The Burden of Allergens in Surimi-Based Products Diminishes With Industrial Processing

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Surimi products are a mixture of the flesh of small fish of many species minced, thoroughly washed, and gelated [1]. To improve the properties of the gel and to give surimi products different textures and flavors, various proteins are added to the mixture, mainly soy protein isolate, whey protein from milk, and egg ovalbumin [2,3].

Allergic reactions to surimi-based products have been reported in fish-allergic patients [4,5]. However, there are no reports of IgE recognition of egg or milk allergens in surimi-derived products or of variations in allergen content during industrial processing.

We investigated the allergenicity of baby eel surimi (BES), which includes milk in its formulation, and crabstick surimi (CS), which includes egg. Prick-by-prick testing (PPT) and the basophil activation test (BAT) were performed in patients allergic to fish, egg, and milk. We included 11 patients with fish allergy, 5 patients with milk allergy, 7 patients with egg allergy, and 3 patients allergic to both fish and egg; all the patients had been referred to Hospital La Paz, Madrid, Spain. We investigated the effects of industrial processing of surimi on IgE recognition during 2 critical steps of manufacturing (before and after heat-induced gelation) and in the final product using ELISA, which was run using sera from a group of 56 patients (18 fish, 14 egg, 14 milk, 7 fish and egg, and 3 egg and milk). The Ethics Committee of Hospital La Paz approved the study (PI-3065), and written informed consent was obtained. Data on age, total IgE and fish-, egg-, and milk-specific IgE are presented in Supplementary Table 1.

For the ELISA experiments, we prepared 0.1 M phosphate-buffered saline (PBS)-based extracts of BES, CS, and 2 intermediate products in each (step 1, before gelation; and step 2, after gelation). PPT was performed according to European guidelines using BES and CS directly without manipulation. The PPT result was considered positive when the wheal diameter was >3 mm. BAT was performed with PBS-based extracts, using BD FastImmune CD63/CD123/HLA-DR mixture (BD Biosciences) according to the manufacturer’s instructions. Samples were analyzed in a FACScan flow cytometer (BD Biosciences) [6]. The IgE reactivity of all the extracts was determined using ELISA as described elsewhere [7]. The ELISA results were evaluated using the Wilcoxon signed rank test. A 2-tailed contrast analysis was performed. Statistical significance was set at P<.05. The results are presented as median (IQR).

The PPT results with BES were positive in 13 fish-allergic patients (13/14; 92.8%) (6.0 [4.5-7.8]), as were those for CS (6.0 mm [4.9-9.0]), indicating the presence of fish allergens in both products. The PPT result was positive with CS in egg-allergic patients (10/10, 100%) (5.8 [4.9-9.2]), although the reaction was less pronounced with BES (2.8 [2.5-5.0]). The results are concordant with the presence of egg in the CS
formula but not in BES. Finally, the PPT result with BES was positive in 75% (3/4) of milk-allergic patients (12.0 [3.8-20.5]) and negative with CS (presence of milk in BES, but not in CS) (Supplementary Figure 1A).

In the BAT with the BES extract, the median %CD63+ basophil value was 27.8% (8.4%-63.6%) for the 12 fish-allergic patients included. Percentages were lower for egg-allergic patients (n=9; 5.9% [0.8%-27.8%]), whereas results were positive for BES in milk-allergic patients (n=5; 22.1% [14.8%-46.7%]). The BAT results with CS were similar to those with BES for fish-allergic patients (28.7% [15.7%-71.5%]) but not for egg- and milk-allergic patients, thus reflecting the difference in their composition. The %CD63+ for CS in egg-allergic patients was positive in 8/9 (88.8%; 26.9% [3.9%-58.7%]). Conversely, activation was less pronounced in milk-allergic patients with CS than with BES (n=5; 16.6% [3.0%-27.4%]) (Supplementary Figure 1B).

We used ELISA to study the variation in allergenicity during the processing of these products. Allergens were extracted from step 1 (before gelation) and step 2 (after gelation) and the final products (BES and CS). We analyzed sera from patients allergic to fish, egg, and milk. The manufacturing process led to decreased IgE recognition, although CS seems to retain more fish allergens than BES in the 3 steps studied. The reduction in IgE recognition reached statistical significance between steps 1 and 2 in BES (P<.001), and a reduction was observed in both products and in the final 2 steps (Figure, A and B). Regarding the egg allergen content, BES yielded negative results in all the steps, as this product does not include egg in its formulation (Supplementary Figure 2A). Conversely, high absorbance was observed for CS, with a significant decrease from step 1 to 2 (P=.024, Supplementary Figure 2C). We did not detect milk allergens in CS, as expected (Supplementary Figure 2D). However, the final BES product and its previous steps were strongly recognized by milk-allergic sera (P=.023; Supplementary Figure 2B).

β-Parvalbumin is a major fish panallergen that is present in most fish and recognized by 80% of allergic patients [8]. We confirmed the presence of β-parvalbumin using Western blot inhibition with recombinant mackerel β-parvalbumin (Sco j 1) before the gelation process, although its ability to recognize IgE disappeared after the gelation process (Supplementary Figure 3).

Allergenicity can be mitigated in surimi production by removal of the allergenic proteins, either during the leaching step or through structural modifications by heating during the gelation process [9-11]; hence the more pronounced fall in IgE recognition by ELISA before and after gelation and the presence of allergens in the final products.

We conclude that when used as additives, milk and egg do not lose IgE-binding ability during processing; therefore, they constitute a real danger for allergic patients. Regarding fish allergens, we observed that β-parvalbumin is undetectable in the final products, although sufficient IgE reactivity is retained. Carvalho et al [12] recently reported that a decrease in sIgE to the parvalbumin rGad c 1 and the mean wheel diameter in skin prick testing for hake and salmon can be used as markers of prognosis in the acquisition of tolerance by fish-allergic patients [12]. In line with this study, our results suggests that some fish-allergic patients could tolerate surimi products, although previous supervised oral food challenge is necessary.

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Conflicts of Interest

JLH works at the Angulas Aguinaga Research Center. The remaining authors declare that they have no conflicts of interest.

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