PEGGY GREB (D776-1)

# Finding New Uses for Fish Byproducts

Alaska's fish-processing industry produces more than 2.2 billion pounds of fish byproducts every year—the weight equivalent of nearly 10,000 blue whales.

Large processors often convert these byproducts into fishmeal or fish oil, which are generally sold for meager profit. There is little economic incentive for smaller or at-sea processors to do the same, so they generally return byproducts to the ocean, where they are consumed by marine creatures.

But is this the best use of these products? Could fish processors be throwing money into the sea?

**Clockwise from upper left: a sheet of gelatin made from Alaskan pollock fish skin, pollock fish skins used for gelatin extraction, shrimp feed pellets made with dried salmon hydrolysate, and salmon hydrolysate powder.**

It's possible, say ARS researchers in Fairbanks, Alaska, and Albany, California. Their research demonstrates that fish byproducts have marketable potential.

Take fish livers, for example. They aren't a very popular menu item in the United States. Kids rarely clamor for fish liver snacks, and few people include them in their regular diet. But do they have potential as a dietary supplement?

Peter J. Bechtel, a food technologist in the Subarctic Agricultural Research Unit at Fairbanks, says yes. Working with colleagues, he found that livers from different species of fish all showed positive nutritional properties, but to varying degrees.

"Not all cold-water marine oils are created equal," says Bechtel. Oils from different marine species have different amounts of omega-3 fatty acids, the long-chain fatty acids that have nutritional benefits for humans.

Cold-water marine fish tend to have higher omega-3 content than many warm-water marine fish, which tend to have more omega-3 than freshwater fish. With omega-3 fatty acids of 20 percent or more, pollock and salmon rank at the top, he says.

In one study, the scientists compared livers from seven fish species harvested in Alaska—walleye pollock, pink salmon, bigmouth sculpin, Pacific halibut, arrow-tooth flounder, flat-head sole, and spiney-head rockfish—and examined their composition in terms of proteins and oils. The liver proteins of all the fish had high levels of essential amino acids. Liver lipid content—a strong indicator of omega-3—ranged from 3.3 percent for pink salmon to 50.3 percent for walleye pollock. Bechtel and his colleagues concluded that differences between species could enable development of unique ingredients for food or animal feed, allowing producers to target products to specific markets.

"Fish oil and protein supplements for humans can be made from high-fat livers. And low-fat livers, such as salmon, can be used as supplements for pets and livestock as well as humans," Bechtel says.

Studies conducted by Bechtel and scientists from the University of Alaska confirmed that protein powders made from cold-water marine byproducts could be used as feed ingredients for aquaculture or livestock. And the fish-based proteins compare favorably to products already used in food, dietary supplements, medical treatments, and animal feed.

Global demand for fish protein will exceed supply by 2016, according to the Juneau Economic Development Council. That group is working with the Alaska Department of Environmental Conservation, the Southeast Conference, and the Southeast Sustainable Salmon Fund to find alternatives for the "grind-and-dump" approach to seafood-processing leftovers.

**Gelatin: From Fish to Film**

Another study, conducted in collaboration with research leader Tara H. McHugh and her colleagues at the Western Regional Research Center in Albany, showed that gelatin recovered from fish skins can be processed into thin, pliable sheets, called films. The scientists made sample films from warm- and cold-water fish, evaluated their physical characteristics, and compared them to mammal-based gelatins.

Most gelatin is made from cattle and swine byproducts. Gelatin made from fish skins has a lower gelling point—about 46˚F to 50˚F, compared to 80˚F to 95˚F for mammals—and is liquid at room temperature, making it impractical for certain products. The scientists concluded that fish gelatins could not substitute universally for mammalian gelatins, but their lower gelling temperature might make them suitable—or superior—for use in products such as frozen desserts.

Experiments led by agricultural engineer Roberto de Jesus Avena-Bustillos, formerly with McHugh's group and now a collaborator based at the University of California-Davis, showed that the fish-derived gelatin films serve as a protective barrier against the damaging effects of moisture and oxygen.

"This suggests that the fish gelatins could be used to reduce water loss in refrigerated and frozen foods," says Avena-Bustillos. The fish-gelatin films "proved to be a better barrier to water vapor than the mammalian gelatins," he says, and offered better protection against oxidation. "Covering a gel-capsule-type medication with a thin coating of fish gelatin would likely slow down natural oxidation."

Working with Avena-Bustillos and his Albany colleagues, Fairbanks-based food technologist Cindy K. Bower added the antibacterial enzyme lysozyme to gels and films made from fish skin gelatins. The lysozyme actively inhibited bacteria—but it also reduced the strength of the gels by as much as 20 percent. Still, researchers concluded that the enhanced gels and films could provide an effective barrier to many bacteria and increase the shelf life of some food products.

"The idea of improving fish-skin gelatin with lysozyme is good but requires more study," Bower says. "Besides antimicrobial agents, we could also add flavorings and aroma compounds."

Expanding the seafood byproducts market with the impressive array of products that ARS scientists are inventing and investigating will enhance the value and scope of seafood-processing plants' product lines. In all, the research provides more options for fish processors, the potential for increased business, and more ways to make environmentally sound use of natural resources from the sea.

"Nobody's opposed to improving efficiency or making more money," Bechtel says. "Our work shows that there are a number of different ways to do that."—By **Laura McGinnis** and **Marcia Wood,** ARS.

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*Peter J. Bechtel and Cindy K. Bower are with the USDA-ARS Subarctic Agricultural Research Unit, 245 O'Neill Bldg., UAF, Fairbanks, AK 99775; phone (907) 474-2708 [Bechtel], (907) 474-6732 [Bower], fax (907) 474-7204, e-mail bechtel@sfos.uaf.edu, bower@sfos.uaf.edu.*

*Tara H. McHugh heads the USDA-ARS Processed Foods Research Unit, Western Regional Research Center, 800 Buchanan St., Albany, CA 94710; phone (510) 559-5864, fax (510) 559-5851, e-mail thm@pw.usda.gov.* ✸