similar to those caused by petroleum and heavy metal exposure have also been observed in the mummichog, *Fundulus heteroclitus,* following exposure to the pesticide methoxychlor, and in Atlantic salmon, *Salmo salar,* exposed to a pulp mill waste (Gardner, 1975; U.S. Environmental Protection Agency, 1972).

Atlantic salmon olfactory senses were impaired by severe cellular damage following exposure to a range of pulp mill waste concentrations in experimental bioassays. Concurrent with laboratory bioassays, Atlantic salmon were exposed in situ to pulp mill waste. Results of in situ studies at locations from the point of discharge to 8 miles downstream from the point source proved similar to laboratory results.

Menhaden examined from three New England coastal areas had lesions associated with internal ear, lateral line, and olfactory organs. Though etiology of these lesions remains unknown, all three collection points were found to have high levels of copper in the water column (Gardner, unpubl. observations; Gardner et al., 1975). Comparability of laboratory and field study results with Atlantic salmon and field observations of menhaden, *Brevoortia tyrannus,* gives credence to histological findings with other species.

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NOAA/NMFS Developments

Inhibition of Proteolysis in Pacific Hake Fillets

To date, U.S. processors have used the Atlantic whiting, *Merluccius bilinearis,* and species of hake imported from South America and South Africa, for much of the production of fish sticks and portions. As a result of the Fishery Conservation and Management Act of 1976, U.S. fishermen and processors have shown an interest in using the Pacific hake, *Merluccius productus,* for domestic markets and possibly for export.

The Utilization Research Division of the Northwest and Alaska Fisheries Center (NWAFC), NMFS, NOAA, Seattle, Wash., has been examining the quality characteristics of the Pacific hake to solve any technological problems that might present themselves as barriers to the full utilization of this resource by U.S. industry. On occasion, the Pacific hake develops an undesirably soft texture of the flesh that must be overcome before the resource meets all the quality requirements of the U.S. consumer. When a change in Pacific hake texture occurs, it is due to the presence of an enzyme (a protease) that is capable of breaking the chemical bonds of the muscle fibers that give any flesh food its characteristic texture. When the protease is present, it is capable of breaking bonds at nearly any temperature above freezing, but it does this most rapidly at temperatures just a bit lower than those that destroy the enzyme itself. During such conventional cooking processes as baking, broiling, and pan-frying, temperatures are reached that enhance the action of the protease and continue for a time before reaching the level that will destroy the protease. Several methods of preventing this textural change have been tried (i.e., very rapid cooking, sonication, and the use of chemicals to inactivate the enzyme, all of which have the potential for inactivating the enzyme before it damages the muscle. Recent laboratory tests by Ruth Miller, research chemist, in the Utilization Research Division, have demonstrated that two common oxidizing agents, hydrogen peroxide and potassium bromate, are effective in inactivating the enzyme. Even when used in concentrations of less than 0.5 percent, either of these additives achieves nearly complete inhibition of the enzymes. Hydrogen peroxide appears to be the reagent of choice because it is rapidly decomposed into water and oxygen, leaving no undesirable residue. The effectiveness of hydrogen peroxide can be enhanced by the simple expedient of changing the pH of the fillet. These parameters and rapid application techniques are being developed at the NWAFC.

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