

Allergen Data Collection - Update:

Bird-Egg Syndrome

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Allergen Data Collection - Update: Bird-Egg Syndrome

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Abstract

An IgE-mediated hypersensitivity designated "bird-egg syndrome" occurs occasionally in adults after repeated exposure to birds (budgerigar, canary, parrot etc.) mostly held in the home. The bird-egg syndrome consists primarily of respiratory symptoms following exposure to bird, and secondarily of allergy symptoms after the ingestion of eggs. This syndrome displays a cross-sensitization to egg yolk and bird allergens (feathers, serum, droppings, and meat). This phenomenon underlines the importance of the sensitization via the respiratory route in food allergy. It could be distinguished from the common egg allergy in children. The pathomechanism of IgE-mediated bird-egg syndrome is also different from pigeon fancier's lung (a form of extrinsic allergic alveolitis), which is not subject of the present data collection.

There are some differences in the clinical features of bird-egg syndrome and common egg allergy without sensitization to bird proteins: patients with bird-egg syndrome are typical adult patients with rhinoconjunctivitis and/or asthma due to bird allergy; the symptoms associated with ingestion of eggs usually include several target organs (digestive, cutaneous or respiratory); and the major allergens are the alpha-livetins (serum albumin) from the egg yolk proteins.

Molecular biological and allergenic properties of egg yolk allergens alpha-livetin (chicken serum albumin), apovitellenin I and VI are presented. Alpha-livetin is also present in avian meat and serum. It is assumed that livetins lead to the cross-sensitization between bird antigens, egg yolk, and chicken meat. Thus, egg yolk allergic individuals have eventually to avoid avian meat too. Up to now only little is known about the properties of feather allergens.

The present data collection reviews detailed information on the prevalence and symptoms of bird-egg syndrome as well as diagnostic features, sensitization patterns, and the occurrence of cross-reactivities in tabular form.

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1 Prevalence of Bird-Egg Syndrome

Prevalence data are based on different diagnostic procedures. While the prevalence of sensitization can be estimated by SPT, RAST, and immunoblot, a clinical relevant sensitization (allergy) is evaluated by convincing history or food challenge tests (ideally by DBPCFC).

Country / Subjects	Allergy / Sensitization	References
<i>Austria, Vienna</i> 31 patients with egg allergy and/or bird allergy (clinical history)	Three groups of patients according to clinical history, SPT, and RAST: a) bird feathers and egg yolk 42% b) egg white 42% c) bird feathers 16%	Szepfalusi et al. 1994
<i>Spain, Madrid</i> 25 bird feather allergic patients (SPT, RAST)	egg yolk 32% egg white 16% chicken meat 28% (RAST)	Anibarro-Bausela et al. 1991
<i>Switzerland, Bern</i> 59 atopic patients	bird feathers and egg proteins 29% (SPT)	Mandallaz et al. 1988
<i>UK</i> 13 food industry workers handling egg solution spray	egg yolk 62% (precipitins)	Edwards et al. 1983

prevalence data of whole egg see [Allergen Data Collection: Hen's Egg White \(Gallus domesticus\)](#)

2 Outgrowing of Sensitivity

Country / Subjects	Allergy / Sensitivity	References
<i>Spain, Madrid</i> a) 27 children with both egg and bird allergy b) 19 egg-allergic children without bird protein sensitization	Loss of hypersensitivity in a) 15% at mean age of 9 years and b) 58% at mean age of 5 years (egg ingestion, 4 years follow-up)	Anibarro Bausela et al. 1997

3 Symptoms of Bird-Egg Syndrome

Symptoms & Case Reports	References
<p><u>systemic reactions</u> anaphylaxis (2, 3)*</p> <p><u>symptoms on skin and mucous membranes</u> angioedema (2, 6), atopic dermatitis (11), conjunctivitis (3, 8, 9), flush (6), chronic urticaria (10), contact urticaria (6), urticaria (2, 6)</p> <p><u>gastrointestinal symptoms</u> food allergy to egg after sensitization to bird feathers (3, 6, 7): abdominal pain (7), diarrhoe (3), throat pruritus (7), vomiting (3, 6, 7)</p> <p><u>respiratory symptoms</u> asthma (1, 3, 4, 5, 6, 7, 8, 9, 11), dyspnea (8), rhinoconjunctivitis (1, 5, 11), rhinitis (3, 8, 9), wheezing (9)</p> <p><u>other symptoms</u> bloating, headache, warmth (3)</p>	<p>(1) Edwards et al. 1983 (2) de Maat-Bleeker et al. 1985 (3) Hoffman & Guenther 1988 (4) Smith et al. 1988 (5) Anibarro-Bausela et al. 1991 (6) Wyss et al. 1991 (7) Anibarro et al. 1993 (8) Szepfalusi et al. 1994 (9) Tauer-Reich et al. 1994 (10) Schönlein et al. 1996 (11) Anibarro Bausela et al. 1997</p>
<p>Percentage of Reactions Cutaneous symptoms in 4 and gastrointestinal symptoms in 4 of 6 patients with bird-egg syndrome (1) Cutaneous symptoms in 89%, gastrointestinal symptoms in 78%, and respiratory symptoms in 37% of 27 children with bird and egg allergy and in 100%, 37%, and 0% of children with egg allergy (without bird allergy) (2)</p>	<p>(1) Mandallaz et al. 1988 (2) Anibarro Bausela et al. 1997</p>

*anaphylaxis to whole egg see [Allergen Data Collection: Hen's Egg White \(Gallus domesticus\)](#)

4 Diagnostic Features of Bird-Egg Syndrome

Parameters / Subjects	Outcome	References
<p>Gender of Patients 13 patients with bird-egg syndrome</p>	77% female adults	Szepfalusi et al. 1994
<p>Primary Sensitization 4 patients with allergy to egg and bird antigens</p>	2 patients were primarily sensitized to bird antigens (bird-egg syndrome) and 2 patients (egg allergy started in infancy) were primarily sensitized to egg yolk (egg-bird syndrome)	Wyss et al. 1991
<p>Skin test, RAST, Precipitins 8 food industry workers with asthma</p>	No correlation between tests and clinical symptoms	Edwards et al. 1983
<p>IgE a) 27 children with both egg and bird allergy b) 19 egg-allergic children without bird protein sensitization</p>	<p><u>mean specific serum IgE to</u> a) egg white 23.6 kU/L, egg yolk 12.5 kU/L b) egg white 9.6 kU/L, egg yolk 0.8 kU/L <u>at 4 years follow-up in patients with persisting allergy:</u> a) egg white 38.9 kU/L, egg yolk 51.4 kU/L b) egg white 12.7 kU/L, egg yolk 2.7 kU/L</p>	Anibarro Bausela et al. 1997

5 Composition of Hen's Egg Yolk

5.1 Distribution of Nutrients

For other celery products see: [USDA Nutrient Database](#)

Nutrients: Content per 100 g		
Energy 1489 kJ (352 kcal)	Vitamins	Phe 790 mg
Water 50.0 g	Vitamin A 1 mg	Thr 1010 mg
Protein 16.1 g	Vitamin D 7-113 µg	Trp 290 mg
Lipid 31.9 g	Vitamin E 2 mg	Tyr 780 mg
Carbohydrate 0.2 g	Vitamin B1 290 µg	Val 1240 mg
Minerals 1.7 g	Vitamin B2 400 µg	
	Nicotinamide 65 µg	Carbohydrates
Minerals	Pantothenic acid 4 mg	Glucose 210 mg
Sodium 50 mg	Vitamin B6 300 µg	
Potassium 140 mg	Biotin 35-70 µg	Lipids
Magnesium 12 mg	Folic acid 150 µg	Palmitic acid 6500 mg
Calcium 16 mg	Vitamin B12 2 µg	Stearic acid 2200 mg
Manganese 50-200 µg	Vitamin C 0	Oleic acid 12.9 g
Iron 7 mg		Linolic acid 2450 mg
Copper 350 µg	Amino Acids	Linoleic acid 220 mg
Zinc 4 mg	Arg 1280 mg	Arachidonic acid 375 mg
Phosphorus 590 mg	His 440 mg	Docosaheaxaenoic acid 395 mg
Chloride 180 mg	Ile 1090 mg	
Fluoride 30 µg	Leu 1630 mg	Other
Iodine 12 µg	Lys 1300 mg	Cholesterol 1260 mg
Selenium 30 µg	Met 470 mg	

Reference: Deutsche Forschungsanstalt für Lebensmittelchemie, Garching bei München (ed), **Der kleine "Souci-Fachmann-Kraut" Lebensmitteltabelle für die Praxis**, WVG, Stuttgart 1991

5.2 Proteinfraction

Proteins / Lipoproteins	Amount of total protein
a) Granules	25 %
Lipovitellines (HDL, 22% lipids)	15 %
Low density lipoproteins (LDL)	6 %
Phosvitin (glycophosphoprotein)	4 %
b) Plasma	75 %
Lipovitellines (LDL, 84-90% lipids)	65 %
Livetines (water soluble) alpha-, beta-, and gamma-livetin (2:5:3, w/w/w)	10 %

Reference: [Ternes et al. 1994](#)

6 Allergens involved in Bird-Egg Syndrome

Proteins / Glycoproteins	Allergen Nomenclature*	References
Alpha-Livetin [70 kDa] (egg yolk) identical to chicken serum albumin	Gal d 5	de Blay et al. 1994 , Szepefalusi et al. 1994
Apovitellenin I [9 kDa] (egg yolk)**		Walsh et al. 1988
Apovitellenin VI [170 kDa] (egg yolk)**		Walsh et al. 1988
bird feathers: 70, 95, 200 kDa Allergens		Szepefalusi et al. 1994
bird feathers: 20-30 kDa and 67 kDa Allergens**		Tauer-Reich et al. 1994

* current list of the WHO/IUIS Allergen Nomenclature ([Larsen & Lowenstein 2000](#))

** patients not related or with unknown relationship to bird-egg syndrome

6.1 Sensitization to Allergens of Bird's Egg Yolk and/or Feathers

Country / Subjects	Sensitivity	References
Australia, North Ryde 4 egg-yolk sensitive patients*	low-density lipoprotein-, livetin- and granule- fractions of egg yolk in all patients (RAST) apovitellenin I in all patients (SDS-PAGE / immunoblot)	Anet et al. 1985
Australia, North Ryde 9 and 7 patients sensitive to egg-yolk ingestion*	egg yolk proteins: apovitellenins I and VI in 100% of patients and phosvitin in some patients (RAST, RAST inhibition)	Walsh et al. 1988
Austria, Vienna 13 patients with bird feather and egg yolk allergy	<u>egg yolk:</u> alpha-livetin (70 kDa) in 100% of patients, 50 kDa allergen in 61%, 40 kD allergen 38%, and minor allergens (26, 42, 150, > 200 kDa) <u>feathers:</u> 70, 95, 200 kDa allergens in 92% of patients (SDS-PAGE / immunoblot)	Szepefalusi et al. 1994
Austria, Vienna 5 patients with bird feather allergy (without egg yolk allergy)*	<u>feathers:</u> 60, 70, 95 kDa and 17 and 75 kDa allergens in 2 patients <u>egg yolk:</u> 70 and 95 kDa allergens in 2 patients (SDS-PAGE / immunoblot)	Szepefalusi et al. 1994
France, Strasbourg 1 patient with bird-egg syndrome	66 kDa allergen in hen serum, livetin and feathers (SDS-PAGE / immunoblot)	de Blay et al. 1994
Germany, Bochum 5 asthmatic bird-fanciers*	feathers and serum proteins of budgerigar, parrot, pigeon, canary, and hen: 20-30 kDa and 67 kDa allergens (SDS-PAGE / immunoblot)	Tauer-Reich et al. 1994
Netherlands, Dijkzigt a) 4 patients with respiratory allergy to birds b) 5 food allergic patients	<u>budgerigar, canary and parrot serum:</u> 60 kDa allergen (25 kDa allergen in canary only) (a) <u>egg yolk:</u> 60 kDa allergen (a) and 35 kDa allergen (b) (SDS-PAGE / immunoblot)	van Toorenenbergen et al. 1994
Netherlands, Utrecht 6 atopic patients*	feather extracts: polydisperse mixture of soluble keratins (SPT)	Berrens 1968
UK, Glasgow 8 feather mite sensitized patients*	20 feather mite allergens, in > 50% of patients: 18, 24, 53, 90, 115, and 200 kDa (SDS-PAGE / immunoblot)	Colloff et al. 1997
USA, Baltimore, MD 28 egg-allergic patients*	antiviral chicken immunoglobulins from egg yolk in 54% of patients (spec. IgE / RAST)	Bernhisel-Broadbent et al. 1991
USA, Greenville, NC 1 patient with bird-egg syndrome	egg yolk, chicken and pigeon serum, phosvitin and chicken meat (RAST, RAST inhibition)	Hoffman & Guenther 1988

* patients not related or with unknown relationship to bird-egg syndrome

6.2 Properties of alpha-Livetin (Chicken Serum Albumin)

6.2.1 Molecular Biological Properties

alpha-Livetin	References
Allergen Nomenclature Gal d 5	(1) Larsen & Lowenstein 2000
Molecular Mass 70 kDa (1, 3), 66 kDa (2) (SDS-PAGE: 2, 3)	(1) Williams et al. 1962 (2) de Blay et al. 1994 (3) Szepfalusi et al. 1994
Isoelectric Point pI 4.3 - 5.7 (1: livetins), pI 4.6-4.8 (2: serum albumin)	(1) Ternes 1989 (2) Miller & Gmeiner 1993
Amino Acid Sequence, mRNA, and cDNA	
Protein Serum albumin	
SWISS-PROT: P19121	
GenBank: X60688 , V00381	
Amino Acids N-terminus: DAHK (1*) 592 aa	(1) Sorkina et al. 1976 (2) Gordon et al. 1978 (3) Hache et al. 1983
mRNA precursor 1892 bp	
cDNA precursor 571 bp (fragment, 3)	
*conflict to SWISS-PROT	
Posttranslational Modifications	
Disulfide bonds 17 disulfide bonds (1)	(1) SWISS-PROT
Biological Function Serum albumin: binding of water and Ca-, Na-, and K- cations, fatty acids, hormones, bilirubin and drugs; regulation of the colloidal osmotic blood pressure (1) 3 homologous domains: domain I: 8-183 domain II: 202-375 domain III: 394-573	(1) SWISS-PROT

* alpha-livetin and chicken serum albumin are identical ([Williams et al. 1962](#))

6.2.2 Allergenic Properties

alpha-Livetin	References
Frequency of Sensitization IgE-binding to alpha-livetin in 100% of patients with bird feather and egg yolk allergy (1)	(1) see 6.1 Sensitization to Allergens of Bird's Egg Yolk and Feathers

6.3 Properties of Apovitellenin I (egg yolk)

6.3.1 Molecular Biological Properties

Apovitellenin I	References
<i>Allergen Nomenclature</i> none	
<i>Molecular Mass</i> 9 kDa, tetramer 36 kDa (1)	(1) Burley & Davies 1976
<i>Isoelectric Point</i>	
<i>Amino Acid Sequence, mRNA, and cDNA</i>	
Protein Apovitellenin I	
SWISS-PROT: P02659	
PIR: VLCH1 , I50374	
GenBank: J00810 , J00809 , M14120	
Amino Acids 82 aa (1, 2)	(1) Dopheide & Inglis 1976
mRNA precursor 2918 bp (4)	(2) Jackson et al. 1977
cDNA precursor 4961 bp (3)	(3) Dugaiczuk et al. 1981
	(4) van het Schip et al. 1983
<i>Posttranslational Modifications</i>	
<u>Disulfide bonds</u> formation of homodimer by interchain disulfide bond: aa 75-75 (1)	(1) SWISS-PROT
<i>Biological Function</i> component of very low density lipoprotein (VLDL) of egg-laying females, lipoprotein lipase inhibitor (1)	(1) SWISS-PROT

6.3.2 Allergenic Properties

Apovitellenin I	References
<i>Frequency of Sensitization</i> IgE-binding to apovitellenin I in 100% of patients with egg yolk allergy (1)	(1) see 6.1 Sensitization to Allergens of Bird's Egg Yolk and Feathers

6.4 Properties of Apovitellenin VI (egg yolk)

6.4.1 Molecular Biological Properties

Apovitellenin VI	References
<i>Allergen Nomenclature</i> none	
<i>Molecular Mass</i> 170 kDa	(1) Burley & Sleight 1980
<i>Isoelectric Point</i>	

6.4.2 Allergenic Properties

Apovitellenin VI	References
<i>Frequency of Sensitization</i> IgE-binding to apovitellenin VI in 100% of patients with egg yolk allergy (1)	(1) see 6.1 Sensitization to Allergens of Bird's Egg Yolk and Feathers

7 Isolation & Preparation

Extract / Purified Allergens	Methods	References
Livetins, apovitellenin II	Fractionation of soluble proteins (delta-, gamma-, alpha-, and beta-livetin and apovitellenin II) of hen's egg-yolk by gel permeation chromatography	Burley & Vadehra 1979
Apovitellenins I-VI	Hydrophobic chromatographic separation, elution with aqueous urea at low pH	Burley & Sleight 1983
Apovitellenin I, egg yolk patterns	Dispersion of the yolk in 8 M guanidine hydrochloride solution, extraction with chloroform-methanol and petrol, HPLC separation	Sheumack & Burley 1988
Egg yolk, egg white proteins	Freeze dried yolk and white extracted with phosphate buffer (0.01 M, pH 7.0) containing suspended polyvinylpyrrolidone, EDTA, diethyldithiocarbamate and sodium azide (24 h, 4°C); centrifugation, dialyzing, lyophilization, reconstitution in water	Szepfalusi et al. 1994
Feathers (parrot, budgerigar, canary)	Extraction with phosphate buffer (0.05 M) containing sodium azide, dialyzing and lyophilized	Tauer-Reich et al. 1994
Feathers (goose and duck down)	Extraction with phosphate buffer (0.1 M, pH 7.0, overnight, 4 to 8°C), filtration, dialyzing and lyophilization, reconstitution in glycerosaline	Kilpio et al. 1998

8 Cross-Reactivities

Cross-Reacting Allergens	Subjects / Methods	References
Egg yolk egg white, chicken serum, chicken meat	egg allergic patients (quantitative immunoelectrophoresis)	Langeland 1983
Egg yolk egg white (**)	6 egg allergic patients: Up to 66% inhibition of IgE-binding to egg yolk by egg white and up to 26% inhibition to egg white by egg yolk; average self inhibition: egg yolk 65% and egg white 70% (RAST inhibition)	Anet et al. 1985
Egg yolk bird serum	1 patient with sensitivity to egg and bird antigens (RAST inhibition)	de Maat-Bleeker et al. 1985
Egg yolk chicken serum, pigeon serum	1 patient with egg allergy: Up to 100% inhibition of IgE-binding to egg yolk by chicken serum and egg yolk, up to appr. 60% inhibition by pigeon serum (RAST inhibition)	Hoffman & Guenther 1988
Apovitellenin I (egg yolk) ovalbumin (egg white) (**)	4 egg allergic patients: Up to 68% inhibition of IgE-binding to apovitellenin I by ovalbumin and up to 70% inhibition to ovalbumin by apovitellenin; self inhibition up to 69% and 66% for apovitellenin I and ovalbumin, respectively (RAST inhibition)	Walsh et al. 1987
Livetins (egg yolk) bird feathers	17 patients concomitantly sensitized to bird dander and egg proteins: livetins are major cross reacting proteins (RAST inhibition)	Mandallaz et al. 1988
alpha-livetin chicken serum, feathers*	1 patient sensitized to egg after exposure to bird antigens (immunoblot)	de Blay et al. 1994

alpha-livetin egg yolk allergens and bird feather allergens (budgerigar, hen)	Pooled serum from 13 patients sensitized to egg proteins and feathers: Complete inhibition of IgE binding to egg yolk allergens (70, 40, and 50 kDa) by bird feather extracts and to feather allergens (70, 95, and 200 kDa) by egg yolk (immunoblot inhibition)	Szepfalusi et al. 1994
alpha-livetin (chicken albumin) chicken serum, feathers	1 egg allergic patient: >90% inhibition of IgE binding to egg yolk by livetins, feather extracts, and chicken serum albumin; no inhibition with ovomucoid (immunoblot, RAST inhibition)	Quirce et al. 1998
alpha-livetin (chicken albumin) dog albumin* (**)	Patients with dog albumin specific serum IgE: cross-reactivity with purified chicken albumin (histamine release test)	Spitzauer et al. 1994

* multiple sensitization (not proven by inhibition-tests)

** patients not related or with unknown relationship to bird-egg syndrome

9 Allergen Sources

Reported Adverse Reactions	References
Food / Food additives Egg solution spray to coat meat rolls caused asthmatic type symptoms in workers (1) Allergic reactions to egg containing products like cake, cookies, egg nogg (itching / swelling of lips) in a 65-year old woman (2) Allergic reactions to egg containing products like mayonnaise and ice cream in a 27-year old woman (3)	(1) Edwards et al. 1983 (2) de Maat-Bleeker et al. 1985 (3) Quirce et al. 1998

* further reactions to whole egg see [Allergen Data Collection: Hen's Egg White \(Gallus domesticus\)](#)

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Common Abbreviations

2D	two-dimensional
3D	three-dimensional
aa	amino acid(s)
Ab	antibody
Act c 1, 2	nomenclature of kiwi fruit allergens (<i>Actinidia chinensis</i>)
Api g 1-5	nomenclature of celery allergens (<i>Apium graveolens</i>)
Ara h 1-7	nomenclature of peanut allergens (<i>Arachis hypogaea</i>)
Bos d 4, 5, 6, 7, 8	nomenclature of cow's milk allergens (<i>Bos domesticus</i>)
C	concentration of N,N'-methylenebisacrylamide (crosslinker)
Cas s 1, 5	nomenclature of chestnut allergens (<i>Castanea sativa</i>)
CAST	cellular antigen stimulation test
CCD	cross-reactive carbohydrate determinants
CICBAA	Cercle d'Investigations Cliniques et Biologiques en Allergologie Alimentaire (France)
CIE	crossed immunoelectrophoresis
CNBr	cyanogen bromide
cIEF	capillary isoelectric focussing
CLA	cutaneous lymphocyte antigen
CLIE	crossed line immunoelectrophoresis
CMA	cow's milk allergy
CRIE	crossed radioimmunolectrophoresis
Cor a 1	nomenclature of hazel pollen allergens (<i>Corylus avellana</i>)
Cyn d 1	nomenclature of bermuda grass pollen allergens (<i>Cynodus dactylus</i>)
DBPCFC	double-blind, placebo-controlled food challenge
DEAE	diethylaminoethyl (cellulose) (anion exchanger)
DNA	deoxyribonucleic acid
EAST	enzyme allergosorbent test
EC	enzyme classification system
EDTA	ethylenediaminetetraacetic acid, disodium salt
ELISA	enzyme linked immunosorbent assay
EW	egg white
Fuc	fucose
Gad c 1	nomenclature of baltic cod allergen (<i>Gadus callarias</i>)
Gal	galactose
Gal d 1-5	nomenclature of egg allergens (<i>Gallus domesticus</i>)
GlcN	glucosamine
GlcNAc	N-acetylglucosamine
Gly m 1, 2, 3	nomenclature of soybean allergens (<i>Glycine max</i>)
Hev b 1-10	nomenclature of latex allergens (<i>Hevea brasiliensis</i>)
HLA	human leucocyte antigen
Hol l 1	nomenclature of sweet velvet grass allergens (<i>Holcus lanatus</i>)
HPLC	high performance liquid chromatography
HR	Histamine Release
IEC	ion exchange chromatography

IEF	isoelectric focussing
Ig	immunoglobulin
IL	interleukin
INF-gamma	interferon-gamma
Lol p 1	nomenclature of rye grass allergens (<i>Lolium perenne</i>)
LTA4	leukotriene A4
LTB4	leukotriene B4
LTC4	leukotriene C4
LY	lysozyme
Man	mannose
Mal d 1, 2, 3	nomenclature of apple fruit allergens (<i>Malus domestica</i>)
MALDI-MS	matrix-assisted laser-induced desorption/ionization mass spectrometry
MAST	multiple allergen sorbent test
MHC	major histocompatibility complex
Mr	molecular mass
Mus a 1	nomenclature of banana allergens (<i>Musa spp.</i>)
NeuNAc	N-acetylneuraminic acid
NMR	nuclear magnetic resonance (spectroscopy)
NPV	negative predictive value
NRL	natural rubber latex
OA	ovalbumin
OAS	oral allergy syndrome
OM	ovomuroid
Ory s 1	nomenclature of rice allergens (<i>Oryza sativa</i>)
OT	ovotransferrin
PAGE	polyacrylamide gel electrophoresis
PBMC	peripheral blood mononuclear cells
PBS	phosphate buffered saline
Phl p 1	nomenclature of timothy grass allergens (<i>Phleum pratense</i>)
pI	isoelectric point
PCA	passive cutaneous anaphylaxis (test)
PCR	polymerase chain reaction
PPT	prick to prick test (skin test with fresh foods)
PPV	positive predictive value
Prs a 1 (Pers a 1)	nomenclature of avocado allergens (<i>Persea americana</i>)
Pru av 1, 2, 4	nomenclature of sweet cherry allergens (<i>Prunus avium</i>)
PVDF	polyvinyliden difluoride
PVPP	polyvinyl polypyrrolidone
RAST	radioallergosorbent test
RBL cells	rat basophil leukaemia cells
RIEP	radioimmuno electrophoresis
RNA	ribonucleic acid
RT	room temperature
SAFT	skin application food test
SDS	sodium dodecylsulfate

SEC	size exclusion chromatography
SPT	skin prick test
T	total acrylamide concentration
TCC	T-cell clone
TCL	T-cell line
TGF-beta-1	transforming growth factor beta-1
TH	thermolysin
TNF-alpha	tumor necrosis factor alpha
TR	trypsin
Tris	tris-(hydroxymethyl)aminomethane
WgA	wheat germ agglutinin
Xyl	xylose

Abbreviations of DNA-encoded Amino Acids

Alanine	Ala	A	Leucine	Leu	L
Arginine	Arg	R	Lysine	Lys	K
Asparagine	Asn	N	Methionine	Met	M
Aspartic acid	Asp	D	Phenylalanine	Phe	F
Cysteine	Cys	C	Proline	Pro	P
Glutamine	Gln	Q	Serine	Ser	S
Glutamic acid	Glu	E	Threonine	Thr	T
Glycine	Gly	G	Tryptophan	Trp	W
Histidine	His	H	Tyrosine	Tyr	Y
Isoleucine	Ile	I	Valine	Val	V