*Allergen Data Collection - Update:*

# Hen's Egg White *(Gallus domesticus)*

by Vibeke BARKHOLT, Matthias BESLER, Hugh A. SAMPSON

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Dr. Matthias Besler, Mildestieg 17, D-22307 Hamburg, Germany
Phone: +49-40-6970-4097, Fax: +49-40-6970-4098
eMail: m.besler@food-allergens.de, home: www.food-allergens.de

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# Hen's Egg White *(Gallus domesticus)*

Authors in alphabetical order [contact information]

Vibeke BARKHOLT (Lyngby, Denmark)
Matthias BESLER (Hamburg, Germany)
Hugh A. SAMPSON (New York, NY, USA)

## Abstract

*Hen's egg white is a major cause of type I allergic reactions in man, particularly in children. Its universal application as a nutrient and food additive has caused several cases of anaphylactic reactions due to incidental ingestion. The present data collection provides an overview of prevalence data, symptoms and common sources of hidden egg white allergens in tabular form. Estimations of total frequency vary considerably with patient cohorts (case history, countries of origin) and diagnostic criteria. Detailed information about chemical and molecular biological as well as allergenic features of the relatively well- characterized four major egg white allergens (ovomucoid Gal d 1, ovalbumin Gal d 2, ovotransferrin Gal d 3 and lysozyme Gal d 4) are given. Studies of B-cell and T-cell epitopes as well as immunoglobulin and cytokine production are summarized..*
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## Contents

## 1 Prevalence of Egg White Allergy

| Country / Subjects | Sensitivity to | References |
|---|---|---|
| ***Australia, Melbourne***<br>620 children at risk of atopy | egg 3.2% (SPT) | Hill et al. 1999 |
| ***Australia, Victoria***<br>100 cow's milk allergic children | egg 58% (parent reported adverse reactions) | Bishop et al. 1990 |
| ***Denmark, Odense***<br>39 cow's milk allergic infants | egg white 29% (adverse reactions) | Host & Halken 1990 |
| ***Estonia***<br>251 allergic infants | egg white 3.6% (RAST) | Julge et al. 1997 |
| ***Finland, Oulu***<br>57, 43, and 42 children with atopic dermatits | egg 64%, 16%, and 14% in patients < 1 year, 1-3 years, and 3-15 years of age (SPT) | Hannuksela 1987 |
| ***France***<br>81 cases of anaphylactic shock to food | egg 11.6% | Moneret-Vautrin & Kanny 1995 |
| ***France***<br>80 cases of food- related anaphylaxis (from 1993-97) | egg 8.8% (reported to CICBAA databank) | European Commission 1998 |
| ***France, Pierre Benite***<br>a) 580 patients with adverse reactions to food<br>b) 60 cases of anaphylaxis (study period 1984-92) | a) egg 23%<br>b) egg 1.7% | Andre et al. 1994 |
| ***France, Toulouse***<br>142 food allergic children | egg white 53 % (Labial food challenge) | Rance & Dutau 1997 |
| ***Germany***<br>790 children (general population) | egg 8.4% (RAST) | Nickel et al. 1997 |
| ***Germany***<br>216 children (general population)<br>estimation based on 4082 children | egg 6% to 4% (at 1 to 6 years of age) (RAST) | Kulig et al. 1999 |
| ***Germany***<br>1235 unselected preschool children (5-6 years) | egg 2.8% (SPT) | Schafer et al. 1999 |
| ***Italy***<br>134 patients with atopic dermatitis | egg 28% (RAST) | Bonifazi et al. 1978 |
| ***Italy, Florence***<br>54 episodes of food-dependent anaphylaxis in 44 children (age of 1 month to 16 years) (from 1994-1996) | egg 11% | Novembre et al. 1998 |
| ***Italy, Rome***<br>371 children with food allergy | egg 46% (RAST) | Giampietro et al. 1992 |
| ***Iceland, Reykjavik***<br>502 unselected adults | egg 0.4% (RAST) | Gislason et al. 1999 |
| ***Japan, Kyoto***<br>55 infants with atopic dermatitis | egg white 91% (SPT) | Kusunoki et al. 1998 |
| ***Japan, Okinawa***<br>127 atopic patients | egg white 12% (MAST) | Kosugi et al. 1992 |
| ***Netherlands***<br>131 cases of food- induced anaphylaxis (from 1993-1997) | egg 7.6% (survey, reported to the TNO Nutrition and Food Research Institute) | European Commission 1998 |
| ***Netherlands, Rotterdam***<br>91 patients with atopic dermatitis | egg 72% (SAFT) | Oranje et al. 1992 |

| | | |
|---|---|---|
| ***Spain, Madrid***<br>355 food allergic children | egg white 34% (SPT, RAST) | Crespo et al. 1995 |
| ***Spain, Pamplona***<br>74 patients with atopic dermatitis | egg 35% (SPT, RAST, Histamine Release) | Resano et al. 1998 |
| ***Sweden***<br>a) 61 cases and b) 55 cases of food- induced anaphylaxis (from 1994-1996) | a) egg 10% (reported to the National Food Administration)<br>b) egg 3.6% (Hospital Reports) | European Commission 1998 |
| ***Sweden, Uppsala***<br>414 unselected adults | egg 0.2% (RAST) | Gislason et al. 1999 |
| ***Switzerland, Zurich***<br>402 food allergic adults | egg white 12% (case history, SPT, RAST) | Wüthrich 1993 |
| ***Switzerland, Zurich***<br>383 food allergic patients (study period 1990-94) | egg 5.7% (case history, SPT, RAST) | Etesamifar & Wüthrich 1998 |
| ***Thailand***<br>100 asthmatic children | egg white 1% (SPT) | Kongpanichkul et al. 1997 |
| ***UK, London***<br>100 patients with food intolerance | egg 40% (repeated challenge) | Lessof et al. 1980 |
| ***UK, Manchester***<br>172 patients expierenced anaphylactic reactions to foods (from 1994-1996) | egg 2.3% (suspected cause of patients' worst reaction) | Pumphrey & Stanworth 1996 |
| ***USA, Baltimore, MD***<br>196 food allergic children | egg 73% (DBPCFC, RAST) | Sampson & Ho 1997 |
| ***USA, Denver, CO***<br>180 food allergic children | egg 26% (DBPCFC) | Bock & Atkins 1990 |
| ***USA, Little Rock***<br>165 patients with atopic dermatitis | egg 35% (SPT), from which 33/56 were DBPCFC-positive | Burks et al. 1998 |

## 2 Outgrowing of Egg White Allergy

| Country / Subjects | Loss of Sensitivity to | References |
|---|---|---|
| ***Germany***<br>Children at risk (subgroup of 216 children of the general population) | Annual Incidence of sensitization to egg decreased from 6% at 1 year of age to <1% at 6 years of age (RAST) | Kulig et al. 1999 |
| ***USA***<br>Food allergic patients | soy, egg, milk, wheat, and peanut:<br>26% loss (after 1 year of onset, DBPCFC) | Sampson & Scanlon 1989 |

## 3 Symptoms of Egg White Allergy

### Symptoms & Case Reports

systemic reactions
anaphylaxis (1, 7, 8, 9, 11), fatal reactions (7)

cutaneous symptoms
angioedema (1, 12), atopic dermatitis (2, 9, 10, 11, 13), eczema (1, 3, 12, 15), erythema (11), urticaria (1, 2, 11, 12, 13, 14, 15)

gastrointestinal symptoms
abdominal pain (12), diarrhea (1, 11), flare (1), oral allergy syndrome (4), vomiting (1, 2, 3, 4, 11), in general (1)

respiratory symptoms
allergic rhinitis (2, 9), asthma (2, 3, 5, 6, 9, 11, 12, 13), cough (13), dyspnea (1), hoarseness (1), laryngeal edema (2), wheeze (1, 11, 13)

other symptoms
convulsion (3), cyanosis (14), hypotonia (14)

### References


(1) Hoffmann 1983
(2) Langeland 1983a, 1983b, 1985
(3) Anet et al. 1985
(4) Clinton et al. 1986
(5) Bernstein et al. 1987
(6) Blanco-Carmona et al. 1992
(7) Sampson et al. 1992
(8) Yamada et al. 1993
(9) Bernhisel-Broadbent et al. 1994
(10) Reekers et al. 1996
(11) Urisu et al. 1997
(12) Patriarca et al. 1998
(13) Yamada et al. 1998
(14) Foucard & Malmheden Yman 1999
(15) Niggemann et al. 1999


### *Percentage of reactions*

| Symptoms / Ref. | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Cutaneous | | | 100% | 87% | | 83% |
| Angio-oedema | 14% | | | | | |
| Atopic dermatitis | 48% | 89% | | 100% | | |
| Allergic rhinitis | 14% | 72% | | | | |
| Urticaria | 26% | | | | | |
| Gastrointestinal | | | 37% | 80% | | 45% |
| Vomiting | 25% | | | | | |
| Respiratory | | | 0% | 42% | 17% | 14% |
| Asthma | 26% | 94% | | | | |
| immediate | | | | | 89% | 82% |
| non-immediate | | | | | 11% | 16% |
| both | | | | | | 2% |
| No. of patients | 84 | 18 | 19 | 92 | 104 | 62 |

(1), (5) after egg ingestion / oral challenge
(3) children with egg allergy (without bird allergy)
(6) children


(1) Langeland 1983a
(2) Bernhisel-Broadbent et al. 1994
(3) Anibarro Bausela et al. 1997
(4) Sampson & Ho 1997
(5) Yamada et al. 1998
(6) Niggemann et al. 1999


### *Threshold of Ingestion*

Amounts of whole egg inducing symptoms ranged from 50 mg to 50 g (DBPCFC, egg allergic patients) (1)


(1) Norgaard & Bindslev-Jensen 1992

## 4 Diagnostic Features of Hen's Egg White Allergy

| Parameters / Subjects | Outcome | References |
|---|---|---|
| ***SPT, IgE and Oral Challenge***<br>11 egg allergic patients (1-15 years of age) | Sensitivities of tests in comparison with oral challenge test:<br>SPT 100%, RAST 85%, MAST 71%;<br>Specificities in comparison with oral challenge test:<br>RAST 50%, MAST 100%;<br>Match with oral challenge test:<br>SPT 63%, RAST 72%, MAST 81%, Case History 63% | Roger et al. 1994 |
| ***SPT and DBPCFC***<br>Children suspected of IgE-mediated symptoms to egg | Significant differences in wheal sizes between individuals who were allergic or tolerant to egg ($P<0.001$) | Eigenmann & Sampson 1998 |
| ***IgG and IgE***<br>120 atopic children | IgG to egg white strongly associated with positive specific IgE in children with and without eczema | Eysink et al. 1999 |
| ***IgG Subclasses***<br>96 children of general population (measured at birth, 6 and 18 months and 8 years by ELISA) | Ovalbumin specific subclasses:<br>IgG1 and IgG3 peaked at 18 months and declined up to 8 years of age; antibody levels not related to exposure to egg; positive SPT and IgE levels correlated with high IgG subclass levels; atopic symptoms associated particularly with high levels of IgG subclass IgG4; difference in antibody levels between atopic and non- atopic children mostly marked at 6 months | Jenmalm & Bjorksten 1999 |
| **a)** ***RAST and DBPCFC***<br>**b)** ***SPT and DBPCFC***<br>food-allergic children with atopic dermatitis | a) predictive values of specific IgE > 0.35 kU/L<br>positive preditive value 84%<br>(>95% at IgE 6 kU/L)<br>negative preditive value 88%<br>b) predictive values of SPT ( > 3 mm)<br>positive preditive value 85%<br>negative preditive value 90% | Sampson & Ho 1997 |
| ***IgE and DBPCFC***<br>children with atopic dermatitis | a) Specific serum IgE in children with<br>positive oral provocation: 6.4 kU/L<br>negative oral provocation: 1.4 kU/L<br>(Significance $P<0.001$)<br>b) predictive value of specific IgE > 0.35 kU/L<br>positive preditive value 79%<br>negative preditive value 75% | Niggemann et al. 1999 |
| ***OM-digest specific IgE and DBPCFC***<br>a) 18 children DBPCFC positive and b) 12 negative to egg white (all RAST positive) | No significant differences in specific IgE- binding to egg white, ovomucoid, ovalbumin, ovotransferrin, and lysozyme in a) and b);<br>IgE binding activity to ovomucoid digests (pepsin and trypsin) significantly higher in a) than in b) | Urisu et al. 1999 |
| ***Predictive Value of IgE***<br>1314 children (general population) | Hen's egg white specific IgE at age of 12 months is a valuable marker for sensitization (asthma, allergic rhinitis, atopic dermatitis) to common allergens at age of 3 years | Nickel et al. 1997 |

## 5 Therapy of Hen's Egg White Allergy

| Treatment* | Outcome | References |
|---|---|---|
| ***Oral Desentization***<br>5 egg allergic patients | A diluted food extract followed by increased pure food was administered following a standardized protocol, at the beginning pretreatment with oral sodium cromoglycate, length of therapy 4 to 5 months, after therapy codfish was tolerated (maintenance dose: 2-3 eggs / week) | Patriarca et al. 1998 |
| ***Treatment with DSCG***<br>5 egg allergic children | Food challenge before and after a seven- day pre- treatment period with oral sodium chromoglycate: Full protection in 4 children | Businco et al. 1983 |

* Studies may be experimental, unproved, or controversial. Please notice the disclaimer !

## 6 Composition of Hen's Egg White

### 6.1 Distribution of Nutrients

| **Nutrients:** Content per 100 g | | |
|---|---|---|
| Energy 203 kJ (48 kcal) | Iodine 7 µg | Leu 1080 mg |
| Water 87.3 g | Selenium 4-10 µg | Lys 740 mg |
| Protein 11.1 g | | Met + Cys 470 mg |
| Lipid 0.2 g | **Vitamins** | Phe 760 mg |
| Carbohydrate 0.4 g | Vitamin A traces | Thr 580 mg |
| Minerals 0.7 g | Vitamin B1 20 µg | Trp 200 mg |
| | Vitamin B2 320 µg | Tyr 460 mg |
| **Minerals** | Nicotinamide 90 µg | Val 980 mg |
| Sodium 170 mg | Pantothenic acid 140 µg | |
| Potassium 155 mg | Vitamin B6 12 µg | **Carbohydrates** |
| Magnesium 12 mg | Biotin 7 µg | Glucose 410 mg |
| Calcium 11 mg | Folic acid 16 µg | |
| Manganese 40 µg | Vitamin B12 traces | |
| Iron 200 µg | Vitamin C 300 µg | |
| Copper 130 µg | | |
| Zinc 20 µg | **Amino Acids** | |
| Phosphorus 20 mg | Arg 680 mg | |
| Chloride 170 µg | His 280 mg | |
| Fluoride 10-150 µg | Ile 740 mg | |

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

## 6.2 Protein Fraction

| **Proteins / Glycoproteins** | **Amount** of total protein (1) | **Heat Coagulated Egg** |
|---|---|---|
| Ovomucoid | 11 % | 14.2 +/- 11.9 mg/ml in soluble fraction of egg white (2) |
| Ovalbumin | 54 % | |
| Ovotransferrin | 12-13 % | |
| Lysozyme | 3.4-3.5 % | |
| Ovomucin | 1.5-3.5 % | |
| G2 Ovoglobulin | 1.0 % | |
| G3 Ovoglobulin | 1.0 % | |
| Ovoflavoprotein | 0.8 % | |
| Ovostatin | 0.5 % | |
| Cystatin | 0.05 % | |
| Avidin | 0.05 % | |
| Thiamin-binding protein | | |
| Glutamyl aminopeptidase | | |
| Minor glycoprotein 1 | | |
| Minor glycoprotein 2 | | |

Reference: (1) Awade 1996, (2) Sakai et al. 1998

## 7 Allergens of Hen's Egg White

| **Proteins / Glycoproteins** | **Allergen Nomenclature** | **References** |
|---|---|---|
| Ovomucoid [28 kDa] | Gal d 1 | Langeland T (1982b) |
| Ovalbumin [44 kDa] | Gal d 2 | Langeland T (1982b) |
| Ovotransferrin [77 kDa] | Gal d 3 | Langeland & Harbitz (1983) |
| Lysozyme [14 kDa] | Gal d 4 | Hoffman 1983 |
| Ovomucin | none | Walsh et al. 1988 |

## 7.1 Sensitization to Egg White Allergens

| Country / Subjects | Sensitivity to | References |
|---|---|---|
| ***Austria, Vienna***<br>13 patients with egg white allergy | 40-45 kDa allergen 100%<br>35 kDa allergen 76%<br>70 kDa allergen 61% | Szepfalusi et al. 1994 |
| ***Denmark***<br>32 adults with suspected egg allergy | ovomucoid 34%<br>ovalbumin 9%<br>ovotransferrin 22%<br>lysozyme 6%<br>(dot-immunoblot) | Djurtoft et al. 1991 |
| ***Denmark***<br>34 egg allergic adults | ovomucoid 38%<br>ovalbumin 32%<br>ovotransferrin 53%<br>lysozyme 15%<br>(SDS-PAGE / immunoblot) | Aabin et al. 1996 |
| ***France, Nancy***<br>52 egg allergic patients | lysozyme 35% (RAST) | Fremont et al. 1997 |
| ***Germany, Hamburg***<br>33 egg allergic patients | ovomucoid 36%<br>ovalbumin 30%<br>(SDS-PAGE / immunoblot) | Besler et al. 1997 |
| ***Japan***<br>39 egg allergic patients | lysozyme 67% (RAST) | Yamada et al. 1993 |
| ***Japan, Toyoake***<br>72 egg allergic patients | decreasing specific serum IgE against<br>OM>OA>>OT>LY (RAST) | Urisu et al. 1997 |
| ***Norway, Oslo***<br>68 egg allergic patients | ovomucoid 69%<br>ovalbumin 100%<br>ovotransferrin 54%<br>(CRIE) | Langeland 1982b, 1983b |
| ***USA, Baltimore, MD***<br>18 egg allergic children | ovomucoid 89%<br>ovalbumin 78%<br>lysozyme 61%<br>(skin prick test) | Bernhisel-Broadbent et al. 1994 |
| ***USA, Baltimore, MD***<br>egg allergic children:<br>a) 10 persistent allergy<br>b) 11 developed clinical tolerance | ovomucoid:<br>a) 44.5 ng/ml b) 3.5 ng/ml<br>ovalbumin:<br>a) 1.6 ng/ml b) 1.5 ng/ml<br>(specific serum-IgE) | Bernhisel-Broadbent et al. 1994 |
| ***USA, NC***<br>33 egg allergic patients | ovomucoid 97%<br>ovalbumin 100%<br>ovotransferrin 94%<br>lysozyme 69%<br>(RAST) | Hoffmann 1983 |

## 7.2 Properties of Ovomucoid

### 7.2.1 Molecular Biological Properties

| Ovomucoid (OM) | References |
|---|---|
| ***Allergen Nomenclature*** Gal d 1 | (1) King et al. 1994 |
| ***Isoallergens and Variants***<br>2 genetic variants a) whole sequence of 186 aa residues and b) deletion of Val-134-Ser-135 (1) | (1) Kato et al. 1987 |
| ***Molecular Mass*** Mr 28.0 kDa (1, 3)<br>26.0-27.7 kDa in mass spectrometry (2)<br>25-31 kDa unresolved distribution in mass spectrometry (3) | (1) Holen & Elsayed 1990<br>(2) Haginaka et al. 1995<br>(3) Besler et al. 1997 |
| ***Isoelectric Point*** pI 4.4 - 4.6<br>2 isoforms in IEF/PAGE (1) | (1) Holen & Elsayed 1990 |
| ***Amino Acid Sequence, mRNA, and cDNA***<br>**Gal d 1**<br>**SWISS-PROT:** P01005<br>**GenBank:** J00902<br>**PIR:** A01239<br>**Amino acids** 186 residues (3)<br>**mRNA** 821bp (2)<br>**cDNA** 5.6 kb (1) | (1) Lai et al. 1979<br>(2) Catterall et al. 1980<br>(3) Kato et al. 1987 |
| ***recombinant Protein***<br>expression in Escherichia coli:<br>domain I (OM 1-68) (Mr 7500) (3)<br>domain III (OM 131-186) (1, 2) | (1) Hinck et al. 1993<br>(2) Kojima et al. 1994<br>(3) DeKoster & Robertson 1997 |
| ***3D-Structure***<br>X-ray studies of enzyme complex with domain III from turkey OM (1)<br>NMR studies of domain III from turkey OM (3, 4)<br>NMR studies of OM-glycopeptide (2)<br>NMR studies of a penta-antennary N-glycan (5) | (1) Bode et al. 1986<br>(2) Davis et al. 1994<br>(3) Krezel et al. 1994<br>(4) Hoogstraten et al. 1995<br>(5) Rutherford et al. 1995 |
| ***Posttranslational Modifications***<br>Disulfide bonds<br>9 disulfide bonds: 5-44, 22-41, 30-62, 70-109, 87-106, 95-127, 138-168, 146-165, 154-186 (2, 6)<br><br>Glycosylation of OM:<br>carbohydrate content: 22-29% of whole Mr (1)<br>carbohydrate composition: 14-16% GlcNAc, 6.5-8.5% Man, 0.5-4.0% Gal and, 0.04-2.2% NeuNAc (1)<br>5 N-glycosylation sites: 10, 53, 69, 75 and partly 175 (3, 7)<br>covalent multiantennary structures of glycans (sequential exoglucosidase digest, mass spectrometry) (4, 5, 8)<br>hydrazinolysis of sialyl-oligosaccharides and sialydase digestion (6) | (1) Beeley 1971<br>(2) Beeley 1976a<br>(3) Beeley 1976b<br>(4) Yamashita et al. 1982<br>(5) Yamashita et al. 1983<br>(6) Yamashita et al. 1984<br>(7) Kato et al. 1987<br>(8) Yet et al. 1988 |

| | |
|---|---|
| ***Biological Function***<br>serin protease inhibitor, Kazal family of protease inhibitors (1)<br>3 tandem domains (1):<br>domain I (OM 1-68)<br>domain II (OM 65-130)<br>domain III (OM 131-186)<br>active sites: 24-25, 89-90, 148-149 (1) | (1) Kato et al. 1987 |
| ***Stability***<br>lower trypsin-inhibitory activity and heat denaturation stability of chemically deglycosylated OM (1)<br>glycosylated first domain has increased thermal stability in comparison with recombinant domain I (2) | (1) Gu et al. 1989<br>(2) DeKoster & Robertson 1997 |

## 7.2.2 Allergenic Properties

**Ovomucoid (OM)** — **References**

***Frequency of Sensitization***
IgE-binding to OM in 34 to 97 % of patients (1)

(1) see 6.1 Sensitization to Egg White Allergens

***IgE-binding of OM Domains***
Average percentage of specific serum IgE*:

| Domain/Ref. | (1) | (2) | (3) |
|---|---|---|---|
| **I (OM 1-68)** | - ** | 33% | 12% |
| **II (OM 65-130)** | - ** | 48% | 16% |
| **III (OM 131-186)** | - | 28% | - |
| **glycosylated** | 35% | - | 27% |
| **non-glycosylated** | < 4% | - | 47% |
| **No. of Patients** | 2 (medium percentage) | 45 children with atopic dermatitis (median percentage) | 9 children (medium percentage) |

* total OM-specific serum IgE = 100% (RAST / EAST)
** domains I+II (OM 1-130) = 78%

(1) Matsuda et al. 1986
(2) Cooke & Sampson 1997
(3) Zhang & Mine 1998

| | |
|---|---|
| ***B-Cell Epitopes***<br>IgE binding sites located on:<br>OM 1-20 (synthetic peptide) (b) (3)<br>OM 40-50 (synthetic peptide) (b) (6)<br>OM 49-56 (synthetic peptide) (b) (3)<br>OM 56-66 (synthetic peptide) (b) (6)<br>OM 71-75 (synthetic peptide) (b) (6)<br>OM 81-91 (synthetic peptide) (b) (6)<br>OM 85-96 (synthetic peptide) (b) (3)<br>OM 90-121 (trypsin digest) (a) (5)<br>OM 115-122 (synthetic peptide) (b) (3)<br>OM 134-186 (pepsin digest) (a) (5)<br>OM 161-174 (synthetic peptide) (b) (6)<br>OM 175-186 (synthetic peptide) (b) (3)<br>OM 179-186 (synthetic peptide) (b) (6)<br><br>Carbohydrate epitopes:<br>Specific serum IgE against N-glycosylated domain III (Asn-175) higher than against non-glycosylated domain III in egg allergic patients (c) (1)<br>Specific serum IgE against N-glycosylated domain III (Asn-175) lower than against non-glycosylated domain III in egg allergic patients (c) (4)<br>No difference in IgE-binding of OM and deglycosylated OM (a, c) (2) | (1) Matsuda et al. 1985<br>(2) Besler et al. 1997<br>(3) Cooke & Sampson 1997<br>(4) Zhang & Mine 1998<br>(5) Besler et al. 1999<br>(6) Mine & Zhang 1999<br><br>Applied methods:<br>(a) SDS-PAGE / immunoblot<br>(b) dot / immunoblot<br>(c) EAST / RAST inhibition |
| ***T-Cell Epitopes***<br>T-Cell Proliferation with:<br><br>domain I (OM 1-68)<br>domain II (OM 65-130) (predominant)<br>domain III (OM 131-186) (predominant)<br>in 4 egg allergic patients (1)<br><br>domain I (OM 1-68) in 28% '<br>domain II (OM 65-130) in 55%<br>domain III (OM 131-186) in 64%<br>of 33 (' 29) egg allergic children with atopic dermatitis (3)<br><br>whole OM (2) | (1) Eigenmann et al. 1996<br>(2) Holen & Elsayed 1996<br>(3) Cooke & Sampson 1997 |
| ***T-Cells / Cytokines***<br>PBMC stimulation with OM: expression of IL-5 in 4 egg allergic patients, OM specific T-cell lines mainly CD3+ (of which 75-97% were CD4+ T-cells), CD8+ phenotypes < 25% (1) | (1) Eigenmann et al. 1996 |

| | |
|---|---|
| ***Alteration of Allergenicity***<br>Cyanogen bromide cleavage:<br>no change in IgE- and IgG-binding in 6 OM allergic patients (direct ELISA) (1)<br>6 of 6 sera showed IgE binding OM fragments (SDS-PAGE immunoblot) (3)<br><br>Deglycosylation: see carbohydrate epitopes<br><br>Digestion<br>5 of 6 sera showed IgE binding to trypsin digested OM, 1of 6 to pepsin digest, and 2 of 6 to thermolysin digest (SDS-PAGE immunoblot) (3)<br>pepsin, trypsin, and chymotrypsin preparations of OM showed high IgE binding activities in DBPCFC positive egg white allergic children (RAST inhibition) (4)<br><br>Performic acid oxidation:<br>no change in IgE- (max. inhibition 93%) and decreased IgG-binding (max. inhibition 39%) in 7 egg allergic patients (EAST inhibition) (2)<br>increased PBMC proliferation in 11 egg allergic patients (2)<br><br>Reduction and alkylation:<br>IgE-binding lost in 4/6 and retained in 2/6 OM allergic patients, respectively (1)<br>IgG-binding lost in 4/6 and retained in 2/6 OM allergic patients, respectively (1)<br>decreased IgE-(max. inhibition 72%) and decreased IgG-binding (max. inhibition 82%) in 7 egg allergic patients (EAST inhibition) (2)<br>increased PBMC proliferation in 11 egg allergic patients (2) | (1) Djurtoft et al. 1991<br>(2) Cooke & Sampson 1997<br>(3) Besler et al. 1999<br>(4) Urisu et al. 1999 |

## 7.3 Properties of Ovalbumin

### 7.3.1 Molecular Biological Properties

| Ovalbumin (OA) | References |
|---|---|
| ***Allergen Nomenclature*** Gal d 2 | (1) King et al. 1994 |
| ***Isoallergens and Variants***<br>Asn / Asp replacement at residue 311 (1) | (1) Nisbet et al. 1981 |
| ***Molecular Mass*** Mr 44.0-45.0 kDa<br>6 and 4 isoforms by mass spectrometry, respectively (1, 2) | (1) Kelly et al. 1996<br>(2) Chakel et a. 1997 |
| ***Isoelectric Point*** pI 4.6 | (1) Holen & Elsayed 1990 |
| ***Amino Acid Sequence, mRNA, and cDNA***<br>**Gal d 2**<br>**SWISS-PROT:** P01012<br>**GenBank:** J00895, V00438, V00383, M34352, M34346<br>**PIR:** A90455<br>**Amino acids** 385 residues (6)<br>**mRNA** 1859 bp (1), 1872 bp (4, 7)<br>**cDNA** 7.564 kb (2, 3, 5, 7) | (1) McReynolds et al. 1978<br>(2) Dugaiczyk et al. 1979<br>(3) Gannon et al. 1979<br>(4) O'Hare et al. 1979<br>(5) Caterall et al. 1980<br>(6) Nisbet et al. 1981<br>(7) Woo et al.1981 |
| ***recombinant Protein***<br>expression in Escherichia coli (1)<br>Japanese quail OA expression in Saccharomyces cerevisiae (7)<br>expression in mouse cells (2)<br>expression in Xenopus laevis oocytes (3)<br>OA and OA mutant expression in mouse L cells (5, 6)<br>expression in human breast carcinoma cell line (4) | (1) Fraser & Bruce 1978<br>(2) Lai et al. 1980<br>(3) Colman et al. 1981<br>(4) Lai et al. 1983<br>(5) Sheares & Robbins 1986<br>(6) Sheares 1988<br>(7) Krizkova et al. 1992 |
| ***3D-Structure***<br>X-ray studies of OA (1, 3)<br>X-ray of plakalbumin (2)<br>OA 257-264 in complex with the murine MHC class I H-2Kb molecule (4) | (1) Stein et al. 1990<br>(2) Wright et al. 1990<br>(3) Stein et al. 1991<br>(4) Fremont et al. 1995 |

| | |
|---|---|
| ***Posttranslational Modifications***<br>Acetylation:<br>N-terminal acetylation (3)<br><br>Disulfide Bridges:<br>1 disulfide bond: 73-120 (3)<br>4 free Cys residues<br><br>Glycosylation of OA:<br>carbohydrate content: 3.2% of whole Mr (1)<br>carbohydrate composition: 1.2% GlcNAc, 1.7-2.0% Man (1)<br>1 N-glycosylation site: Asn-292 (3)<br>hydrazinolysis of sialyl-oligosaccharides and sialydase digestion (4)<br>isolation and mass spectrometry of OA-glycans (5)<br>purified glycopeptides characterized by sequential exoglycosidase digestion (9)<br>sequential exoglycosidase digestion and mass spectrometry of glycans (11)<br>transiently diglycosylated ovalbumin (Asn-292, Asn-311) in hen oviduct (12)<br>glycosylation of recombinant OA (6, 7)<br><br>Phosphorylation of OA:<br>2 phosphorylation sites: Ser-68, Ser-344 (2, 3)<br>posphate content: 1.73 mol/mol OA (10)<br>variants: A1, A2, or A3 depending on 2, 1, or no phosphorylation, ratios A1:A2:A3 = 12:7:1 (8)<br>separation by capillary isoelectric focussing and mass spectrometry of mono- and diphospho-OA (13) | (1) Robinson 1972<br>(2) Henderson et al. 1981<br>(3) Nisbet et al. 1981<br>(4) Yamashita et al. 1984<br>(5) Chen et al. 1988<br>(6) Sheares & Robbins 1986<br>(7) Sheares 1988<br>(8) Burley & Vadehra 1989<br>(9) Rago et al. 1992<br>(10) Ekman & Jäger 1993<br>(11) Kuster et al. 1997<br>(12) Suzuki et al. 1997<br>(13) Wei et al. 1998 |
| ***Biological Function***<br>function unknown, OA belongs to serpin family of protease inhibitors (1)<br>active site: 352-353 | (1) Burley & Vadehra 1989 |
| ***Stability***<br>conversion to S-Ovalbumin by heat or storage (1, 2)<br>5% S-form in fresh eggs, 81% in eggs stored for 6 months (1)<br>S-form more resistant to denaturation by heat, urea, or guanidine (2) | (1) Smith 1964<br>(2) Smith & Back 1965 |

## 7.3.2 Allergenic Properties

| Ovalbumin (OA) | References |
|---|---|
| ***Frequency of Sensitization***<br>IgE-binding to OA in 9 to 100% of patients (1) | (1) see 6.1 Sensitization to Egg White Allergens |
| ***Immunoglobulines***<br>IgM, IgG, IgE production by OA-specific B-Cells (1)<br>lower OA-specific IgA production in egg allergic children (2) | (1) Ohshiba & Yata 1991<br>(2) Noma et al. 1996a |
| ***B-Cell Epitopes***<br>IgE binding sites located on:<br>OA 1-10 (synthetic peptide) (c) (1)<br>OA 11-19 (synthetic peptide) (c) (4)<br>OA 41-171 (CNBr-fragement) (a) (3)<br>OA 56-70 (synthetic peptide) (c) (4)<br>OA 301-385 (CNBr-fragment) (a) (3)<br>OA 323-339 (synthetic peptide) (b, c) (2)<br>OA 347-385 (V8 protease digest) (a) (5)<br>OA 347-366 (synthetic peptide) (d) (5)<br>OA 357-366 (synthetic peptide) (e) (5)<br>OA 357-376 (synthetic peptide) (d) (5)<br>OA 367-385 (synthetic peptide) (d) (5) | (1) Elsayed et al. 1988<br>(2) Johnsen & Elsayed 1990<br>(3) Kahlert et al. 1992<br>(4) Elsyed & Stavseng 1994<br>(5) Honma et al. 1996<br><br>Applied methods:<br>(a) SDS-PAGE / immunoblot<br>(b) CRIE<br>(c) EAST / RAST-inhibition<br>(d) Histamine Release<br>(e) Histamine Release inhibition |
| ***T-Cell Epitopes***<br>Specific T-Cell Proliferation with:<br>OA 1-33 (synthetic peptide) (3)<br>OA 105-122 (synthetic peptide) (2)<br>OA 198-231 (synthetic peptide) (3)<br>OA 201-213 (synthetic peptide) (3)<br>OA 261-277 (synthetic peptide) (3)<br>OA 323-339 (synthetic peptide) (1, 2)<br><br>with whole OA (1, 2) | (1) Shimojo et al. 1994<br>(2) Holen & Elsayed 1996<br>(3) Katsuki et al. 1996 |
| ***PBMC Proliferation***<br>stimulation with OA<br>positive PBMC proliferation in 10 egg allergic patients (4)<br>decreased proliferation during elimination diets in egg allergic patients with atopic dermatitis (2)<br>higher proliferation in egg allergic patients with atopic dermatitis showing non-immediate symptoms to oral challenge than in patients showing immediate type symptoms (1, 3)<br>increased proliferation in allergy developing infants (5)<br>higher proliferation in egg allergic children with persisting symptoms of atopic dermatitis (6) | (1) Kondo et al. 1990<br>(2) Agata et al. 1993<br>(3) Fukutomi et al. 1994<br>(4) Eigenmann et al. 1996<br>(5) Miles et al. 1996<br>(6) Shinoda et al. 1997 |
| ***PBMC Stimulation / Cytokines***<br>PBMC stimulation with OA:<br>increase of PBMC proliferation and decrease in IFN-gamma in egg allergic infants with atopic dermatitis (1)<br>increase of IL4 and decrease in IFN-gamma in egg allergic children with atopic dermatitis (not in outgrown and healthy children) (2)<br>increase of IFN-gamma (exclusively by simultaneous IL-2 stimulation) in egg allergic patients (3)<br>increase of IL-5 mRNA in egg allergic children (not in outgrown and healthy children) (4) | (1) Warner et al. 1994<br>(2) Noma et al. 1996b<br>(3) Shinbara et al. 1996<br>(4) Tomiita et al. 1998 |

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| ***T-Cell Lines (TCL) / Cytokines***<br>OA-stimulated lymphocytes from egg allergic patients induced IL-2-responsiveness of T-Cells (CD4+), induction of T-Cell responsiveness inhibited by anti-HLA-DP and anti-HLA-DQ monoclonal antibodies (1, 3)<br><br>Antibody to CD45RA+ (CD4+ T-Cells) induced IL-2 responsiveness in lymphocytes of non-allergic patients, but did not increase responsiveness in egg allergic patients (2)<br><br>Anti-HLA-DP monoclonal antibodies inhibited T-Cell proliferation in 5 egg allergic patients, anti-HLA-DQ monoclonal antibodies restored T-Cell proliferation in 2 egg allergic patients with atopic dermatitis (5)<br><br>OA-specific TCL ( CD4+, alpha beta T-Cell receptors) recognized OA presented by HLA-DR10, production of IL-5 on stimulation with OA or OA 323-339 observed (1 egg allergic patient) (4)<br><br>30 OA-specific TCL mainly CD4+ T-Cells significant production of IL-4 and IL-5, low production of IFN-gamma (6 egg allergic patients with atopic dermatitis) (6)<br><br>28 OA- or casein-specific T-Cell clones (TCC) (16 CD8+) from egg and cow's milk allergic patient, 75% of CD4+ TCC and 44% of CD8+ TCC secreted IL-4 (7) | (1) Noma et al. 1990<br>(2) Kawano et al. 1992<br>(3) Noma et al. 1994<br>(4) Shimojo et al. 1994<br>(5) Shinbara et al. 1995<br>(6) Katsuki et al. 1996<br>(7) Reekers et al. 1996 |
| ***Alteration of Allergenicity***<br>Acidic treatment:<br>HCl, pH 3.0: increased IgE-binding in EAST (157% of binding to native OA, for IgG 122%, IgA 104%) (2)<br><br>Alkaline treatment:<br>NaOH, pH 11 overnight: decreased IgE-binding in EAST (0.4% of binding to native OA, for IgG 5.2%, IgA 27%) (2)<br><br>Cyanogen bromide cleavage:<br>decreased 50%-inhibition of IgE-binding in RAST (1)<br><br>Pepsin hydrolysis:<br>limited hydrolysis decreased IgE-binding (max. inhibition: 50%) in RAST (1)<br><br>Reduction and alkylation:<br>decreased IgE-binding (max. inhibition: 20%) in RAST (1)<br>no change in in IgE-binding in EAST (89% of binding to native OA, for IgG 100%, IgA 111%) (2)<br><br>Heat denaturation:<br>80°C, 10 min and treatment with urea or guanidine HCl resulted in no change in RAST inhibition (1)<br>100°C, 3 min: decreased IgE-binding in EAST (9.4% of binding to native OA, for IgG 39%, IgA 76%) (2)<br><br>Trypsin hydrolysis:<br>decreased 50%- inhibition of IgE-binding in RAST (1)<br><br>Urea denaturation:<br>increased IgE-binding in EAST (136% of binding to native OA, for IgG 120%, IgA 133%) (2) | (1) Elsayed et al. 1986<br>(2) Honma et al. 1994 |

## 7.4 Properties of Ovotransferrin

### 7.4.1 Molecular Biological Properties

| Ovotransferrin (OT) | References |
|---|---|
| ***Allergen Nomenclature*** Gal d 3 | (1) King et al. 1994 |
| ***Isoallergens and Variants***<br>5 isoforms with replacement of residues: 64 (A/V), 81 (V/I), 135 (R/W), 220-221 (Q/K-L/N), 667 (S/N) (1) | (1) SWISS-PROT: P01012 |
| ***Molecular Mass*** Mr 77.3-77.7 kDa<br>4 isoforms by mass spectrometry (1) | (1) Awade et al. 1994 |
| ***Isoelectric Point*** pI 5.6 - 6.2 (1)<br>iron-free form: pI 7.17, monoferric form: pI 6.68, 2 Fe/mol OT: pI 6.24 and pI 6.09 (cIEF) (2) | (1) Holen & Elsayed 1990<br>(2) Richards & Huang 1997 |
| ***Amino Acid Sequence, mRNA, and cDNA***<br>**Gal d 3**<br>**SWISS-PROT:** P02789<br>**GenBank:** X02009, Y00407<br>**PIR:** A03262, TFCHE<br>**Amino acids** 686 residues (1)<br>**mRNA** 2376 bp (2)<br>**cDNA** 11068 bp (3) | (1) Williams et al. 1982<br>(2) Jeltsch & Chambon 1982<br>(3) Jeltsch et al. 1987 |
| ***recombinant OT***<br>expression in baby hamster kidney cells (1) | (1) Mason et al. 1996 |
| ***3D-Structure***<br>monoferric N-terminal half-molecule (1) | (1) Dewan et al. 1993 |
| ***Posttranslational Modifications***<br>Disulfide bonds:<br>12 disulfide bonds: 10-45, 115-197, 160-174, 171-182, 228-242, 348-380, 405-680, 421-643, 454-530, 478-671, 488-502, 499-513 (2) additional bonds: 20-36 / 358-371 / 570-584 (2)<br><br>Glycosylation of OT:<br>carbohydrate content: 2.6% of whole Mr (1)<br>carbohydrate composition: 1.7% GlcNAc, 0.9% Man (1)<br>1 N-glycosylation site: 473<br>structures of glycans (mass spectrometry) (3)<br>biantennary glycans (hydrazinolysis, methanolysis, methylation analysis and, 1H-NMR spectroscopy) (4) | (1) Robinson 1972<br>(2) Williams et al. 1982<br>(3) Yet et al. 1990<br>(4) Jacquinot et al. 1994 |
| ***Biological Function***<br>iron transport:<br>domain I 1-332<br>domain II 342-686<br>active sites: iron binding 60 / 92, 191 / 250, 395 / 431, 524 / 592, anion bindung: 121 / 460 (1)<br><br>antimicrobial activity (2) | (1) SWISS-PROT<br>(2) Valenti et al. 1983 |

### 7.4.2 Allergenic Properties

| Ovotransferrin (OT) | References |
|---|---|
| ***Frequency of Sensitization***<br>IgE-binding to OT in 22 to 94 % of patients (1) | (1) see 6.1 Sensitization to Egg White Allergens |

## 7.5 Properties of Lysozyme

### 7.5.1 Molecular Biological Properties

| Lysozyme (LY) | | References |
|---|---|---|
| ***Allergen Nomenclature*** Gal d 4 | | (1) King et al. 1994 |
| ***Molecular Mass*** Mr 14.3 kDa | | (1) Awade et al. 1994 |
| ***Isoelectric Point*** pI 11 | | (1) Holen & Elsayed 1990 |
| ***Amino Acid Sequence*** | | (1) Blake et al. 1965<br>(2) Baldacci et al. 1979<br>(3) Jung et al. 1980<br>(4) Imoto et al. 1981 |
| **Gal d 1** | | |
| **SWISS-PROT:** | P00698 | |
| **GenBank:** | M10640, J00885, V00428 | |
| **PIR:** | A00853, A41423 | |
| **Amino acids** | 129 residues (1, 4) | |
| **mRNA** | 584 bp (3) | |
| **cDNA** | 3.9 kb (2) | |
| ***recombinant LY***<br>Expression in Aspergillus niger (1, 8)<br><br>Expression in Escherichia coli (5, 14)<br>Expression of LY mutants in Escherichia coli (7, 9)<br><br>Expression in Lactococcus lactis (4)<br>Expression of LY mutants in Saccharomyces cerevisiae (2, 3, 7, 11, 13)<br>Expression of glycosylated mutants in yeast (6, 15) and tabacco (15)<br><br>Expression by phage display of LY (12) | | (1) Archer et al. 1990<br>(2) Inoue et al. 1992a<br>(3) Inoue et al. 1992a<br>(4) van de Guchte et al. 1992<br>(5) Fischer et al. 1993<br>(6) Nakamura et al. 1993<br>(7) Ueda et al. 1993<br>(8) Jeenes et al. 1994<br>(9) Tachibana et al. 1994<br>(10) Tsumoto et al. 1995<br>(11) Hashimoto et al. 1996<br>(12) Maenaka et al. 1996<br>(13) Ueda et al. 1996<br>(14) De Bernardez Clark et al. 1998<br><br>(15) Kato et al. 1998 |

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|---|---|
| ***3D-Structure***<br>X-ray of LY (1)<br>NMR study comparison with X-ray data (2)<br>NMR of LY (4)<br>15N-labeled LY (NMR studies) (3)<br>NMR studies of oxidized, reduced and, denatured LY (9)<br>antibody-LY complexes (3, review: 8)<br>antibody-LY mutant complex (6)<br>LY mutants (X-ray) (7)<br>murine MHC II - LY 50-62 complex (10)<br>molecular modeling of murine MHC II - LY 52-61 complex (11) | (1) Blake et al. 1965<br>(2) Redfield et al. 1988<br>(3) Fischmann et al. 1991<br>(4) Bartik et al. 1993<br>(5) Buck et al. 1995a , 1995b<br>(6) Chacko et al. 1995<br>(7) Shih et al. 1995<br>(8) Bentley 1996<br>(9) Schwalbe et al. 1997<br>(10) Fremont et al. 1998<br>(11) Weber et al. 1998 |
| ***Posttranslational Modifications***<br>Disulfide bonds:<br>4 disulfide bonds: 24-145, 48-133, 82-98, 94-112 (1)<br><br>Glycosylation of LY:<br>glycosylated LY (Mr 18 kDa): 0.3% of total LY in commercial preparation (2) | (1) Haeffner-Gormley et al. 1985<br>(2) Trudel & Asselin 1995 |
| ***Biological Function***<br>bacteriolytic function: muramidase and chitinase activity<br>1,4-beta-N-Acetyl-muramidase C (EC 3.2.1.17)<br>active sites: 35 / 52, substrate binding: 101 (1) | (1) Kirby 1987 |

## 7.5.2 Allergenic Properties

| Lysozyme (LY) | References |
|---|---|
| ***Frequency of Sensitization***<br>IgE-binding to OT in 6 to 69 % of patients (1) | (1) see 6.1 Sensitization to Egg White Allergens |
| ***PBMC / T-Cell proliferation***<br>lymphocyte transformation test (LTT) LY (1, 3)<br>TCL Proliferation induced by LY (2) | (1) Pichler & Campi 1993<br>(2) Holen & Elsayed 1996<br>(3) Nyfeler & Pichler 1997 |

## 8 Isolation & Preparation

| Extract / Purified Allergens | Methods | References |
|---|---|---|
| ovomucoid, ovalbumin, lysozyme | IEC-HPLC | Bernhisel-Broadbent et al. 1994 |
| ovomucoid, ovalbumin, ovotransferrin, lysozyme | IEC / SEC | Awade et al. 1994<br>Ebbehoj et al. 1995 |
| ovomucoid, ovalbumin, ovotransferrin, lysozyme | capillary electrophoresis | Besler et al. 1998 |
| egg white / yolk proteins | review: liquid chromatography applications | Awade 1996 |

## 9 Cross-Reactivities

| Cross-Reacting Allergens to | Subjects / Methods | References |
|---|---|---|
| ***Egg White***<br>egg yolk, chicken serum, chicken meat | egg allergic patients (quantitative immunoelectrophoresis) | Langeland 1983c |
| ***Egg White***<br>egg yolk | 6 egg allergic patients (RAST inhibition) | Anet et al. 1985 |
| ***Ovalbumin***<br>ovomucoid, ovotransferrin, lysozyme | 6 egg allergic patients (RAST inhibition) | Walsh et al. 1987 |
| ***Ovalbumin***<br>apovitellenin I (egg yolk) | 4 egg allergic patients (RAST inhibition) | Walsh et al. 1987 |
| ***Lysozyme***<br>alpha-lactalbumin (cow's milk) | 6 egg allergic patients (RAST inhibition) | Walsh et al. 1987 |

## 10 Stability of Egg White Allergens

| Treatment | Effects | References |
|---|---|---|
| ***Egg White***<br>hard-boiled (100°C, 20 min)<br>soft-boiled (100°C, 3 min) | some antigenicity retained,<br>ovalbumin and ovomucoid were detectable (RIEP) | Hoffmann 1983 |
| ***Egg White***<br>diluted and heated (90°C, 10 min) | significantly decreased RAST for 50% of 16 egg allergic patients | Anet et al. 1985 |
| ***Egg White***<br>9 household cleaning solutions and 5 chemical detergents mixed with egg white allergen extract, incubation for 20 min at RT | Soft soap and sodium lauryl sulphate reduced IgE- binding to allergens; none of the detergents totally destroyed the allergenic activities, even in concentrations up to 10 times of recommended (CIE, CRIE, serum pool of >5 patients) | Dybendal et al. 1990 |
| ***Dried Whole Egg***<br>(1) heat (120°C, 40 min)<br>(2) succinic anhydride, sodium hydroxide and heat | (1) no significant decrease in antigenicity<br>(2) decreased antigenicity (1/1000)<br>(ELISA/RAST inhibition, PCA) | Hisatomi et al. 1991 |
| ***Egg White***<br>(1) heat (90°C, 60 min)<br>(2) ovomucoid-depletion of heated egg white | (1) 55% negative challenge in patients with positive challenge to freeze-dried egg white<br>(2) 94% negative challenge in patients with positive challenge to heated egg white (DBPCFC) | Urisu et al. 1997 |
| ***Egg White***<br>boiling (for 5 or 60 min) | Specific IgE, IgG1 and IgG antibody responses in ovalbumin-sensitized mice suppressed by raw egg white, not suppressed by boiled egg white fed prior to sensitization; mice spleen cell proliferation and secretion of Th2 cytokines IL-4 and IL-5 by stimulation with ovalbumin suppressed by feeding raw egg white, but not by boiled egg white | Peng et al. 1998 |
| ***Pork Meat Pastes***<br>containing 2% dry egg white powder<br><br>(1) raw pastes<br>(2) pasteurized (70°C, 2 h)<br>(3) sterilized (115°C, 90 min) | Detection of egg white allergens by patients' sera in (1) and (2), but not in sterilized paste (3) (EAST: 3 patients, IEF-PAGE immunoblot: 2 patients) | Leduc et al. 1999 |
| of ovalbumin, ovomucoid | | |

## 11 Allergen Sources

| Reported Adverse Reactions | References |
|---|---|
| ***Food***<br>egg in hamburger roll (1)<br>egg in meatballs containing 0.14% and 0.16% ovalbumin, in pasta containing 0.003-0.013% ovalbumin (2)<br>lysozyme: unlabeled additive in cheese preparation (3) | (1) Sampson et al. 1992<br>(2) Malmheden Yman et al. 1994<br>(3) Fremont et al. 1997 |
| ***Vaccines***<br>egg white: influenza virus vaccine (1, 4)<br>egg white: influenza A/New Jersey/76 virus vaccines (2)<br>ovalbumin / egg white: measles vaccine (3, 6)<br>egg white: measles-mumps-rubella vaccine (5, 7) | (1) Davies & Pepys 1976<br>(2) Bell et al. 1977<br>(3) Herman et al. 1983<br>(4) Yamane et al. 1988<br>(5) Levine & Lavi 1991<br>(6) Aickin et al. 1994<br>(7) Levy et al. 1994 |
| ***Other Pharmaceuticals***<br>lysozyme / egg white: vaginal suppository (1) | (1) Pichler & Campi 1993 |

| Allergens in Food Products | Content / Products | References |
|---|---|---|
| ***Fat Substitutes***<br>13 (16) egg and/or cow's milk allergic patients | Allergenicity of microparticulated egg and cow's milk proteins in fat substitues (Simplesse, Beta IL): No alteration of allergenic potencies in SDS-PAGE immunoblot | (1) Sampson & Cooke 1990<br>(2) Sampson & Cooke 1992 |
| ***Ovomucoid in Egg Yolk***<br>Determination by ELISA and immunoblot | Heat-coagulated egg yolk (boiled egg, 15 min): Ovomucoid 4.8 +/- 0.8 µg/g, content increased up to 78.8 +/- 31.3 µg/g after standing of boiled egg for 120 min; not detectable in raw egg yolk | Sakai et al. 1998 |
| ***Egg White Preparations***<br>2 egg white allergic patients (IEF-PAGE immunoblot) | IgE-binding proteins in pasteurized egg white powder, frozen and pasteurized egg white, liquid pasteurized egg white and pork meat pastes containing 2% dry powder | Leduc et al. 1999 |

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## Common Abbreveations

| | |
|---|---|
| 2D | two-dimensional |
| 3D | three-dimensional |
| aa | amino acid(s) |
| Ab | antibody |
| Act c 1, 2 | nomenclature of kiwi fruit allergens *(Actinidia chinensis)* |
| Bos d 4, 5, 6, 7, 8 | nomenclature of cow's milk allergens *(Bos domesticus)* |
| C | concentration of N,N'-methylenbisacrylamide (crosslinker) |
| CAST | cellular antigen stimulation test |
| 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 |
| CRIE | crossed radioimmunoelectrophoresis |
| Cor a 1 | nomenclature of hazel pollen allergens *(Corylus avellana)* |
| Cyn d 1 | nomenclature of bermuda grass pollen allergens *(Cynodus dactylus)* |
| DBPCFC | double-blind, placebo-controlled food challenge |
| 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 *(Gadus callarias)* |
| Gal | galactose |
| Gal d 1, 2, 3, 4 | nomenclature of egg white allergens *(Gallus domesticus)* |
| GlcN | glucosamine |
| GlcNAc | N-acetylglucosamine |
| Gly m 1, 2, 3 | nomenclature of soybean allergens *(Glycine max)* |
| HLA | human leucocyte antigen |
| Hol l 1 | nomenclature of sweet velvet grass allergens *(Holcus lanatus)* |
| 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 *(Lolium perenne)* |
| LTA4 | leukotriene A4 |
| LTB4 | leukotriene B4 |

| | |
|---|---|
| LTC4 | leukotriene C4 |
| LY | lysozyme |
| Man | mannose |
| Mal d 1, 3 | nomenclature of apple fruit allergens *(Malus domestica)* |
| MALDI-MS | matrix-assisted laser-induced desorption/ionization mass spectrometry |
| MAST | multiple allergen sorbent test |
| MHC | major histocompatibility complex |
| Mr | molecular mass |
| NeuNAc | N-acetylneuraminic acid |
| NMR | nuclear magnetic resonance (spectroscopy) |
| OA | ovalbumin |
| OAS | oral allergy syndrome |
| OM | ovomucoid |
| Ory s 1 | nomenclature of rice allergens *(Oryza sativa)* |
| OT | ovotransferrin |
| PAGE | polyacrylamide gel electrophoresis |
| PBMC | peripheral blood mononuclear cells |
| PBS | phosphate buffered saline |
| Phl p 1 | nomenclature of timothy grass allergens *(Phleum pratense)* |
| pI | isoelectric point |
| PCA | passive cutaneous anaphylaxis (test) |
| PCR | polymerase chain reaction |
| PVDF | polyvinyliden difluoride |
| PVPP | polyvinyl polypyrrolidone |
| RAST | radioallergosorbent test |
| RBL cells | rat basophil leukaemia cells |
| RIEP | radioimmunoelectrophoresis |
| 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 |
| Xyl | xylose |