

Rapid communication

Surimi: Something fishy

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During the last decade, Americans have become aware of the dangers of a diet high in fat and cholesterol and of the beneficial effects of fish consumption^{1,2}; consequently, dietary changes have resulted in an increased consumption of seafood from 11.8 pounds per capita in 1980 to 15.5 pounds per capita in 1990.³ As demand for seafood has grown, producers and suppliers have explored ways to use inexpensive, readily available species of fish in the development of processed fish products. The use of one of these products, surimi, has increased 50-fold from 3000 metric tons in 1980 to almost 150,000 metric tons in 1992 (personal communication, National Marine Fisheries Service).⁴

Surimi is processed fish meat derived, in the United States, primarily from Alaskan pollack.⁵⁻⁷ The main ingredients used in surimi-based consumer products, other than fish, are egg white (up to 1% to 2%) and vegetable starches. These are added to the raw surimi to modify performance characteristics and improve the texture (reduce rubberiness) of the product. Other ingredients such as meat proteins, seafood-derived flavorings, spices, and seasonings are mixed with the raw surimi, which is shaped into analog products sold to the public.⁴⁻⁶ Surimi is used as an ingredient for imitation crab, shrimp, scallops, and seafood snacks. Additionally, surimi-meat blend products, such as "meatless" hot dogs, hybrid ham and bologna, sausages, pepperoni sticks, and pizza toppings are being developed and test-marketed in the United States.^{4,6,7}

Abbreviations used

DBPCFC:	Double-blind, placebo-controlled food challenge
PEFR:	Peak expiratory flow rate

Fish are among the most common causes of allergic reactions to food, especially among adults.⁸⁻¹⁰ Appreciation of the seriousness of reactions to fish in sensitive individuals is important. If a highly sensitized subject unwittingly ingests fish as a "hidden" food ingredient, he or she could have a serious or even fatal reaction. The following case is the first report of an immediate allergic reaction to a surimi-based product confirmed by a double-blind, placebo-controlled food challenge (DBPCFC).

CASE REPORT

A 39-year-old woman with mild asthma, rhinitis, and fish allergy reported two episodes of oral pruritus, wheezing, and hives within minutes of ingesting imitation crabmeat. She ate imitation crabmeat in restaurant-prepared food on two separate occasions, believing that it was true crabmeat. Although allergic to fish since childhood, she has always enjoyed and tolerated eating crab and other crustacea. She denied any other food allergies.

For evaluation, the patient was skin tested with 18 routine aeroallergens, 16 commercial fish extracts, and surimi and pollack extracts prepared in our laboratory. A positive response to the test antigen was defined as a mean wheal diameter of 3 mm or greater than that produced by the negative control. Results were recorded 15 minutes after testing. Ten fish-tolerant atopic individuals served as control subjects for the surimi and pollack skin testing. Frozen pollack fillet and unflavored pollack-based surimi were obtained from Seafest/JAC Creative Foods (Motley, Minn.). Extracts were prepared by homogenization of 500 gm of the surimi or pollack in 1 L of 0.1 mol/L phosphate-buffered saline (pH 7.2) in a Waring blender (Waring, New Hartford, Conn.). Homogenates were extracted overnight at 4° C under constant stirring. Extracts were centrifuged at 70,000 g, and the supernatants were concentrated with an Amicon-YM1

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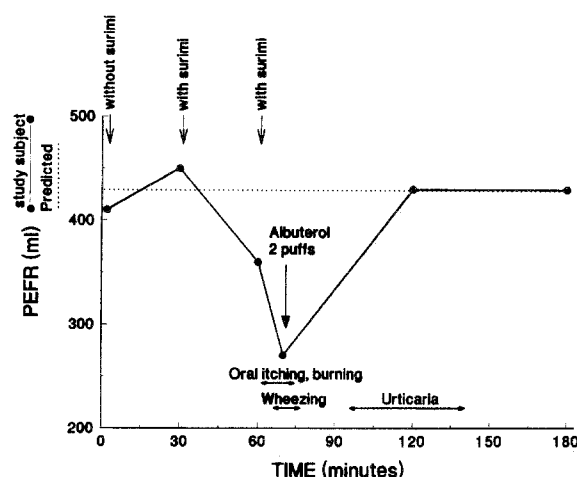


FIG. 1. Results of the subject's subjective symptoms, physical examination, and PEFR values during the DBPCFC.

filter (molecular weight cutoff < 1 kd; Amicon Corp., Danvers, Mass.) and recentrifuged (180,000 g). Protein concentrations were determined by a commercial phenol reagent method (Sigma Diagnostics, St. Louis, Mo.). For preparation of skin test reagents, extracts were sterile-filtered, and sterility was demonstrated. A skin test reagent in 50% glycerol was prepared with a final protein concentration of 10 mg/ml.

RASTs were performed in duplicate with disks coated with surimi or pollack (1 mg of protein per disk) by using the method of Ceska and Lundkvist.¹¹ Sera from five atopic fish-tolerant subjects served as controls for the RAST. A positive RAST result was defined as percent binding greater than 2 standard deviations for the mean of the controls.

For the food challenge, the surimi was masked in ground turkey burgers. The turkey and surimi were pureed separately in a food processor and then formed into hamburger-like patties containing either turkey alone (placebo) or turkey mixed with 1, 4, 16, or 64 gm of surimi. A-1 Steak Sauce (Nabisco Brands, Inc., East Hanover, N.J.) and salt were added to mask the flavor of the surimi. The burgers were baked at 175°C for approximately 30 minutes and reheated in a 500 W microwave oven on high for 3 minutes before ingestion.

The DBPCFC was performed at the Tulane-Louisiana State Medical Center of Louisiana General Clinical Research Center. The challenge protocol was approved by the General Clinical Research Center's Human Subjects Committee and by the Tulane Committee on the Use of Human Subjects. Before any study, informed consent was obtained from all subjects, and a physical examination was performed. Vital signs, baseline peak expiratory flow rate (PEFR), and intravenous access were obtained. For the challenge, either turkey (placebo) burgers or turkey-surimi burgers were administered in a double-blind fashion. Progressively increasing

amounts of surimi (1, 4, 16, and 64 gm) in the surimi-turkey or placebo turkey burgers were given randomly to the subject at hourly intervals.

The study subject was found to be atopic on the basis of positive skin test responses to several grasses, cockroach, and dust mite species *Dermatophagoides farinae* and *D. pteronyssinus*. She also had positive skin test responses to all (16) commercial fish extracts tested, as well as to surimi and pollack extracts. She had a negative skin test response to a crab extract. None of the 10 atopic control subjects demonstrated skin test reactivity to either surimi or pollack extracts.

The study subject's pollack and surimi RAST values were 5.1% and 3.0%, respectively. The mean RAST values of the five atopic control subjects were 1.7% $\pm$ 0.5% in response to surimi and 1.7% $\pm$ 0.6% in response to pollack.

Before the DBPCFC (Fig. 1), the results of the subject's physical examination and her PEFR were normal. After ingesting the first burger, which was a placebo turkey burger, the subject did not have any objective signs or subjective symptoms. With ingestion of the next burger, which contained 1 gm of surimi, the subject complained of oral itching and burning, and her PEFR dropped 14%. The oral itching resolved after approximately 10 minutes. With ingestion of the next burger, which contained 4 gm of surimi, the subject again complained of oral itching and burning, and approximately 10 minutes later she experienced wheezing and her PEFR dropped over 45%. Twenty minutes after ingestion of this burger, urticarial lesions developed on her arms and trunk. Because the subject accurately identified each burger containing surimi by oral allergy symptoms and manifested several objective signs including urticaria, wheezing, and a drop in PEFR, the DBPCFC was considered positive. Because her response was similar to her historic reactions, the diagnosis of surimi sensitivity was confirmed.

DISCUSSION

This case report demonstrates that a patient allergic to fish may have a significant allergic reaction to surimi. In a previous study, Helbling et al.¹² investigated the allergic potential of surimi in a group of 30 adults allergic to fish. Fifty percent (15 of 30) of the group had positive skin test responses to both pollack and surimi extracts. Further, 30% of the group had positive RAST responses to surimi and pollack.¹² The authors demonstrated cross-reactivity between a surimi-derived pizza topping and several fish species, including pollack, by RAST inhibition. Mata et al.¹⁴ tested the allergenicity of surimi by sodium dodecylsulfate-polyacrylamide gel electrophoresis and protein-Sepharose (Pharmacia, Uppsala, Sweden) IgE radioimmunoassay inhibition. They found that surimi, although less allergenic than

codfish, reacted with all six sera tested. These findings suggest that surimi, even after extensive processing into consumer products, has the potential to induce allergic reactions in patients allergic to fish.

Most of the soluble sarcoplasmic proteins are removed in the processing of surimi, although approximately 75% of the fish's original protein content remains.⁴⁻⁶ Although the major allergen in codfish is a parvalbumin from sarcoplasmic proteins,¹⁴ the studies by Helbling et al.¹² and Mata et al.¹³ demonstrate that significant allergenicity is retained in surimi. It is interesting to note that the subject's RAST reactivity to surimi was 3.0%, whereas reactivity to pollack was 5.1%. The decreased IgE antibody reactivity to surimi as compared with pollack suggests that allergens are removed or destroyed in refining of the fish meat to surimi. Other processed fish products, such as canned tuna and salmon, have been shown to be relatively hypoallergenic.¹⁵ The retained allergenicity of surimi in contrast to the lack of allergenicity of canned tuna and salmon is most likely due to the fact that canned tuna and salmon are cooked for up to 14 hours, whereas surimi is cooked only briefly and at low temperatures.

Fish typically has not been a hidden ingredient in foods. However, surimi may be a hidden ingredient in some foods, and as this case illustrates, can induce significant reactions in sensitive individuals. Further, it is possible that surimi poses a significant risk to subjects with egg allergy because it contains egg white protein. As surimi production and consumption continue to grow, surimi will become incorporated into a wider array of consumer products that may not resemble seafood. Patients allergic to fish will need to be vigilant about the food they eat, or as this case demonstrates, risk having a significant and potentially serious allergic reaction.

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REFERENCES

1. Summary of the Second Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel II). *JAMA* 1993;269:3015-23.
2. Kromhout D, Bosschieter EB, Coulander CDL. The inverse relation between fish consumption and 20-year mortality from coronary heart disease. *N Engl J Med* 1985;312:1205-9.
3. Statistical Abstract of the United States 1992. In: The National Data Book. 112th ed. Washington (DC): U.S. Department of Commerce, 1992:132.
4. Martin R. Surimi products—a review. In: Flick GJ Jr, Martin RE, editors. *Advances in seafood biochemistry*. Lancaster (PA): Technomic Publishing, 1992:377-91.
5. Lee CM. Surimi manufacturing and fabrication of surimi-based products. *Food Technol* 1986;40:115-24.
6. Lanier TC. Fish protein in processed meats—the surimi potential. Chicago: National Provisioner, Inc., 1985.
7. Kiratsous AS. Flavor developments for the surimi-based seafood analogues. In: Charalambous G, editor. *Flavors and off-flavors*. Amsterdam: Elsevier Science Publishers, 1990:659-69.
8. Aas K. Studies of hypersensitivity to fish. *Int Arch Allergy Immunol* 1966;29:346-63.
9. O'Neil C, Helbling AA, Lehrer SB. Allergic reactions to fish. *Clin Rev Allergy* 1993;11:183-200.
10. Yunginger JW, Sweeney KG, Sturmer WQ, Glannachea LA, Tiegland JD, Bray M, et al. Fatal food-induced anaphylaxis. *JAMA* 1988;260:1450-2.
11. Ceska M, Lundkvist V. A new and simple radioimmunoassay method for the determination of IgE. *Immunochemistry* 1972;9:1021-30.
12. Helbling A, Lopez M, Lehrer SB. Fish allergy: Is it a real problem with surimi-based products? *Int Arch Allergy Immunol* 1992;99:452-5.
13. Mata E, Favier C, Moneret-Vautrin DA, Nicolas JP, Han Ching L, Gueant JL, et al. Surimi and native codfish contain a common allergen identified as a 63kDa protein. *Allergy* 1994;49:442-7.
14. Elsayed S, Aas K. Isolation of purified allergens (cod) by isoelectric focusing. *Int Arch Allergy Appl Immunol* 1971;40:428-38.
15. Bernhisel-Broadbent J, Strause D, Sampson HA. Fish hypersensitivity. II. Clinical relevance of altered fish allergenicity Caused by various preparation methods. *J Allergy Clin Immunol* 1992;90:622-9.