

Allergen Data Collection:**Beef** (*Bos domesticus*)

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Abstract

The prevalence of beef allergy is between 3% and 6.5% among children with atopic dermatitis and can be up to 20% in cow's milk allergic children. Several studies reported an incidence of 1-2% of food-induced anaphylactic reactions caused by ingestion of beef. In another study an even higher figure of 9% of anaphylactic events from foods were induced by beef.

The diagnosis of beef allergy is based on a thorough case history supported by skin prick tests, specific serum IgE, and reactions could be confirmed by oral challenge procedures, when anaphylactic reactions are not expected.

Several muscle and serum proteins have been identified as beef allergens. Bovine serum albumin and gamma globulins (mainly immunoglobulin G / bovine IgG), as well as the muscle proteins actin and less frequently myoglobin and tropomyosin were described as IgE-binding proteins. The major beef allergens are bovine serum albumin and bovine IgG. Both allergens have been implicated in cross-reactivities to other bovine products such as milk and to other mammalian meats. Therefore, including alternative meats in the diet of beef-allergic patients must be carefully evaluated on an individual basis. Treatments such as heating, freeze-drying, homogenization and mincing are capable of reducing the allergenicity of beef.

This review presents data on prevalence, symptoms, and cross-reacting allergens of beef in tabular form. The stability and sources of beef allergens are also summarized.

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Disclaimer

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 Beef 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 Subjects with Atopic or Other Diseases

Country / Subjects	Sensitivity / Allergy to	References
<i>Australia, Melbourne</i> 96 cow's milk allergic children	beef 15% (adverse reactions reported by parents)	Bishop et al. 1990 Hill et al. 1997
<i>France</i> 34 idiopathic nephrotic syndrome (INS) patients with or without atopic manifestations	beef 18% (human basophil degranulation test)	Lagruet et al. 1986
<i>France</i> 80 cases of food- related anaphylaxis (from 1993-97)	beef 1.3% (reported to CICBAA databank)	European Commission 1998
<i>France, Pierre Benite</i> 60 cases of anaphylaxis (study period 1984-92)	beef 1.7%	Andre et al. 1994
<i>France, Nancy and Toulouse</i> 544 food allergic children	beef 1.5% (food challenge)	Rance et al. 1999b
<i>Italy, Milano</i> 184 children with atopic dermatitis and positive SPT to foods	raw beef 11% (SPT) raw beef 6.5% (anamnesis, DBPCFC)	Fiocchi et al. 1995a
<i>Italy, Parma</i> 31 children with atopic dermatitis	beef 3.2% (RAST)	Caffarelli et al. 2001
<i>Malaysia, Kuala Lumpur</i> 148 adults with symptoms of nasal congestion and rhinorrhea	beef 12% (SPT)	Gendeh et al. 2000
<i>South Africa, Cape Town</i> 112 children with atopic dermatitis	beef 3.1% (reported by parents)	Steinman & Potter 1994
<i>Switzerland, Zurich</i> 402 food allergic adults (study period 1978-87)	beef and pork 4.5%	Wüthrich 1993
<i>Switzerland, Zurich</i> 383 food allergic patients (study period 1990-94)	beef 2.9%	Etesamifar & Wüthrich 1998

UK, London 100 patients with food intolerance	beef 2% (n = 51, SPT) beef 2% (repeated challenge)	Lessof et al. 1980
USA, Baltimore, MD 335 children referred for evaluation of atopic dermatitis and possible food allergy	beef 27% (SPT) beef 3.3% (DBPCFC)	Werfel et al. 1997
USA, Baltimore, MD 25 cow's milk allergic subjects (DBPCFC)	beef 84% (SPT) beef 20% (DBPCFC)	Werfel et al. 1997
USA, Durham, NC 113 atopic children	beef 16% (SPT) beef 1.8% (DBPCFC)	Sampson & McCaskill 1985
USA, Little Rock, AR 165 patients with atopic dermatitis	beef 7.9% (SPT) from which 8% were DBPCFC-positive (n=12)	Burks et al. 1998
USA, Memphis, TN 266 patients with anaphylaxis (age of 12-75 years, study period 1978-92)	beef 6.7% (from 89 food-induced cases of anaphylaxis)	Kemp et al. 1995

1.2 Prevalence of Associated Allergies

Country / Subjects	Sensitivity / Allergy to	References
Italy, Milano 27 beef-allergic children (DBPCFC) (age of 0.75-4.66 years, study period 1992-99)	cow's milk 93% (SPT) cow's milk 93% (DBPCFC)	Fiocchi et al. 2001a
USA, Baltimore, MD 11 beef-allergic patients (DBPCFC)	cow's milk 73% (DBPCFC)	Werfel et al. 1997
USA, New Orleans, LA 57 subjects with suspected meat allergy	beef 73% lamb 71% pork 58% venison 59% chicken 41% turkey 38% (grid immunoblot)	Ayuso et al. 1999

2 Outgrowing of Beef Allergy

Country / Subjects	Sensitivity / Allergy	References
Italy, Milano 27 beef-allergic children (DBPCFC) (median age of 2.54 years, range 0.75-4.66 years, study period 1992-99)	Loss of beef allergy in 89% within median of 3 years, range 0.83-4.83 years (tolerance to beef prospectively evaluated by DBPCFC on yearly basis)	Fiocchi et al. 2001b
USA, Baltimore, MD 11 beef-allergic children (age of 16 months to 14 years) (DBPCFC)	Loss of beef allergy in 36% within 2 years after diagnosis (DBPCFC)	Werfel et al. 1997

3 Symptoms of Beef Allergy

Symptoms & Case Reports	References
<p><u>systemic reactions</u> anaphylaxis (14), exercise induced anaphylaxis (15)</p> <p><u>cutaneous symptoms</u> angioedema (6), contact dermatitis (4, 11, 13), hand dermatitis (1), itching of ears, face, and hands (9), edema (10), lip edema (12), pruritic lips (10), nasal pruritus (10), pruritic and erythematous rash (10), urticaria (6, 10), contact urticaria (3), generalized urticaria (8, 10, 15)</p> <p><u>gastrointestinal symptoms</u> abdominal pain (9), diarrhea (9), eosinophilic gastroenteritis (7), nausea (9), oral pruritus (10), vomiting (10)</p> <p><u>respiratory symptoms</u> asthma (8, 10, 12), cough (8, 12), dyspnea (10), allergic rhinitis (8, 12)</p> <p><u>other symptoms</u> migraine (2, 5), ocular and nasal symptoms (rhinorrhea) (10)</p>	<p>(1) Fisher & Stengel 1977 (2) Grant 1979 (3) Fisher 1982 (4) Jovanovic et al. 1992 (5) Mylek et al. 1992 (6) de Blay et al. 1993 (7) Verdager et al. 1993 (8) Fiocchi et al. 1995a (9) Wüthrich 1996 (10) Werfel et al. 1997 (11) Boehncke et al. 1998 (12) Fiocchi et al. 1998b (13) Iliev & Wüthrich 1998 (14) Kanny et al. 1998 (15) Biedermann et al. 1999</p>
<p>Percentage of Reactions Asthma in 7.7%, allergic rhinitis and asthma in 23%, lip edema and coughing in 7.7%, urticaria in 46%, and allergic rhinitis and urticaria in 15% of patients (13 beef allergic children, DBPCFC) (1)</p>	<p>(1) Fiocchi et al. 1998b</p>
<p>Threshold for Elicitation of Symptoms Doses between 10 and 16 g of well-cooked beef elicited allergic symptoms in 36% of patients, doses between 30 and 60 g in 55%, and a dose of 250 g in 9% (DBPCFC, 11 beef allergic patients aged between 16 months and 14 years) (2) The total dose of 90 mg bovine serum albumin (corresponding to the amount present in 180 g of calf meat) elicited immediate reactions in 3 children (12 beef allergic children, DBPCFC) (1) Positive reaction to 55 mg of bovine serum albumin (1 beef allergic adult, DBPCFC) (3)</p>	<p>(1) Fiocchi et al. 1995a (2) Werfel et al. 1997 (3) Kanny et al. 1998</p>

4 Diagnostic Features of Beef Allergy

Parameters / Subjects	Outcome	References									
<p>SPT, Clinical Relevance 4 reportedly beef allergic subjects</p>	25% had positive SPT	Boccafogli et al. 1994									
<p>SPT, Clinical Relevance 20 beef allergic children (DBPCFC) (median age of 2.29 years, range 1-4.33 years, study period 1992-96)</p>	<table border="1"> <thead> <tr> <th>SPT</th> <th>commercial</th> <th>fresh food</th> </tr> </thead> <tbody> <tr> <td>sensitivity</td> <td>90%</td> <td>100%</td> </tr> <tr> <td>specificity</td> <td>85%</td> <td>85%</td> </tr> </tbody> </table>	SPT	commercial	fresh food	sensitivity	90%	100%	specificity	85%	85%	Fiocchi et al. 1998a
SPT	commercial	fresh food									
sensitivity	90%	100%									
specificity	85%	85%									
<p>IgE, Clinical Relevance 34 children with atopic dermatitis (20 DBPCFC positive, 14 DBPCFC negative to beef) (median age of 2.26 years, range 1-4.41 years)</p>	sensitivity 90% specificity 57% cut-off point 1.8 kU/L (RAST)	Fiocchi et al. 2000									
<p>IgE, Clinical Relevance 41 beef sensitive subjects</p>	29% had a clinically relevant beef allergy (SDS-PAGE immunoblot)	Ayuso et al. 1999									

5 Therapy of Beef Allergy

Treatment*	Outcome	References
Elimination Diet Infants with beef and cow's milk allergy	High therapeutic effect of canned pork meat and horse meat formulas in the diet of infants	Ladodo et al. 1989
Oral Desensitization After elimination diet for 1 year oral desensitization was performed with extracts from raw beef, veal, and pork in dilutions from 1:10 million and 1:1000 over a period of 3 years (a beef and pork allergic woman)	After the treatment the patient could eat 100 g beef or pork up to 4 times a week; suddenly a relapse with severe allergic symptoms occurred after ingestion of beef; then a strict elimination diet was followed again	Wüthrich 1996

* Studies may be experimental, unproved, or controversial. Please notice the [disclaimer](#) !

6 Composition of Beef

6.1 Distribution of Nutrients (Fillet Steak)

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

Nutrients: Content per 100 g			
Energy 494 kJ (116 kcal)	Vitamins Vitamin D traces Vitamin E 230 µg Vitamin B1 100 µg Vitamin B2 130 µg Nicotinamide 4600 µg Pantothenic acid 1000 µg Vitamin B6 500 µg Biotin 5 µg Folic acid 10 µg Vitamin B12 2 µg	Phe 930 mg	
Water 75.1 g		Thr 1010 mg	
Protein 19.2 g		Trp 260 mg	
Lipid 4.4 g		Tyr 780 mg	
Minerals 1.1 g		Val 1150 mg	
Minerals		Lipids Palmitic acid 1080 mg Stearic acid 520 mg Oleic acid 1690 mg Linolic acid 80 mg Linoleic acid 50 mg Arachidonic acid 40 mg Cholesterol 70 mg	
Sodium 50 mg			
Potassium 340 mg			
Magnesium 20 mg			
Calcium 5 mg			
Manganese 20 µg			
Iron 2100 µg			
Copper 70 µg			
Zinc 3600 µg			
Phosphorus 165 mg			
Fluoride 100 µg			
Iodine 1 µg	Amino Acids Arg 1350 mg His 740 mg Ile 1090mg Leu 1700 mg Lys 2020 mg Met 570 mg	Others Purines 120 mg	
Selenium 35 µg			

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

6.2 Proteinfraction

Muscle Proteins	Amount of total protein
Myofibrils	50-55%
Myosin	45%
Actin	22%
Tropomyosin	8%
Troponin	2%
Sarkoplasm	30-34%
Albumins Globulins (Myoglobins)	
Connective Tissue	10-15%
Collagen	40-60%
Tropocollagen	
Elastin	10-20%
Serum Proteins	Concentration in Serum
Bovine Serum Albumin	35-55 g / L (50 mg / 100 g Calf Meat)
Immunoglobulin G	8-18 g / L

References: [Lawrie 1985](#), [Morrissey et al 1987](#), [Fiocchi et al. 1995a](#)

7 Allergens of Beef

Proteins / Glycoproteins	Allergen Nomenclature*	References
Bovine Serum Albumin [67 kDa]	Bos d 6	Restani et al. 1997a , Werfel et al. 1997 , Han et al. 2000
Immunoglobulin [160 kDa]	Bos d 7	Werfel et al. 1997 , Ayuso et al. 2000 , Han et al. 2000
Actin, Myoglobin		Restani et al. 1997a
Allergens: 160, 66, 45, 38, and 21 kDa		Ayuso et al. 2000

* current list of the [Allergen Nomenclature Sub-Committee 2001](#)

7.1 Sensitization to Beef Allergens

Country / Subjects	Sensitivity to	References												
Italy, Milan 10 children with positive SPT to raw and cooked beef and positive DBPCFC to cooked beef	bovine serum albumin 100% (SPT)	Fiocchi et al. 1998b												
USA, New Orleans, LA a) 12 beef allergic subjects b) 29 beef tolerant subjects (5 months to 48 years of age)	<table border="1"> <thead> <tr> <th>Allergens in raw beef:</th> <th>a)</th> <th>b)</th> </tr> </thead> <tbody> <tr> <td>160 kDa (bovine IgG)</td> <td>83%</td> <td>24%</td> </tr> <tr> <td>66 kDa</td> <td>25%</td> <td>27%</td> </tr> <tr> <td>45 kDa</td> <td>17%</td> <td>20%</td> </tr> </tbody> </table> (SDS-PAGE immunoblot)	Allergens in raw beef:	a)	b)	160 kDa (bovine IgG)	83%	24%	66 kDa	25%	27%	45 kDa	17%	20%	Ayuso et al. 2000
Allergens in raw beef:	a)	b)												
160 kDa (bovine IgG)	83%	24%												
66 kDa	25%	27%												
45 kDa	17%	20%												

7.4 Properties of Bovine Serum Albumin

7.4.1 Molecular Biological Properties

Bovine Serum Albumin (BSA)	References
Allergen Nomenclature Bos d 6	(1) Allergen Nomenclature Sub-Committee 2001
Molecular Mass Mr in SDS-PAGE: 67.0 kDa (1), 66.3 kDa (2) Mr (calculated): 66.4 kDa (precursor, 3)	(1) Miller & Gemeiner 1993 (2) Wal 1998 (3) SWISS-PROT
Isoelectric Point pI 4.7-4.95 (1), 4.9-5.1 (2)	(1) Miller & Gemeiner 1993 (2) Wal 1998
Amino Acid Sequence, mRNA, and cDNA	
BSA	
SWISS-PROT: P02769	
GenBank: M73993 , X58989 , Y17769	
PIR: ABBOS	(1) Brown 1975
Amino acids 583 residues (1), 607 (precursor)	
mRNA 2035 bp, 2061 bp, 1883 bp	
cDNA	
Posttranslational Modifications	
Disulfide Bridges: 9 disulfide bonds (1)	(1) Brown 1974
Biological Function BSA belongs to the ALB/AFP/VDB family, main plasma protein (1) 3 homologous domains: I aa 4-177, II aa 196-369, III aa 388-567 (on precursor: I aa 28-201, II aa 220-393, III aa 412-591 (1) good binding capacity for water, Ca ²⁺ , Na ⁺ , K ⁺ , fatty acids, hormones, bilirubin and drugs, main function regulation of colloidal osmotic blood pressure (1)	(1) SWISS-PROT
Location production in plasma, extracellular secretion (1)	(1) SWISS-PROT
Sequence Homology serum albumin from sheep: aa sequence identity 92% (1) serum albumins from pig, cat, human, rhesus macaque, horse, rabbit: aa sequence identities 72-79% (1)	(1) BLAST at PIR
Other Properties possible trigger of insulin-dependent diabetes mellitus: BSA peptide aa 126-144 (ABBOS) may be the reactive epitope (1)	(1) Karjalainen et al. 1992

7.4.2 Allergenic Properties

Bovine Serum Albumin (BSA)	References
<p>Frequency of Sensitization IgE-binding to BSA in 0-88% of patients (1)</p>	(1) see 7.1 Sensitization to Beef Allergens
<p>B-Cell Epitopes IgE binding sites located on aa sequence of BSA: aa 500-574 (of BSA) / aa 524-598 (of precursor) (1)</p> <p>(1) tryptic peptides, SDS-PAGE immunoblotting, 5 beef allergic children</p>	(1) Beretta et al. 2001
<p>Alteration of Allergenicity <u>heat treatment:</u> Negative reaction to cooked BSA (1.8 g) and positive reaction to uncooked BSA (55 mg) in DBPCFC in a 19-year old woman (2)</p> <p><u>pepsin hydrolysis:</u> ABBOS epitope (aa 126-144) not completely eliminated during digestion at pH 3-4 (mAb ELISA inhibition)* (1) Progressive reduction of positive responses in SPT and RAST after digestion with pepsin (5 min to 1 h) (3)</p> <p>* no IgE-binding studies</p>	<p>(1) Alting et al. 1997 (2) Kanny et al. 1998 (3) Fiocchi et al. 1995b</p> <p>see also 10 Stability of Beef Allergens</p>

8 Isolation & Preparation

Extract / Purified Allergens	Methods	References
Protein extract	Ground raw beef was pulverized and extracted with PBS buffer (pH 7.4) overnight at 4°C, then centrifuged, the fat removed and centrifuged again	Werfel et al. 1997
Bovine serum albumin	Isolation by cold alcohol precipitation	Fiocchi et al. 1995a
bovine IgG	Acid precipitation of colostrum whey and concentration of supernatant, isolation of IgG by affinity chromatography (Avid Gel AL) and further purification by IEC, dialysis, lyophilization	Lefranc-Millot et al. 1996

9 Cross-Reactivities

Cross-Reacting Allergens	Subjects / Methods	References
<p>Beef: (Lamb) serum albumins from beef and lamb*</p>	<p>Significant correlations in SPT between bovine and ovine serum albumins ($r = 0.846$, $p < 0.0001$) and between beef and lamb meat ($R = 0.771$, $p < 0.005$) (All 12 children SPT positive to bovine and ovine meat, and to serum albumins); 6 of 12 children were RAST positive to bovine meat, 3 to lamb meat, 4 to bovine serum albumin and 3 to ovine serum albumin; in DBPCFC 3 children were positive to bovine serum albumin and 4 to ovine serum albumin (another child had a delayed reaction to ovine serum albumin)</p>	Fiocchi et al. 1995a
<p>Beef: (Lamb, Venison, Milk) bovine IgG, lamb, venison, and milk</p>	Inhibition of IgE to bovine IgG by lamb and venison extracts and milk	Ayuso et al. 2000

Beef: (Pork, Sheep) serum albumins from beef, pork, and sheep	Cross-reactivity between purified bovine, pig, and ovine serum albumins was demonstrated; no cross-reactivity with serum albumins from horse, rabbit, turkey, and chicken (SDS-PAGE immunoblot inhibition, beef allergic patients with bovine serum albumin specific serum IgE)	Restani et al. 1997a, 1998
Beef: (Cow's Milk) beef, cow's milk*	8/11 beef allergic children presented concomitant reactivity to cow's milk (DBPCFC)*	Werfel et al. 1997
Bovine Gelatin: (Fish Gelatin) bovine and fish gelatin	Little cross-reactivity between fish and bovine gelatins (pooled serum from fish gelatin sensitive patients)	Sakaguchi et al. 2000

* multiple sensitization (not proved by inhibition-tests)

Unique Allergens	Subjects / Methods	References
Beef (Pork, Chicken) Beef vs pork and chicken	No IgE- binding from sera of 10 beef allergic individuals to pork and chicken meat extracts (ELISA, SDS-PAGE immunoblot)	Han et al. 2000

10 Stability of Beef Allergens

Treatment	Effects	References
Homogenization, Lyophilization homogenized beef and freeze-dried beef	2 children with weak reactions in SPT (12 children with beef allergy)	Fiocchi et al. 1995b
Homogenization, Lyophilization 1) homogenized beef 2) freeze-dried beef	1) no positive reactions in SPT and DBPCFC 2) 1 child positive in SPT, no positive reaction in DBPCFC (10 children with positive SPT to raw and cooked beef and positive DBPCFC to cooked beef)	Fiocchi et al. 1998b
Heat cooked beef (100°C, 5 min)	10 toddlers with positive SPT to raw and cooked beef: Positive DBPCFC with 180 g of cooked beef	Fiocchi et al. 1998b
Heat cooked beef	Positive SPT to raw beef and negative SPT to cooked beef in a meat allergic patient	Kanny et al. 1998
Heat cooked beef	Stronger IgE reactivity to raw meats in comparison to cooked meats (57 sera from suspected meat-allergic subjects, grid immunoblot)	Ayuso et al. 1999
Heat cooked beef (20 min, 140°C in conventional oven)	61% of sera showed IgE-binding to proteins of raw beef only, 24% to proteins of raw and cooked beef, and 7% to cooked beef only (41 beef sensitive patients, SDS-PAGE immunoblot)	Ayuso et al. 2000
Heat heated bovine serum albumin	7 children were sensitive to heated bovine serum albumin in SPT and 4 children were DBPCFC positive to bovine serum albumin (11 children with beef allergy and positive SPT to bovine serum albumin)	Fiocchi et al. 1998b
Heat cooked bovine serum albumin (100°C, 10 min)	Negative reaction to cooked bovine serum albumin (1.8 g) and positive reaction to uncooked bovine serum albumin (55 mg) in DBPCFC in a 19-year old woman	Kanny et al. 1998

<p>Heat a) rare-cooked beef (red centrally and pink peripherally) b) well-cooked beef (brown)</p>	<p>11 beef allergic children a) 3 children: positive DBPCFC b) 8 children: positive DBPCFC</p>	<p>Werfel et al. 1997</p>												
<p>Heat raw and cooked beef</p>	<p>Allergenic potencies comparing maximal inhibition of IgE binding to raw beef: raw beef > cooked beef (2 sera from beef allergic children, EAST inhibition)</p>	<p>Werfel et al. 1997</p>												
<p>Heat minced beef extract heated a) up to 2h at 85°C b) for 20 min up to 80°C</p>	<p>Bovine serum albumin and gamma globulin were heat-labile, 6 protein fractions persisted heat treatment: Strongest IgE-binding to 17.8 kDa and strong IgE-binding to 19 kDa protein; weak IgE-binding to 14, 20, 45, and >60 kDa proteins (11 beef allergic children, SDS-PAGE immunoblot)</p>	<p>Werfel et al. 1997</p>												
<p>Heat minced beef, purified bovine serum albumin and gamma-globulin</p>	<p><u>Heating of minced beef at 80°C:</u> a) bovine serum albumin stable for 10 min b) gamma-globulin stable for 3 min <u>Heating of purified proteins:</u> a) bovine serum albumin stable for 15 min at 95°C b) gamma-globulin stable for 15 min at 65°C (11 beef allergic children, SDS-PAGE immunoblot)</p>	<p>Werfel et al. 1997</p>												
<p>Reduction, Detergents bovine serum albumin 1) reduction with 2-mercaptoethanol 2) SDS-treatment (and heating)</p>	<p>1) reduction but not elimination of IgE-binding 2) no decrease in IgE-binding of bovine serum albumin (PAGE immunoblot)</p>	<p>Restani et al. 1998</p>												
<p>Reduction reducing conditions (mercaptoethanol, iodoacetamide)</p>	<p>IgE reactivity to bovine IgG completely disappeared when beef extracts were separated under reducing conditions, indicating conformational epitopes (SDS-PAGE immunoblot)</p>	<p>Ayuso et al. 2000</p>												
<p>Pepsin Hydrolysis (Serum albumins) hydrolysis of bovine serum albumin with pepsin a) for 5 min and b) for 2 and 4 hours</p>	<p>a) positive SPT in 4 children, RAST all negative b) positive SPT in 2 children, RAST all negative (12 children with beef allergy and positive SPT to bovine serum albumin)</p>	<p>Fiocchi et al. 1995b</p>												
<p>Hydrolysis multienzymatic in vitro digestion of meat samples (raw, steam-cooked (home-made and industrial cooking), homogenized (strained) and freeze-dried)</p>	<p>Enzymatic digestibility is strongly affected by heat treatment; cooking and technological treatments reduce positive responses in SPT (8 children with , SPT and SDS-PAGE immunoblot)</p>	<p>Restani et al. 1997b</p>												
<p>Pepsin Hydrolysis, Pancreatic Enzymes, Whey Proteins hydrolysis with pepsin (pH 2, 3, and 4, for 90 min) followed by hydrolysis with a mixture of pancreatic enzymes (pH 7.5 for 150 min) of bovine serum albumin and bovine IgG</p>	<p>Percent inhibition of IgE-binding from sera of patients with IgE- mediated cow's milk allergy to native proteins by respective hydrolysates of homologue protein:</p> <table border="1"> <thead> <tr> <th>pepsin hydrolysis at</th> <th>pH 2</th> <th>pH 3</th> <th>pH 4</th> </tr> </thead> <tbody> <tr> <td>BSA</td> <td>0%</td> <td>0%</td> <td>58%</td> </tr> <tr> <td>bovine IgG</td> <td>2.5%</td> <td>54%</td> <td>91%</td> </tr> </tbody> </table> <p>(RAST inhibition)</p>	pepsin hydrolysis at	pH 2	pH 3	pH 4	BSA	0%	0%	58%	bovine IgG	2.5%	54%	91%	<p>Schmidt et al. 1995</p>
pepsin hydrolysis at	pH 2	pH 3	pH 4											
BSA	0%	0%	58%											
bovine IgG	2.5%	54%	91%											

11 Allergen Sources

11.1 Beef Allergen Sources

Reported Adverse Reactions	References
Beef	see 2 Symptoms of Beef Allergy
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 A case of IgE-mediated reactions to bovine serum albumin contained in the dilution fluid added to semen for artificial insemination (1)	(1) de Blay et al. 1993
Pharmaceuticals Immunizing with sera containing adjuvants the subjects became sensitized to other substances in the immunizing sera, specifically to beef protein (1)	(1) Hollander 1995
Pharmaceuticals: Aprotinin Anaphylactic reactions associated to the administration of aprotinin, either by injection route or as a biological sealant application; documented risk factors include allergy to beef meat, egg white, cheese and milk; aprotinin is a proteinase inhibitor (1)	(1) Laxenaire et al. 2000

11.2 Beef Associated Allergen Sources

The table lists adverse events due to unexpected allergens (other than beef allergens) present in a variety of beef products.

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)	(1) 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
Hamburger Meat (Spice) Allergic reactions in a 40-year old meat industry worker handling flavourings for minced beef in the preparation of hamburgers; evaluation revealed IgE-mediated reactions to ginger as a ingredient of the flavourings (1)	(1) Cueva et al. 2001
"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 <i>Penicillium</i> spp. was present and the suspected cause of hypersensitivity reactions (1)	(1) Rivero et al. 1999

Veterinary Drug Residues

Occurrence of allergic reactions was demonstrated in 2/9 patients challenged with penicillin- contaminated meat (1)

Anaphylaxis on 4 occasions in a child, likely caused by beef containing streptomycin (2)

A 64 year old woman experienced anaphylactic shocks after ingestion of beef and pork meat, respectively. Food allergy to animal proteins excluded. The woman was highly sensitized to penicillin. It was concluded that food induced anaphylaxis was linked to penicillin residues in meats (3)

(1) [Lindemayr et al. 1981](#)

(2) [Tinkelman & Bock 1984](#)

(3) [Kanny et al. 1994](#)

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