TECHNICAL NOTE

FISH PROTEINS AS BINDERS IN PROCESSED FISHERY PRODUCTS

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The binding role of proteins has been well established for emulsified products such as frankforts and baloney. Much work has been done on the water-holding capacity and emulsification properties of beef and poultry proteins.

The Japanese have worked on the binding properties of fish proteins in fish sausages and the traditional Kamaboko, which are also emulsified or gelled products.

Recently in the meat and poultry industry, there has been interest in binding together pieces or chunks of flesh to produce loaves or rolls. The need for binders in these fabricated foods has initiated much research into a host of protein materials. These include soy protein, gluten, gelatin, milk solids, and egg whites.

At the Fishery Products Technology Laboratory in Gloucester, Mass., we became interested in the binding properties of fish proteins to increase the structural stability of fish fillets exposed to various thermal processes. Research showed that when fillets were coated with a slurry made from diluted fish muscle their physical structure was unaffected by thermal processing and storage at temperatures above freezing.

The following describes some of the research on the use of fish proteins as binders in new-product development.

THE FORMATION OF ROLLS OR LOAVES

Research was carried out to develop roll or loaf-type products incorporating other fishery products as flavoring agents. Haddock and cod fillets were comminuted (pulverized) for various times in a silent cutter (30-180 sec). Pieces of shrimp and clams were incorporated into the ground muscle and the mixtures were placed in No. 2 cans. The cans were sealed and heat-processed to internal temperatures ranging from 50 to 100° C. The resulting product, Figure 1, was a solid mass of flesh physically stable at above-freezing temperatures. For taste-testing, the rolls were sliced into 1.5 cm. portions, lightly breaded and deep-fat fried.

In general, these products were considered highly acceptable by the test panel. The flavor of the products was considered to be that of clam or shrimp and not haddock or cod. The texture of the products appeared to be related directly to the amount of grinding or the particle size of the ground fish muscle. Fish muscle comminuted for 30 seconds resulted in very little binding, whereas muscle treated for 3 minutes produced an almost rubbery texture. The heat treatment needed to bind the flesh did not appear to be critical. Highly acceptable products were prepared by heating them to internal temperatures as low as 50° C and up to 77° C. Products heated to internal temperatures above 77° C had a tendency to be dry and slightly discolored. This was especially true of heat-sterilized products.

Other products of this type were prepared using various flavoring agents such as ocean quahogs, Maine shrimp, and crab meat. All these were highly acceptable.

REFORMATION OF CRAB MEAT

As part of our blue-crab research program, we continued this line of research to develop new products from crab meat. Flake

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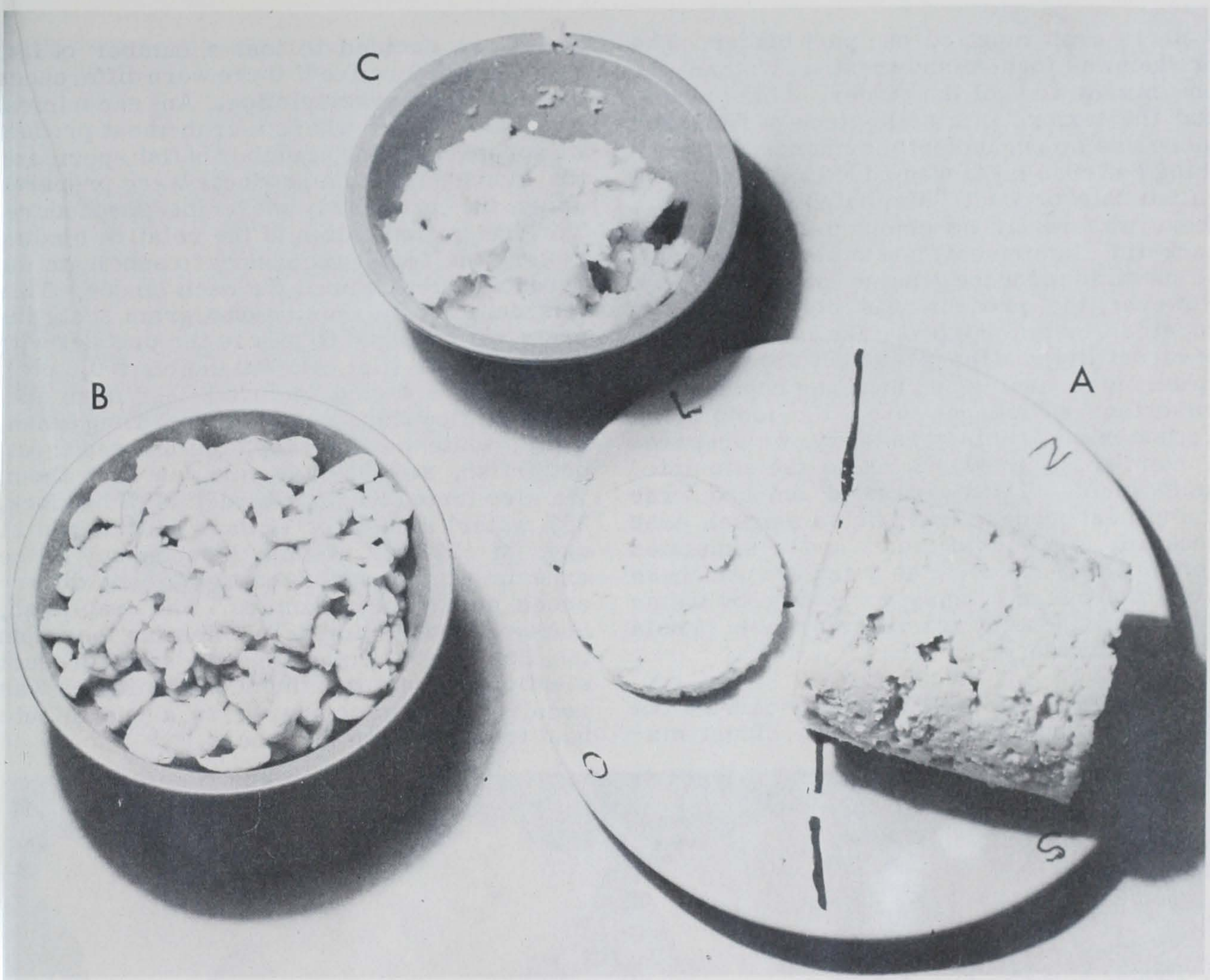

Fig. 1 - Shrimp roll (A) prepared from Maine shrimp (B) and diluted comminuted fish muscle (C).

meat, the meat picked from crab bodies, is much less desirable than the solid "back fin lump" meat. It is also more difficult to pick, resulting in an adverse effect on quality, especially with increasing labor costs. For this reason, the industry is moving towards machines to remove the meat from the bodies. To date, these machines show a tendency to break up the meat, making it less desirable for the salad or cocktail market.

Using a fish protein binder, we attempted to upgrade the broken flake meat to something similar to the desirable "back fin lump" meat now produced by the industry. A binder was prepared by grinding fish muscle in a silent cutter and mixing this with commercial-grade flake meat. The product was formed to the desired shape and sealed or bonded by steaming. A number of formulations and processing conditions were tried in an attempt to produce exactly the right texture--the texture of a solid piece of flesh. The texture of the finished product appears to be related to three interdependent variables: the size of the particles in the binder, the moisture content of the product, and the heat treatment. The binding property and product elasticity increased with decreasing particle size and decreasing moisture content. The application of heat decreased the moisture content and increased the binding property. The most acceptable product was prepared in the following manner:

Haddock or cod fillets were comminuted in a silent cutter for 60 seconds. The binder was prepared by mixing 8 parts fish flesh to 2 parts water. Commercial blue-crab flake meat was mixed with the binder at a ratio of

9 parts crab meat to one part binder. The product was formed and treated in steam for one minute to seal the binder. This product had the texture of a solid piece of flesh and there was no organoleptic evidence that anything but crab meat was added. Although we called this product "simulated lump meat", there was really no comparison with "real back fin" lump meat, and it certainly cannot be substituted for the genuine "back fin" lump. However, the product was considered far superior to the original flake meat in terms of versatility, and the fact that it did not break up during packaging and handling represented important advantages over the lump meat. To demonstrate this versatility, we prepared a number of products using the simulated lump meat. These included smoked crab (lump meat prepared with liquid smoke), crab cocktail, fried lump meat, and a simulated soft-shell crab (Figures 2 and 3). All these were considered highly acceptable by members of the industry as well as by taste panels at the laboratory.

Since most of this work was carried out on cod and haddock muscle as the binder material, we decided to test a number of fish species to determine if there were differences in binding characteristics. An experiment was carried out where a crab-meat product was prepared using a number of fish species as the binder. All the products were prepared using the previously described procedure. To give an indication of the relative binding power, the force necessary to penetrate the product was measured for each binder. This was done by measuring on a gram scale the pressure required to pierce the product with a steel shaft (flat end--diameter = 0.5 cm). The binders tested included flesh from cod, haddock, flounder, ocean perch, whiting, hake, skate, white perch, skup, mullet, sea trout, butterfish, striped bass, and raw crab flesh. We also tested haddock binder (80% haddock, 20% water) stored for 10 days at 1° C and 11 days at -20° C. Within the accuracy of the experiment, we found no significant differences among fish samples. The crab flesh, however, had binding properties far less than the fish flesh. To achieve the same product elasticity, a heat treatment of 25 minutes was required. This compares to a one-minute heat treatment for the others.

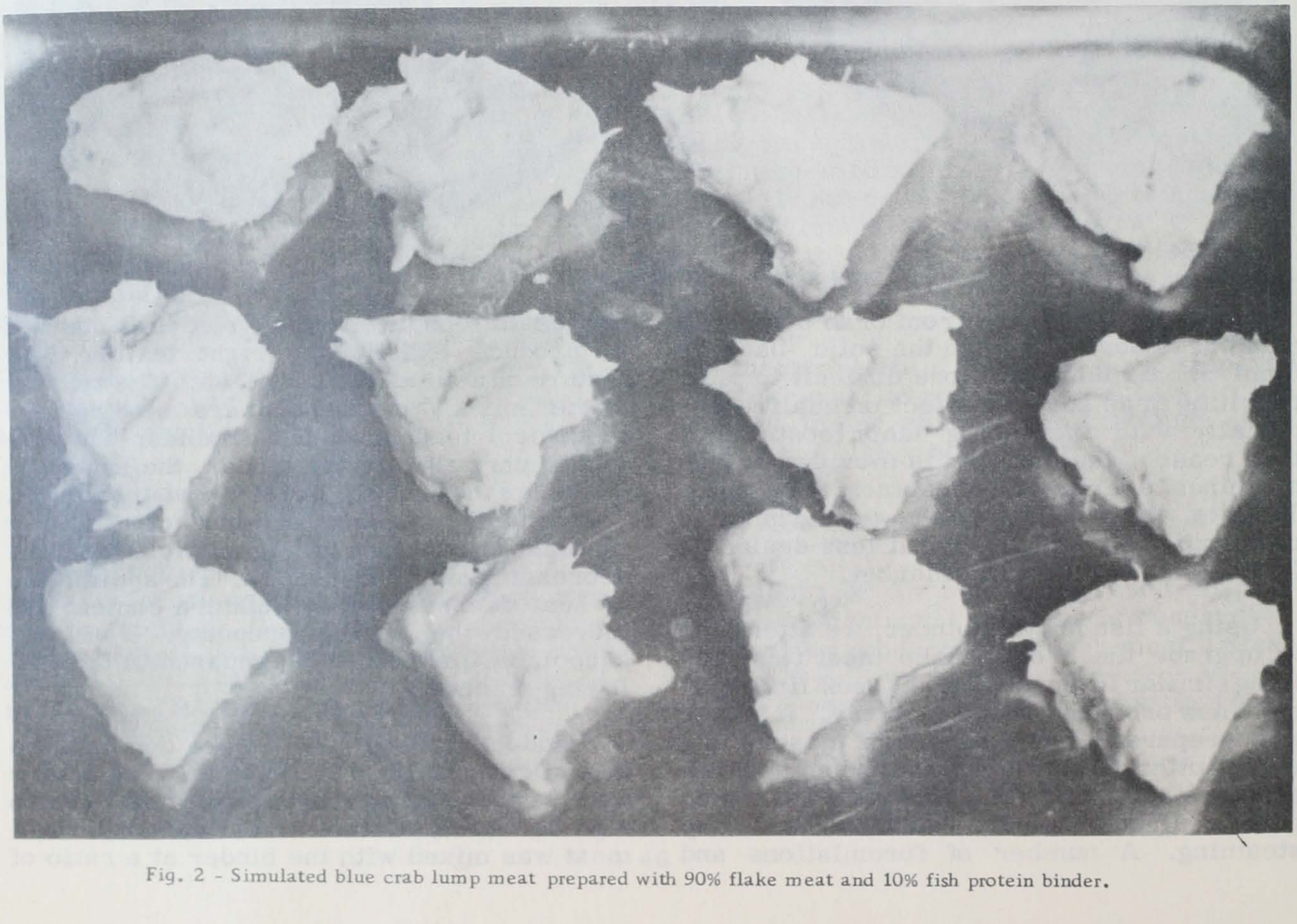

Fig. 2 - Simulated blue crab lump meat prepared with 90% flake meat and 10% fish protein binder.

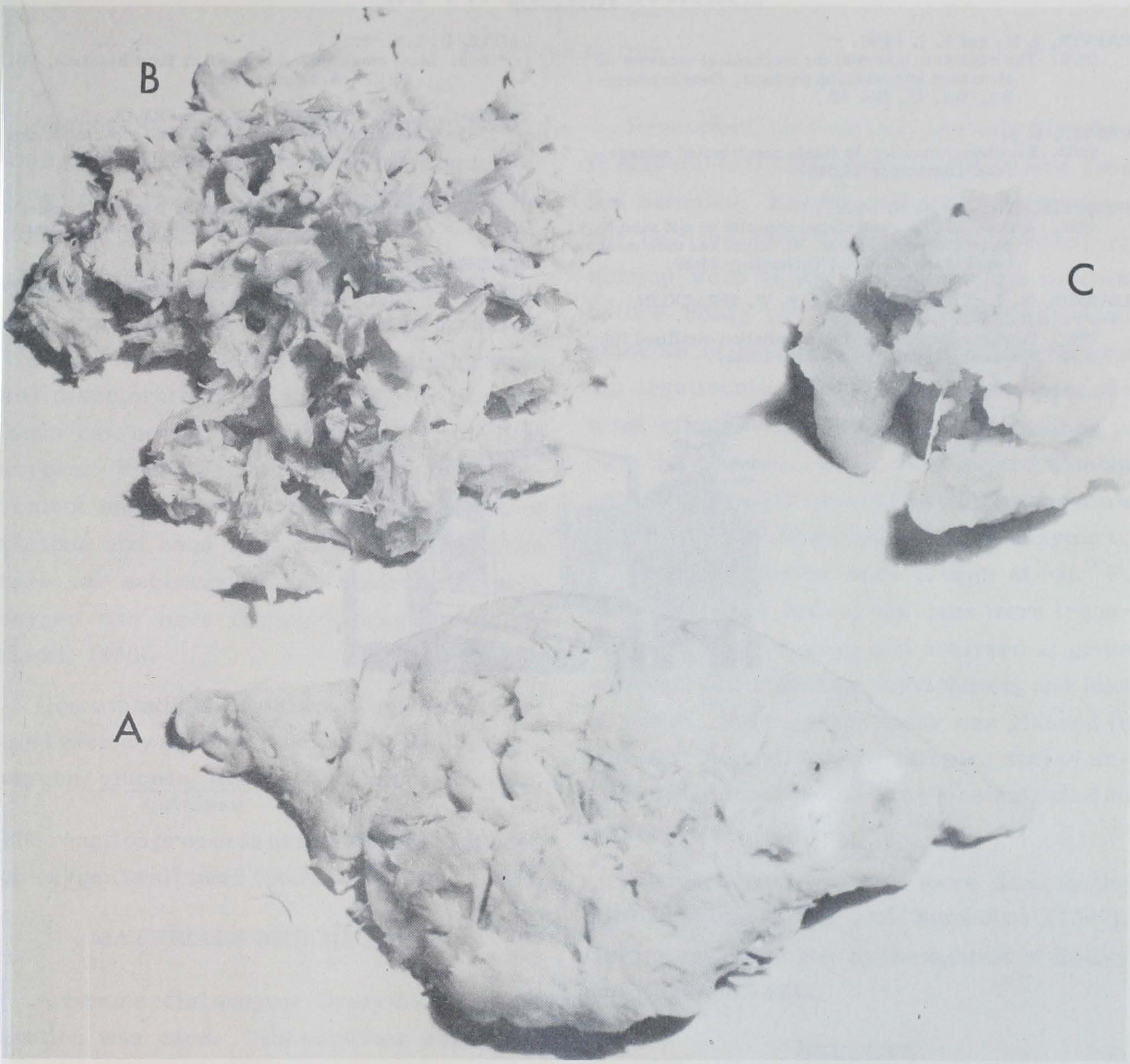

Fig. 3 - Simulated soft shell crab (A) prepared with 90% flake meat (B) and 10% fish protein binder (C).

SUMMARY

In general, all our data indicate that the role of fish proteins is similar to that theorized for meat. The application of heat produces an unravelling of the protein and random cross linking by means of hydrogen bonding. The cross linking of randomly organized protein mixed with connective tissue is responsible for the tightly adhering mass.

So, in general, it appears that a fish-protein binder can be used effectively in the development of formed fishery products. The binder material is cheap and easy to obtain by means of meat/bone separators. It is reasonably stable at both refrigerated and frozen temperatures. It can be flavored and colored and, finally, it is a protein natural to fishery products and readily available to fish processors.

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