Seafood Allergy and its Prevalence

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Introduction

Food allergy is a problem of public health importance which is to be considered seriously. There are different kinds of adverse reactions to food materials which are broadly divided into two groups called as food intolerance and food allergy/hypersensitivity. Allergy is an abnormal reaction to a normally harmless substance. Food allergy is immune mediated hypersensitivity reaction in which symptoms become visible rapidly subsequent to exposure of macromolecules or proteins (Bruijnzeel-Koomen et al., 1995). Food allergy is a serious issue in sensitive individuals and it is showing an overall increasing trend which is affecting approximately 3% of the world population. As a result of the increase in food allergy incidences in many countries such as US, Canada, Europe, Australia, New Zealand, UK, and Japan where very stringent regulations are there on control of food allergens. Food allergic reactions are mediated through a specific class of antibody, known as immunoglobulin E (IgE). The eight major allergens identified are milk, egg, fish, shellfish, tree nut, peanut, wheat and soybean and these contributes for 90% of food allergic reactions. Labeling of any product with an ingredient or food protein derived from any of these food allergens is stringent by regulations as per International Codex Alimentarius guidelines and the US Food Allergen Labeling and Consumer Protection Act (FALCPA). Allergen labeling also stringent as per directive 2007/68/EC made mandatory food labeling of 14 allegenic food ingredients.

Food allergy and Food intolerance

Food allergy is an immune system disorder mediated through IgE antibodies against undigested or partially digested food proteins. Allergens are antigens stimulating the production of IgE antibody. IgE mediated food allergic reactions are immediate hypersensitive in nature known as type I food allergy or true food allergy. Intake of minute quantities of food allergens can result allergic reactions in sensitized individuals. While IgG or IgM mediated cytotoxic hypersensitivity reactions comes under type II and it includes autoimmune issues like haemolytic anaemia. Food allergens are mainly water soluble glycoproteins having molecular weight ranging from 10 to 70 kDa and are reported to be stable to conditions of proteolysis, heat and acid treatments.

Food intolerances signify non-immune-mediated responses to food materials, and it can dependent on enzyme deficiencies, pharmacological reactions or unknown mechanisms in the majority of cases. They are also reproducible and sometimes symptoms can take days to manifest. Coeliac disease is an important example of food intolerance. Also intolerances including metabolic disorders such as lactose intolerance, responses to toxins like histamine in scombroid fishes or pharmacologically active compounds like caffeine in coffee, tyramine in aged cheeses etc. It is significant to discriminate food allergy from non-immune mediated responses to foods, as above 20% of adults and children modify food types because of perceived food allergy.

Seafood allergy and important allergens

Seafood is having a major role in human nutrition and health; it comprises fishes and shellfishes (crustaceans and molluscs). The international trade of seafood and its products is growing due to its popularity and frequency of consumption in many countries. Adverse health issues accompanied with consumers and processors of seafood is frequent and well reported. Fish and shellfish are included in the "big eight" categories of food allergens and they are mainly mediated through IgE antibody. The different channels of contact for seafood allergy are food intake, direct contact via skin or breathing of odors while preparation of food. Crustaceans primarily shrimps are the 3rd main source of food induced anaphylaxis in the world after peanut and tree nut and reported to affect >2% of population. Although shellfish allergy is frequent in western

countries namely Europe, United States and Australia, the prevalence of shellfish allergy is very high in Asian countries especially in children and adults.

Fish allergens

A limited number of fish proteins are associated with induction of allergic symptoms in sensitive individuals. It also depends upon geographical eating habits, type of fish processing, and fish species exposure. Fish proteins identified as allergens include parvalbumins, aldolases and enolases.

Parvalbumin is a calcium binding protein in fish muscle and responsible for allergic reactions in 95% of fish allergic patients on clinical basis. It has a molecular weight ranges from 10 to 13 kDa. It was first identified in Atlantic cod, Gadus callarias called as Gad c 1of 12 kDa. Parvalbumins are water soluble proteins having high resistance to elevated temperature and enzymic hydrolysis. Allergenicity of parvalbumin purified from fishes of different geographical locations confirmed it as the major fish allergen.

Other fish allergens reported are enolases (50 kDa) and aldolases (40 kDa). They are heat labile enzymes involved in metabolic glycolysis having potential allergenicity. Also gelatin from fish skin, vitellogenin, from caviar and topomyosin from tilapia are also reported as fish allergens.

Shellfish allergens

Shellfish allergy is of long lasting one and rising health issue in both children and adults. In both crustacean and molluscan shellfishes tropomyosin is identified as the major allergen. Tropomyosin is responsible for 80% of shrimp allergies. It is a myofibrillar protein with molecular weight ranging between 34 to 39 kDa. It is involved in the regulation of muscle contraction along with actin and myosin and highly stable in nature. It is also identified as a panallergen having cross reactivity between crustaceans, insects and mollusks.

Another important allergen identified in shellfishes is arginine kinase of molecular weight 40 kDa. It is a next major allergen in case of shrimp. But it cannot thermal and acid base treatment. It is also an important cross reactive allergen. Arginine kinase is an important enzyme involved in energy metabolism in invertebrates and it has similar activity of vertebrate creatine kinase. Sarcoplasmic calcium binding protein is another identified allergen with molecular weight ranging from 20 to 22 kDa. It is an EF hand type calcium binding muscle protein with heat resistant nature. The amino acid sequence homology of this allergen shows more similarity among crustacean species than that with molluscan species. Myosin light chain is allergen identified in many species which is a protein involved in muscle contraction along with actin, tropomyosin and troponin. It is also having the similar molecular weight as that of sarcoplasmic protein.

Table 1. Types of seafood allergens

Food source	Allergic protein	IUIS name	Molecular weight (kDa)
Fin fish	Parvalbumin	Gad c 1, Gad m 1, Lat c 1, Sal s 1, Thu a 1, Clu h 1, Cyp c 1, Sar sa 1, Seb m1, Lep w 1, Ore m 4	34-39
	Enolase	Gad m 2, Sal s 2, Thu a 2	50
	Aldolase	Gad m 3, Sal s 3, Thu a 3	40
	Vitellogenin	Onc k 5	18
	Tropomyosin	Ore m 4	33
Crustaceans	Tropomyosin	Cha f 1, Cra 1, Hom a 1, Lit v 1, Mac r 1, Mel l 1, Met e 1, Pan b1, Pan s1, Pen a1, Pen m1	34-39
	Myosin light chain 1	Art tr 5, Cra c 5	17.5
	Myosin light chain 2	Hom a 3, Lit v 3, Pen m 3	20-23
	Troponin C	Cra c 6, Hom a 6, Pen m 6	20-21
	Arginine kinase	Cra c 2, Lit v 2, Pen m 2	40-45
	Sarcoplasmic binding protein	Cra c 4, Lit v 4, Pen m 4, Pon l 4	20-22
Molluscans	Tropomyosin	Cra g 1, Hal d 1, Hel as 1, Mim n1, Per v 1, Tod p1	

Source: Ekezie et al., (2018)

Prevalence of seafood allergy

Seafood allergy is a common type of food allergy and the prevalence of fish and shellfish allergies, in the world population is 0.3 and 0.6 % respectively (Sicherer et al., 2004). Hypersensitivity to shellfish and fish is more common than that of nuts, peanuts and wheat. The prevalence of fish allergy in the general population ranges between 0.2% and 2.3% (Sharp et al., 2014). Fish sensitive individuals are observed to be allergic to many fish species and hence they are suggested to exclude fish from diet, but mono-sensitivity to particular fish, like cod, nile perch and mackerel in individuals reactive to enolases and aldolases also reported. Allergy to fish and crustacean is highly frequent than to mollusc and is more frequently reported in adults than children.

Khora (2016) reported a prevalence percentage ranging from 0.5 to 2.5% in case of shellfish allergy alone for general population and it is more in coastal Asian countries where shellfish is a major part of seafood consumption than that of United States, Europe and Australia. While the prevalence of shellfish allergy in children of United States is 1.3% with more children allergic to crustaceans (1.2) than to mollusks (0.5%) (Wang et al., 2020). The prevalence of seafood allergy in school children in Singapore between the ages of 14 and 16 is 5.2%. The prevalence of shellfish allergy in Europe and Canada is reported to be 0.6 and 1.6% respectively. The shrimp allergy rate in China is at 8.6%. While the highest prevalence of crustacean allergy reported in Italian adult population is at 10%. Kamath (2014) reported the paucity of information regarding prevalence of shellfish allergy in populated countries like India and China. Shellfish allergy is the major causative of anaphylaxis in South-East Asia, Hong Kong and Taiwan. Prevalence rates also depend upon the diagnostic methods used, rate varies between self reported allergy and food challenge proven one.

The likelihood of seafood sensitization can be correlated to geographical food habits, where seafood forms a part of staple diet. Anaphylactic reaction in association with food consumption is a major health issue. In case of adults, shellfishes act as a common trigger with a higher risk of anaphylaxis. Prevalence of shellfish allergy is not only unique to consumers, but also to occupational environment. The readily availability of seafood in wider range of populations and countries with the improvement in shipping facilities, globalization of food supply and increasing socio economic standards has contributed towards the increase in prevalence of seafood allergy all over the world.

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