


## Comprehensive Study on Key Pollen Allergens

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### Abstract

Pollens are typically the primary reason for seasonal hypersensitivity caused in many people that are released by a hundred different species of plants for fertilization. Not all pollens are the same or have the same effect on human beings, there are those worse than others. The human body works out on a defence mechanism by creating certain reactions against those offensive pollens as a response by the immune system. The allergic reactions include sneezing, coughing, wheezing, itching, red-watery swelled eyes, runny nose, inflammation in the nasal passage frequently leading to rhinitis, asthma, skin irritation, and other respiratory disorders. This study is intended to acquire knowledge about a few plants with high allergenic properties along with their major allergens. It is evident that the pollination of the plants varies from season to season as it depends on various factors such as species, weather, and geographical location. Understanding these high allergenic plants with respect to their varying factors and cross-reacting properties is the purpose of this study. It is an effort to obtain deeper insights into these common pollen offenders.

**Keywords:** Pollens, Allergy, Immune system, Hazel, Birch, Ragweed

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## INTRODUCTION

The current review outlines the highly allergenic pollens that generally come from three significant groups of plants namely, trees, weeds, and grass. Various species of all three groups produce millions of pollens per day during flowering season that affect nearly 40% of sensitized people.<sup>1</sup> Most people show sensitization towards only one species although it is normal for individuals to react to more than one type of plant pollen as similar protein might be exchanged by some certain pollens. Nearly 60-75 percent of individuals afflicted by allergic rhinitis have indicated a reaction to weed pollens, 40% of those individuals have been affected by grass pollen and only about 10% have registered a response to tree pollen.<sup>2</sup> Allergenic trees which are usually absent in tropical regions<sup>3</sup> produce dry and weightless pollens that are carried away by the wind to far places. Trees are geographically less concentrated and do not flourish in all environments comparative to grass and weeds. The plants that are categorized as weeds are generally disruptive and unwanted ones that neither fall in the group of trees nor grasses. Weeds have no aesthetic appeal but show immense cross-reaction as they have of calcium-binding proteins.<sup>4</sup> Grass pollens generally work their way in late spring and summer. Nearly 11 groups of allergens, in the grass pollen, are characterized in more than one species.<sup>5</sup>

### Hazel

Hazel is widespread in forests, hedges, and plantations in the northern hemisphere. Also found as mild shrubs or trees, woodlands, grows in plains to highlands, especially along forest boundaries. The blooming period of hazel goes from January and lasts up until April. Contorta (*Corylus avellana*), Turkish hazel (*Corylus colurna*), Filbert (*Corylus maxima*), are some of the most common and widespread species of hazel, primarily present as embellished plants. These are prevalent in more frigid regions of Europe and West Asia. The allergenicity of hazel is mild with moderate potency, toxicity, and presence of the allergen. The allergen generally exhibits cross-reactivity among hazelnut and birch or also alder and hornbeam.<sup>6</sup> Cor a 1 is the major hazel allergen and displays a significant level of homology towards the Bet v 1, major birch allergen which highlights the cross-reactivity.<sup>7</sup> Cor a 1 is a heat-

sensitive protein found in both hazel and hazelnut<sup>8</sup> whose involvement impacts the detection of hazelnut allergy.<sup>9</sup> The allergenicity towards Cor a 1 labels a pollen-food syndrome that is conflated with oropharyngeal abnormalities.<sup>10</sup> There are very often local reactions connected with individuals that are solely sensitized to Cor a 1 and are also tolerant of fried hazelnuts.<sup>11</sup>

### Birch

Birch which has high allergenicity exhibits regular and conspicuous cross-reactivity with plants of Fagales order, hazel, mugwort, and ragweed (weeds), timothy and rye (grass),<sup>12</sup> etc. Among foods, apples, kiwi,<sup>13</sup> stone fruits, carrots, a few nuts, and celery<sup>14</sup> all seem to be potential factors for food allergies combined with this pollen. During the spring, the most common airborne allergens are produced by birch pollens that are released in millions and spread up to 100 yards by the wind. The flowering period of birch is from April to May that sometimes extends till June. Birch is a taiga plant usually absent in the Mediterranean climate including nearly 50 species, 12 of which are available in North America. The Bet v 1 major allergen is named after the natural and widespread *Betula verrucosa* (common birch) native to Central Europe. Bet v 1 triggers slight effects of oral allergic reactions which are normally activated by apple, plum, cherry, allergens that have structural similarity with it.<sup>15</sup> The homology of Bet v 1 is closely related to that of Cor a 1 (Hazel) and Cas s 1 (European chestnut)<sup>16</sup> with a substantially identical sequence of amino acids, thereby inducing similar allergenicity. Based on regional proximity to birch pollen, receptor activation to the cross-reactive allergen from birch pollen differs and is mostly found in birch specific areas.

### Ragweed

The ragweed plants, with a flowering season from August to September, are the most effective source of allergies among the weeds that are most active during the late spring and fall months. Common ragweed (*Ambrosia artemisiifolia*) is the native allergen source and is the major cause of allergic rhinitis in North America<sup>17</sup> that shows its effect there on almost one in five people. These allergies also were spread through parts of Europe mainly Austria, Italy, and also in Asia.<sup>18</sup> Roughly a billion pollen

grains can be unveiled by one individual ragweed plant,<sup>19</sup> but only a few pollen grains per m<sup>3</sup> are necessary to cause inflammation, often contributing to both dermatitis and asthma.<sup>20</sup> The ragweed pollens that are usually spread by air are also distributed through tainted bird food and ruderal environments. Ragweed pollen has high allergenicity and pays responsibility for the seasonal or fall hay fever. Amb a 1 being the major allergen of the ragweed pollen contributes to 90% of the allergenic behavior within the plant.<sup>21</sup> Environmental conditions have a significant effect on the nature of the main allergen,<sup>22</sup> and Amb a 1 affects more than 90 percent of ragweed-sensitized patients.<sup>23</sup> Ragweed pollen has shown cross-reactivity with Asteraceae sunflower, goldenrod, and other plants in its genus. Cross-reactivity was also identified by comparison of Amb a 1 with a closely related mugwort weed allergen Art v 6 as of nearly 65% sequence similarity.<sup>24</sup>

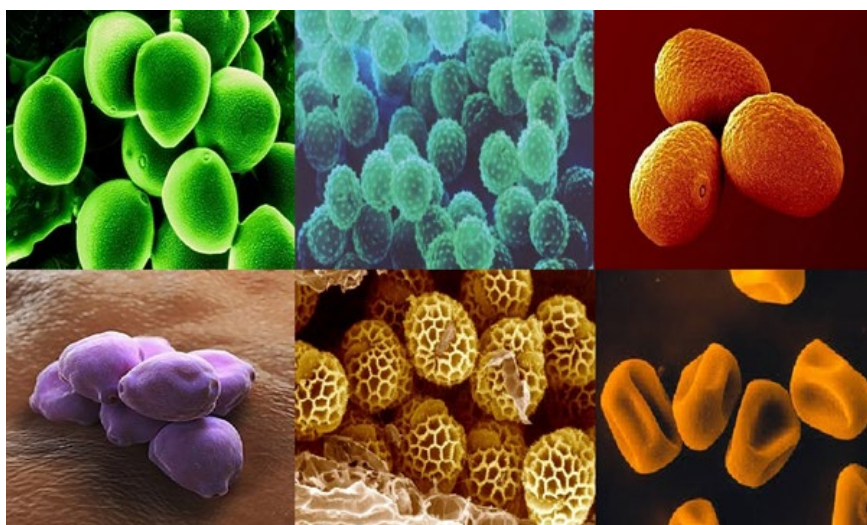
#### Mugwort

Starting from July until September is the blooming period which also varies in a few south European countries from November to April. The mugwort pollens effect is high and widespread through the northern hemisphere as herbaceous plants or shrubs on fertile land spaces. The most common type of mugwort that shows high allergenicity is the *Artemisia vulgaris* (common wormwood) which are grown all over the northern

regions except for the high-temperature dry places. The major pollen of common mugwort Art v 1 shows an unexceptional homology with a purified protein of ragweed making the patients allergic to Art v 1 also react to Amb a 4.<sup>25</sup> In certain countries of Europe and Asia, the main mugwort pollen is accountable for IgE-mediated adverse allergic reactions.<sup>26</sup> 87% of celery allergic people, 52% of carrot allergic people, and 26% of caraway seed allergic people also show hypersensitivity towards mugwort leading to the concept of the celery-carrot-mugwort-birch-spice syndrome.<sup>27,28</sup> Mugwort shares common epitopes with other tree pollens like birch, olive, Italian funeral cypress, and pine.<sup>29</sup> Cross-reactivity is also observed between the alder tree and mugwort due to the presence of calcium-binding proteins in either.

#### Rye-grass

Originating in Europe, though rye-grass is now commonly available, and grown in the temperate regions and islands. The rye-grass is the first meadow cultivated that can be a pasture for grazing. The seasonal blooming of rye-grass starts from May and lasts until July almost the entire summer. The grass that causes the most hypersensitivity among the family of sweet grasses is perennial rye-grass (*Lolium perenne*) that has Lol p 1 as its main allergen that is responsible for type I allergies.<sup>30</sup> Immense cross-reactivity is exhibited by this grass with many other species



**Fig. 1.** Top – Birch, Ragweed, Ryegrass. Bottom – Hazel, Mugwort, Timothy grass pollen, adopted from Marcos JV et. al.,<sup>40</sup>.

and also within the family especially with canary grass.<sup>31</sup> Rye-grass pollens are induced with group 1 allergens that show high homology with Phl p 1, a major allergen of canary grass including 88.8% of sequence similarity. Also, with timothy grass major pollen Phl p 1 with a sequence identity of 86.6%.<sup>32</sup> The allergenicity of rye-grass pollen is almost as similar to that of cocksfoot grass that shows nearly 76% similarity.<sup>33</sup> Group 5 allergen that is usually not present in all grasses, acquires epitopes that involve cross-reactivity with group 1 allergen of timothy grass (Phl p 1) and rye-grass (Lol p 1) respectively.<sup>34</sup> Ryegrass also is induced with group 2, group 4, and group 9 allergens. Rye-grass pollen sensitization is worldwide, patients were affected with various allergic diseases like as allergic rhinitis reported in Switzerland, children in New Zealand affected by asthma<sup>35</sup> also causing allergic conjunctivitis in many other parts of the world like Netherlands, Germany and South Africa.

#### **Timothy grass**

Timothy grass is one of the common grasses which generally grows on a wide range in meadows or fields that is cultivated as pasture generally for animal grazing. The flowering phase of timothy grass begins in the early summer and ends around midsummer which is usually the period used for hay removal. Timothy grass which can grow well in chilly and muggy climates has an origin in Europe, North Asia, and Africa which spread across America and Australia as well. With differing protein content every season, the impact of allergens in timothy grass will also vary on the affected person.<sup>36</sup> Timothy grass is by far the only one from which a complete set of allergens are derived amongst the grasses and were cloned. Phl p1 is the major group 1 allergen of the *Phleum pratense* (Timothy grass) that shows cross-reactions mainly between group 1 allergens derived from various grasses, corns, and other monocotyledons.<sup>37</sup> The group 13 allergen of Timothy grass includes the main allergen in grasses that express IgE cross-reactivity, being similar to the calcium-binding protein of timothy grass.<sup>38</sup> Timothy grass shows cross-reactivity with bahiagrass pollen<sup>39</sup> and also share IgE epitopes with weed plants like mugwort and ragweed. Timothy

grass pollens have resulted in hypersensitivity to various places like Sweden, Norway, and other European regions with nasal symptoms like asthma and rhinitis in cold weather.

#### **CONCLUSION**

The current studies offer a glimpse into some of the intensely reactive pollens that are responsible for hypersensitivity within individuals. Recent investigations also provide information about the major allergens of the respective plant play their part in various allergies. The evidence suggests that the major allergens of different plants involve cross-reactivity or co-sensitization due to homology in their amino acid sequences. The main allergens of these hyper-allergic plants and their distribution across many parts of the world and sign that the extent of pollination changes along with the seasons, weather, and geography of that particular plant are assessed. Advancement in analyzing the pollen sensitization, interpretation, and characterization has enhanced our insights into the plant pollen or allergen sensitization mechanism in susceptible individuals.

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#### **CONFLICTS OF INTEREST**

The authors declare that there is no conflict of interest.

#### **AUTHORS' CONTRIBUTION**

PSGV and GSDV conceptualized and designed the study. AAM did the literature review and drafted the manuscript. SN and SV critically revised the article. RS checked the references. PKV edited and approved the final manuscript for publication.

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#### **DATA AVAILABILITY**

All datasets generated or analyzed during this study are included in the manuscript.

**ETHICS STATEMENT**

Not applicable.

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