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The differential analysis of seasonal changes of the moisture condensate macromolecular structure of the exhaled air according to laser correlation spectroscopy data

Abstract: The paper covers the investigation of the moisture condensate subfractions of the exhaled air in healthy people and influence of a season in carrying out examination for the condensate structure. It is revealed that the season is not the independent factor influencing the LC-spectrum. At the same time smoking leads to occurrence of the sufficiently expressed spectral distinctions depending on the season of carrying out examination.

Keywords: moisture condensate of the exhaled air, laser correlation spectroscopy, seasonal changes.

Introduction. As it is known, the internal organization of cells of the broncho-alveolar tracts is maintained by the active processes directed at limitation, prevention or elimination of the shifts caused by various influences from the surroundings and internal environment [1]. Each of these processes (destructive, proliferative, metabolic, etc.) is accompanied by the passage of biosubstrates various in size into the intercellular space, which get in the moisture condensate of the exhaled air (MCEA) in passage of the air from the lungs. In destructive processes the passage of low-molecular biosubstrates (1 – 100 nanometers) is observed, in active metabolic processes – medium-molecular (101 – 1000 nanometers), in active proliferation of cells – high-molecular (> 1000 nanometers) biological particles and molecules of the albuminous nature [2].

It is established that various disperse structures of MCEA correspond to various pathological conditions of the respiratory system [3 – 5]. There was also studied the dependence of changes of the tissue homeostasis of the lungs and respiratory tracts in various kinds of cyclic and acyclic physical activities and adaptation to them [6 – 7].

The purpose of the work is investigation of the MCEA subfractions in healthy people and seasonal changes of its structure.

Materials and methods. In total 3 groups of people not having verified diseases were examined – young men and girls aged 18-20. The group under examination made 220 persons in autumn, 168 – in winter and 134 – in spring. The MCEA samples were obtained for each examined, which were processed by using a method of laser correlation spectroscopy (LCS) that has allowed to receive functions of distribution of the light-scattering particles, presented in the form of histograms, by their size [8].

Results. Fig. 1 presents the comparative characteristic of the LC-spectra data of MCEA for autumn and winter seasons.

According to both seasons the basic contribution to light-scattering is made by particles of the low-molecular range. Seasonal distinctions of their contributions are insignificant; the greatest distinction makes 4% for particles of 2 nanometers in size.

There were similarly made comparisons of MCEA LC-spectra data for seasons autumn – spring (Fig. 2) and winter – spring (Fig. 3).

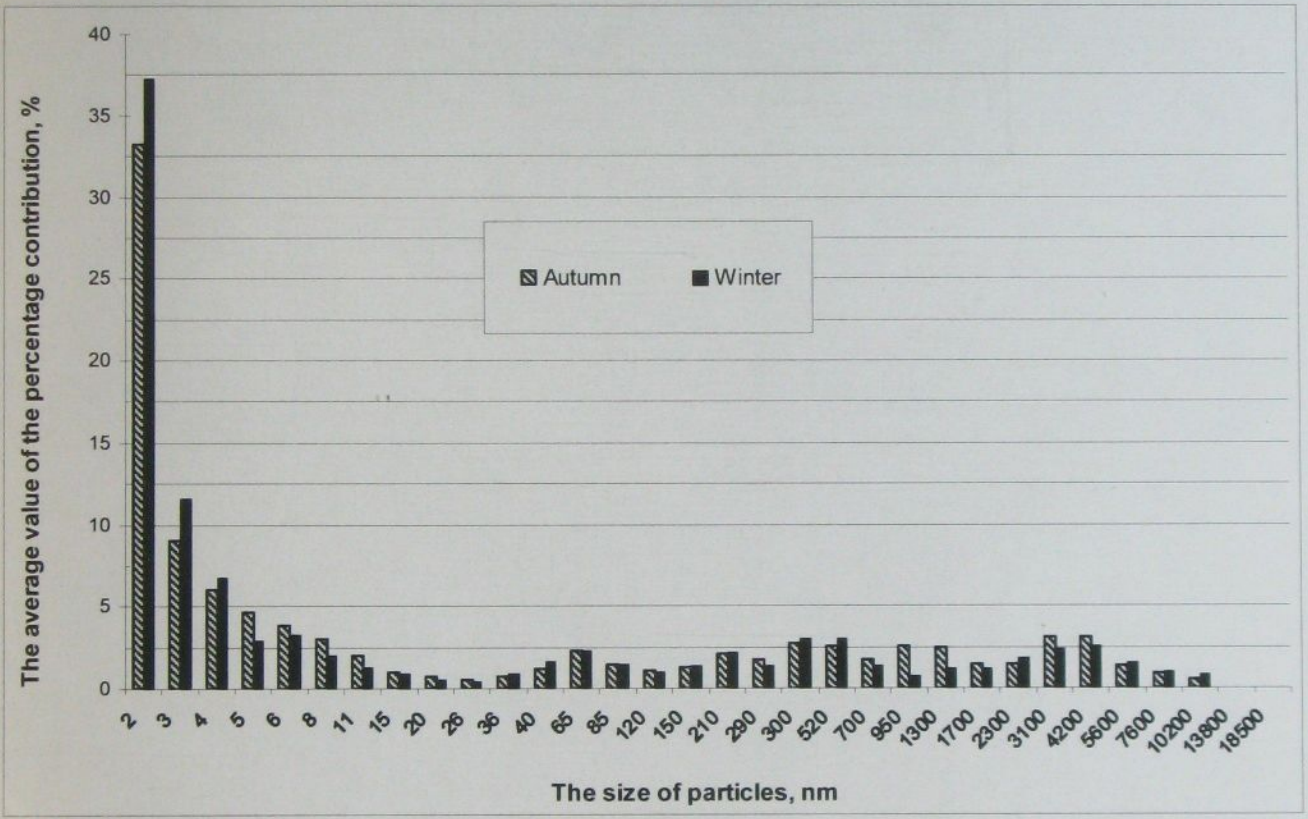

Figure 1. Comparison of MCEA LC-spectra by seasons autumn – winter

Figure 2. Comparison of MCEA LC-spectra by seasons autumn – spring

Figure 3. Comparison of MCEA LC-spectra by seasons winter – spring

Both comparisons have shown that the basic spectral distinctions were also manifested in the low-molecular range (1 – 26 nanometers). The highest peaks of MCEA spectra for autumn and winter seasons are made by particles of 2 nanometers, for spring – by particles of 3 nanometers. The contribution of particles of 2 nanometers in size has exceeded the spring contribution almost 2.5 times in the autumn. However, the spring contribution of almost all particles in the range of 3 – 26 nanometers exceeds autumn one up to 2.5 – 3 times. One more seasonal difference is absence of contributions of the MCEA particles over 5600 nanometers during the spring period.

The percentage contribution of particles by their sizes in all three seasons is presented in Tabl. 1.

Table 1. Distribution of MCEA macromolecular fractions by their contribution to light-scattering (in %)

Size of participles	Seasons		
	Autumn	Winter	Spring
Low-molecular range	69.8 %	73.4 %	73.7 %
Medium-molecular range	15.8 %	14.0 %	19.3 %
High-molecular range	14.4 %	12.6 %	7.0 %
The first maximum– max_1	33.3% –2 nm	37.2% –2 nm	20.5% –3 nm
The second maximum– max_2	9.0% –3 nm	11.6% –3nm	12.9% – 2 nm
The third maximum– max_3	6.0% –4 nm	6.8% – 4 nm	6.2% – 6 nm

The method of discriminant analysis was used to assess the importance of distinctions between average MCEA spectra by seasons. With its help each examined was calculated two quantitative differentiating estimations (Root1 and Root2), allowing to position the condition of his respiratory system on the plane. For a visual assessment of distinctions between seasons the diagram of dispersion of individual values of LC-spectra was built for the examined in different groups (Fig. 4). Contributions to light-scattering subfractions of the MCEA particles for the examined in three seasons have a big area of crossing. Thus, seasonal prevalence of examination is not the independent essentially influencing factor in assessment of the respiratory system condition of healthy persons by the LCS method.

Having divided the examined into groups of smokers and non-smokers, we made the differential analysis of seasonal changes of the MCEA structure. The group of non-smoking people included 153 persons in carrying out autumn examinations, and 126 – in winter and 94 – in spring. The group of smokers was composed of 67 persons examined in autumn, 42 – in winter and 40 – in spring.

As it is known regular tobacco smoking often brings about inflammatory changes in all system of the respiratory organs, which have severe enough and prolonged course, with frequent complications. The previous studies [9] have shown that there are some spectral changes in MCEA depending on loading on the respiratory system, associated with smoking. However, grouping of the examined on the basis of presence of tobacco smoking only, without taking into account additional factors has not allowed to receive essential distinctions.

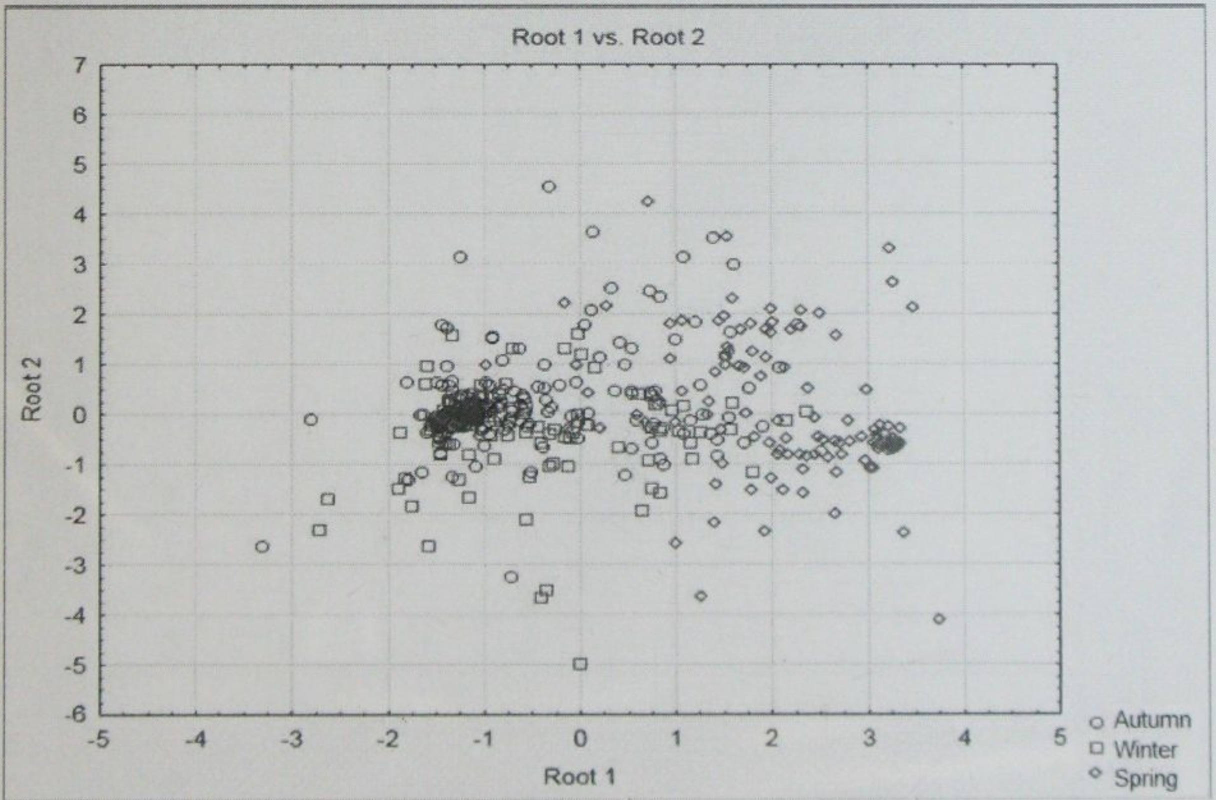

Figure 4. Diagram of LC-spectra of the MCEA values taking into account the season during examination

Examination of the group of non-smoking young men and girls has shown that spectral contributions of MCEA to light-scattering feebly depend on the season (Fig. 5). At the same time examination of the group of smoking young men and girls by seasons has revealed visible distinctions of the MCEA subfractional structure (Fig. 6 – 8).

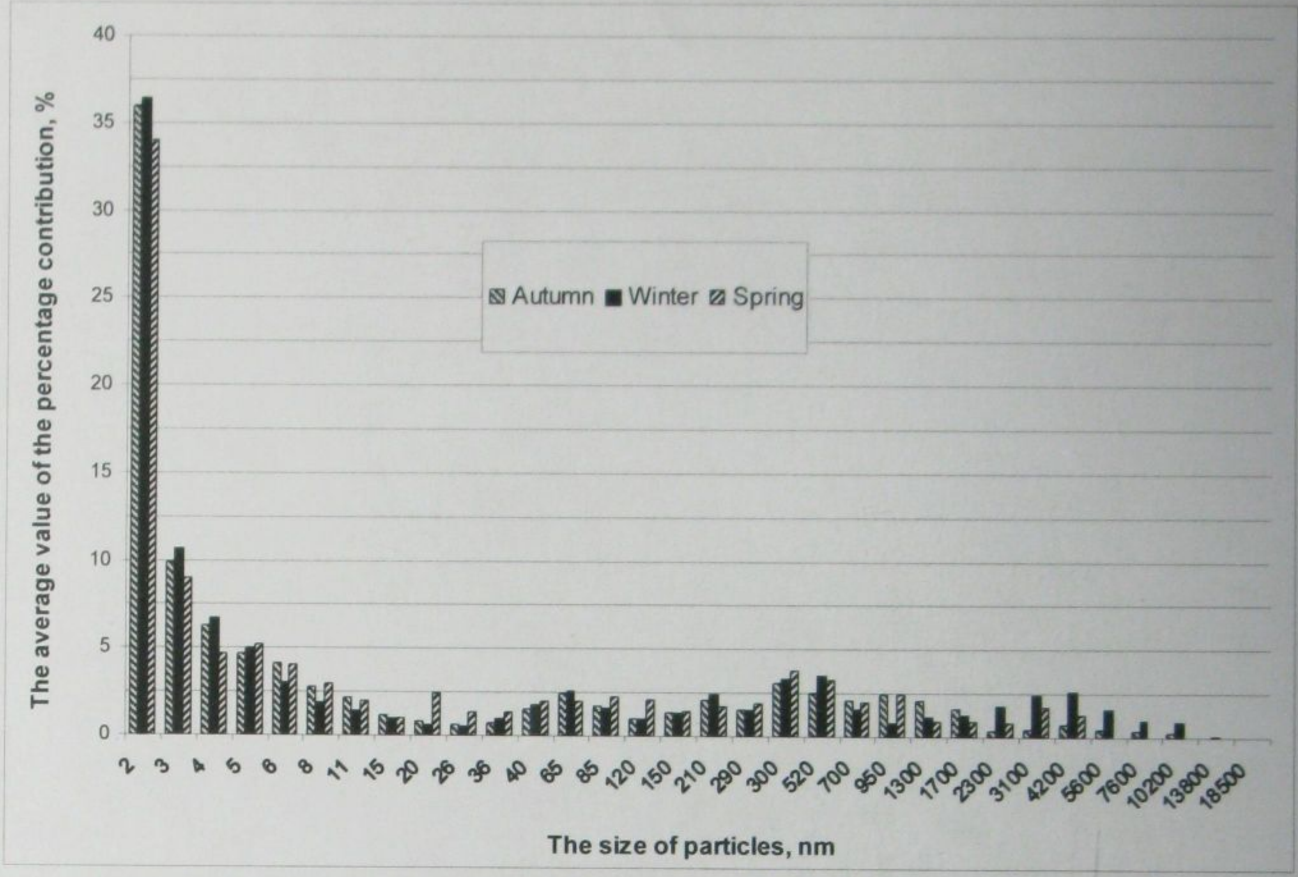

Figure 5. Seasonal comparisons of LC-spectra of MCEA of the healthy population

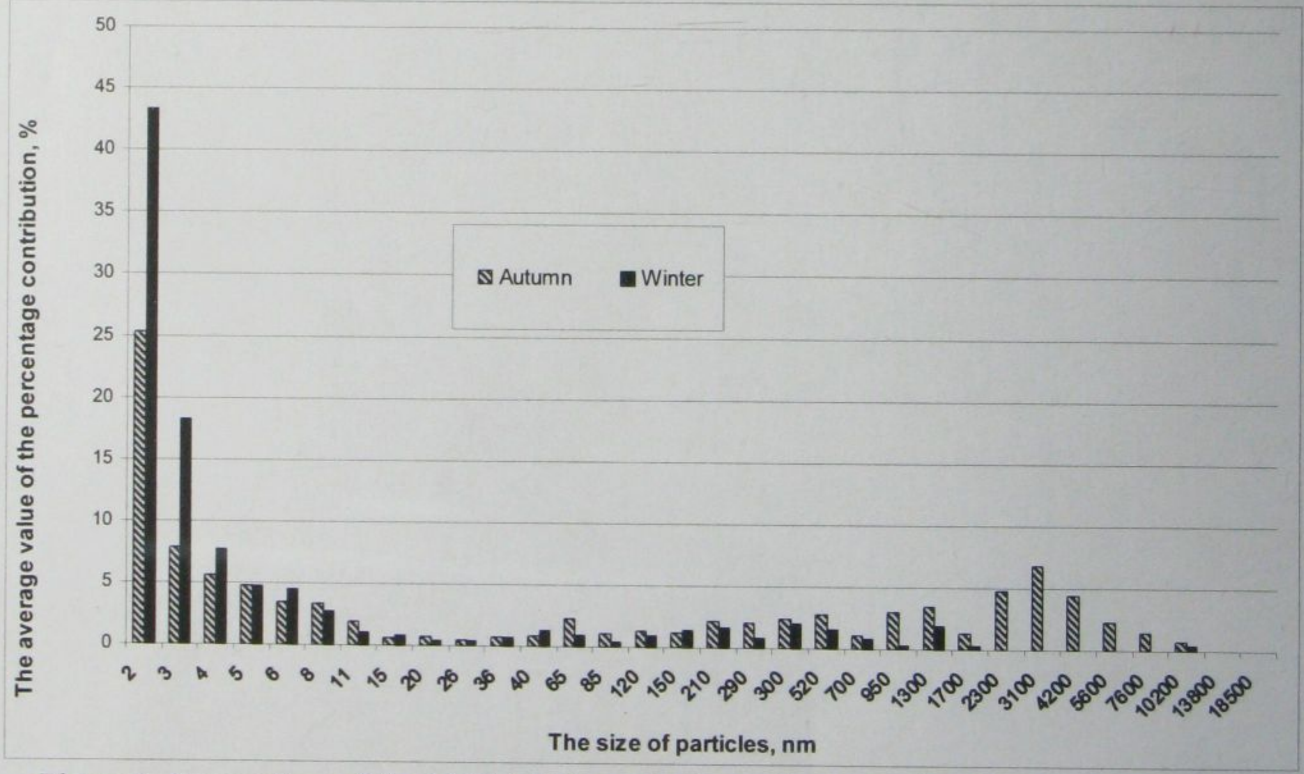

Figure 6. Comparison of the MCEA LC-spectra in smokers examined by seasons autumn – winter

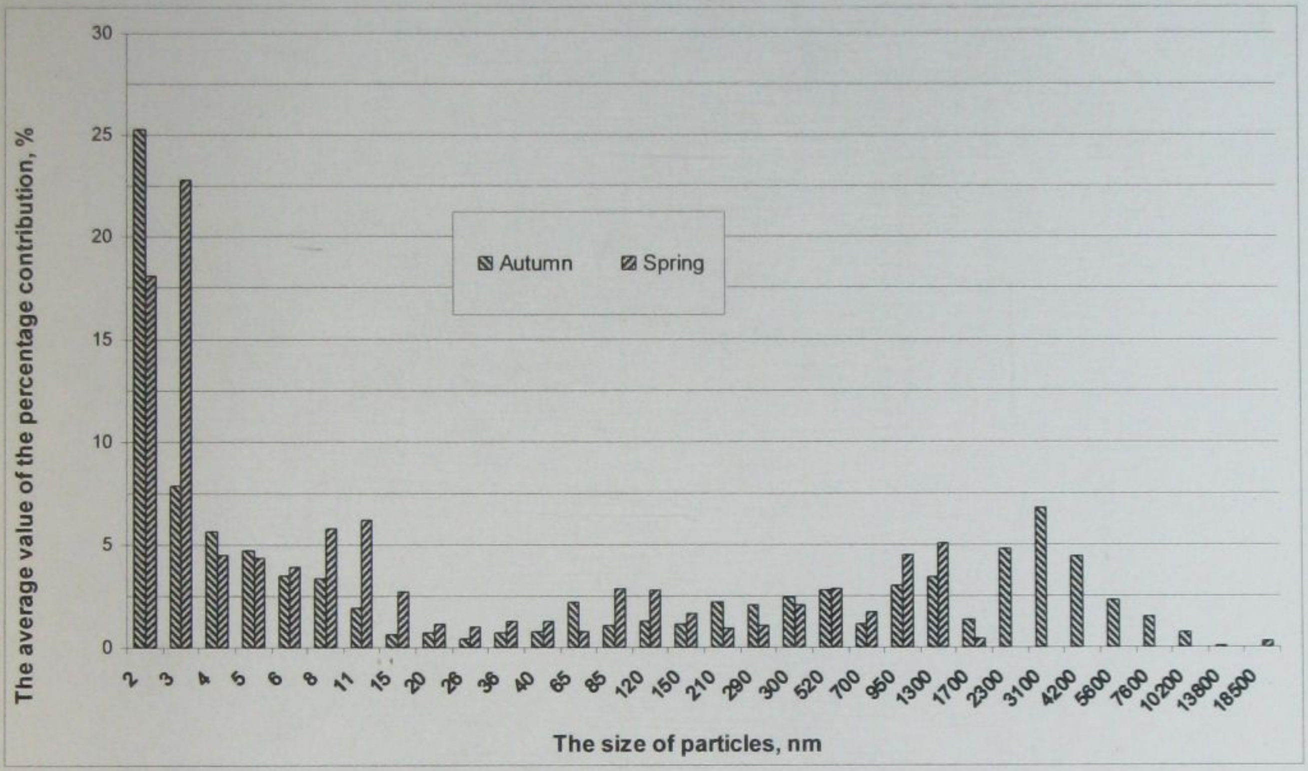

Figure 7. Comparison of the MCEA LC-spectra in smokers examined by seasons autumn – spring

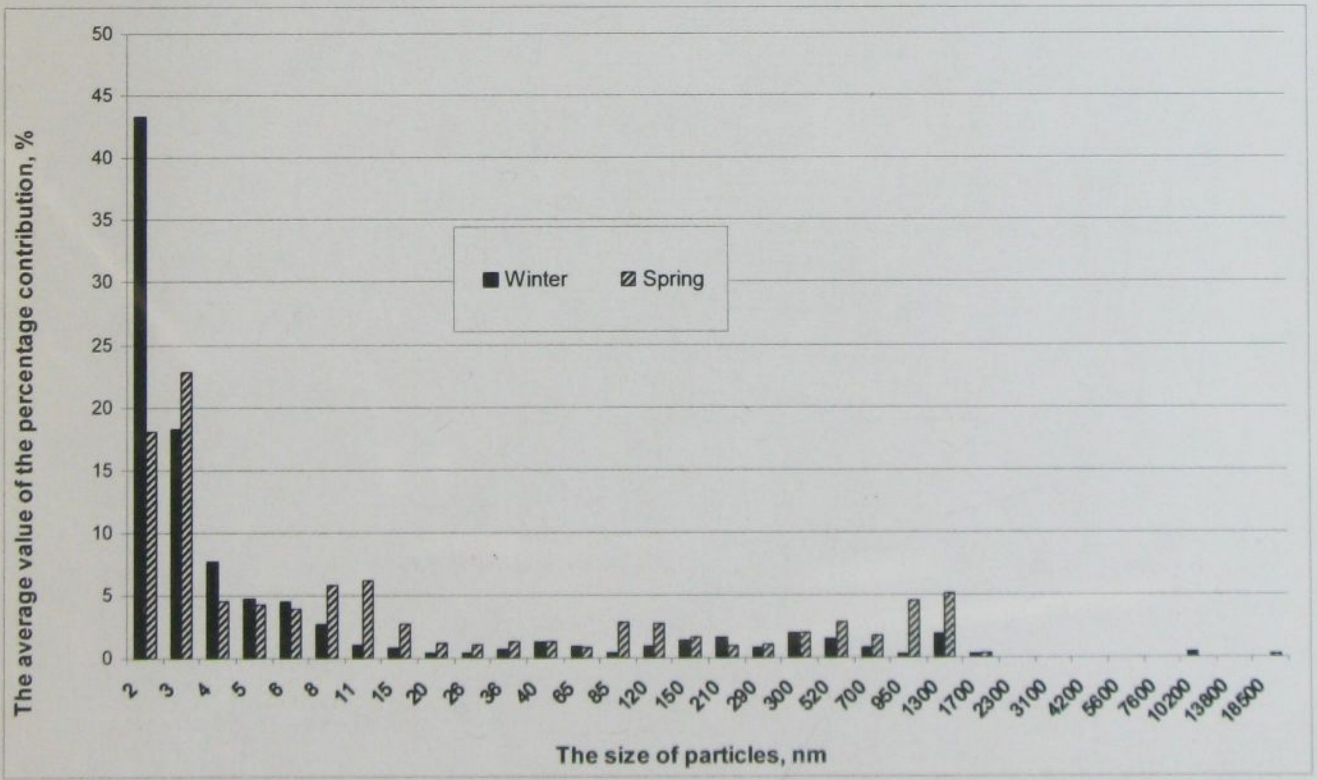

Figure 8.Comparison of the MCEA LC-spectra in smokers examined by seasons winter – spring

Relative values of the contribution of particles of the various sizes for non-smoking and smoking population are presented in the Tabl. 2. Results are evidence that it is smokers that bring the essential contribution to seasonal distinctions.

Table 2. Relative contribution of various subfractions of macromolecular particles to the MCEA LC-spectra

Ranges	Seasons					
	Autumn, %		Winter, %		Spring, %	
	Healthy	Smokers	Healthy	Smokers	Healthy	Smokers
Low-molecular	75.5	58.8	74.2	87.6	74.3	76.7
Medium-molecular	17.1	16.0	15.5	9.6	18.4	17.6
High-molecular	7.4	25.2	10.3	2.8	7.3	5.7

Values of the three first maxima for non-smoking and smoking population were distributed as follows.

Non-smoking people:

- Autumn: max_1 for 2 nanometers – 36.1 %, max_2 for 3 nanometers – 9.9 %, max_3 for 4 nanometers – 6.2 %;
- Winter: max_1 for 2 nanometers – 36.4 %, max_2 for 3 nanometers – 10.7 %, max_3 for 4 nanometers – 6.7 %;
- Spring: max_1 for 2 nanometers – 34.0 %, max_2 for 3 nanometers – 9.0 %, max_3 for 5 nanometers – 5.2 %.

Smoking population:

- Autumn: max_1 for 2 nanometers – 25.3 %, max_2 for 3 nanometers – 7.8 %, max_3 for 3100 nanometers – 6.8 %;
- Winter: max_1 for 2 nanometers – 43.4 %, max_2 for 3 nanometers – 18.3 %, max_3 for 4 nanometers – 7.7 %;
- Spring: max_1 for 3 nanometers – 22.8 %, max_2 for 2 nanometers – 18.1 %, max_3 for 11 nanometers – 6.2 %.

In smokers seasonal fluctuations of MCEA are observed in the low-molecular range (up to 20 nanometers) that corresponds to a change of intensity of the destructive processes occurring in the respiratory system. Besides, the contribution of particles over 1700 nanometers in smokers is observed only during autumn examinations, its share is 21.8 % of general value. It speaks about active proliferation of the cells, occurring in smokers in autumn.

Only LC-spectra of smokers were examined using a method of the discriminant analysis there. Contributions to light-scattering particles in the range 20 - 700 nanometers have been excluded from classifying signs, which as it is noted above, do not give seasonal distinctions. It has allowed to receive more expressed differences of the areas corresponding to three seasons (Fig. 9). Seasons "winter" and "spring" are characterized by obvious centers of grouping, results of autumn examination have more dim borders that is evidence of obvious distinction of the respiratory system conditions in smokers in comparison with non-smokers depending on the season of carrying out examination.

Conclusions. Thus, this study investigated for the first time the influence of the season of carrying out examination by fluctuations of the MCEA LC- spectra. The investigations have shown that the season is not an independent factor influencing the MCEA structure. Additional division of the examined into groups on the basis of presence of tobacco smoking has shown that non-smokers were not observed to have significant seasonal fluctuations of MCEA either. At the same time, the smokers gave such dependence, therefore in presence of this bad habit the season should be necessarily considered as the additional factor influencing a ratio of subfractions of the MCEA LC-spectra particles.

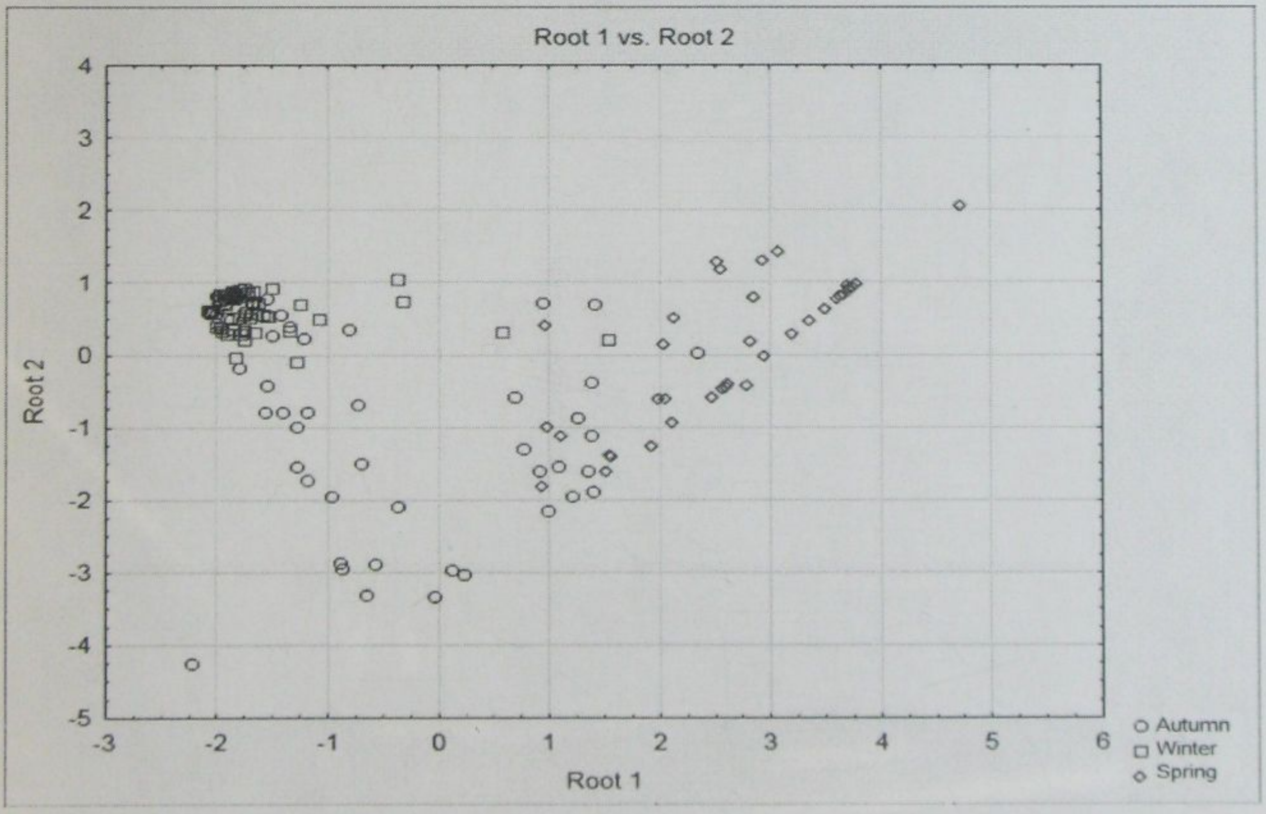

Figure 9. Diagram of dispersion of MCEA values in smokers examined by seasons

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