Allergen Data Collection:
Pork *(Sus scrofa)*

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Abstract

Reports of allergy to pork are relatively rare. Several events of anaphylactic reactions have been described. Recently the frequency of sensitization in skin prick test to pork in the general population was estimated to be 2.0% in a German study population. Meanwhile challenge proven allergy to pork ranges from 0.6% to 2.6% in food allergic individuals.
Allergic reactions occurred after ingestion of food products containing pork meat, kidney and gut.
A peculiar cross-reactivity of pork and cat epithelia has been reported in subjects with so-called "pork-cat syndrome". Cross-reactivity is due to serum albumins. Besides serum albumin several other IgE-binding proteins were detected.
This review presents data on prevalence and symptoms of pork allergy, and cross- reactivities and sources of pork allergens in tabular form.
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Contents

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The reference lists of the Allergen Data Collections are based mainly on searches of Medline and FSTA (Food Science & Technology Abstracts) databases up to the related dates of publication. The scientific rigor of the studies listed is variable and not subject of critique or evaluation by the authors or the editor of the Allergen Data Collections. The reader should be aware of considerable problems in comparing data from different studies (eg. patient cohorts, diagnostic performances, possible flaws in allergen preparations and methodologies for allergen characterization) and is encouraged to review the original publications.
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1 Prevalence of Pork Allergy

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

1.1 General Population

Prevalence estimates within the author's selected populations are listed. Those that are assigned randomly selected ("unselected") with numbers more than 500 may be regarded as representative of the "general populations". Inclusion criteria may involve circumstances not related to atopic predisposition according to current knowledge.

Country / Subjects	Sensitivity / Allergy to	References
Germany, Augsburg 1537 subjects between 28 and 78 years of age (study period from 1997 to 1998)	pork 3.4% (SPT) pork 2.0% (corresponding frequency estimates for the representative study base, n=4178)	Böhler et al. 2001

1.2 Subjects with Atopic or Other Diseases

Country / Subjects	Sensitivity / Allergy to	References
France 34 idiopathic nephrotic syndrome (INS) patients with or without atopic manifestations	pork meat 26% (human basophil degranulation test)	Lagrue et al. 1986
France a) asthmatic children b) asthmatic adults	a) pork 20% (RAST) b) pork 8.6% (RAST)	Sabbah 1990
France 80 cases of food- related anaphylaxis (from 1993-97)	pork kidney 1.3% (reported to CICBAA databank)	European Commission 1998
France, Pierre Benite 580 patients with adverse reactions to food (study period 1984-92)	pork 17% (RAST)	Andre et al. 1994
France, Nancy and Toulouse 544 food allergic children	pork 0.6% (food challenge)	Rance et al. 1999b
South Africa, Cape Town 112 children with atopic dermatitis	pork 2.9% (reported by parents)	Steinman & Potter 1994
Switzerland, Zurich 402 food allergic adults (study period 1978-87)	beef and pork 4.5%	Wüthrich 1993
Switzerland, Zurich 383 food allergic patients (study period 1990-94)	pork 2.6%	Etesamifar & Wüthrich 1998

USA, Durham, NC 113 atopic children	pork 28% (SPT) pork 1.8% (DBPCFC)	Sampson & McCaskill 1985
USA, Little Rock, AR 165 patients with atopic dermatitis	pork 6.7% (SPT) from which non were DBPCFC-positive (n=7)	Burks et al. 1998
USA, Memphis, TN 266 patients with anaphylaxis (age of 12-75 years, study period 1978-92)	pork 4.5%	Kemp et al. 1995

1.3 Prevalence of Associated Allergies

Country / Subjects	Sensitivity / Allergy to	References
France, Angers pork-allergic patients	cat epithelia	Drouet et al. 1994b
USA, New Orleans, LA 57 subjects with suspected meat allergy	beef 73% lamb 71% pork 58% vension 59% chicken 41% turkey 38% (grid immunoblot)	Ayuso et al. 1999

2 Symptoms of Pork Allergy

Symptoms & Case Reports	References
systemic reactions anaphylaxis (1, 4*, 9*), excercise induced anaphylaxis (5), fatal reactions (10**), tachycardia (4) cutaneous symptoms angioedema (4), contact urticaria (6), contact dermatitis (7), itching (4), itching of ears, face, and hands (4), pruritus (2), urticaria (4), generalized urticaria (4) gastrointestinal symptoms abdominal pain (2, 4), diarrhea (4), glottis edema (4), nausea (4), oral allergy syndrome (8), sore throat (2), vomiting (4) respiratory symptoms dyspnoe (4) other symptoms migraine (3) * after ingestion of pork kidney (4, 9) and gut (9) ** after ingestion of wild boar meat	(1) Pavel & Comanescu 1969 (2) Bernstein et al. 1982 (3) Mylek et al. 1992 (4) Wüthrich 1996 (5) Drouet et al. 1994b (6) Valsecchi et al. 1994 (7) Kanerva 1996 (8) Asero et al. 1997 (9) Llatser et al. 1998 (10) Drouet et al. 2001
Threshold for Elicitation of Symptoms The cumulative dose of 14.1 g freeze-dried pork induced allergic symptoms in a pork allergic adult (DBPCFC) (1)	(1) Bernstein et al. 1982

3 Diagnostic Features of Pork Allergy

Parameters / Subjects	Outcome	References
SPT, Clinical Relevance 9 reportedly pork allergic subjects	0% had positive SPT	Boccafogli et al. 1994

4 Composition of Pork

4.1 Distribution of Nutrients (Fillet)

For other beef products see: USDA Nutrient Database

Nutrients: Content per 100 g		
Energy 685 kJ (162 kcal) Water 69.4 g Protein 20.4 g Lipid 8.9 g Minerals 1.0 g **Minerals** Sodium 75 mg Potassium 350 mg Magnesium 25 mg Calcium 5 mg Manganese 14 µg Iron 890 µg Copper 105 µg Zinc 3630 µg Phosphorus 175 mg Iodine 1 µg Selenium 7 µg	**Vitamins** Vitamin A 6 µg Vitamin D 1 µg Vitamin E 80 µg Vitamin K 80 µg Vitamin B1 900 µg Vitamin B2 230 µg Nicotinamide 5 mg Pantothenic acid 700 µg Vitamin B6 500 µg Biotin 5 µg Folic acid 6 µg Vitamin B12 5 µg Vitamin C 2 mg **Amino Acids** Arg 1355 mg His 890 mg Ile 1130mg Leu 1865 mg	Lys 2120 mg Met 545 mg Phe 900 mg Thr 1035 mg Trp 265 mg Tyr 860 mg Val 1260 mg **Lipids** Palmitic acid 2100 mg Stearic acid 1080 mg Oleic acid 3645 mg Linolic acid 595 mg Linoleic acid 50 mg Arachidonic acid 50 mg Cholesterol 70 mg **Others** Purines 150 mg

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

5 Allergens of Pork

Proteins / Glycoproteins	Allergen Nomenclature*	References
Serum Albumin [67 kDa]**		Sabbah et al. 1994a + 1994b, Asero et al. 1997
Allergens: 51, 40, and 28-30 kDa (pork meat)		Llatser et al. 1998
Allergens: 200, 90, 57, and 47 kDa (pork kidney)		Llatser et al. 1998
Allergens: 57 and 27 kDa (pork gut)		Llatser et al. 1998

* current list of the Allergen Nomenclature Sub-Committee 2001

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5.1 Sensitization to Pork Allergens

Country / Subjects	Sensitivity to	References
USA, New Orleans, LA 57 subjects with suspected meat allergy	pork tropomyosin in 1 of 57 (Grid immunoblot)	Ayuso et al. 1999

6 Isolation & Preparation

Extract / Purified Allergens	Methods	References
Pork Protein	Extraction from raw and cooked meat with PBS (pH 7.2) overnight; followed by centrifugation, dialysis, and lyophilization	Asero et al. 1997

7 Cross-Reactivities

Cross-Reacting Allergens	Subjects / Methods	References
Pork: *(Beef)* serum albumins from pork and beef	83% of patients sera reacted to pork serum albumin, 50% of patients had positive SPT to pork serum albumin (SDS-PAGE immunoblot inhibition, beef allergic patients with bovine serum albumin specific serum IgE)	Restani et al. 1997, 1998
Pork: *(Lamb)* pork kidney and gut from pork and lamb, respectively	IgE-binding 200 and 90 kDa allergens from pork kidney inhibited by gut from pork and lamb, no inhibition by pork meat extract (SDS-PAGE inhibition, 1 patient with anaphylaxis to pork kidney and gut and tolerance to pork meat)	Llatser et al. 1998
Pork: *(Cat)* pork meat and cat epithelia, serum albumin	In patients with pork / cat syndrome the common allergen is the 67-kDa albumin, while the major cat allergen Fel d 1 is characteristic in patients monosensitized to cat (RAST inhibition)	Sabbah et al. 1994b Drouet & Sabbah 1996

8 Stability of Pork Allergens

Treatment	Effects	References
Heat raw and cooked pork	4 IgE-binding proteins with Mr from 20 to >100 kDa in raw pork, only a 65-kDa allergen (probably serum albumin) was detected in raw and cooked pork (1 pork allergic patient, SDS-PAGE immunoblot)	Asero et al. 1997
Heat raw and cooked pork	Positive SPT to raw meat and serum albumin; negative SPT to cooked meat in a meat allergic patient	Kanny et al. 1998

9 Allergen Sources

9.1 Pork Allergen Sources

Reported Adverse Reactions	References
Pork	see 2 Symptoms of Pork Allergy
Breast Milk Intestinal permeability tests showed breast-milk-induced alterations in a 1-month-old boy with gastrointestinal symptoms suggesting food allergy. Improvement of symptoms and normalization of intestinal permeability during provocation with the milk were obtained after elimination of egg and pork from the mother's diet (1)	(1) de Boissieu et al. 1994
Several Pork Products Oral allergy syndrome after ingestion of salami, both raw and cooked ham, and bacon in a 16-year old woman; other cooked pork products such as chops and sausages were tolerated (SPT, SDS-PAGE immunoblot) (1)	(1) Asero et al. 1997
Salami Oral allergy syndrome after ingestion of salami containing dried, uncooked pork in a 21-year old woman (open challenge with fresh food, SPT) (1)	(1) Liccardi et al. 1996
Salami A case of anaphylaxis induced by ingestion of a salami (source of meat not specified) (1)	(1) Pastorello et al. 2001
Gelatine Two cases of anaphylaxis induced by ingestion of gelatine (source not specified) (1)	(1) Pumphrey & Stanworth 1996
Pharmaceuticals: Aprotinin Severe allergic reactions in a pork and beef allergic woman after ingestion of poultry sausage containing ham (1)	(1) Wüthrich 1996

9.2 Pork Associated Allergen Sources

Reported Adverse Reactions	References
Several Food Products 9 Adverse reactions to unexpected cow's milk allergens in a) Meatballs containing 1.1% CAS (undeclared) b) Hot dog containing 0.04% CAS (contaminated) c) Recombined ham containing 2.6% (undeclared) d) Sausage containing 1.0% CAS (undeclared) e) Sausage containing 0.06% CAS (contaminated)	Malmheden Yman et al. 1994
Sausage *(Texturing Agent)* Severe reactions after ingestion of sausage containing CAS (texturing agent) (1)	(1) Foucard et al. 1997
Meat *(Tenderizing Agent)* Asthma after long-term contact with papain dust in a supervisor of a meat tenderizer factory (1)	(1) Novey et al. 1979
Salami Oral allergy syndrome after ingestion of salami in a subject with monosensitization to mite allergens (1)	(1) Liccardi et al. 1996
"Salami Worker's Lung" Hypersensitivity pneumonitis in a woman (56 years) due to inhaled antigens from dust in a factory producing salamis; in the cultures of the material that covered the salamis Penicillium spp. was present and the suspected cause of hypersensitivity reactions (1)	(1) Rivero et al. 1999

Veterinary Drug Residues A 64 year old woman experienced anaphylactic shocks after ingestion of pork and beef, respectively. Food allergy to animal proteins excluded. The woman was highly sensitzed to penicillin. It was concluded that food induced anaphylaxis was linked to penicillin residues in meats (1)	(1) Kanny et al. 1994

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