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Poisonous and allergenic plant species in kindergarten gardens in Novi Zagreb city districts

Otrovne i alergene biljne vrste uz vrtiće na području gradskih četvrti Novi Zagreb

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ABSTRACT

Plantings surrounding kindergartens are an integral part of urban green spaces. These open areas play a very important role in the lives of children, in their development, their eating habits, and environmental awareness. For this reason, it is extremely important to select adequate plant species, which are not dangerous for the children. There are 10 public and 9 private preschool institutions in the entire area of the two Novi Zagreb (East and West) city districts. Only public kindergartens have been included in this research. The aim was to determine the size of green open space surrounding public kindergartens, analyse woody plants on site, determine the taxonomic affiliation of plant species, and detect the presence of poisonous and allergenic plant taxa. In green space surrounding kindergartens in the Novi Zagreb – East city district, 49 taxa of trees, and 18 taxa of shrubs and woody climbers from a total of 22 plant families have been identified. Similary, in the Novi Zagreb – West city district, 49 taxa of trees, and 24 taxa of shrubs and woody climbers from a total of 26 plant families have been determined in kindergarten plantings. A total of 32 poisonous taxa, and 36 allergenic taxa have been catalogued in the Novi Zagreb – East city district, while a total of 34 poisonous taxa, and 42 allergenic taxa have been listed in the Novi Zagreb – West city district. The most poisonous species were: *Taxus baccata*, *Prunus laurocerasus* and *Sambucus nigra*. The species with the highest allergenic potential were: *Thuja occidentalis*, *Betula pendula* and *Acer platanoides*.

Keywords: gardening, children, suitable taxa, toxicity, allergenicity, horticulture

SAŽETAK

Vrtovi u sklopu vrtića sastavni su dio gradskih zelenih površina. Ovi vrtovi imaju vrlo značajnu ulogu u životu djece, potenciranju njihovih radnih i prehrambenih navika te razvijanju ekološke svijesti. Iz tog razloga, izuzetno je važno da biljne vrste u sklopu vrtića budu primjereno odabrane. Na cijelom području Novog Zagreba (Istok i Zapad) postoji 10 gradskih i 9 privatnih predškolskih ustanova, a u istraživanje je bilo uključeno 10 gradskih vrtića. Ciljevi ovog istraživanja bili su ustanoviti postojanje vrtova uz vrtiće na području gradskih četvrti (GČ) Novog Zagreba, odrediti njihovu veličinu, inventarizirati dendrološku floru, odrediti taksonomsku pripadnost te analizirati prisutnost otrovnih i alergenih biljnih svojti. U vrtovima vrtića GČ Novi Zagreb – istok utvrđeno je 49 svojti stabala i 18 svojti grmlja i penjačica iz ukupno 22 porodice. U vrtovima vrtića GČ Novi Zagreb – zapad determinirano je 49 svojti stabala te 24 svojti grmlja i penjačica iz ukupno 26 porodica. U vrtovima GČ Novi Zagreb – istok ukupno su zabilježene 32 otrovne svojte i 36 alergenih svojti

dok je u vrtovima GČ Novi Zagreb – zapad ukupno utvrđeno 34 otrovnih svojti te 42 alergene svojte. Najotrovnije vrste bile su: *Taxus baccata*, *Prunus laurocerasus* i *Sambucus nigra*. Vrste s najvećim alergenim potencijalom bile su: *Thuja occidentalis*, *Betula pendula* i *Acer platanoides*.

Ključne riječi: vrtlarenje, djeca, prikladne svojte, otrovnost, alergenost, hortikultura

INTRODUCTION

Urban greenery is an important element of sustainable urban development providing a wide range of ecosystem services, including biophysical, environmental, cultural, and perceptive dimensions (Andersson et al., 2015, Bolund and Hunhammar, 1999). Municipal greenery also has social and economic functions, including recreational, leisure or tourist functions (White and Gatersleben, 2011).

Visiting green spaces can effectively reduce stress when activities such as walking, relaxing, and observing are taken part in (Hansmann et al., 2007). Furthermore, an increase in one's well-being has been shown to be positively correlated with the length of time one spends in parks or forests (Rupprecht et al., 2015; Yang et al., 2013). Research also shows that work and school spaces, and healthcare facilities are spaces in which much stress is generated (Hansmann et al., 2007; Lau and Yang, 2009; Lottrup et al., 2013).

Taylor et al. (2002) find that spending time in close proximity to nature leads to the development of a more efficient and self-disciplined lifestyle, and provides benefits for children's mental health.

Given that children spend the biggest part of their day in kindergartens and schools, as far as urban green spaces are concerned, special attention should be paid to the green spaces of kindergartens and schools in cities. According to Paravina (1996), these are open, landscaped, and designed spaces for spontaneous and organised play, for various recreational and creative activities, and for socialisation, communication, and collaboration among children.

Both Simoneti (1998) and Paravina (1996) state that spending time outdoors and in fresh air have a positive effect on the psychophysical development of children. Spending time in outdoor spaces can meet children's need for active play and freedom much better than spending time in indoor spaces, although it is important that they are provided with diverse and complex activities while outdoors. Spending time in outdoor spaces intended for children includes playing games and enjoying outdoor facilities that mobilise the whole body, and involves activities such as running, climbing, jumping, etc. Through such activities, children get to know their body, become aware of their capabilities (abilities) and limitations, and develop self-esteem by learning different skills. Developing an approach such as this one to both learning and the role of the environment in education should arouse interest in nature amongst children, and help to create as intimate a relationship between the child and nature as possible.

For this reason, the approach to planning and landscaping the environment of educational institutions needs to be focused and special attention needs to be given to the selection of plant species (Mrđan et al., 2017).

When selecting plant taxa, attention should be given not only to the usefulness of the role of different horticultural plants, but also to avoiding plant taxa that may have harmful effects on humans, animals, and the environment in general (Perinčić et al., 2014). In this, toxic plant taxa – i.e., plants that are toxic in their entirety or plants that contain toxins in some of their parts (leaves, fruits, seeds, etc.) – should be avoided altogether (Perinčić et al., 2014).

A poisonous plant species can be defined as a species whose parts contain potentially harmful substances in sufficiently high concentrations to cause various reactions when touched or ingested. In other words, one is exposed to plant toxins when one ingests plant toxins and/or comes into dermal contact with a toxic plant. Adverse reactions to any of these substances include allergic reactions, skin

irritation, rashes or dermatitis, skin photosensitisation, and poisoning. In terms of their level of toxicity, plants are classified as highly, moderately, and minimally toxic. It is estimated that 3.5% of all poisonings are caused by poisonous plants (Douglas, 2005; Vlahović and Karlović, 2013). The vast majority of these poisonings happens to children of school age or even younger. Lawrence (1997) states that plant consumption is common amongst children in the United States, that 5-10% of all calls taken by the emergency services that involve poisoning are made due to someone being exposed to plants, and that the majority of these cases involve children under the age of six. Also, in Slovakia, more than 50% of cases of child poisoning are caused by children accidentally consuming plants (Plačková et al., 2006, as cited in Fančovičová and Prokop, 2011).

In recent years, there has been an increase in the incidence of allergies in preschool children. This increase is attributed to changes in lifestyle, and the fact that most activities that people engage in take place mainly indoors. That is the reason why children don't get in repeated contact with the many allergens present in nature during their childhood. This repeated contact would lead to natural desensitisation. Allergy prevention measures are aimed at: removing allergens from the environment, avoiding repeated exposure to potent allergens, people avoiding allergens that they have already developed an allergy to (Lipozenčić, 2011).

Although the vast majority of plant species used in horticulture are not hazardous to either humans or animals, and although the number of reported incidents of poisoning is relatively low, several countries have recognised the need to warn the general public of the potential harm of some species (Perinčić et al., 2014). Lists are compiled of potentially harmful plants including their toxicity class and risk reduction measures when handling toxic plants (Hamilton, 1980; Anonymous, 2004, 2008). According to Perinčić et al. (2014), Croatia has not compiled a complete list of poisonous plants, although there is a list of 497 evolutionarily more developed plants that are poisonous to vertebrates (Nikolić and Rešetnik, 2007), amongst which there are plant taxa that are used in horticulture (Grlić, 1984; Forenbacher, 1998).

In the last ten years, interest in the horticultural landscaping of schools and kindergartens has grown. This makes research of the horticultural flora of these places important. This research aims to establish whether gardens exist within the kindergartens in the two Novi Zagreb city districts, to determine their size, to make a dendrology inventory, to determine the taxonomic affiliation of plant species, and to analyse the presence of poisonous and allergenic plant taxa in these gardens.

MATERIAL AND METHODS

The research was conducted in selected kindergartens in the city districts of Novi Zagreb. There are two city districts in Novi Zagreb; namely, Novi Zagreb – West (NZ – West), and Novi Zagreb – East (NZ – East). The research was conducted in a total of 10 kindergartens in the two city districts listed on official site of city of Zagreb (Grad Zagreb).

The two city districts of Novi Zagreb are located in the Central European time zone. Novi Zagreb is at an altitude of 130 m, so it belongs to lowland Croatia.

The research investigated only the gardens of kindergartens founded by the City of Zagreb (public kindergartens) (Table 1). Given that all kindergartens have both, a central and a branch facility, this research included only the central kindergarten facilities as a representative location. The research was approved by the head teacher of each kindergarten who granted the researchers entry.

To measure the size of the kindergarten plots, the Geoportal of the State Geodetic Administration of the Republic of Croatia (2015) was used. The Geoportal is Croatia's central point of access to spatial data, and is one of the basic elements of the National Spatial Data Infrastructure. Using the GIS online tool, the following was measured: the total area of each kindergarten plot; built area (building, parking spaces, trails, etc.); front yard area; the area of children's playground (nursery and kindergarten); and the length of hedge. Each area was measured in square metres (m^2), and each hedge in metres (m).

Table 1. The selected kindergarten green space in the city districts of Novi Zagreb – East, and Novi Zagreb – West

City district	Kindergarten mark	Year of opening	Total number of kindergarten groups	Total number of children
East	I-1	1977	12	277
	I-2	1981	14	295
	I-3	1977	9	213
	I-4	1973	8	152
	I-5	1973	9	219
West	Z-1	1972	14	348
	Z-2	1981	9	195
	Z-3	2008	12	296
	Z-4	1972	9	178
	Z-5	1968	10	239
Average		1978	10.6	241.2

The field research was conducted between March and May 2019. During this period, the gardens were visited several times for the purposes of making a dendrology inventory. The tree taxa found in the gardens were determinated with the following relevant professional literature: Horvatić and Trinajstić (1967-1981), Tutin et al. (1968-1980, 1993), Walters et al. (1984-1989), Grlić (1984), Vukićević (1987), Šilić (1990), Gelenčir and Gelenčir (1991), Crvenka (1996), Domac (2002), Erhardt et al. (2002), Petrić and Tomašević (2003), Vidaković and Franjić (2004), Dreyer and Dreyer (2007) and Idžojtić (2009). The nomenclature of the taxa is according to Borzan (2001).

Once a dendrology inventory was made for each kindergarten's green area, all the poisonous and allergenic plant taxa were identified and their presence analysed in the kindergartens in the two city districts of Novi Zagreb.

The toxic tree taxa differ in the degree of their toxicity. If they come into contact with or enter the human body, some poisonous plants can cause minor and some others major adverse health effects, while some can even be fatal. The toxicity class of the toxic tree taxa was determined in accordance with the modified plant toxicity categorisation of Filmer (2012), Frohne and Pfänder (1997), and Ivanić et al. (1996), and is presented from higher to lower degree of toxicity in table 2 as highly toxic (1), very toxic (2), moderately toxic (3), and slightly toxic (4).

Less than one hundred plant species worldwide produce pollen which is allergenic. A plant species is potentially aero-allergenic if its pollen grain contains allergenic compounds, if it is anemophilous, and if it produces pollen in large quantities. The occurrence of airborne pollen is temporally limited and typical for each plant species (Peternel et al., 2004). Not all types of pollen are equally allergenic. Some plant allergens can cause minor, and some major health issues. The allergenicity category of each plant species was determined in accordance with the modified categorisation of Peternel et al. (2004), which classifies dendrological plants according to their level of allergenicity as follows: low (I), moderate (II), high (III), and very high (IV) pollen count levels (Table 3).

Highly sensitive individuals will develop symptoms of an allergic reaction even when the pollen count is low (1), most sensitive individuals when the count is moderate (2), and when the pollen count is high (3) and very high (4), all individuals sensitive to pollen will develop symptoms of an allergic reaction.

Table 2. Toxicity classes of poisonous plants including the symptoms they cause

Toxicity class	Symptoms
Highly toxic 1	Extremely toxic plants; if they enter the human body even in small quantities, they can cause severe poisoning or even death
Very toxic 2	Toxic plants that can cause less severe poisoning; symptoms include vomiting and/or diarrhoea; the human body can suffer from severe consequences, including death, if first aid is not administered in time
Moderately toxic 3	Poisonous plants that contain highly potent substances; if they enter the human body, it is poisoned, although death is excluded as a possibility
Slightly toxic 4	Plants that are considered poisonous; they can cause certain symptoms of poisoning, and skin rashes or irritation

Table 3. Pollen count levels of dendrological plants (Peternel et al., 2004)

Pollen count levels	Pollen concentration (number of pollen grains/m^3 of air)
Low (I)	1 – 15
Moderate (II)	16 – 90
High (III)	91 – 1 500
Very high (IV)	> 1 500

RESULTS AND DISCUSSION

Kindergarten I-1 has the largest total plot area (11 754 m^2) in the NZ – East city district, while kindergarten I-4 has the smallest (6 154 m^2). On average, the built area of the kindergartens in the NZ – East city district – i.e., the area occupied by the kindergarten building itself including parking spaces, and other detached and associated facilities (e.g., garage, storage spaces, waste disposal spaces, access paths, etc.) – takes up 39% of the total plot area. Front yard areas do not take up much space compared to other areas. More specifically, on average, front yard areas of kindergartens in the NZ – East city district take up 14% of the total plot area. Children's playgrounds, green areas featuring slides, climbers, swings, carousels and seesaws, as well as sandpits and benches, take up almost half of the total plot area of each kindergarten – i.e., 48%. Interestingly, not one single kindergarten in the NZ – East city district has a hedgerow planted around its plot, while in the NZ – West city district all kindergartens have a hedgerow, with the exception of Z-2 (Table 4).

Kindergarten Z-1 has the largest total plot area (8 128 m^2) in the NZ – West city district, which is significantly larger than the total plot area of the other kindergartens in the same city district. Kindergarten Z-5 has the smallest total plot area (4 056 m^2). On average, the built areas of the kindergartens in the NZ – West city district take up 44% of the total plot area, while front yard areas take up 11%. Children's playgrounds take up an average of 45% of the total plot area, which is very similar to how much area construction areas take up on average.

Paravina (1996) states that a preschool child needs approximately 4-6 m^2 of usable space for movement and play, and that the number of children who use the playground at any given time should not exceed approximately one third of the total number of children attending kindergarten. If the averages of all the areas of the kindergartens in the NZ – East city district are compared with the same in the NZ – West city district, it can be concluded that the kindergartens in the NZ – East city district are larger than the kindergartens in the NZ – West city district.

Appendix 1 brings the complete list and number of taxa of trees, shrubs, and woody climbers in the kindergarten areas in the urban districts of NZ – East, and NZ – West, including the catalogued species' level of toxicity and allergenicity. The most widespread plant family is the Pinaceae family with a total of 38 specimens from 12 taxa, and the Rosaceae family with 30 specimens from 14 taxa. The Sapindaceae family is represented by 26 specimens from 11 taxa. The plant species that are

Table 4. The characteristics of kindergarten gardens in the city districts of Novi Zagreb – East, and Novi Zagreb – West

City district	Kindergarten mark	Built area (m^2)	Front yard area (m^2)	Children's play-ground area (m^2)	Total plot area (m^2)	Hedgerow length (m)
East	I-1	4 515	1 572	5 667	11 754	-
	I-2	1 976	619	3 918	6 513	-
	I-3	2 587	1 822	2 117	6 526	-
	I-4	2 612	690	2 852	6 154	-
	I-5	2 785	377	3 139	6 301	-
Average		2 894.6	1 016	3 538.6	7 449.6	-
West	Z-1	3 711	727	3 690	8 128	141
	Z-2	1 693	892	2 105	4 690	-
	Z-3	2 424	763	2 472	5 659	162
	Z-4	2 716	414	2 695	5 825	164
	Z-5	1 806	401	1 849	4 056	193
Average		2 470	639.4	2 562.2	5 671.6	165

present in most kindergarten areas are the European white birch or *Betula pendula* Roth (itemised in all 10 areas), the European spruce or *Picea abies* L. (catalogued in nine areas), and the Norway maple or *Acer platanoides* L. (listed in eight areas).

The gardens of kindergartens Z-3 (23 taxa), Z-1 (21 taxa), and I-1 (19 taxa) stand out as areas that boast the largest number of tree taxa planted in them (Table 5). Besides leading in the number of tree taxa, the areas of kindergartens Z-3 and Z-1 also boast the largest number of taxa of shrubs, and woody climbers – i.e., ten and nine, respectively. These two are followed by the area of kindergarten I-2 where eight taxa of shrubs and woody climbers have been catalogued. Interestingly, the area of kindergarten Z-3 has the largest number of plant taxa in it, although the total area of its area is amongst the smallest (only the areas of kindergartens Z-5 and Z-2 are smaller). The total plot area (5 659 m^2) of kindergarten Z-3 is closest to the average total plot area of all the kindergartens in the NZ – West city district (5 671.6 m^2), whose kindergarten areas are generally smaller than the kindergarten areas in the neighbouring NZ – East city district (7 449.6 m^2).

Appendix 1 also shows the presence of poisonous and allergenic taxa of trees, shrubs, and woody climbers in the kindergarten area in the two city districts of Novi Zagreb. 32 taxa of poisonous woody plants have been catalogued in the kindergartens in the NZ – East city district, and 33 in the kindergartens in the NZ – West city district. The most widespread poisonous taxa are the northern white cedar (*Thuja occidentalis* L.), the European white birch (*Betula pendula*), and the European black elderberry (*Sambucus nigra* L.). In terms of their level of toxicity, nine taxa are classified as highly poisonous plants (1). From the listed taxa, only three are truly hazardous to children, and these are: the cherry laurel (*Prunus laurocerasus* L.), the English yew (*Taxus baccata*), and the Irish yew (*Taxus baccata* 'Fastigiata'). Other species classified as poisonous shouldn't be treated that way as the seeds encased in the hard stone are not attractive for children (Grlić, 1984).

Table 5. Number of plant species

	Kindergarten gardens in Novi Zagreb – East					Kindergarten gardens in Novi Zagreb – West					Total
	I-I	I-2	I-3	I-4	I-5	Z-I	Z-2	Z-3	Z-4	Z-5	
Number of tree taxa per area	19	16	15	12	17	21	13	23	12	15	
Number of itemised specimens per area	46	39	53	48	61	71	62	37	28	32	
			247					230			477
Number of taxa of shrubs and woody climbers per area	2	8	5	1	5	9	5	10	6	5	
Number of itemised specimens of shrubs and woody climbers per area	40	29	23	1	23	11	14	36	23	10	
			116					94			210

All parts of the cherry laurel (*Prunus laurocerasus*) are poisonous except the fleshy part of the fruit, which is harmless. Its fresh leaves and seeds contain the cyanogenic glycoside prunasin, and the cyanogenic glycoside amygdalin. Cherry laurel poisonings are rare because its fruit is very bitter (Grlić, 1984; Ivanić et al., 1996).

Similarly, all parts of the English yew (*Taxus baccata*) are poisonous except the fleshy part around the seed (aril), which is edible. The English yew contains taxine alkaloids, and cyanogenic glycosides. The English yew's aril, which contains its poisonous seeds, is red in colour, which is why it attracts children the most. English yew shoot and seed poisoning can be very severe, and can result in death (Grlić, 1984; Frohne and Pfänder, 1997; Ivanić et al., 1996). In the Czech Republic, for instance, according to Vichova and Jahodar (2003), English yew shoot and seed poisoning is the third most common reason why children are hospitalised with poisoning. Cherry laurel and English yew were amongst the more common poisonous species found around primary schools in Zagreb's Lower Town district (Kušen et al., 2022) and in Novi Sad preschool and primary schools' surroundings (Mrđen et al., 2017).

All the parts of the European black elderberry (*Sambucus nigra*) are highly poisonous when fresh. Its black fruits are edible; however, when fresh and unprocessed, they are neither healthy nor particularly tasty, which makes them less interesting to children. Nevertheless, caution should be exercised given that its unripe fruits are extremely toxic due to the presence of the cyanogenic glycoside sambunigrin that releases hydrogen cyanide. Its fruits can cause nausea, vomiting, and diarrhoea; however, when boiled, the fruits of the European black elderberry have medicinal properties and benefits (Grlić, 1984).

The toxic glycosides that the above species contain are easily accessible given that they are found in the seeds and leaves of these plants. Due to their ornamental value they should be used in landscaping. Cherry laurel, when it is managed well and pruned properly on time will not have fruits. English yew, when it is used in children playground landscaping, should be surrounded by other, not dangerous species.

Appendix 1 also shows the allergenic taxa of trees, shrubs, and woody climbers catalogued in the areas of kindergartens in the two city districts of Novi Zagreb; specifically, 36 in the kindergarten areas in the NZ – East city district, and 42 in the kindergarten areas in the NZ – West city district. The most widespread allergenic plants in the kindergartens in the NZ – East city district are the northern white cedar (*Thuja occidentalis*), the European white birch (*Betula pendula*), and the Norway

maple (*Acer platanoides*). In terms of allergenicity, only one taxon whose pollen count level is high has been itemised; namely, the European white birch or *Betula pendula*. The other allergenic species catalogued in the kindergartens in the NZ – East city district include the American ash (*Fraxinus americana* L.), the narrow-leaved ash (*Fraxinus angustifolia* Vahl), the European ash (*Fraxinus excelsior* L.), and the London planetree (*Platanus* × *acerifolia* (Aiton)Wild), all of which produce moderate to high levels of pollen concentration in the air. The most widespread allergenic plants in the kindergartens in the NZ – West city district are the European spruce (*Picea abies* L. 'Karsten'), and the European white birch (*Betula pendula*). In terms of allergenicity, two taxa whose pollen count level is high have been catalogued; specifically, the European white birch (*Betula pendula*), and the common hazel (*Corylus avellana* L.). The other allergenic species catalogued in the kindergartens in the NZ – West city district include the wild privet (*Ligustrum vulgare*), the common privet (*Ligustrum vulgare*), the European ash (*Fraxinus excelsior*), and the London planetree (*Platanus* × *acerifolia*), all of which produce moderate to high levels of pollen concentration in the air. European white birch, as a highly allergenic (3) species, was most common around schools of Lower Town district of Zagreb (Kušen et al., 2022). A number of authors pointed out *B. pendula* pollen as major allergen carrier in Northern, Central and Eastern Europe (D'amato et al., 2007; Spieksma, 1990). Allergic reactions caused by *Ligustrum* sp. appear only close to the source, and points that continuous pruning usually diminishes flower production, so exposure to pollen is rare (Mrđan et al., 2017).

CONCLUSIONS

On average, the kindergartens in the city district of Novi Zagreb – East are larger than the kindergartens in the city district of Novi Zagreb – West in three measurements: the total plot area of the kindergartens (7 449.6 m^2 vs. 5 671.6 m^2), the area of children's playgrounds within the kindergartens (3 538.6 m^2 vs. 2 562.2 m^2), and the front yard area of the kindergartens (1 016 m^2 vs. 639.4 m^2).

A total of 95 species of ornamental woody plants from 31 plant families have been catalogued. In the kindergarten areas in the NZ – East city district a total of 247 specimens of trees, and 116 specimens of shrubs have been identified, while in the kindergarten areas in the NZ – West city district a total of 230 specimens of trees, 94 specimens of shrubs, and 670 m of hedgerow have been listed.

From the total number of catalogued species, a total of 47 poisonous species (i.e., 20 taxa of toxicity level 4, three taxa of toxicity level 3, 13 taxa of toxicity level 2, and 11 taxa of toxicity level 1) have been itemised; more specifically, 32 poisonous species in the kindergarten areas in the city district of NZ – East, and 33 in the kindergarten areas in the city district of NZ – West. A total of 53 allergenic taxa have been catalogued; specifically, 36 in the kindergarten areas in the city district of NZ – East, and 42 in the kindergarten areas in the city district of NZ – West. In terms of their level of allergenicity, 2 taxa of allergenicity level 3, 30 taxa of allergenicity level 2, and 21 taxa of allergenicity level have been catalogued.

There is essential need for green surroundings of kindergartens due to positive influence on childrens' development. However, many ornamental species, traditionally used in landscaping, are poisonous or allergenic. Male plants should be avoided at dioecious taxa while the quantity of pollen would be lower. Good management praxis are also needed because some taxa (*Ligustrum*) pruned on time wouldn't be hazardous for children. Educational institutions have to fulfil their role and teach the children the value of plants.

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APPENDIX

Appendix 1. Complete list and number of taxa of trees, shrubs, and woody climbers in the kindergarten areas in the urban districts of NZ – East, and NZ – West

Family/Porodica	Taxa/Svojta	Toxicity level / St. otrovnosti	Level of allergenicity / St. Alergenosti	Kindergarten areas in Novi Zagreb –					Kindergarten areas in Novi Zagreb – West Vrtovi Novi Zagreb – Zapad / Vrtovi Novi Zagreb – zapad					Total / Ukupno
				I-1	I-2	I-3	I-4	I-5	Z-1	Z-2	Z-3	Z-4	Z-5	
Altingiaceae	*Liquidambar styraciflua* L.		1		×		×		×		×		×	5
Anacardiaceae	*Rhus typhina* L.	4									×			1
Araliaceae	*Hedera helix* L.	2				×		×	×	×		×		5
Asparadaceae	*Yukka filamentosa* L.								×					1
Asteraceae	*Santolina chamaecyparissus* L.				×									1
Berberidaceae	*Berberis thunbergii* DC. 'Atropurpurea'	2				×								1
	Mahonia aquifolium Nutt.	3										×		1
Betulaceae	*Betula pendula* Roth	4	3	×	×	×	×	×	×	×	×	×	×	10
	Carpinus betulus L.		2			×	×				×			3
	Carpinus betulus L. 'Fastigiata'		2						×					1
	Corylus maxima Mill.		3								×	×		2
Bignoniaceae	*Campsis radicans* (L.) Seem. ex Bureau	4									×			1
	Catalpa bignonioides Walt.	3		×		×			×		×	×		5
Buxaceae	*Buxus sempervirens* L.	2								×				1
Caprifoliaceae	*Lonicera pileata* Oliv.	2									×			1
	Sambucus nigra L.	1	1						×					1
	Symphoricarpos orbiculatus Moench	2		×										1
	Viburnum rhytidophylum Hemsl.	3			×									1
	Weigela florida (Bunge) A. DC.								×					1
Cornaceae	*Cornus florida* L.	4									×			1
Cupressaceae	*Chamaecyparis lawsoniana* Parl.		2					×	×				×	3

Continued. Appendix 1.

Family/Porodica	Taxa/Svojta	Toxicity level / St. otrovnosti	Level of allergenicity / St. Alergenosti	Kindergarten areas in Novi Zagreb –					Kindergarten areas in Novi Zagreb – West Vrtovi Novi Zagreb – Zapad / Vrtovi Novi Zagreb – zapad					Total / Ukupno
				I-I	I-2	I-3	I-4	I-5	Z-I	Z-2	Z-3	Z-4	Z-5	
	Chamaecyparis obtusa Siebold et Zucc. ex Endl.		2						×					1
	Juniperus chinensis L.	2	2						×					1
	Thuja occidentalis L.	2	2	×					×	×				3
	Thujopsis dolabrata Siebold et Zucc.		2								×			1
Elaeagnaceae	*Elaeagnus angustifolia* L.								×					1
Ericaceae	*Erica carnea* L.		2		×									1
Fabaceae	*Gleditsia tricanthos* L.												×	1
Fagaceae	*Fagus sylvatica* L. 'Atropunicea'		2-3								×			1
	Quercus robur L.	2	2				×			×		×		3
	Quercus robur L. 'Fastigiata'	2	2			×				×		×		3
Hydrangeaceae	*Hydrangea macrophylla* Thunb. ex Murray	4						×						1
Juglandaceae	*Juglans regia* L.	4	1-2	×	×				×	×	×			5
Lamiaceae	*Lavandula angustifolia* Mill.				×						×			2
	Rosmarinus officinalis L.				×				×		×			3
Malvaceae	*Hibiscus syriacus* L.								×	×				2
Magnoliaceae	*Liriodendron tulipifera* L.								×		×	×		3
	Magnolia kobus DC.											×		1
	Magnolia liliiflora Desr.										×			1
	Magnolia × soulangiana Soul.-Bod.			×										1
Oleaceae	*Forsythia suspensa* Thunb.												×	1
	Fraxinus americana L.	4	2-3	×										1
	Fraxinus angustifolia Vahl	4	2-3			×		×						2

Continued. Appendix 1.

Family/Porodica	Taxa/Svojta	Toxicity level / St. otrovnosti	Level of allergenicity / St. Alergenosti	Kindergarten areas in Novi Zagreb –					Kindergarten areas in Novi Zagreb – West Vrtovi Novi Zagreb – Zapad / Vrtovi Novi Zagreb – zapad					Total / Ukupno
				I-1	I-2	I-3	I-4	I-5	Z-1	Z-2	Z-3	Z-4	Z-5	
	Fraxinus excelsior L.	4	2-3	×				×	×			×		4
	Ligustrum ovalifolium Hassk.	2	2-3									×	×	2
	Ligustrum vulgare L.	2	2-3						×					1
	Syringa vulgaris L.		2			×		×						2
Pinaceae	*Abies alba* Mill.		1	×										1
	Abies concolor Lindl. ex Hildebr.		1										×	1
	Abies koreana E. H. Wilson		1						×					1
	Abies nordmaniana Spach		1	×										1
	Larix decidua Mill.												×	1
	Picea abies (L.) H. Karst.		1	×	×	×		×	×	×	×	×	×	9
	Picea glauca (Moench) Voss		1						×					1
	Picea omorika (Pančić) Purk.		1	×	×	×		×	×	×			×	7
	Picea pungens Engelm.		1	×		×		×	×				×	5
	Picea pungens glauca Engelm.		1		×	×	×			×				4
	Pinus mugo Turra		1								×			1
	Pinus nigra J. F. Arnold		1				×	×	×	×		×	×	6
Platanaceae	*Platanus* × *acerifolia* Willd.		2-3		×		×		×			×		4
Rosaceae	*Crataegus laevigata* (Pior.) DC.										×			1
	Cotoneaster horizontalis Decne.	2			×								×	2
	Malus domestica Borkh.	1			×			×						2
	Prunus avium L.	1			×									1
	Prunus cerasifera Ehrh.	1			×						×			2

Continued. Appendix 1.

Family/Porodica	Taxa/Svojta	Toxicity level / St. otrovnosti	Level of allergenicity / St. Alergenosti	Kindergarten areas in Novi Zagreb –					Kindergarten areas in Novi Zagreb – West Vrtovi Novi Zagreb – Zapad / Vrtovi Novi Zagreb – zapad					Total / Ukupno
				I-1	I-2	I-3	I-4	I-5	Z-1	Z-2	Z-3	Z-4	Z-5	
	Prunus cerasifera Ehrh. 'Nigra'	1		×	×		×			×				4
	Prunus cerasus L.	1							×					1
	Prunus laurocerasus L.	1						×		×		×		3
	Prunus serrulata Lindl.	1				×						×	×	3
	Prunus serrulata Lindl. 'Kanzan'	1						×						1
	Rosa sp. L.		1		×	×			×	×			×	5
	Rubus fruticosus L.							×						1
	Spiraea japonica L. f.				×									1
	Spiraea × *vanhouttei* Zabel										×	×	×	3
Salicaceae	*Populus nigra* L. 'Italica'		1				×							1
	Salix alba L. var. *vitellina* cv. *Pendula*		1	×		×		×						3
Sapindaceae	*Acer japonicum* Thunb.	4	2								×			1
	Acer negundo L.	4	2		×	×					×			3
	Acer negundo L. 'Variegatum'	4	2								×			1
	Acer palmatum Thunb. ex Murray	4	2							×				1
	Acer palmatum Thunb. ex Murray 'Atropurpureum'	4	2								×			1
	Acer platanoides L.	4	2	×	×	×	×	×			×	×	×	8
	Acer platanoides L. 'Crimson King'	4	2	×									×	2
	Acer platanoides L. 'Crimson Sentry'	4	2					×						1
	Acer pseudoplatanus L.	4	2		×			×			×		×	4
	Acer saccharinum L.	4	2		×	×		×						3
	Aesculus hippocastanum L.	2	2	×						×	×		×	4

Continued. Appendix 1.

Family/Porodica	Taxa/Svojta	Toxicity level / St. otrovnosti	Level of allergenicity / St. Alergenosti	Kindergarten areas in Novi Zagreb –					Kindergarten areas in Novi Zagreb – West Vrtovi Novi Zagreb – Zapad / Vrtovi Novi Zagreb – zapad					Total / Ukupno
				I-1	I-2	I-3	I-4	I-5	Z-1	Z-2	Z-3	Z-4	Z-5	
Scrophulariaceae	*Paulownia tomentosa* Steud.										×			1
Taxaceae	*Taxus baccata* L.	1				×								1
	Taxus baccata L. 'Fastigiata'	1					×							1
Tiliaceae	*Tilia cordata* Mill.		1	×	×		×	×	×					5
	Tilia platyphyllos Scop.		1	×						×				2
	Tilia tomentosa Moench		1			×	×							2
Ulmaceae	*Celtis occidentalis* L.		1					×						1
	Ulmus pumila L.	4	2	×										1