



Allergens of weed pollen: An overview on recombinant and natural molecules



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ARTICLE INFO

Article history:

Available online 24 June 2013

Keywords:

Ragweed
Mugwort
Parietaria
IgE binding
Recombinant allergen
Hypoallergen
Allergy diagnosis and therapy

ABSTRACT

Weeds represent a botanically unrelated group of plants that usually lack commercial or aesthetical value. Pollen of allergenic weeds are able to trigger type I reactions in allergic patients and can be found in the plant families of *Asteraceae*, *Amaranthaceae*, *Plantaginaceae*, *Urticaceae*, and *Euphorbiaceae*. To date, 34 weed pollen allergens are listed in the IUIS allergen nomenclature database, which were physicochemically and immunologically characterized to varying degrees. Relevant allergens of weeds belong to the pectate lyase family, defensin-like family, Ole e 1-like family, non-specific lipid transfer protein 1 family and the pan-allergens profilin and polcalcins. This review provides an overview on weed pollen allergens primarily focusing on the molecular level. In particular, the characteristics and properties of purified recombinant allergens and hypoallergenic derivatives are described and their potential use in diagnosis and therapy of weed pollen allergy is discussed.

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1. Introduction

The term weed does not refer to any particular botanical group or family of plants. However, it is commonly applied to undesirable plants in human-controlled environments. Weeds are plants that grow and reproduce invasively and generally lack economic or esthetic value. Notably, they display a high ability to adapt and thus, giving them advantages in environments in which natural vegetation has been damaged. In addition, they represent a threat to human health as their pollen is an important source of seasonal allergens.

Weed pollen responsible for allergic reactions can be found in several botanical families and a number of allergenic molecules have been identified so far. Clinically relevant weed pollen allergens can be found in ragweed, mugwort, pellitory, chenopod, Russian thistle, plantain as well as annual mercury. Interestingly, the major weed pollen allergens are restricted to four main families of proteins: pectate lyases, defensin-like proteins, Ole e 1-like proteins, as well as the group of non-specific lipid transfer proteins. Beside major allergens, the panallergens profilin and polcalcins have been identified in weed pollen as highly cross-reactive molecules recognized by pollen-sensitized patients. Table 1 gives an overview on allergenic molecules from weed pollen listed in this review.

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The incidence of allergic reactions has continuously increased over the last decades and has fueled intense basic and clinical research on allergen molecules and their potential application in allergy diagnosis and therapy. Numerous allergens were identified, produced as recombinant proteins, and their physicochemical and immunological properties were investigated in detail. Here we review the current knowledge on allergenic molecules in pollen of weeds with special emphasis on the properties of recombinant proteins produced in bacteria and yeast (Table 1). Furthermore, strategies for the generation of hypoallergenic derivatives and their possible application in allergen-specific immunotherapy are discussed.

2. Allergens of the *Asteraceae* family

The *Compositae* or *Asteraceae* comprises a large family of flowering plants including approximately 20,000 species. Important allergenic members are ragweed (*Ambrosia*), mugwort (*Artemisia*), feverfew (*Parthenium*), and sunflower (*Helianthus*).

2.1. *Ambrosia*

The genus *Ambrosia* comprises about 40 different species, most of them native to Eastern and Central North America. Short ragweed or common ragweed (*Ambrosia artemisiifolia*, *Ambrosia elatior*) represents the most widespread species, followed by the much less abundant giant ragweed (*Ambrosia trifida*). Both species are major elicitors of type I allergic reactions in late summer and fall. In the USA and Canada more than 15 million people suffer

Table 1
Molecular and allergenic properties of weed pollen allergens.

	Allergen	MW (kDa)	Protein function/family	AP (%)	Purified molecules			
					Nat	Recombinant full-length	Recombinant derivative	
<i>Asteraceae</i>								
<i>Ambrosia artemisiifolia</i>	Amb a 1/ Amb a 2	38	Pectate lyase	>95	+	<i>E. coli</i> , INS, His-tag fusion protein	Alpha chain: <i>E. coli</i> , INS, His-tag fusion protein Beta chain: <i>E. coli</i> , INS, His-tag fusion protein	
	Amb a 3	11	Plastocyanin protein family	30–50	–	–	–	
	Amb a 4	13–15	Defensin-like protein fused with proline-rich C-terminal domain	20–40	+	<i>E. coli</i> , SOL, His-tag fusion protein	–	
	Amb a 5	5	Secreted basic protein	10–15	+	<i>E. coli</i> , INS, GST fusion protein	–	
	Amb a 6	10	Non-specific lipid transfer protein 1	20	+	<i>P. pastoris</i> , SOL, non-fusion protein <i>E. coli</i> , SOL, His-tag fusion protein [§]	–	
	Amb a 7	12	Plastocyanin protein family	15–20	+	–	–	
	Amb a 8	14	Profilin	35–50	+	<i>E. coli</i> , SOL, non-fusion protein <i>E. coli</i> , SOL, His-tag fusion protein [§] <i>E. coli</i> , INS, S-tag fusion protein	–	
	Amb a 9	9	Polcalcine, 2 EF-hand calcium binding protein	10–15	–	<i>E. coli</i> , SOL, His-tag fusion protein [§]	–	
	Amb a 10	17	Polcalcine, 3 EF-hand calcium binding protein	10–15	–	<i>E. coli</i> , SOL, His-tag fusion protein [§]	–	
	<i>Ambrosia trifida</i>	Amb t 5	5	Amb a 5 homologue	5	+	<i>E. coli</i> , SOL, GST fusion protein	–
<i>Ambrosia psilostachya</i>	Amb p 5	5	Amb a 5 homologue	10–15	+	–	–	
<i>Artemisia vulgaris</i>	Art v 1	13–16	Pefensin-like protein fused with proline-rich C-terminal domain	95	+	<i>E. coli</i> , SOL, non-fusion protein <i>E. coli</i> , SOL, His-tag fusion protein [§] <i>N. tabacum</i> , SOL, non-fusion protein	Defensin: <i>E. coli</i> , SOL, His-tag fusion Protein [§] proline: <i>E. coli</i> , INS, His-tag fusion protein [§] Cys-mutants: <i>E. coli</i> , SOL, His-tag fusion protein [§]	
	Art v 2	16	Pathogenesis-related protein family 1	60	+	<i>E. coli</i> , INS, non-fusion protein	–	
	Art v 3	12	Non-specific lipid transfer protein 1	22–70	+	<i>E. coli</i> , SOL, non-fusion protein	–	
	Art v 4	14	Profilin	35	+	<i>E. coli</i> , SOL, non-fusion protein	–	
	Art v 5	10	Polcalcine	10–28	–	<i>E. coli</i> , SOL, His-tag fusion protein [§]	–	
	Art v 6	38	Pectate lyase, Amb a 1 homologue	26	+	<i>E. coli</i> , INS, His-tag fusion protein	–	
	Art v 60	60	Acidic glycoprotein	70	–	–	–	
	<i>Helianthus annuus</i>	Hel a 1	34	No sequence information available	65	+	–	–
		Hel a 2	14	Profilin	31	+	<i>E. coli</i> , SOL, non-fusion protein	–
	<i>Amaranthaceae</i>							
<i>Chenopodium album</i>	Che a 1	18	Ole e 1-like protein	70	+	<i>P. pastoris</i> , SOL, non-fusion protein <i>E. coli</i> , INS, His-tag fusion protein	Che a 1–3: <i>E. coli</i> , SOL, His-tag fusion protein	
	Che a 2	14	Profilin	55	+	<i>E. coli</i> , SOL, non-fusion protein	–	
	Che a3	10	Polcalcine	46	+	<i>E. coli</i> , SOL, non-fusion protein	–	
<i>Salsola kali</i>	Sal k 1	38	Pectin methylesterase family	65	–	<i>E. coli</i> , SOL, thioredoxin + His-tag fusion protein	B cell epitope mutant: <i>E. coli</i> , SOL, thioredoxin + His-tag fusion protein	
	Sal k 2	36	Protein kinase homologue	–	–	–	–	
	Sal k 3	85 (35 + 45)	Cobalamin independent methionine synthase	63	–	–	35 and 45 kDa Fragment: <i>E. coli</i> , SOL, thioredoxin + His-tag fusion protein	
	Sal k 4	14	Profilin	46	–	<i>E. coli</i> , SOL, thioredoxin + His-tag fusion protein	–	
	Sal k 5	18	Ole e 1-like protein	30–60	–	–	–	
<i>Amaranthus retroflexus</i>	Ama r 2	14	Profilin	33	–	<i>E. coli</i> , SOL, His-tag fusion protein	–	
<i>Plantaginaceae</i>								
<i>Plantago lanceolata</i>	Pla l 1		Ole e 1-like protein	86	+	<i>P. pastoris</i> , SOL, non-fusion protein	–	
<i>Urticaceae</i>								
<i>Parietaria judaica</i>	Par j 1	15	Non-specific lipid transfer protein 1	95	+*	<i>E. coli</i> , INS, His-tag fusion protein <i>P. pastoris</i> , SOL, non-fusion protein	Cys-mutants: <i>E. coli</i> , INS, His-tag fusion protein Par j 1-Par j 2 hybrid: <i>E. coli</i> , INS, His-tag fusion protein Par j 1-Par j 2 hybrid deletions Q2/Q3: <i>E. coli</i> , SOL/INS, His-tag fusion protein	
	Par j 2	11	Non-specific lipid transfer protein 1	80	+*	<i>E. coli</i> , INS, His-tag fusion protein <i>P. pastoris</i> , SOL, non-fusion protein	Fragment 1–55 and fragment 52–102: <i>E. coli</i> , INS, His-tag fusion protein	

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