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Professional paper

TREE POLLEN SPECTRA AND POLLEN ALLERGY RISK IN THE OSIJEK-BARANJA COUNTY

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The forests of north-eastern Croatia, as well as various plants and trees in the parks and streets of the Osijek-Baranja County, produce large amounts of pollen during the pollen season, which can cause allergy symptoms in pollen sensitive individuals. The aim of this study was to determine the most frequent types of pollen in this area and estimate possible health risks, especially the risk of allergy. In 2009 and 2010, the staff of the Health Ecology Department of the Osijek Public Health Institute monitored tree pollen concentrations in four cities from the Osijek – Baranja County (Osijek, Našice, Đakovo and Beli Manastir) using a Burkard volumetric instrument. The results were affected by weather conditions. Windy and sunny days facilitated the transfer of pollen, whereas during rainy days, the concentration of pollen grains decreased. High pollen concentrations of *Cupressaceae/Taxaceae, Betulaceae, Salicaceae* and *Aceraceae* could be the cause for symptoms of pollen allergy.

In 2009, conifers, birch and poplar pollen were dominant at all monitoring stations with 5000 pollen grains (PG), 3188 PG and 3113 PG respectively. The highest number of pollen grains was recorded at measuring site Osijek. The variations in airborne pollen concentration between pollen seasons were recorded at all monitoring stations. The most obvious variations were recorded at measuring site Osijek. The usual pollination period lasts two to three months, which means that most pollen grains remain present from February to early June. However, the *Cupressaceae / Taxaceae* pollination periods last the longest and their pollen grains remain present until the end of summer. The risk of allergy was determined at four monitored measuring stations and the obtained data confirmed that the largest number of days with a high health risk was at the Đakovo measuring station for a species of birch.

The research information aims to help allergologists and individuals allergic to plant pollen develop preventive measures and proper treatment therapies.

KEY WORDS: Aceraceae, *air, airborne pollen,* Betulaceae, Cupressacea/Taxaceae, Salicaceae

Pollinosis is defined as the appearance of respiratory symptoms that result from the inhalation of pollen to which an individual is sensitive. Pollen is one of the main causes of allergic rhinitis and asthma (1). In northern, central and eastern Europe, early springtime allergic airway diseases are commonly caused by pollen from the family Betulacae. This includes the genera *Alnus* (alder), *Betula* (birch) and *Corylus* (hazel) (2).

Pollen grains of all the above mentioned plant species are transferred by wind.

The allergenic potency of pollen is related to the presence of hydrophilic protein or glycoprotein (antigen) with a molecular mass of 10 kDa to 70 kDa, which is resistant to pH changes and high temperatures, and can cause stronger or weaker allergic reactions in people.

Since most tree pollen allergens in a single climate zone are structurally and immunochemically similar,

cross-reaction is a common phenomenon. Apart from genetic factors and one's present condition, there are some additional risk factors that can stimulate an allergic reaction, such as airflow, rainfall type and intensity, air temperature and possible pollen grains' microflora (bacteria or fungi on the surface of pollen grain can enhance allergic reaction). Birch tree pollen is one of the most common causes of pollinosis. Exposure to house dust, which contains a high concentration of birch tree pollen as much as three weeks after pollination, can also trigger allergy symptoms.

In urban areas, the number of people sensitive to environmental allergens is constantly increasing. That is why the monitoring of airborne allergens has become medically justified (3). Many studies regarding pollen types and their influence on human health have been published thus far (2, 4).

Allergic diseases are a global public health problem, especially in industrialized countries. According to statistics, 65 % of the European adult population has allergic rhinitis symptoms and 27 % has symptoms of asthma. In order to prevent allergic symptoms, it is very important to know when a pollen season begins and ends. Obtaining information about allergenic pollen content in the air allows for a systematic pollen count measurement (5-11).

The Public Health Institute of the Osijek – Baranja County, together with the Osijek Allergy Organisation, began to monitor the ragweed pollen concentration count in 2001. The Pollen concentration count has been measured and the results have been accessible to the public since 2002. The aim of the present study was to determine the concentrations of spring tree pollen in the air during 2009 and 2010 in the area of the Osijek-Baranja County, as well as to analyse them comparatively. The aim was also to determine the highest annual concentration of pollen as well as risk of allergies, and obtain the number of days with medium and high risks of allergy. The risk of pollen allergy was calculated by the number of days with different levels of risk of allergy diseases caused by the pollen of the dominant taxa, according to the allergy thresholds proposed by the Forsyth County Environmental Affairs Department Pollen Rating Scale (12).

MATERIALS AND METHODS

Study area

The Osijek-Baranja County is located in the north-east of Croatia, extending across an area of 4,152 km^2. It encompasses the region of Baranja and the northeast of the region of Slavonija around the lower flow of the river Drava, before its confluence into the Danube.

The average yearly temperature is 11 °C, while yearly rainfall averages on 116 mm in 125 days. North-west winds are prevalent and the air is mostly humid (13). The average monthly relative humidity ranges from 73 % to 90 % (14).

The floodplain forests of the Osijek-Baranja County, depending on the underground and flooding waters, mostly belong to *Salicion albae* Soó 1930 with the following characteristic plant species as pioneer tree species: purple willow (*Salix purpurea* L.*)*, white willow (*Salix alba* L.), brittle willow (*Salix fragilis* L.*),* almond willow (*Salix amygdalina* L.*),* black poplar (*Populus nigra* L.*)* and white poplar *(Populus alba* L.*).* However, oak (*Quercus robur* L.), common elm (*Ulmus minor* Mill.) and white elm (*Ulmus laevis* Pall.) can also be found at higher elevations. In plain areas around Đakovo, where there are several forest complexes with waterfalls, oak is dominant (*Quercus robur* L.). In areas with indented relief, the sessile oak (*Quercus petraea* Liebl.) is dominant, while in the southern exposed slopes, above carbon surfaces, downy oak (*Quercus pubescens* Willd.) can be found. In the area around Našice, the Betulaceae families dominate with characteristic plant species such as hornbeam (*Carpinus betulus* L.), the silver birch (*Betula pendula* Roth.), the common hazel (*Corylus avellana* L.) and the black alder (*Alnus glutinosa* (L.) Gärtn). In the Našice area, oak trees are very important as well as the species from the Betulaceae and Salicaceae family (15).

Osijek monitoring station is placed in the center of the city, arounded with many parks. The following tree species are relevant for the study: *Acer platanoides* L.*, A. ginola* L.*, A. dasycarpum* L.*, A. pseudoplatanus* L.*, A. platanoides* L.*, A. campestre* L.*, Coryluss avellana* L.*, Populus alba* L.*, Betula pendula* Roth.*, Alnus glutinosa* (L.) Gärtn*, Fraxinus excelsior* L.*, Fagus silvatica* L.*, Thuja occidentalis* L.*, Th. Orientalis L., Th. Giganta* L.*, Buxus sempervirens*_L.*, Juniperus communis* L.*, J. virginiana* L., *Taxus baccata* L. (16). Plant species belonging to the *Acer, Betula, Corylus, Fraxinus, Populus, Juniperus and Thuja* genera are found in the city of Našice and Đakovo parks (17).

Pollen concentration was monitored at four stations: Osijek (N:45°33'28,9"; E18°41'14,6", h=119 m), Našice (N:45°29'22,3"; E: 18°05'37,0", h=115

m), Đakovo (N: 45°18'38,0"; E: 18°24'37, 1", h=132 m) and Beli Manastir (N: 45°46'14,5"; E18°35'55,1", h=115 m). All stations were located in the centres of the cities.

METHODS

Pollen grains were sampled with a Burkard spore trap placed 10 m to 15 m above ground level with a flow rate of 10 L min^{-1}. In the Osijek monitoring station, pollen samples were analysed on a daily basis. In the remaining stations, pollen samples were analysed weekly. After seven days of exposure, the tape (Melinex tape from a Burkard spore trap) was cut into 48 mm daily segments. The daily segments were mounted in Gelvatol (Burkard Manufacturing Co.Ltd., UK) and the pollen grains were determined microscopically using a 400x magnification lens (12, 18). The presence of pollen grains found on the microscope slide (pollen count) was converted to concentration of pollen grains per cubic meter (PG m^{-3}). With the help of a correction factor, the result was expressed by the number of pollen grains per m^3. The pollen identification is based on scientific studies and pollen samples from the European Aerobiology Society (19, 20).

The Andersen method is used to identify the most common pollen grains during a pollen season (21).

Results are expressed according to the Pollen Rating Scale (PRS) (12). The Forsyth County Environmental Affairs Department Pollen Rating Scale defines different health risk levels caused by particular types of tree pollen. A pollen concentration of up to (16 to 90) PG m^{-3} represents a 'moderate health risk'; while a pollen concentration of over 90 PG m^{-3} represents a 'high health risk'.

RESULTS

Grass and weed pollen, as well as spring tree pollen, were monitored during 2009 and 2010. The following pollen types were identified: *Acer* (maple), *Alnus* (alder), *Betula* (birch), *Corylus* (hazel), *Cupressaceae* (cypress), *Fraxinus* (ash), *Populus* (poplar). The total *Cupressaceae* pollen concentration was 13 times lower in 2010 than in 2009. The total amount of poplar pollen concentration was six times lower. The total amount of birch pollen decreased by half, while in 2010 alder pollen was dominant. In 2009 (at all monitoring stations), conifer, birch and poplar pollen with 5000 PG, 3188 PG and 3113 PG, respectively, were dominant. These values were recorded at the Osijek station. The number of other pollen grains was up to 500 PG during pollen season (Figure 1). In 2010, alder pollen dominated with 2942 PG at the Beli Manastir monitoring station, as well as birch pollen with 1590 PG at the Osijek monitoring station. The number of other pollen grains was up to 500 PG during pollen season (Figure 2).

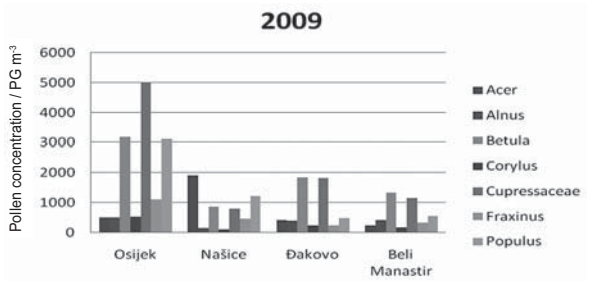

Figure 1 *Trees pollen concentration during 2009*

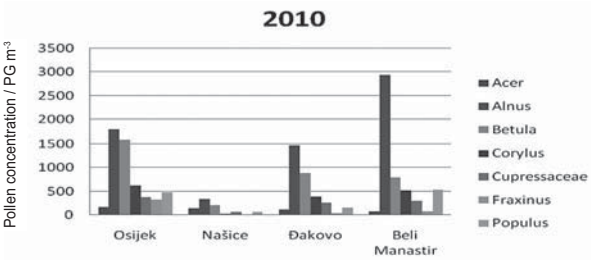

Figure 2 *Trees pollen concentration during 2010*

The pollen season in Osijek-Baranja County begins in the first half of February with alder and lasts 45 to 54 days, usually ending by the end of March, (Table 1). Alder and maple trees (Table 2) produce the earliest pollen types. Cypress (Table 3) begins to bloom at the end of February. Birch (Table 4) begins to bloom in March. Pollen season ends at the end of May or the beginning of June.

In 2009, a high concentration of maple pollen was recorded in Osijek, where pollen grains from maple trees showed a moderate allergic potential (22, 23). The maple pollen season is usual in April and May. In Našice, the pollen from maple trees showed a high potential for allergy, which lasted for 7 days.

DISCUSSION

The results of this study show that there are many different types of trees in the forests and parks of the

Table 1 *Pollen concentration of alder*

ALNUS						
		Pollination season			**Number of days by category**	
		Beginning	**End**	**Duration / days**	**I**	**II**
Location	**Year**	**Date**	**Date**		**(16 to 90) PG m^{-3}**	**> 90 PG m^{-3}**
OSIJEK	2010	19/02	17/04	54	6	5
NAŠICE	2010	02/03	09/03	7	0	1
ĐAKOVO	2010	13/02	28/03	41	8	5
BELI MANASTIR	2010	10/02	08/04	54	6	10

Table 2 *Pollen concentration of maple tree.*

ACER						
		Pollination season			**Number of days by category**	
		Beginning	**End**	**Duration / days**	**I**	**II**
Location	**Year**	**Date**	**Date**		**(16 to 90) PG m^{-3}**	**> 90 PG m^{-3}**
OSIJEK	2009	04/03	11/05	65	2	0
NAŠICE	2009	17/03	11/05	52	5	7
ĐAKOVO	2009	02/03	24/04	61	6	0
BELI MANASTIR	2009	08/03	28/04	48	3	0

Table 3 *Pollen concentration of cypress.*

CUPRESSACEAE						
		Pollination season			**Number of days by category**	
		Beginning	**End**	**Duration / days**	**I**	**II**
Location	**Year**	**Date**	**Date**		**(16 to 90) PG m^{-3}**	**> 90 PG m^{-3}**
OSIJEK	2009	27/02	30/08	175	7	0
NAŠICE	2009	17/03	11/09	169	16	1
ĐAKOVO	2009	28/02	18/08	162	20	5
BELI MANASTIR	2009	06/03	14/10	211	15	1

Table 4 *Pollen concentration of birch.*

BETULA						
		Pollination season			**Number of days by category**	
		Beginning	**End**	**Duration / days**	**I**	**II**
Location	**Year**	**Date**	**Date**		**(16 to 90) PG m^{-3}**	**> 90 PG m^{-3}**
OSIJEK	2009	24/02	14/05	75	8	6
	2010	27/03	14/06	75	9	5
NAŠICE	2009	17/03	15/05	56	7	3
	2010	10/04	30/05	48	2	1
ĐAKOVO	2009	08/03	11/05	61	5	7
	2010	24/03	7/06	71	7	4
BELI MANASTIR	2009	08/03	19/05	68	10	4
	2010	21/03	24/05	63	7	2

Osijek-Baranja County. Considering the recorded numbers, the duration of pollen season, as well as pollen allergenicity and cross-reactivity, only the relevant pollens were analysed in detail. Although the total concentration of pollen varied among the monitoring stations, the most obvious changes between two observed pollen seasons were recorded at the Osijek station. The Croatian Meteorological Society has documented with regard to precipitation that 2009 was a very dry year, whereas 2010 was very

rainy. That may explain lower concentrations of pollen in the majority of studied plant species in 2010 when compared to 2009.

The tree pollen season in the Osijek-Baranja County is similar to the tree pollen seasons in other regions of south-eastern Europe (23-30). Luckily, alder flowering occurs in February and March, when temperatures are low, which means that people do not stay outdoors too long, thus limiting their exposure to alder pollen. However, allergic reactions are possible since alder pollen season partially cross-reacts with birch pollen season. It was found that 9 % to 20 % of people suffering from allergic rhinitis in north-western Spain are allergic to alder pollen (31). In 2010, the Osijek-Baranja County recorded moderate and high risk allergy symptoms that lasted 6 to 8 days and 5 to 10 days, respectively. Birch pollen season lasted 65 days. In 2010, birch pollen season started a month later. During both observed pollen seasons, moderate and high health risks lasted 2 to 9 days and 1 to 6 days, respectively. It is estimated that birch pollen causes asthma and seasonal rhinitis in 10 % to 20 % of European subjects (24). According to scientific information, major birch pollen allergens are proteins which occur after pollen hydration. In contact with respiratory tract mucosa, these proteins cause symptoms of rhinoconjunctivitis. Due to its size, birch pollen cannot get into the lower respiratory tract. However, its allergens are transported into lower respiratory tracts by means of submicroscopic particles such as gases and dust, often causing asthma (24). Over 90 % of people suffering from pollinosis are allergic to birch pollen. Dust containing high concentrations of birch allergen can cause allergy symptoms in a matter of only several weeks after pollination (5).

Since the 1990s, aerobiologists have taken an interest in *Cupressaceae* pollen because it contains allergens (32). The monitoring results indicate the presence of *Cupressaceae* pollen in the air throughout the year. Its pollination period lasts over 200 days with only short periods of high health risks. Similar results were obtained for Spain, where *Cupressaceae* pollen was also found in the air most of the year (31), and the pollination period lasted from September to August. During our research, the longest period of moderate allergy risk for *Cupressaceae* was measured at the Đakovo station (20 days), while high risk concentrations were recorded during a period of 5 days. Identical measurements in Spain recorded 30 days of moderate risk and 15 days of high risk concentrations. We could conclude that the number of high and moderate risk pollen concentration days in the studied region is significantly lower compared to Spain. *Cupressaceae* pollen is considered to be responsible for winter pollinosis on the Mediterranean, especially *Cupressus sempervirens* and *Cupressus arizonica* (31). In urban areas, more and more people are exposed to *Cupressaceae* pollen allergen. This is explained by the fact that allergens are transmitted by gas and dust particles. It can also be explained by increased horticultural activities and better diagnostics of "winter colds" (32). From May 2002 to May 2003, the Center for Allergic Diseases in Sardinia (Università degli Studi di Cagliari, Servizio di Puericultura - Allergologia infantile) examined 100 children with different respiratory, ophthalmic and cutaneous allergy symptoms. Thirteen percent of the patients were allergic to cypress pollen. During the winter months, the symptoms were more prominent (33). Geographical, hydro meteorological and climatic factors affect the intensity and duration of a tree pollen season. Since climate changes can affect aeroallergens, they may also affect respiratory system diseases caused by allergies. Higher birch, alder and Japanese cedar pollen counts in the air are influenced by air temperature. Pollen concentration may get higher due to temperature increases. As the climate becomes warmer, early blooming is expected, and certain taxa may disappear, while new taxa may appear involving potentially different rations in allergenic pollen types. It is also expected that pollen grains will be spread over vast distances due to changes in atmospheric flow (34).

CONCLUSION

The air over the Osijek-Baranja County consists of various tree pollen types persisting throughout the year. Tree pollen contains allergens which cause allergy symptoms. Seasonal variation in pollen concentration as well as pollen types over the study area is similar to that in the surrounding regions and countries. The largest annual pollen concentration was registered at the Osijek measuring station during 2009.

Alder pollen dominated at all measuring stations during 2010. The pollination season starts with alder pollen. In the studied area in 2010, medium risk for the occurrence of allergic symptoms lasted 6 to 8 days, and high risk 5 to 10 days. During 2009, the pollination

of birch lasted for 65 days and the blooming period in 2012 started a month later. Maple pollen retained for the longest in Našice in high and risky concentrations during a period of 7 days. Some of the most potential pollen types come from trees used in horticulture. That is why it should be carefully planned which trees to plant. Pollen containing allergen can negatively affect human health which requires public health measures in order to inform and educate people as well as to prevent allergic disorders.

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Sažetak

VRSTE PELUDA DRVEĆA I RIZIK OD POLENOZA U OSJEČKO-BARANJSKOJ ŽUPANIJI

Šume sjeveroistočnog dijela Hrvatske, kao i raznolike biljne vrste parkova i perivoja gradova Osječko-baranjske županije tijekom perioda polinacije stvaraju velike količine peluda koji kod osjetljivih osoba može izazvati simptome alergije – polenoze. Tijekom 2009. i 2010. godine radnici Službe za zdravstvenu ekologiju ZZJZ-a Osječko-baranjske županije provodili su monitoring koncentracija peluda u četiri grada u Osječko-baranjskoj županiji (Osijek, Našice, Đakovo, Beli Manastir). Mjerenja su se obavljala s pomoću Burkardova volumetrijskog aparata. Na rezultate ispitivanja utječu vremenske prilike. Rasprostiranju peludnih zrnaca pogoduju vjetroviti i sunčani dani, dok je tijekom kišovitih dana koncentracija peluda niža. Visoka koncentracija peluda *Cupressaceae/Taxaceae, Betulaceae i Aceraceae* može izazvati polenozu. U 2009. godini dominirao je pelud četinjača, breze i topole na svim mjernim postajama: 5000 peludnih zrnaca (PG); 3188 PG, odnosno 3113 PG, s najvećim utvrđenim brojem na postaji Osijek. Na svim postajama primijećene su varijacije u koncentracijama peluda istraživanih vrsta između dvije promatrane vegetacijske sezone, a najuočljivije su zabilježene na mjernoj postaji Osijek. Period polinacije za istraživani pelud kreće se od dva do tri mjeseca. Istraživani se pelud zadržava u zraku od veljače do početka lipnja ovisno o vrsti, izuzetak je pelud *Cupressaceae/Taxaceae* čiji se pelud zadržavao do kraja ljeta. Određivan je rizik od pojave alergije na sve četiri istraživane postaje, a dobiveni podaci pokazuju da je najveći broj dana s visokim zdravstvenim rizikom zabilježen na postaji Đakovo za vrstu breza. Podaci o početku pojavljivanja peluda u zraku pomažu pacijentima i liječnicima da primijene preventivne mjere i odgovarajuću terapiju.

KLJUČNE RIJEČI: Aceraceae, Betulaceae, Cupressaceae/Taxaceae, *pelud u zraku,* Salicaceae, *zrak*

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