty acids are pair-numbered (Table 2).

Table 2: Main fatty acids in SL of leaves of Coniferous of 1 year old, %

| | Type of plant | | | | | |
|---|---|---|---|---|---|---|
| Fatty acid | Picea pungens | Picea abies | Pinus pallasiana | Pinus sylvestris | Pinus nigra | Larix sibirica |
| $C_{15}$ | 14,52± 0,15 | 12,09± 0,12 | 12,74± 0,25 | 10,77± 0,11 | 10,75± 0,11 | 0,06± 0,01 |
| $C_{16}$ | 6,99± 0,14 | 2,62± 0,08 | 4,39± 0,04 | 6,32± 0,13 | 3,52± 0,03 | 2,09± 0,02 |
| $C_{17}$ | 12,32± 0,24 | 10,73± 0,21 | 15,72± 0,15 | 8,43± 0,09 | 12,04± 0,12 | сл. |
| $C_{18}$ | - | 4,91± 0,05 | 2,08± 0,02 | 1,07± 0,01 | 1,44± 0,01 | 1,55± 0,02 |
| $C_{19}$ | 38,40± 0,40 | 56,33± 0,56 | 15,21± 0,17 | 14,97± 0,15 | 12,09± 0,24 | 0,50± 0,01 |
| $C_{20}$ | - | 3,02± 0,03 | 5,10± 0,10 | 1,81± 0,01 | - | 2,13± 0,02 |
| $C_{22}$ | 6,93± 0,07 | 4,25± 0,05 | 28,72± 0,29 | 36,71± 0,37 | 47,79± 0,94 | 90,30± 0,91 |
| $C_{24}$ | 3,89± 0,04 | 4,15± 0,08 | сл. | 6,75± 0,07 | 2,78± 0,03 | 1,04± 0,01 |

Carbonyl absorbtion area in UR-spectra of SL of investigated plants was represented by two bands 1705-1710 $sm^{-1}$ (I) and 1725-1740 $sm^{-1}$ (II) that is relevant to absorbtion of carbonyl groups of esters and free fatty acids. (Table 3).

Table 3: Characteristics of UR-spectra of SL of Coniferous of 1 year old.

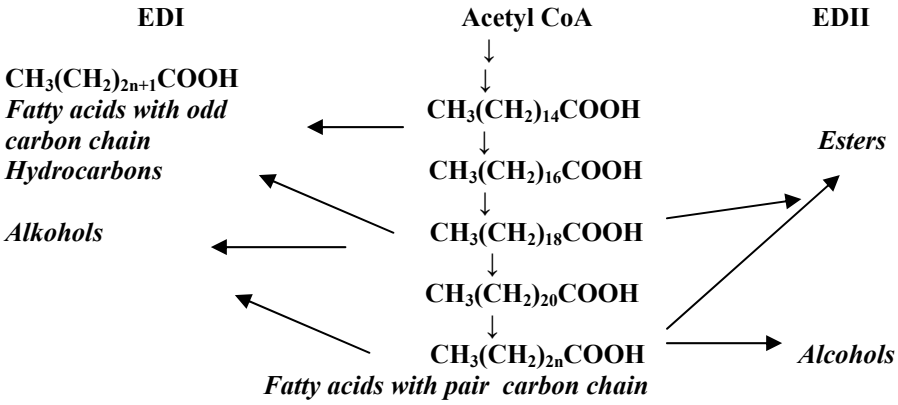
| Type of plant | UR-spectra of carbonyl groop | |
|---|---|---|
| | max, $cm^{-1}$ | Ratio of intensity |
| Picea pungens | 1705<br>1725 | 1:2,5 |
| Picea abies | 1705<br>1725 | 1:5,6 |
| Pinus pallasiana | 1710<br>1735 | 1:2,5 |
| Pinus nigra | 1705<br>1735 | 1:2,1 |
| Pinus sylvestris | 1705<br>1735 | 1:2,5 |
| Larix sibirica | 1710<br>1725 | 1:1 |

The second band is more intensive in young leaves and increased with age. In SL of fir-tree we found significant quantities of $C_{19}$ – fatty acid, that may exist in free state and gives an unusial absorbtion in UR-spectra of this specie. We found that fatty acid composition of SL of Pinus sylvestris changes with age too: quantity of odd-carbon fatty acids decreased but $C_{22:0}$ – behenic acid – increased.

SL of leaves of Pinus sylvestris grown on the territory of a chemical plant with significant atmosphere contamination of the same age had another UR-spectra than control plants. Especially significant shift was found for the youngest leaves – 1-st year old.

**Discussion**

According to [4] two elongation-decarboxylation (ED) systems in surface tissues of plants work independently:




Scheme of elongation-decarboxylation systems in surface tissues of plants

EDI – lead to hydrocarbons, alcohols, free fatty acids with odd-carbon chain (free components of SL) and EDII – lead to esters where only pair-carbon fatty acids occurred (bound components of SL) as it is shown on the scheme. Thus, changing of ratio of carbonyl substances in SL with age is a result of intensification of the EDII biosynthetic pathway in normal condition of growth.

As free fatty acids and bound fatty acids are the only carbonyl-containing components of SL, it is reasonable to suggest, that EDI and EDII systems are sensitive to atmosphere contamination and this sensitivity is different. Studying only spectral characteristics of SL it is impossible to make final conclusion but it is interesting to suppose that EDI – system is more mobile then EDII. Recently we have obtained data about significant quantities of terpenoids in SL of coniferous plants that is a matter of following investigations and requires special concern.

**Conclusions**

Biochemical shifts that took place in plant organisms in the process of adaptation to contamination are discussed. Spectral data of surface lipids of Coniferous showed the direction of rebuilding of

surface layer molecules under contamination. Spectral investigations confirm that fact that surface lipids of plants take part in the process of adaptation to environmental factors.

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