Animal models of allergen-specific immunotherapy in food allergy: Overview and opportunities

Food allergy is an adverse reaction to otherwise harmless proteins in food. The disease is a major health problem of growing concern, affecting approximately 5-8% of young children and 2-4% of adults. No accepted strategy exists for prevention and treatment of food allergy, and strict avoidance of the offending food is presently the only viable management option. Living with food avoidance may have a huge impact on the quality of life of food allergic patients, with daily fear of serious or even fatal reactions. The urgent need for safe and efficient food allergy treatment options has led to massive research efforts to develop and improve strategies for food allergy immunotherapeutic approaches. A first step in developing new and improved strategies of immunotherapy often involves the use of animal models. In present review, we provide an overview of animal studies of allergen-specific immunotherapy highlighting opportunities and challenges for each approach. The presented models, almost exclusively performed in mice, assess therapeutic efficacy and immunological outcomes following oral, intraperitoneal, subcutaneous, epicutaneous, and sublingual administration of native allergens, or preparations of hydrolyzed allergen, T cell directed peptides, or allergen with immunomodulatory adjuvants. Recently, approaches using immune cell therapy have demonstrated efficacy. Current models mainly assess anaphylaxis as the primary clinical outcome. With the increased appreciation that food allergy is a heterogeneous disease presenting different phenotypes, there is a continued need to develop new disease-relevant therapeutic models of food allergy.
Immunogenicity and allergenicity of camel and cow's milk: a comparative study in brown Norway rats

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology, Research Group for Analytical Food Chemistry
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Scopus rating (2017): CiteScore 6.23 SJR 2.702 SNIP 2.332
Web of Science (2017): Impact factor 6.048
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 6.23 SJR 2.841 SNIP 2.521
Web of Science (2016): Impact factor 7.361
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 5.73 SJR 3.17 SNIP 2.17
Web of Science (2015): Impact factor 6.335
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 5.51 SJR 2.529 SNIP 2.161
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.91 SJR 2.218 SNIP 1.939
Web of Science (2013): Impact factor 5.995
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 4.81 SJR 2.126 SNIP 1.853
Web of Science (2012): Impact factor 5.883
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 4.89 SJR 2.221 SNIP 1.801
Web of Science (2011): Impact factor 6.271
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.898 SNIP 1.86
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.735 SNIP 0.982
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.432 SNIP 1.933
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.389 SNIP 1.861
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.499 SNIP 2.692
Web of Science (2006): Indexed yes
Modermælkserstatninger til forebyggelse og behandling af komælksallergi

Resumé

Projektet viste, at dyremodeller er et godt og solidt værktøj til en overordnet undersøgelse af komælksbaserede produkters evne til at inducere allergi versus tolerance. Projektet viste også, at den generelle grad af modificering, mere end blot hydrolysegraden, spiller en afgørende rolle for komælksbaserede produkters allergi- versus tolerance-inducerende egenskaber.

Derfor er det vigtigt at lave grundige protein-kemiske karakteriseringer af produkterne. Projektet belyste ydermere potentialet af modificerede intakte produkter som alternativer til hypoallergene modermælkserstatninger baseret på hydrolysater.

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology
Contributors: Bøgh, K. L.
Pages: 8-9
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Peer-reviewed: No

Publication information
Journal: Mælkeritidende
Preventive sublingual allergen immunotherapy with house dust mite extract modulates epitope recognition in pre-school children

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology, University of Vienna, Austrian Institute of Technology, Evaxion Biotech, Chinese University of Hong Kong, University of Toronto
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Peer-reviewed: Yes

Publication information
Journal: Allergy
Volume: 73
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Article number: 0180
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Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 6.23 SJR 2.702 SNIP 2.332
Web of Science (2017): Impact factor 6.048
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 6.23 SJR 2.841 SNIP 2.521
Web of Science (2016): Impact factor 7.361
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 5.73 SJR 3.17 SNIP 2.17
Web of Science (2015): Impact factor 6.335
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 5.51 SJR 2.529 SNIP 2.161
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.91 SJR 2.218 SNIP 1.939
Web of Science (2013): Impact factor 5.995
ISI indexed (2013): ISI indexed yes
Protein-chemical features of five different wheat products affect the sensitising capacity through the skin

General information
State: Published
Organisations: National Food Institute, Research Group for Analytical Food Chemistry, University of Milan, University of Liege, INRA Institut National de La Recherche Agronomique
Number of pages: 1
Publication date: 2018
Peer-reviewed: Yes
Event: Abstract from 4th ImpARAS conference, Naples, Italy.
Electronic versions:
Protein_chemical_features_of_five_different_wheat_products_affect_the_sensitising_capacity_through_the_skin_.pdf
Source: PublicationPreSubmission
Source-ID: 151639277
Research output: Research - peer-review › Conference abstract for conference – Annual report year: 2018
Sensitising potential of gluten products via intact, damaged and inflamed skin

General information
State: Published
Organisations: National Food Institute, Medical University of Vienna
Contributors: Kazemi, S., Larsen, J. M., Madsen, C. B., Epstein, M., Bøgh, K. L.
Number of pages: 1
Publication date: 2018
Peer-reviewed: Yes
Event: Abstract from 4th ImpARAS conference, Naples, Italy.
Electronic versions:
Abstract_Sahar.pdf
Source: PublicationPreSubmission
Source-ID: 153256887
Research output: Research - peer-review › Conference abstract for conference – Annual report year: 2018

The influence of protein-chemical features on the skin sensitising capacity of five different wheat products: A dose-response study in brown Norway rats

General information
State: Published
Organisations: National Food Institute, Research Group for Analytical Food Chemistry, University of Milan, University of Liege, INRA Institut National de La Recherche Agronomique
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Publication information
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BFI (2018): BFI-level 1
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Web of Science (2017): Impact factor 6.048
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 6.23 SJR 2.841 SNIP 2.521
Web of Science (2016): Impact factor 7.361
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 5.73 SJR 3.17 SNIP 2.17
Web of Science (2015): Impact factor 6.335
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 5.51 SJR 2.529 SNIP 2.161
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.91 SJR 2.218 SNIP 1.939
Web of Science (2013): Impact factor 5.995
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Milk allergy prevention and treatment
The invention provides a new strategy for achieving desensitisation or induction of tolerance to milk protein allergens, e.g. BLG, in humans or animals, comprising formulating and using a composition comprising a purified intact expressed milk protein together with one or more purified peptides from said intact milk protein.

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology
Contributors: Bøgh, K. L., Madsen, C. B.
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Publication information
IPC: G01N 33/68 A1
Patent number: WO2017144730
Date: 31/08/2017
Priority date: 26/02/2016
Priority number: EP20160157602
Original language: English
A review of animal models used to evaluate potential allergenicity of genetically modified organisms (GMOs)

Food safety regulators request prediction of allergenicity for newly expressed proteins in genetically modified (GM) crops and in novel foods. Some have suggested using animal models to assess potential allergenicity. A variety of animal models have been used in research to evaluate sensitisation or elicitation of allergic responses. However, protocols for sensitisation and challenge, animal species and strains, diets and other environmental factors differ widely. We present a comprehensive review of published, peer-reviewed experimental animal models used for the evaluation of allergenicity of genetically modified organisms (GMOs).

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology, University of Nebraska, Medical University of Vienna
Contributors: Marsteller, N., Bøgh, K. L., Goodman, R. E., Epstein, M. M.
Number of pages: 8
Pages: 81-88
Publication date: 2017
Peer-reviewed: Yes

Publication Information
Journal: Drug Discovery Today: Disease Models
Volume: 17-18
ISSN (Print): 1740-6757
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.62 SJR 0.218 SNIP 0.167
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.74 SJR 0.479 SNIP 0.225
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.55 SJR 0.31 SNIP 0.112
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 0.72 SJR 0.373 SNIP 0.199
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 0.62 SJR 0.288 SNIP 0.229
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 0.61 SJR 0.228 SNIP 0.17
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 0.8 SJR 0.364 SNIP 0.19
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.33 SNIP 0.178
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.264 SNIP 0.156
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.197 SNIP 0.123
Scopus rating (2007): SJR 0.205 SNIP 0.097
Scopus rating (2006): SJR 0.177 SNIP 0.084
Scopus rating (2005): SJR 0.13 SNIP 0.029
Original language: English
DOIs:
10.1016/j.ddmod.2016.11.001
Source: FindIt
Source-ID: 2349064696
Correlation of the allergenicity and tolerogenicity of two cow's milk protein products with intestinal uptake

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology, Technical University of Denmark, Utrecht University, Arla Foods
Pages: 320-320
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Peer-reviewed: Yes

Publication information
Journal: Allergy: European Journal of Allergy and Clinical Immunology
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Ratings:
BFI (2018): BFI-level 1
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BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 6.23 SJR 2.702 SNIP 2.332
Web of Science (2017): Impact factor 6.048
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 6.23 SJR 2.841 SNIP 2.521
Web of Science (2016): Impact factor 7.361
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 5.73 SJR 3.17 SNIP 2.17
Web of Science (2015): Impact factor 6.335
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 5.51 SJR 2.529 SNIP 2.161
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.91 SJR 2.218 SNIP 1.939
Web of Science (2013): Impact factor 5.995
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 4.81 SJR 2.126 SNIP 1.853
Web of Science (2012): Impact factor 5.883
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 4.89 SJR 2.221 SNIP 1.801
Web of Science (2011): Impact factor 6.271
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.898 SNIP 1.86
Correlation of the allergenicity and tolerogenicity of two cow's milk protein products with their intestinal uptake – a study in Brown Norway (BN) rats

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology, Technical University of Denmark, Utrecht University, Arla Foods Ingredients Group P/S
Number of pages: 1
Pages: 35-35
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Proceeding book

Correlation of the allergenicity and tolerogenicity of two cow's milk protein products with their intestinal uptake – a study in Brown Norway rats

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology, Technical University of Denmark, Arla Foods Ingredients Group P/S, Utrecht University
Number of pages: 1
Publication date: 2017
Peer-reviewed: Yes
Food allergy skin sensitization: A comparative study with three different gluten products in Brown Norway rats

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology, INRA Institut National de La Recherche Agronomique
Contributors: Castan, L., Ballegaard, A. R., Bouchaud, G., Bøgh, K. L.
Number of pages: 1
Pages: 58-58
Publication date: 2017

Host publication information
Title of host publication: Proceedings of the 3rd International ImpARAS Conference
Place of publication: Helsingør, Denmark
Article number: F05
Electronic versions:
Proceeding book
Research output: Research - peer-review › Conference abstract in proceedings – Annual report year: 2017

IgE - the main player of food allergy
Food allergy is a growing problem worldwide, presently affecting 2-4% of adults and 5-8% of young children. IgE is a key player in food allergy. Consequently huge efforts have been made to develop tests to detect either the presence of IgE molecules, their allergen binding sites or their functionality, in order to provide information regarding the patient's food allergy. The ultimate goal is to develop tools that are capable of discriminating between asymptomatic sensitization and a clinically relevant food allergy, and between different allergic phenotypes in an accurate and trustworthy manner. This may generate better diagnostic, prognostic and therapeutic monitoring tools for the future.

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology, University Medical Centre Utrecht, Hospital for Sick Children
Contributors: Broekman, H. C. H., Eiwegger, T., Upton, J., Bøgh, K. L.
Number of pages: 8
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BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.62 SJR 0.218 SNIP 0.167
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.74 SJR 0.479 SNIP 0.225
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.55 SJR 0.31 SNIP 0.112
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 0.72 SJR 0.373 SNIP 0.199
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 0.62 SJR 0.288 SNIP 0.229
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 0.61 SJR 0.228 SNIP 0.17
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 0.8 SJR 0.364 SNIP 0.19
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.33 SNIP 0.178
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.264 SNIP 0.156
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.197 SNIP 0.123
Scopus rating (2007): SJR 0.205 SNIP 0.097
Scopus rating (2006): SJR 0.177 SNIP 0.084
Scopus rating (2005): SJR 0.13 SNIP 0.029
Original language: English
Keywords: Molecular Medicine, Drug Discovery
DOIs:
10.1016/j.ddmod.2016.07.001
Source: FindIt
Source-ID: 2347943439
Research output: Research - peer-review › Journal article – Annual report year: 2017

Sensitising capacity of five different wheat products through the skin

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology, Fujita Health University, National Institute of Health Sciences Tokyo
Number of pages: 1
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Publication date: 2017

Host publication information
Title of host publication: Proceedings of the 3rd International ImpARAS Conference
Place of publication: Helsingør, Denmark
Article number: 018
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Abstract_ImpARAS_Anne_Sofie_R._Ballegaard.pdf
Proceeding book
Source: PublicationPreSubmission
Source-ID: 139064524
Research output: Research - peer-review › Conference abstract in proceedings – Annual report year: 2017

Sensitising capacity of unmodified and acid hydrolysed gluten through the skin—a comparative study in naïve vs tolerant Brown Norway rats

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology
Contributors: Ballegaard, A. R., Madsen, C. B., Bøgh, K. L.
Pages: 316-316
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Allergy: European Journal of Allergy and Clinical Immunology
Volume: 72
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Article number: 0445
ISSN (Print): 0105-4538
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BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 6.23 SJR 2.702 SNIP 2.332
Web of Science (2017): Impact factor 6.048
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 6.23 SJR 2.841 SNIP 2.521
Web of Science (2016): Impact factor 7.361
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 5.73 SJR 3.17 SNIP 2.17
Web of Science (2015): Impact factor 6.335
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 5.51 SJR 2.529 SNIP 2.161
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.91 SJR 2.218 SNIP 1.939
Web of Science (2013): Impact factor 5.995
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 4.81 SJR 2.126 SNIP 1.853
Web of Science (2012): Impact factor 5.883
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 4.89 SJR 2.221 SNIP 1.801
Web of Science (2011): Impact factor 6.271
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.898 SNIP 1.86
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.735 SNIP 0.982
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.432 SNIP 1.933
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.389 SNIP 1.861
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.499 SNIP 2.692
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.901 SNIP 1.635
Scopus rating (2004): SJR 0.795 SNIP 1.918
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.55 SNIP 1.105
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.679 SNIP 0.646
Current challenges facing the assessment of the allergenic capacity of food allergens in animal models

Food allergy is a major health problem of increasing concern. The insufficiency of protein sources for human nutrition in a world with a growing population is also a significant problem. The introduction of new protein sources into the diet, such as newly developed innovative foods or foods produced using new technologies and production processes, insects, algae, duckweed, or agricultural products from third countries, creates the opportunity for development of new food allergies, and this in turn has driven the need to develop test methods capable of characterizing the allergenic potential of novel food proteins. There is no doubt that robust and reliable animal models for the identification and characterization of food allergens would be valuable tools for safety assessment. However, although various animal models have been proposed for this purpose, to date, none have been formally validated as predictive and none are currently suitable to test the allergenic potential of new foods. Here, the design of various animal models are reviewed, including among others considerations of species and strain, diet, route of administration, dose and formulation of the test protein, relevant controls and endpoints measured.
General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology
Number of pages: 13
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Peer-reviewed: Yes

Publication information
Journal: Clinical and Translational Allergy
Volume: 6
Issue number: 1
ISSN (Print): 2045-7022
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
Scopus rating (2017): CiteScore 3.62 SJR 1.425 SNIP 1.188
Web of Science (2017): Impact factor 3.539
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 1.13 SJR 1.14 SNIP 1.172
Web of Science (2016): Impact factor 3.239
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 0.78 SJR 1.219 SNIP 1.147
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 0.62 SJR 1.324 SNIP 1.281
Scopus rating (2013): CiteScore 0.5 SJR 1.037 SNIP 0.792
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.468 SNIP 0.245
ISI indexed (2012): ISI indexed no
Original language: English
Keywords: Animal models, Food allergy, Hazard identification, Novel allergens

Electronic versions:
art_3A10.1186_2Fs13601_016_0110_2.pdf
DOIs:
URLs:
Source: FindIt
Source-ID: 2304745163
Research output: Research - peer-review › Journal article – Annual report year: 2016

Development of a food allergy skin sensitisation model in naive Brown Norway rats

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology
Contributors: Ballegaard, A. R., Madsen, C. B., Gregersen, J. M., Bøgh, K. L.
Number of pages: 1
Publication date: 2016
Peer-reviewed: Yes
Event: Abstract from 4th Food Allergy and Anaphylaxis Meeting, Rome, Italy.
Research output: Research - peer-review › Conference abstract for conference – Annual report year: 2017

Establishing methods to evaluate intestinal uptake of food proteins

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology, Utrecht University
Food Allergens: Is There a Correlation between Stability to Digestion and Allergenicity?

Food allergy is a major health problem in the Western countries, affecting 3-8% of the population. It has not yet been established what makes a dietary protein a food allergen. Several characteristics have been proposed to be shared by food allergens. One of these is resistance to digestion. This paper reviews data from digestibility studies on purified food allergens and evaluates the predictive value of digestibility tests on the allergenic potential. We point out that food allergens do not necessarily resist digestion. We discuss how the choice of in vitro digestibility assay condition and the method used for detection of residual intact protein as well as fragments hereof may greatly influence the outcome as well as the interpretation of results. The finding that digests from food allergens may retain allergenicity, stresses the importance of using immunological assays for evaluating the allergenic potential of food allergen digestion products. Studies assessing the allergenicity of digestion products, by either IgE-binding, elicitation or sensitizing capacity, shows that digestion may abolish, decrease, have no effect, or even increase the allergenicity of food allergens. Therefore, the predictive value of the pepsin resistance test for assessing the allergenic potential of novel proteins can be questioned.

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology
Contributors: Bøgh, K. L., Madsen, C. B.
Number of pages: 23
Pages: 1545-1567
Publication date: 2016
Peer-reviewed: Yes

Publication information
Journal: Critical Reviews in Food Science and Nutrition
Volume: 56
Issue number: 9
ISSN (Print): 1040-8398
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 5.15 SJR 1.596 SNIP 1.998
Web of Science (2017): Impact factor 6.015
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.65 SJR 1.569 SNIP 2.063
Web of Science (2016): Impact factor 6.077
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.72 SJR 1.941 SNIP 2.264
Web of Science (2015): Impact factor 5.492
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 5.97 SJR 2.041 SNIP 2.417
Web of Science (2014): Impact factor 5.176
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 5.83 SJR 2.072 SNIP 2.374
Web of Science (2013): Impact factor 5.548
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 5.73 SJR 2.055 SNIP 2.684
Web of Science (2012): Impact factor 4.82
Gluten, Enzymatic or Acid hydrolysed gluten does not induce sensitisation by the oral route in contrast to i.p. dosing: A study in gluten-tolerant Brown Norway rats.

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology
Contributors: Madsen, C. B., Bøgh, K. L.
Number of pages: 1
Publication date: 2016
Peer-reviewed: Yes
Event: Abstract from 4th Food Allergy and Anaphylaxis Meeting, Rome, Italy.
Research output: Research - peer-review › Conference abstract for conference – Annual report year: 2017

Linear epitope mapping of peanut allergens demonstrates individualized and persistent antibody-binding patterns

General information
State: Published
Organisations: Department of Civil Engineering, Department of Micro- and Nanotechnology, Fluidic Array Systems and Technology, National Food Institute, Research Group for Gut Microbiology and Immunology, Technical University of Denmark, Roche NimbleGen, Medical University of Vienna, Universidad Nacional de San Martin
Contributors: Hansen, C. S., Dufva, M., Bøgh, K. L., Sullivan, E., Patel, J., Eiwegger, T., Szépfalusi, Z., Nielsen, M., Christiansen, A.
Pages: 1728-1730
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Journal: Journal of Allergy and Clinical Immunology
Tarmens mikroflora og spædbørns komælkstolerance skal undersøges

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology
Contributors: Graversen, K., Bøgh, K. L.
Number of pages: 2
Pages: 6-7
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Peer-reviewed: Yes

Publication information
Journal: Mælkeritidende
Issue number: 25-26
Original language: Danish
Research output: Research - peer-review › Journal article – Annual report year: 2017

Acid hydrolysed gluten induces high avidity antibodies to gluten: A study in gluten tolerant Brown Norway rats.

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology
Contributors: Bøgh, K. L., Madsen, C. B.
Number of pages: 1
Publication date: 2015
Peer-reviewed: Yes
Event: Abstract from 1st ImpARAS congress, Belgrade, Serbia.
Research output: Research - peer-review › Conference abstract for conference – Annual report year: 2015

Characterization of the Immunogenicity and Allergenicity of Two Cow's Milk Hydrolysates – A Study in Brown Norway Rats

Hypoallergenic infant formulas based on hydrolysed milk proteins are used in the diet for cow's milk allergic infants. For a preclinical evaluation of the immunogenicity and allergenicity of new protein ingredients for such hypoallergenic infant formulas as well as for the investigation of which characteristics of hydrolysates that contribute to allergenicity, in vivo models are valuable tools. In this study, we examine the immunogenicity and allergenicity of two hydrolysates in a Brown Norway (BN) rat model, using i.p. dosing, which allows for the use of small quantities. Intact BLG, hydrolysed BLG and a hydrolysed whey product suitable for use in extensively hydrolysed formulas were thoroughly characterized for protein chemical features and administered to BN rats by i.p. immunization with or without adjuvant. Sera were analysed for specific IgG and IgE for evaluation of sensitizing capacity, immunogenicity and antibody-binding capacity. For evaluation of eliciting capacity a skin test was performed. The study showed that the hydrolysates had no residual allergenicity, lacking the capacity to sensitize and elicit reactions in the BN rats. Dosing with or without adjuvant induced a large difference in immunogenicity. Only antibodies from rats sensitized to intact BLG with adjuvant were able to bind the hydrolysates, and the whey-based hydrolysate only showed immunogenicity when dosed with adjuvant. This study showed that hydrolysates can be evaluated by an i.p. animal model, but that the choice of in vitro tests used for evaluation of antibody responses may greatly influence the result as well as may the use of adjuvant.

General information
State: Published
Organisations: National Food Institute, Division of Toxicology and Risk Assessment, Department of Systems Biology, Enzyme and Protein Chemistry
Contributors: Bøgh, K. L., Barkholt, V., Madsen, C. B.
Number of pages: 10
Pages: 274-283
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: Scandinavian Journal of Immunology
Volume: 81
Issue number: 5
ISSN (Print): 0300-9475

Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.11 SJR 0.891 SNIP 0.621
Web of Science (2017): Impact factor 2.314
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.03 SJR 0.979 SNIP 0.644
Web of Science (2016): Impact factor 2.256
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.97 SJR 0.933 SNIP 0.679
Web of Science (2015): Impact factor 2.27
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.91 SJR 0.901 SNIP 0.665
Web of Science (2014): Impact factor 1.739
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.05 SJR 0.875 SNIP 0.709
Web of Science (2013): Impact factor 1.882
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.16 SJR 0.89 SNIP 0.742
Web of Science (2012): Impact factor 2.199
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.06 SJR 0.865 SNIP 0.654
Web of Science (2011): Impact factor 2.23
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.859 SNIP 0.621
Web of Science (2010): Impact factor 1.935
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.973 SNIP 0.659
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.24 SNIP 0.078
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.288 SNIP 0.141
Scopus rating (2006): SJR 0.426 SNIP 0.124
Scopus rating (2005): SJR 1.017 SNIP 0.641
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.858 SNIP 0.6
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.819 SNIP 0.625
Scopus rating (2002): SJR 0.74 SNIP 0.587
Web of Science (2002): Indexed yes
Development of two Brown Norway rat models for the assessment of primary prevention and desensitising capacity of cow's milk based hydrolysates

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology, Arla Foods
Number of pages: 1
Pages: 498-498
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: Allergy
Volume: 70
Issue number: Supplement S101
Article number: 1224
ISSN (Print): 0105-4538
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 6.23 SJR 2.702 SNIP 2.332
Web of Science (2017): Impact factor 6.048
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 6.23 SJR 2.841 SNIP 2.521
Web of Science (2016): Impact factor 7.361
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 5.73 SJR 3.17 SNIP 2.17
Web of Science (2015): Impact factor 6.335
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 5.51 SJR 2.529 SNIP 2.161
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.91 SJR 2.218 SNIP 1.939
Web of Science (2013): Impact factor 5.995
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 4.81 SJR 2.126 SNIP 1.853
Web of Science (2012): Impact factor 5.883
ISI indexed (2012): ISI indexed yes
High-throughput sequencing enhanced phage display enables the identification of patient-specific epitope motifs in serum

Phage display is a prominent screening technique with a multitude of applications including therapeutic antibody development and mapping of antigen epitopes. In this study, phages were selected based on their interaction with patient serum and exhaustively characterised by high-throughput sequencing. A bioinformatics approach was developed in order to identify peptide motifs of interest based on clustering and contrasting to control samples. Comparison of patient and control samples confirmed a major issue in phage display, namely the selection of unspecific peptides. The potential of the bioinformatic approach was demonstrated by identifying epitopes of a prominent peanut allergen, Ara h 1, in sera from patients with severe peanut allergy. The identified epitopes were confirmed by high-density peptide micro-arrays. The present study demonstrates that high-throughput sequencing can empower phage display by (i) enabling the analysis of complex biological samples, (ii) circumventing the traditional laborious picking and functional testing of individual phage clones and (iii) reducing the number of selection rounds.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Fluidic Array Systems and Technology, Department of Systems Biology, Center for Biological Sequence Analysis, National Food Institute, Regulatory Genomics, Roche NimbleGen, Quadram Institute, Medical University of Vienna
Number of pages: 13
Publication date: 2015
Peer-reviewed: Yes

Publication information
High-Throughput Tools for Characterization of Antibody Epitopes

Antibodies are molecules of tremendous importance. In their primary role, they protect our bodies against disease. However, in recent decades, scientists have harnessed the binding capabilities of antibodies and have applied them widely in research, diagnostics and therapeutics. Consequently, it is important to characterize antibodies thoroughly. In parallel to the characterization of antibodies, it is also important to characterize the binding area that is recognized by the antibody, known as an epitope. With the development of new technologies, such as high-throughput sequencing (HTS), it is important to determine how these methods can improve our understanding of antibodies and their epitopes. The overall objective of the presented studies was to investigate how emerging technologies (specifically HTS coupled with phage display and next-generation peptide microarrays) could be used for epitope mapping.
In Chapter 1, it was examined whether combining phage display, a traditional epitope mapping approach, with HTS would improve the method. The developed approach was successfully used to map Ara h 1 epitopes in sera from patients with peanut allergy. Notably, the sera represented difficult biological samples due to the rarity of the relevant antibodies and the polyclonal nature of serum. The inclusion of control samples enabled the development of a bioinformatic approach that identified peptide motifs of interest based on clustering and contrasting. A widespread problem in phage display, which is the unintended selection of peptides that are target-unspecific, was examined by comparing patient and control samples. The experiments highlighted that HTS can potentially improve on phage display by enabling the analysis of complex biological samples. Coupling the two methods furthermore has the capacity to omit traditional clone picking and functional testing which is a laborious part of phage display.

In the following study, Chapter 2, it was described how the approach developed in Chapter 1 could be utilized for a different application of phage display, specifically the identification of peptide binders. In this study, phage display screenings were used to identify peptides that could inhibit a major toxin in cobra snake venom, α-cobratoxin. Peptide inhibitors were successfully identified. Importantly, HTS enabled the identification of toxin inhibitors that were not discovered by traditional phage display.

Phage display coupled with HTS was again used in Chapter 3 in an attempt to map the epitopes of a therapeutic target injected into animals. The animals were immunized with a therapeutic target and the expectation was that they develop antibodies, which can be used in therapy. While no epitopes could be definitively identified, the study demonstrated the potential of the MiSeq HTS platform. Sequencing of the phage library also showed that many of the target-unrelated phages identified in the previous chapters, were frequent in the original library, thus indicating that they held proliferation advantages.

Finally, in Chapter 4, a different emerging technology, next-generation peptide microarrays, was applied for epitope mapping of major peanut allergens using sera from allergic patients. New developments in the peptide microarray have enabled a greatly increased throughput. In this study, these improvements were utilized to characterize epitopes at high resolution, i.e. determine the importance of each residue for antibody binding, for all major peanut allergens. Epitope reactivity among patients often converged on known epitope hotspots, however the binding patterns were somewhat heterogeneous when examined at the residue level. A high degree of correlation between IgE and IgG4 epitope binding patterns were observed, possibly indicating a common clonal origin. Finally, since the patients had been sampled over time it could be confirmed that the epitope binding patterns were stable over multiple years.

Taken together, the presented studies demonstrated new applications for the investigated techniques focusing on their utilization in epitope mapping. In the process, new insights were obtained into how antibodies recognize their targets in a major disease, i.e. food allergy.
The influence of physico-chemical properties of cow's milk based hydrolysates on the allergenic versus primary preventive capacity.

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology, Arla Foods Ingredients Group P/S
Number of pages: 1
Publication date: 2015
Peer-reviewed: Yes
Event: Abstract from 1st ImpARAS congress, Belgrade, Serbia.
Research output: Research - peer-review › Conference abstract in journal – Annual report year: 2016

The influence of various forms of processing on the sensitising capacity of cow’s milk and peanut allergens

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology, Division of Food Chemistry, Technical University of Denmark, Quadram Institute
Number of pages: 1
Publication date: 2015
Peer-reviewed: Yes
Event: Abstract from 1st ImpARAS congress, Belgrade, Serbia.
Research output: Research - peer-review › Conference abstract for conference – Annual report year: 2015

The use of aluminum hydroxide as adjuvant modulates the antibody response to food allergens

General information
State: Published
Organisations: Division of Toxicology and Risk Assessment, National Food Institute, Research Group for Gut Microbiology and Immunology, Division of Food Chemistry
Contributors: Baegh, K. L., Andreasen, M. S., Madsen, C. B.
Number of pages: 1
Pages: 100
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: Clinical and Translational Allergy
Volume: 5
Issue number: Suppl 3
ISSN (Print): 2045-7022
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
Scopus rating (2017): CiteScore 3.62 SJR 1.425 SNIP 1.188
Web of Science (2017): Impact factor 3.539
Transgenic DQ2 mice on a total knock out background have a suboptimal humoral immune response to gluten

General information
State: Published
Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology, Odense University Hospital, Hvidovre Hospital
Number of pages: 1
Publication date: 2015
Peer-reviewed: Yes
Event: Abstract from 16th International Coeliac Disease Symposium, Prague, Czech Republic.
Research output: Research - peer-review » Conference abstract for conference – Annual report year: 2015

Ultra-high density peptide arrays demonstrate unique patient-specific IgE and IgG4 epitope patterns for peanut allergens that persist over multiple years

Clinicians are seeing a growing number of cashew nut allergic patients. One of the peculiarities of this allergy is that a minimal amount of cashew nut allergen may cause severe allergic reactions, suggesting high potency of the allergen comparable to other tree nuts and peanuts. The double blind placebo controlled food challenge (DBPCFC) test is currently the gold standard to establish cashew nut allergy. The development of predictive tools in diagnosing cashew nut allergy is needed and research should be done on cross-sensitization between cashew nut and other botanically related allergens.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Fluidic Array Systems and Technology, Department of Systems Biology, Center for Biological Sequence Analysis, National Food Institute, University of Vienna, Roche NimbleGen
Number of pages: 1
Pages: 90-90
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: Allergy
Volume: 70
Issue number: Suppl. 101
Article number: 183
ISSN (Print): 0105-4538
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 6.23 SJR 2.702 SNIP 2.332
Web of Science (2017): Impact factor 6.048
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 6.23 SJR 2.841 SNIP 2.521
Web of Science (2016): Impact factor 7.361
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 5.73 SJR 3.17 SNIP 2.17
Web of Science (2015): Impact factor 6.335
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 5.51 SJR 2.529 SNIP 2.161
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.91 SJR 2.218 SNIP 1.939
Web of Science (2013): Impact factor 5.995
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 4.81 SJR 2.126 SNIP 1.853
Web of Science (2012): Impact factor 5.883
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 4.89 SJR 2.221 SNIP 1.801
Web of Science (2011): Impact factor 6.271
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.898 SNIP 1.86
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.735 SNIP 0.982
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.432 SNIP 1.933
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.389 SNIP 1.861
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.499 SNIP 2.692
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.901 SNIP 1.635
Scopus rating (2004): SJR 0.795 SNIP 1.918
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.55 SNIP 1.105
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.679 SNIP 0.646
Scopus rating (2001): SJR 0.507 SNIP 0.487
A novel approach for characterisation of conformational allergen epitopes combining phage display and high-throughput sequencing

**General information**
State: Published
Organisations: Department of Micro- and Nanotechnology, Fluidic Array Systems and Technology, Department of Systems Biology, Center for Biological Sequence Analysis, Immunological Bioinformatics, National Food Institute, Division of Toxicology and Risk Assessment
Contributors: Christiansen, A., Hansen, C. S., Kringelum, J. V., Lund, O., Bøgh, K. L., Dufva, M.
Pages: P27
Publication date: 2014
Peer-reviewed: Yes

**Publication information**
Journal: Clinical and Translational Allergy
Volume: 4
Issue number: Suppl 2
ISSN (Print): 2045-7022
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
Scopus rating (2017): CiteScore 3.62 SJR 1.425 SNIP 1.188
Web of Science (2017): Impact factor 3.539
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 1.13 SJR 1.14 SNIP 1.172
Web of Science (2016): Impact factor 3.239
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 0.78 SJR 1.219 SNIP 1.147
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 0.62 SJR 1.324 SNIP 1.281
Scopus rating (2013): CiteScore 0.5 SJR 1.037 SNIP 0.792
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.468 SNIP 0.245
ISI indexed (2012): ISI indexed no
Original language: English
Electronic versions:
2045_7022_4_S2_P27.pdf
DOIs:
10.1186/2045-7022-4-S2-P27

**Bibliographical note**
Poster presentation

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Source: dtu
Source-ID: n:oai:DTIC-ART:bmc/444951334::38497
Research output: Research - peer-review › Conference abstract in journal – Annual report year: 2014

Assessment of the Sensitizing Potential of Processed Peanut Proteins in Brown Norway Rats: Roasting Does Not Enhance Allergenicity
Background
IgE-binding of process-modified foods or proteins is the most common method for examination of how food processing affects allergenicity of food allergens. How processing affects sensitization capacity is generally studied by administration of purified food proteins or food extracts and not allergens present in their natural food matrix.

Objectives
The aim was to investigate if thermal processing increases sensitization potential of whole peanuts via the oral route. In parallel, the effect of heating on sensitization potential of the major peanut allergen Ara h 1 was assessed via the intraperitoneal route.

Methods
Sensitization potential of processed peanut products and Ara h 1 was examined in Brown Norway (BN) rats by oral administration of blanched or oil-roasted peanuts or peanut butter or by intraperitoneal immunization of purified native (N-), heated (H-) or heat glycated (G-)Ara h 1. Levels of specific IgG and IgE were determined by ELISA and IgE functionality was examined by rat basophilic leukemia (RBL) cell assay.

Results
In rats dosed orally, roasted peanuts induced significant higher levels of specific IgE to NAra h 1 and 2 than blanched peanuts or peanut butter but with the lowest level of RBL degranulation. However, extract from roasted peanuts was found to be a superior elicitor of RBL degranulation. Process-modified Ara h 1 had similar sensitizing capacity as NAra h 1 but specific IgE reacted more readily with process-modified Ara h 1 than with native.

Conclusions
Peanut products induce functional specific IgE when dosed orally to BN rats. Roasted peanuts do not have a higher sensitizing capacity than blanched peanuts. In spite of this, extract from roasted peanuts is a superior elicitor of RBL cell degranulation irrespectively of the peanut product used for sensitization. The results also suggest that new epitopes are formed or disclosed by heating Ara h 1 without glucose.

General information
State: Published
Organisations: National Food Institute, Division of Toxicology and Risk Assessment, Quadram Institute, National Institute for Agronomic Research
Number of pages: 11
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Publication information
Journal: P L o S One
Volume: 9
Issue number: 5
Article number: e96475
ISSN (Print): 1932-6203
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 3.01 SJR 1.164 SNIP 1.111
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.11 SJR 1.236 SNIP 1.101
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.32 SJR 1.427 SNIP 1.136
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 3.54 SJR 1.559 SNIP 1.148
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.94 SJR 1.772 SNIP 1.153
ISI indexed (2013): ISI indexed yes
Characterisation of the Ara h 1-specific IgE repertoire in peanut allergic patients using phage display technology and next generation sequencing

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Fluidic Array Systems and Technology, National Food Institute, Division of Toxicology and Risk Assessment, Department of Systems Biology, Center for Biological Sequence Analysis, Immunological Bioinformatics, Quadram Institute, Medical University of Vienna
Number of pages: 1
Pages: 140-140
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: ALLERGY
Volume: 69
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Article number: 297
ISSN (Print): 0105-4538
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 6.23 SJR 2.702 SNIP 2.332
Web of Science (2017): Impact factor 6.048
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 6.23 SJR 2.841 SNIP 2.521
Web of Science (2016): Impact factor 7.361
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 5.73 SJR 3.17 SNIP 2.17
Web of Science (2015): Impact factor 6.335
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 5.51 SJR 2.529 SNIP 2.161
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.91 SJR 2.218 SNIP 1.939
Web of Science (2013): Impact factor 5.995
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 4.81 SJR 2.126 SNIP 1.853
Web of Science (2012): Impact factor 5.883
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 4.89 SJR 2.221 SNIP 1.801
Web of Science (2011): Impact factor 6.271
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.898 SNIP 1.86
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.735 SNIP 0.982
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.432 SNIP 1.933
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.389 SNIP 1.861
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.499 SNIP 2.692
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.901 SNIP 1.635
Scopus rating (2004): SJR 0.795 SNIP 1.918
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.55 SNIP 1.105
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.679 SNIP 0.646
Scopus rating (2001): SJR 0.507 SNIP 0.487
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.154 SNIP 0.46
Scopus rating (1999): SJR 0.342 SNIP 0.277
Original language: English
IgE versus IgG4 epitopes of the peanut allergen Ara h 1 in patients with severe allergy

Background: Development and maintenance of tolerance to food allergens appears to be associated with alterations in antigen specific IgE and IgG4 responses. Previous studies have focused only on comparing IgE and IgG4 linear epitope recognition patterns but take no account of conformational epitopes. Objective: The aim of this study was to compare Ara h 1-specific IgE and IgG4 epitope recognition patterns in patients with severe peanut allergy, applying a method allowing for identification of both linear and conformational epitopes. Methods: Polyclonal sera from three individual patients, suffering from severe allergic reaction to peanuts, including anaphylaxis, were used to analyse the IgE and IgG4 epitope recognition patterns of the major peanut allergen Ara h 1. Epitope identification was conducted by competitive immuno-screening of a phage-displayed random heptamer peptide library. Resulting epitope-mimicking sequences were aligned for identification of consensus sequences and localised on the surface of the Ara h 1 molecule by a computer-based algorithm. Results: All epitope-mimicking sequences identified were found to correspond to conformational epitopes. Each individual patient had his/her own distinct IgE as well as IgG4 epitope recognition profile, though some important IgE epitopes were common to all patients. In general the IgG4 epitope pattern was more heterogeneous than the IgE pattern, did not coincide with IgE epitopes and had a lower affinity than IgE. Conclusions: This study demonstrated the usefulness of the phage-display technology in distinguishing between the epitope pattern of IgE and IgG4, giving detailed information on fine specificity and affinity. Competitive immuno-screening of phage-display random peptide libraries could be a future valuable tool to study the balance and dynamics of the IgE and IgG4 epitope recognition repertoire and provide a diagnostic tool giving information on the associated allergic phenotype. (C) 2013 Elsevier Ltd. All rights reserved.

General information
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Peer-reviewed: Yes

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Journal: Molecular Immunology
Volume: 58
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Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 3.16 SJR 1.352 SNIP 0.941
Web of Science (2017): Impact factor 3.188
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.2 SJR 1.572 SNIP 0.962
Web of Science (2016): Impact factor 3.236
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.16 SJR 1.576 SNIP 0.93
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.89 SJR 1.484 SNIP 0.922
Web of Science (2014): Impact factor 2.973
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
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Linear versus conformational epitopes of three cow's milk allergens

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Mælkeproteiner og allergi: Kan modernmælkserstatninger forebygge mælkeallergi?

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The impact of structural integrity and route of administration on the antibody specificity against three cow's milk allergens - a study in Brown Norway rats.

This study showed that the three-dimensional (3D) structure has a significant impact on the antibodies raised for both systemic and orally administered allergens. A remarkable difference in the antibody binding patterns against linear and conformational epitope was seen between the allergens, indicating that the structural characteristics of proteins may heavily affect the induced antibody response.

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Experimental approaches to predict allergenic potential of novel food

There are many unanswered questions relating to food allergy sensitization in humans. We don't know under what circumstances sensitization takes place i.e. route (oral, dermal, respiratory), age, dose, frequency of exposure, infection or
by-stander effect of other allergens. In addition we don't know under what circumstances oral tolerance develops.

With all these unanswered questions, it is a big challenge to design an animal model that, with relatively few animals, is able to predict if a food protein is a potential allergen. An even larger challenge is to predict its potency, a prerequisite for risk evaluation. Attempts have been made to rank proteins according to their allergenic potency based on the magnitude of the IgE response in experimental animals. This ranking has not included abundance as a parameter. We may be able to predict potential allergenicity i.e. hazard but our lack of understanding of the significance of dose for the development of food allergy or its counterpart oral tolerance makes risk assessment very difficult. In addition route of exposure and digestibility are relevant variables. Examples of the use and limitations of animal models for predicting the allergenicity of food proteins will be given. Possibilities and pitfalls will be discussed.
IgE vs IgG4 epitopes of the peanut allergen Ara h 1 in patients with severe allergy

Background: Development and maintenance of tolerance to food allergens may be associated with increased levels of specific IgG4. It has been suggested that co-localisation of IgG4 and IgE binding epitopes may be of great significance for the tolerance, where IgG4 may act by blocking IgE binding to the allergen. However, recent studies have demonstrated the very importance of the IgG4-epitope affinity for the blocking ability. Studies comparing IgE and IgG4 binding epitopes mainly focus on the identification of linear epitopes.

Peanut allergy is one of the most severe and persistent forms of food allergy. The importance of conformational epitopes, of the major peanut allergen Ara h 1, has been demonstrated. The aim of this study was to compare Ara h 1-specific epitope patterns for IgE and IgG4 in patients with severe peanut allergy applying a method suitable to identify both linear and conformational epitopes.

Methods: Ara h 1-specific IgE and IgG4 epitope patterns were examined by competitive immunoscreening of a phage-displayed random 7-mer peptide library using polyclonal IgE and IgG4 from three individual patients suffering from severe peanut allergy. The resulting peptide sequences were mapped on the surface of a 3D model of the Ara h 1 molecule to mimic epitopes by the use of a computer-based algorithm.

Results: All identified epitope mimics corresponded to conformational epitopes. Each individual peanut allergic patient had his/her own distinct IgE as well as IgG4 epitope binding profile. Although three motifs were identified for all three patients and accounted for half of all identified IgE epitope mimics, no consensus motifs were identified for IgG4. Even though the epitopes overlapped, the IgG4 binding epitope mimics were more heterogeneous than the IgE binding epitope mimics. In addition a higher epitope binding affinity for IgE than IgG4 was indicated.

Conclusion: This preliminary study using competitive immunoscreening of a phage-displayed peptide library successfully distinguished IgE binding patterns from IgG4 binding patterns. The method allows an identification of both, linear and conformational epitopes and gives information on the specificity, diversity and affinity of the identified epitope mimics. This could be a valuable tool to study the balance and dynamics of the antibody IgE- and IgG4-repertoire, and increase the knowledge and understanding of the mechanisms involved in the development of allergy and tolerance.
The Sensitising Capacity of Intact β-Lactoglobulin Is Reduced by Co-Administration with Digested β-Lactoglobulin

Background: It is generally believed that protein hydrolysis in the gastrointestinal tract decreases the allergenicity of food allergens. However, it remains unknown if specific properties of digestion products determine whether a sensitisation or tolerogenic immune response will develop. We sought to examine the sensitising capacity of the cow’s milk allergen β-lactoglobulin (BLG) and digestion products thereof in a Brown Norway (BN) rat model. Methods: Intact BLG was digested in an in vitro model simulating the gastro-duodenal digestion process and subsequently fractionated by gel permeation chromatography. BN rats were dosed with either PBS, 200 μg of intact BLG, 30 μg of intact BLG, 200 μg of partially digested BLG, 200 μg of digested BLG, or with 200 μg of a fraction of large complexes or a fraction of small complexes. Sera from BN rats were analysed for specific antibodies and avidity was measured. Results: BLG partly resisted the digestion process. However, the BLG molecules that did not survive the digestion process were rapidly broken down to peptides of sizes less than Mr 4,500. Specific antibody responses revealed that both 200 and 30 μg of intact BLG had immunogenic as well as sensitising capacity, while digested BLG could not induce any specific antibodies. Most importantly, while intact BLG showed a significant sensitising capacity when administered alone, this sensitising capacity was significantly reduced when co-administered with digested BLG. Conclusions: Co-immunisation of intact BLG with digested BLG reduces the sensitising capacity of intact BLG, which could result from tolerogenic mechanisms induced by the digestion products. Copyright © 2012 S. Karger AG, Basel
Digested Ara h 1 Loses Sensitizing Capacity When Separated into Fractions

The major peanut allergen Ara h 1 is an easily digestible protein under physiological conditions. The present study revealed that pepsin digestion products of Ara h 1 retained the sensitizing potential in a Brown Norway rat model, while this sensitizing capacity was lost by separating the digest into fractions by gel permeation chromatography. Protein chemical analysis showed that the peptide composition as well as the aggregation profiles of the fractions of Ara h 1 digest differed from that of the whole pool. These results indicate that the sensitizing capacity of digested Ara h 1 is a
consequence of the peptides being in an aggregated state resembling the intact molecule or that most peptides of the
digests need to be present in the same solution, having a synergistic or adjuvant effect and thereby augmenting the
immune response against other peptides.

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Digested BLG can induce tolerance when co-administered with intact BLG in Brown Norway rats

Background: Milk is a major constituent of small children’s diet. Milk allergy is also one of the most common allergies in small children. Prevention, treatment and general understanding of this allergy are therefore important.

Methods: Intact BLG was digested in an in vitro model simulating the human gastro-duodenal digestion process. Four different fractions of BLG-digest was made, based on sizes of peptides or aggregates hereof.

Intact BLG and the four fractions of BLG-digest were characterized by protein chemical analyses. Brown Norway (BN) rats were immunised i.p. three times without the use of adjuvant with either PBS (control), 200 µg of intact BLG, 30 µg of intact BLG, 200 µg of digested BLG (with 30 µg of intact BLG), 200 µg of a fraction of large complexes or 200 µg of a fraction of small complexes (all three without intact BLG). Sera from BN rats were analysed for specific IgG and IgE responses and avidity of specific antibodies was measured.

Results: Native BLG is relatively resistant to digestion. However, when first broken down to larger fragments these are rapidly digested to smaller peptides of sizes ≤ 4.5 kDa. The small peptides did aggregate to complexes of larger sizes. Specific antibody responses revealed that both the high (200 µg) and low (30 µg) amount of intact BLG had both immunogenic and allergenic sensitising capacity, while digested BLG had no sensitizing capacity. In contrast digested BLG and the fraction of large complexes retained their antibody binding capacity. Most importantly, while intact BLG showed a significant sensitising capacity when administered alone, the sensitising capacity of the intact BLG was significantly reduced when co-administered with digested BLG.

Conclusion: Co-administration of intact and digested BLG reduced sensitising capacity of intact BLG, indicating induction of tolerance or other protective mechanism by the digested BLG.

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Food allergen digestibility: The Influence on allergenicity

Food allergy is a major health problem in the Western countries, affecting 3-8% of the population. What makes a dietary protein a food allergen has not yet been established, though several characteristics have been proposed to be shared by the food allergens. One of the features believed to be a general characteristic is resistance to digestion. This is based on studies showing that allergenic dietary proteins in general were more resistant to digestion than dietary proteins with no proven allergenicity, leading to the conclusion, that a correlation between stability to digestion and allergenic potential exist. Resistance to digestion is therefore a test parameter included in the safety assessment of the allergenic potential of novel proteins in genetically modified foods. In recent years, the association between resistance to digestion and allergenic potential has been challenged.

When reviewing existing data from digestibility studies on known food allergens, it becomes evident that food allergens do not necessarily resist digestion. However, the choice of assay conditions, the method used for detection of residual intact protein as well as fragments hereof greatly influences the outcome. Studies assessing the allergenicity of digestion products, by either IgE-binding, elicitation or sensitising capacity, shows that digestion may abolish, decrease, have no effect, or even increase the allergenicity of food allergens. However, this dependents on the given allergen.

In conclusion, reviewing existing digestibility data shows that no absolute correlation between resistance to digestion and allergenic potential exist. Therefore stability to digestion may not necessarily be a good parameter for assessing the allergenic potential of novel proteins. Even very small peptides from food allergens may retain both IgE-binding, eliciting and sensitising capacity. As a consequence immunological studies should be performed when evaluating the digestibility of protein allergens.

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IgE epitopes of intact and digested Ara h 1: A comparative study in humans and rats

Background Allergen epitope characterization provides valuable information useful for the understanding of proteins as food allergens. It is believed that IgE epitopes in general are conformational, nevertheless, for food allergens known to sensitize through the gastrointestinal tract linear epitopes have been suggested to be of great importance. ObjectiveThe aim of this study was to identify IgE specific epitopes of intact and digested Ara h 1, and to compare epitope patterns between humans and rats. MethodsSera from five peanut allergic patients and five Brown Norway rats were used to identify intact and digested Ara h 1-specific IgE epitopes by competitive immunoscreening of a phage-displayed random hepta-mer peptide library using polyclonal IgE from the individual sera. The resulting peptide sequences were mapped on the surface of a three-dimensional structure of the Ara h 1 molecule to mimic epitopes using a computer-based algorithm. ResultsPatients as well as rats were shown to have individual IgE epitope patterns. All epitome mimics were conformational and found to cluster into three different areas of the Ara h 1 molecule. Five epitope motifs were identified by patient IgE, which by far accounted for most of the eluted peptide sequences. Epitope patterns were rather similar for both intact and digested Ara h 1 as well as for humans and rats. ConclusionsIndividual patient specific epitope patterns have been identified for the major allergen Ara h 1. IgE binding epitopes have been suggested as biomarkers for persistency and severity of food allergy, wherefore recognition of particular epitope patterns or motifs could be a valuable tool for prevention, diagnosis, and treatment of food allergy.

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Limitations and possibilities of animal models for human allergenic risk evaluation

There are many unanswered questions relating to food allergy sensitization in humans. We don't know under what circumstances sensitization takes place i.e. route (oral, dermal, respiratory), age, dose, frequency of exposure, infection or bystander effect of other allergens. In addition we don't know under what circumstances oral tolerance develops.

With all these unanswered questions, it is a big challenge to design an animal model that, with relatively few animals, is able to predict if a food allergen is not only a potential allergen but also predict its potency, a prerequisite for risk evaluation.

One of the pitfalls may be the premise that an animal model needs to mimic the disease. Chemical contact sensitizers may be predicted in an animal test, the Local Lymph Node Assay (LLNA). This assay is based on detailed mechanistic knowledge of contact sensitization including knowledge on dose-response relationship. The outcome of the test is sensitization measured as cell proliferation in the regional lymph node.

Animal models in food allergy can be used to increase our understanding of food allergens and food allergy sensitization e.g. the influence of digestion or processing or to compare closely related allergens. Examples of this will be given.

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Mælkeproteiner og allergi - Hvilke egenskaber ved nedbrudte mælkeproteiner bidrager til deres evne til at inducere allergi?

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Sensitising capacity of peptides from food allergens

Food allergy is a major health problem in the Western countries, affecting 3-8% of the population. What makes a dietary protein a food allergen has not yet been established, though several characteristics have been proposed to be shared by food allergens. One of the features believed to be a general characteristic of food allergens is resistance to digestion. This is based on studies showing that allergenic dietary proteins in general are more resistant to digestion than dietary proteins with no proven allergenicity, concluding that a correlation between stability to digestion and allergenic potential exist. Resistance to digestion is for this reason a test parameter included in the safety assessment of the allergenic potential of novel proteins in genetically modified foods. The association between resistance to digestion and allergenic potential has though been challenged in recent years. This PhD project aimed to investigate the sensitising potential of digestion products from the peanut allergen Ara h 1 and the cow’s milk allergen β-lactoglobulin (BLG) in a Brown Norway (BN) rat model. Further the project aimed to compare the IgE binding epitopes of intact and digested Ara h 1. This was done by digesting Ara h 1 and BLG in an in vitro model simulating the human gastric or gastroduodenal digestion process. Simulated gastric digestion was performed with immobilised pepsin for 120 min at pH 2.5, while simulated duodenal digestion was performed with immobilised trypsin and chymotrypsin for 15 min at pH 6.5. Fractions of digestion products were made by separating the peptide fragments according to sizes in gel permeation chromatography (GPC). The intact allergens as well as digestion products hereof were thoroughly characterised by reverse phase high-performance liquid chromatography, MALDI-TOF mass spectrometry, amino acid analysis and GPC. To study the sensitising capacity groups of BN rats were immunised with the intact allergy or digestion products hereof by i.p. immunisation and specific antibody responses were examined by ELISAs, RBL-assay or avidity measurements. Comparison of intact and digested Ara h 1-specific IgE binding epitopes were performed by competitive immunoscreening using a random phage-displayed peptide library followed by mapping the identified IgE-binding epitope mimics on the surface of the Ara h 1 molecule. In addition to sera from the sensitised BN rats, sera from peanut allergic patients were used. Both the gastric as well as the gastro-duodenal digests of the peanut allergen Ara h 1 were found to be very efficient for sensitising the BN rats. While gastric digest consisted of peptide fragments of up to Mr 4,000 the duodenal digest consisted of peptide fragments of up to Mr 2,000, yet both the peptide fragments in the gastric as well as in the gastro-duodenal digests were aggregated to complexes of larger sizes. After separation of the digested Ara h 1 into fractions the sensitising capacity was lost, though the IgE-binding capacity was retained. Epitope mapping of intact and digested Ara h 1 showed IgE binding epitopes of Ara h 1 to be conformational in origin and at least to some extent surviving the digestion process. For the peanut allergic patients five motifs were found to account for more than 65% of all identified epitope mimics and were found for both the intact as well as the digested Ara h 1. Digested BLG with peptide sizes of up to Mr 4,500 could on the other hand not induce any sensitisation response in the BN rats. They were instead suggested to possess tolerogenic capacity when co-administered together with intact BLG. The results presented in the current thesis demonstrate that even very small peptide fragments, originally thought to be too small to act as a food allergens may indeed possess all features of a ‘complete’ allergen. This implies that an association between allergenicity and resistance to digestion is not an absolute feature of food allergens. The presented work indicates that peptide fragments may either possess sensitising capacity per se or that the observed allergenic capacity could be a result of the small peptide fragments aggregating to complexes of larger sizes. The importance of formation of aggregates is suggested by the epitope mapping study, where survival of conformational epitopes is demonstrated. This together with the findings, that fractionation of digestion products leads to a loss of the sensitising potential, reveals that the allergenicity had to be more than simply a result of the small peptide fragments aggregating, and more a result of them being in an aggregated state resembling the intact Ara h 1 molecule. While small peptide fragments derived from one food allergen may retain sensitising capacity this is not necessarily the truth for other food allergens. This was demonstrated with the cow’s milk allergen BLG, from which peptide fragments were shown not to be efficient for inducing any specific antibodies. Instead the results indicated that the peptide fragments derived from BLG had tolerogenic capacity, demonstrating that while some mixtures of peptides may guide the immune system in one direction, other mixtures of peptides may guide the immune system in another direction. Together these results demonstrate that several characteristics of digestion products from food allergens may collectively contribute the allergenic potential, where more than just peptide sizes and structures may contribute. In conclusion, the experimental data presented in this PhD thesis contribute to the understanding of induction of allergy by investigating the sensitising potential of peptides derived from a food allergen. It add knowledge to our understanding of the mechanisms underlying the sensitisation, but at the same time points to the difficulties, if not infeasibilities, in identifying features that can be used as an ubiquitous marker for allergenicity of a dietary protein.
The influence of digestibility on the allergenicity of food allergens

Food allergy is a major health problem in the Western countries, affecting 3-8% of the population. What makes a dietary protein a food allergen has not yet been established, though several characteristics have been proposed to be shared by the food allergens. One of the features believed to be a general characteristic is resistance to digestion. This is based on studies showing that allergenic dietary proteins in general were more resistant to digestion than dietary proteins with no proven allergenicity, leading to the conclusion, that a correlation between stability to digestion and allergenic potential exist. Resistance to digestion is therefore a test parameter included in the safety assessment of the allergenic potential of novel proteins in genetically modified foods. In recent years, the association between resistance to digestion and allergenic potential has been challenged.

When reviewing existing data from digestibility studies on known food allergens, it becomes evident that food allergens do not necessarily resist digestion. However, the choice of assay conditions, the method used for detection of residual intact protein as well as fragments hereof greatly influences the outcome. Studies assessing the allergenicity of digestion products, by either IgE-binding, elicitation or sensitising capacity, shows that digestion may abolish, decrease, have no effect, or even increase the allergenicity of food allergens. However, this dependents on the given allergen.

In conclusion, reviewing existing digestibility data shows that no absolute correlation between resistance to digestion and allergenic potential exist. Therefore stability to digestion may not necessarily be a good parameter for assessing the allergenic potential of novel proteins. Even very small peptides from food allergens may retain both IgE-binding, eliciting and sensitising capacity. As a consequence immunological studies should be performed when evaluating the digestibility of protein allergens.

Ara h 1-digesta lose sensitizing activity when separated into fractions

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Contributors: Beigh, K. L., Barkholt, V.
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Milk hydrolysis products may retain their allergenic reactivity

Background: Milk allergy is one of the most common allergies in small children. Extensively hydrolyzed milk formulas are therefore an important source of nutrients for infants being predisposed for allergy and not being breastfeed and to infants with cows milk allergy. The aim of this study was to investigate some extensively hydrolyzed milk whey products for their ability to retain sensitizing and reacting activity in a Brown Norway (BN) rat model.

Method: BN rats were immunized i.p. three times without the use of adjuvant with 200 µg of either PBS (control), intact β-lactoglobulin (BLG), enzyme hydrolyzed BLG or the enzyme hydrolysis product PEPTIGEN IF-3080 from Arla, Denmark. There was no intact BLG left in the two hydrolysates. Sera from BN rats were analyzed for specific IgG and IgE.

Result: The study showed that while intact BLG had a significant sensitizing capacity, both hydrolyzed BLG and PEPTIGEN had no sensitizing capacity. However, antibodies from all rats immunized with the intact BLG could still react with both hydrolyzed BLG and PEPTIGEN in a manner that was statistically significant.

Conclusion: The extensively hydrolyzed milk whey products investigated in this study showed no sensitizing capacity, but could bind to antibodies raised in rats immunized with intact BLG. The results in this study resemble observations seen in humans where infants sensitized to cow's milk may react to extensively hydrolyzed infant formulas. These observations should lead to the development of new standards for extensively hydrolyzed infant formulas based on peptide sizes rather than degree of hydrolysis (DH).

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Sensitization with 7S Globulins from Peanut, Hazelnut, Soy or Pea Induces IgE with Different Biological Activities Which Are Modified by Soy Tolerance

Background: It is not known why some foods sensitizing via the gastrointestinal tract are prevalent allergenic foods and others are not. Eating habits, processing, and the food matrix have been suggested to influence the allergenicity of a given food. Factors related to protein structure, such as stability to digestion, have also been suggested. 7S globulins from peanut, hazelnut, soy, and pea were studied to determine whether related proteins would induce a similar sensitization when removed from their ‘normal’ matrix. Methods: Brown Norway rats (soy tolerant or nontolerant) were immunized i.p. 3 times with 100 µg purified peanut, hazelnut, soy, or pea 7S without adjuvant. Sera were analyzed for specific antibodies by different ELISAs (IgG1, IgG2a, and IgE), inhibition ELISA, and rat basophilic leukemia cell assay. Results: The 4 related 7S globulins induced a response with an almost identical level of specific antibodies, but peanut 7S induced IgE of higher avidity than hazelnut and pea 7S which, again, had a higher avidity than IgE induced by soy 7S. Soy tolerance reduced the functionality of IgE without influencing antibody titers. Conclusions: Although the 4 7S globulins are structurally related allergens, they induce antibodies with different antigen-binding characteristics. Peanut 7S induces IgE of a higher avidity than hazelnut and pea 7S which, again, has a higher avidity than IgE induced by soy 7S. We also show that soy tolerance influences the function of antibodies to peanut 7S. These findings may help explain how antibodies of different clinical significances can develop in different individuals sensitized to the same allergen. Copyright © 2011 S. Karger AG, Basel

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Digested Ara h 1 has sensitizing capacity in Brown Norway rats

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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.26 SJR 2.181 SNIP 1.482
Web of Science (2016): Impact factor 5.264
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 4.15 SJR 2.2 SNIP 1.43
Web of Science (2015): Impact factor 5.587
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 4.1 SJR 1.942 SNIP 1.639
Web of Science (2014): Impact factor 4.769
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.95 SJR 1.618 SNIP 1.501
Web of Science (2013): Impact factor 4.324
ISI indexed (2013): ISI indexed yes
Food processing affects the immunogenic and allergenic potential of peanut and soy allergens in an oral rat model

General information
State: Published
Organisations: Division of Toxicology and Risk Assessment, National Food Institute, Quadram Institute
Pages: 373-374
Publication date: 2009
Peer-reviewed: Yes

Publication information
Journal: Allergy. European Journal of Allergy and Clinical Immunology
Volume: 64
Issue number: Suppl 90
ISSN (Print): 0105-4538
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 6.23 SJR 2.702 SNIP 2.332
Web of Science (2017): Impact factor 6.048
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 6.23 SJR 2.841 SNIP 2.521
Web of Science (2016): Impact factor 7.361
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 5.73 SJR 3.17 SNIP 2.17
Web of Science (2015): Impact factor 6.335
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 5.51 SJR 2.529 SNIP 2.161
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.91 SJR 2.218 SNIP 1.939
Web of Science (2013): Impact factor 5.995
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 4.81 SJR 2.126 SNIP 1.853
Web of Science (2012): Impact factor 5.883
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 4.89 SJR 2.221 SNIP 1.801
Web of Science (2011): Impact factor 6.271
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.898 SNIP 1.86
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.735 SNIP 0.982
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.432 SNIP 1.933
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.389 SNIP 1.861
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.499 SNIP 2.692
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.901 SNIP 1.635
Scopus rating (2004): SJR 0.795 SNIP 1.918
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.55 SNIP 1.105
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.679 SNIP 0.646
Scopus rating (2001): SJR 0.507 SNIP 0.487
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.154 SNIP 0.46
Scopus rating (1999): SJR 0.342 SNIP 0.277
Comparison of sensitisation potential of 7S globulins from peanut, hazelnut, soy and pea

General information
State: Published
Organisations: Division of Toxicology and Risk Assessment, National Food Institute
Contributors: Kroghsbo, S., Rigby, N. M., Mills, E. N. C., Bøgh, K. L., Madsen, C. B.
Publication date: 2008
Peer-reviewed: No
Event: Abstract from Immunotoxicology and Chemical Allergy Specialty Section meeting, Oslo, Norway,
Source: orb
Source-ID: 238616
Research output: Research › Conference abstract for conference – Annual report year: 2008

Digested Ara h 1 retains its sensitising capacity in Brown Norway rats

General information
State: Published
Organisations: Division of Toxicology and Risk Assessment, National Food Institute, Enzyme and Protein Chemistry, Department of Systems Biology
Publication date: 2008
Peer-reviewed: No
Event: Abstract from 8th Nordic Symposium on Allergy, Sønderborg,
Source: orb
Source-ID: 234773
Research output: Research › Conference abstract for conference – Annual report year: 2008

Mælkeproteiner og allergi: Kan aggregater af peptider fra nedbrudte mælkeproteiner medføre en udvikling af mælkeallergi

General information
State: Published
Organisations: Division of Toxicology and Risk Assessment, National Food Institute, Enzyme and Protein Chemistry, Department of Systems Biology
Contributors: Bøgh, K. L., Madsen, C. B., Barkholt, V.
Pages: 252-254
Publication date: 2008
Peer-reviewed: Unknown
Publication information
Journal: Mælkeritidende
Volume: 10
ISSN (Print): 0024-9645
Ratings:
Web of Science (2017): Indexed yes
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Danish
Source: orb
Source-ID: 233477
Research output: Communication › Journal article – Annual report year: 2008

Sensitisation capacity of intact and digested 2S albumin from Brazil nut in a Brown Norway rat model

General information
State: Published
Organisations: Division of Toxicology and Risk Assessment, National Food Institute
Degraded food allergens may retain their sensitising capacity

General information
State: Published
Organisations: National Food Institute, Division of Toxicology and Risk Assessment, Technical University of Denmark, Quadram Institute
Number of pages: 1
Publication date: 2007
Peer-reviewed: Yes
Event: Abstract from Nordic Research Symposium in Allergy, Sønderborg, Denmark.
Electronic versions: poster.pdf

Bibliographical note
Poster presentation
Source: dtu
Source-ID: u::5557
Research output: Research - peer-review → Poster – Annual report year: 2007

Epitope mapping of intact and digested Ara h 1

General information
State: Published
Organisations: Division of Toxicology and Risk Assessment, National Food Institute
Publication date: 2006
Peer-reviewed: Yes
Event: Abstract from XXV Congress of the European Academy of Allergology and Clinical Immunology, Vienna, Austria.
Electronic versions: Abstract1.pdf
Source: orbit
Source-ID: 237787
Research output: Research - peer-review → Conference abstract for conference – Annual report year: 2006

Projects:

Evaluering af risikoen ved indtagelse af græs-juice/-ekstrakt - en potentiel fremtidig protein kilde
Formålet med projektet er at få videnskabelig evidens for om rajgræs kan benyttes som en ny fødevare uden øget risiko for inducering af allergiske reaktioner, dette enter ved de novo sensibilisering eller ved krydsreaktioner i individer med græsspollenallergi.
Bang-Berthelsen, C. H., Project Participant, National Food Institute, Research Group for Microbial Biotechnology and Biorefining
Bøgh, K. L., Project Participant, National Food Institute
Sancho Vega, A. I., Project Participant, National Food Institute
Holst, S., Project Participant, National Food Institute, Office for Study Programmes and Student Affairs
01/09/2018 → 31/01/2019
Project: Research

Birch Sap: Development of a birch sap with extended shelf life for prevention and treatment of birch pollen allergy
The prevalence of allergic diseases is rising dramatically in both developed and developing countries, representing a major health problem and a burden to society. In particular, tree pollen allergies are estimated to affect approximately 40% of the population in the Northern Hemisphere, where birch pollen displays the greatest allergic potency. Moreover, 50-75% of birch pollen allergic patients also experience allergic symptoms upon consuming foods containing cross-reactive allergens. Current options to change the course of the disease and restore allergen-specific immune tolerance may be
associated with adverse side effects. Therefore, innovative therapies to enhance the therapeutic efficacy and safety are needed. Across Scandinavia, many birch pollen allergy sufferers have reported mitigation of their symptoms after drinking birch sap. However, there is no scientific evidence supporting the use of birch sap as a treatment of pollen allergy. The aim of this project is to develop new commercially available birch sap products to induce tolerance in birch pollen allergic individuals. These products could be used as natural medicine/functional foods in the treatment of birch pollen allergy. To achieve this objective, we will: (1) Identify immune reactive allergens in birch sap and cross-reactive allergens in birch pollen and related foods. (2) Investigate the potential induction of oral tolerance to birch pollen by birch sap and consequently, the prophylactic efficacy against birch pollen allergy and cross-reactive food allergies. (3) The safety and efficacy of birch sap for the treatment of birch pollen allergy and related food allergies. The outcome of this project could provide the foundation for developing new ways to treat millions of people worldwide suffering from birch pollen allergy in a safe and efficient manner.

Bøgh, K. L., Project Manager, National Food Institute, Research Group for Gut Microbiology and Immunology
Sancho Vega, A. I., Project Participant, National Food Institute, Research Group for Gut Microbiology and Immunology
Birk, T., Project Participant, National Food Institute, Research Group for Microbial Food Safety

01/01/2018 → 31/12/2019
Keywords: Birch Sap, Pollen Allergy, Treatment, Prevention, Shelf life
Collaborators: Birkesaft.dk, Tapperiet
Project: Research

Allergenicity of camel milk
Maryniak, N. Z., PhD Student, National Food Institute
Bøgh, K. L., Main Supervisor, National Food Institute
Hansen, E. B., Supervisor, National Food Institute
Sancho Vega, A. I., Supervisor, National Food Institute

Samfinansierede - Virksomhed
01/05/2018 → 30/04/2021
Award relations: Allergenicity of camel milk
Project: PhD

Health related effects of quinoa - impact on intestinal permeability and immune responses
Ballegaard, A. R., PhD Student, National Food Institute
Bøgh, K. L., Main Supervisor, National Food Institute
Pilegaard, K., Supervisor, National Food Institute
Rasmussen, P. H., Supervisor, National Food Institute

Institut stipendie (DTU)
01/12/2017 → 30/11/2020
Award relations: Health related effects of quinoa - impact on intestinal permeability and immune responses
Project: PhD

ALLEVIATE: ALLEVIATE - A novel strategy for food allergy prevention and treatment
Food allergy is an adverse effect to otherwise harmless proteins in the food, whereas oral tolerance is the default result from ingestion of food proteins. Food allergy is a major health problem of growing concern, affecting ~5-8% of young children and 2-4% of adults. No reliable strategy exists for prevention and treatment of food allergy, and strict avoidance of the offending food is presently the only viable management option. Living with food avoidance has a huge impact on the quality of life of food allergic patients, with daily fear of serious or even fatal reactions. The need for efficient methods for prevention and treatment is therefore evident and urgent. The purpose of the project is to develop methods to prevent and treat food allergy using a novel strategy, recently invented. Our vision is to overcome limitations in current strategies for food allergy prevention and treatment; being efficient without inducing allergic reactions. The specific goals of the project are: 1) To develop protein ingredients for a new generation of hypoallergenic (HA) infant formulas (IF) for cow's milk allergy (CMA) prevention 2) To develop a drug candidate for use in immunotherapy (IT) for peanut allergy (PA) treatment These products would have the capacity to enhance the quality of life for millions of patients in risk of developing CMA and of patients with an already established PA. The market potential is great for both product categories. In addition, the newly developed strategy may form the basis for prevention, treatment and diagnostic products targeting other food allergies.

Bøgh, K. L., Project Manager, National Food Institute, Research Group for Gut Microbiology and Immunology
Madsen, C. B., Project Participant, National Food Institute, Research Group for Gut Microbiology and Immunology
Kryger, K., Project Participant, National Food Institute

01/01/2017 → 31/12/2020
Microbiota and cow's milk tolerance
Graversen, K., PhD Student, National Food Institute
Bøgh, K. L., Main Supervisor, National Food Institute
Bahl, M. I., Supervisor, National Food Institute
Licht, T. R., Supervisor, National Food Institute
Samfinansieret - Andet
15/12/2015 → 09/09/2019
Award relations: Microbiota and cow's milk tolerance
Project: PhD

Droplet technology for ultra rapid epitope mapping of allergens
Christiansen, A., PhD Student, Department of Micro- and Nanotechnology
Dufva, M., Main Supervisor, Department of Micro- and Nanotechnology
Bøgh, K. L., Supervisor
Heegaard, P. M. H., Examiner
Kristensen, P., Examiner
Ohlin, M., Examiner
Institut stipendie (DTU)
01/09/2012 → 20/01/2016
Award relations: Droplet technology for ultra rapid epitope mapping of allergens
Project: PhD

Allergenicity of Peptides from Food Allergens - a Food Allergy Sensitisation Study
Bøgh, K. L., PhD Student, National Food Institute
Madsen, C. B., Main Supervisor, National Food Institute
Barkholt, V., Supervisor
Jessen, F., Examiner, National Food Institute
Knippels, L. M. J., Examiner
Skov, P. S., Examiner
1/3 DTU-stip, 2/3 FUR/andet
01/01/2007 → 27/06/2012
Award relations: Allergenicity of Peptides from Food Allergens - a Food Allergy Sensitisation Study
Project: PhD

Microbiota and cow's milk tolerance
Cow's milk allergy is a health problem of growing concern for which reason efficient strategies for the prevention is urgently needed. In recent years it has been demonstrated that the gut microbiota composition influences the development of allergy. However, our knowledge about how the microbiota composition influences the sensitising or tolerance inducing capacities of the food is only scarcely described. The objectives of this project are: (1) to increase our knowledge about the interplay between food proteins and the gut microbiota, and how this interplay impact on induction of cow's milk allergy versus tolerance, and (2) in a broader perspective to gain knowledge about mechanisms influenced by microbiota, which drives the immune system towards allergy or tolerance. Intact whey, which is one fraction of cow's milk often used for infant formula, and enzymatic hydrolysed products hereof, used for hypoallergic infant formulas, will used as model protein ingredients. The interplay between whey-based ingredients and the gut microbiota will be investigated in in vitro fermentation studies based on faecal samples from food allergic and healthy infants, as well as in animal studies in which the gut microbiota is manipulated by antibiotics treatment. Microbial composition will be analysed by 16S rRNA gene sequencing in combination with quantitative real-time PCR. The allergy or tolerance inducing capacity of the different whey-based ingredients and the influence of the gut microbiota composition will be analysed by evaluating different serological and cell based end-points. Appropriate functional in vitro, in vivo and ex vivo assays will be applied to investigate the mechanism by which the gut microbiota and metabolites hereof impact on directing the immune system towards allergy or tolerance.
Food allergy skin sensitisation
Allergic sensitisation to foods may occur in infancy without prior oral exposure to the offending food. This has led to the assumption that food allergy sensitisation may occur through alternative routes, such as via the skin. Recently, concern has been raised regarding the safety of use of cosmetic and personal care products containing food proteins and their derivatives hereof, especially hydrolysed wheat proteins. However, little is known about the conditions necessary for protein/peptide aggregation tendency, 3) matrices in which the proteins/peptides are present and 4) skin conditions, on the skin sensitising capacity of protein products. Intact wheat and different enzyme and acid hydrolysed wheat products, used in cosmetic and personal care products will be used as model proteins and applied on intact, damaged as well as inflamed skin, in order for examination of: 1) specific IgG1 and IgE antibody responses, according to: antibody levels, antibody avidity and cross reactivity by means of different ELISAs, 2) IgE functionality by means of in vivo skin test, 3) protein/peptide reactivity and cross-reactivity by means of immunoblotting, 4) proliferative responses of lymphocytes from the regional lymph nodes after stimulation with different wheat products, 5) cytokine responses of lymphocytes from regional lymph nodes after stimulation with different wheat products, and 6) histopathology of skin. With this project we anticipate to contribute with substantial knowledge to our understanding on how and why food proteins sensitise through the skin. This is important for the potential prevention of new cases of food allergy.

Bøgh, K. L., Project Participant, National Food Institute, Research Group for Gut Microbiology and Immunology
The Lundbeck Foundation: DKK2,100,000.00
01/10/2015 → 31/03/2020
Award relations: Food allergy skin sensitisation
Project: Research

INFOGEST: Improving health properties of food by sharing our knowledge on the digestive process
The action will gradually build a European network that will spread and improve current basic knowledge on food digestion and promote harmonization of currently used digestion models used including validation with human data from different populations such as infants, elderly, sport professionals etc. A multidisciplinary scientific community will be built on this topic gathering scientists from different disciplines (food science, nutrition, physiology, immunology, cell biology…).

Madsen, C. B., Project Participant, National Food Institute, Division of Toxicology and Risk Assessment
Verhoeckx, K., Project Manager, Netherlands Organisation for Applied Scientific Research - TNO
01/01/2014 → 31/12/2017
Collaborators: Novozymes A/S, University of Athens, Vienna University of Technology, Unilever, Netherlands Organisation for Applied Scientific Research - TNO, National Institute for Agronomic Research, Paul-Ehrlich-Institut
Project: Research
already diagnosed cow's milk allergy (secondary prevention), whereas partially hydrolysed infant formulas are used primarily for infants predisposed for developing cow's milk allergy (primary prevention). However, our knowledge about which characteristics of cow's milk proteins that contributes to the development of allergy and which contributes to the prevention of allergy are very scarce. In order to establish knowledge-based strategies for production of new and improved hypo-allergenic infant formulas, we therefore need thorough studies investigating which properties of milk proteins that direct the immune system towards allergy and which that direct the immune system towards tolerance (primary or secondary prevention). Such studies must be conducted in animal models of food allergy. The main objective of this project is to investigate and characterise the properties of cow’s milk based hydrolysates contributing to sensitisation (allergy induction) and the properties that prevents allergy by the induction of tolerance. The project aims to establish two new animal models based on our own colony of Brown Norway rats to study: (1) induction of tolerance in non-allergic subjects (primary prevention) and (2) induction of tolerance in already sensitised subjects (secondary prevention). These models will together with our well-established model for examination of sensitising (allergy inducing) capacity of food proteins and their breakdown products form the basis for studying the properties of cow’s milk based hydrolysates contributing to allergy versus tolerance induction. A total of four extensively and four partially hydrolysed cow’s milk protein products will be tested in the three animal models. These hydrolysates will differ from each other in: (1) degree of hydrolysis, (2) peptide composition, (3) complex formation, (4) residual intact proteins and (5) starting material. Collectively this will allow us to provide knowledge for establishment of new and improved infant formulas for allergy prevention.

Project year 1 will focus on and end up with establishment of the two new animal models for testing of tolerance and project year 2 will focus on and end up with a panel of tests for ability of hydrolysates to induce allergy, primary prevention or secondary prevention. Results from this project will at first be presented at international conferences and at the latest in 2016 be published in Danish as well as in internationally peer-reviewed journals.

Bøgh, K. L., Project Manager, National Food Institute, Division of Toxicology and Risk Assessment
Madsen, C. B., Project Participant, National Food Institute, Division of Toxicology and Risk Assessment
01/01/2014 → 31/12/2016
Collaborators: Arla Foods Ingredients Group P/S
Project: Research

Activities:

Training School in Food Allergy Animal Models
Period: 5 Jun 2018 → 7 Jun 2018
Katrine Lindholm Bøgh (Guest lecturer)
National Food Institute
Research Group for Gut Microbiology and Immunology
Degree of recognition: International

Related external organisation
Medical University of Vienna
Austria
Activity: Talks and presentations › Guest lectures, external teaching and course activities at other universities

3rd ImpARAS Conference
Period: 10 Oct 2017 → 12 Oct 2017
Charlotte Bernhard Madsen (Organizer)
Katrine Lindholm Bøgh (Organizer)
National Food Institute
Research Group for Gut Microbiology and Immunology
Description
Improving Allergy Risk Assessment Strategy for new food proteins (ImpARAS)
Degree of recognition: International

Related event
3rd ImpARAS Conference
10/10/2017 → 12/10/2017
Elsinore, Denmark
Activity: Attending an event › Participating in or organising a conference
Sensitisation capacity of intact and digested 2S albumin from Brazil nut in a Brown Norway rat model
Period: 1 Jan 2008 → …
Katrine Lindholm Bøgh (Speaker)
National Food Institute
Division of Toxicology and Risk Assessment

Description
Place: Nordic Research Symposium in Allergy, 2008, Sønderborg, Denmark

Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations

Digested Ara h 1 retains its sensitising capacity in Brown Norway rats
Period: 1 Jan 2007 → …
Katrine Lindholm Bøgh (Speaker)
National Food Institute
Division of Toxicology and Risk Assessment

Description
Place: 8th Nordic Symposium on Allergy, Sønderborg

Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations

Epitope mapping of intact and digested Ara h 1
Period: 1 Jan 2006 → …
Katrine Lindholm Bøgh (Speaker)
National Food Institute
Division of Toxicology and Risk Assessment

Description
Place: Vienna, Austria

Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations

Press clippings:

Forskningsprojektet ALLEVIATE
Katrine Lindholm Bøgh
13/06/2017
National Food Institute, Research Group for Gut Microbiology and Immunology

Media coverage (1)

Uddybning af og status på forskningsprojektet Alleviate
13/06/2017
Allergia.se, Denmark, Web
Susanne Rosén
Katrine Lindholm Bøgh
National Food Institute, Research Group for Gut Microbiology and Immunology
**Innovationsfondsprojektet ALLEVIATE**
Katrine Lindholm Bøgh
19/01/2017
National Food Institute, Research Group for Gut Microbiology and Immunology

**Media contribution (1)**

**Innovationsfondsprojektet ALLEVIATE**
19/01/2017
Asthma-Allergi Danmarks hjemmeside og medlemsblad, Print
Henriette Baun Gautier
Katrine Lindholm Bøgh
National Food Institute, Research Group for Gut Microbiology and Immunology
Press/Media: Press / Media

**Produktudvikling til modermælkserstatninger**
Katrine Lindholm Bøgh
12/01/2017
National Food Institute, Research Group for Gut Microbiology and Immunology

**Media contribution (1)**

**Produktudvikling til modermælkserstatninger**
12/01/2017
Food Supply, Web
Morten Vittrup Lund
Katrine Lindholm Bøgh
National Food Institute, Research Group for Gut Microbiology and Immunology
Press/Media: Press / Media

**Alleviate forskningsprojekt - udvikling af produkter til forebyggelse og behandling af fødevareallergier**
Katrine Lindholm Bøgh
20/12/2016
National Food Institute, Research Group for Gut Microbiology and Immunology

**Media contribution (1)**

**Alleviate forskningsprojekt - udvikling af produkter til forebyggelse og behandling af fødevareallergier**
20/12/2016
Ritzau, Print
Sabrina Melina Andersen
Katrine Lindholm Bøgh
National Food Institute, Research Group for Gut Microbiology and Immunology
Press/Media: Press / Media