ARTICLES

NEW TESTS ASSESS QUALITY CHANGES IN FISH

By John Spinelli*

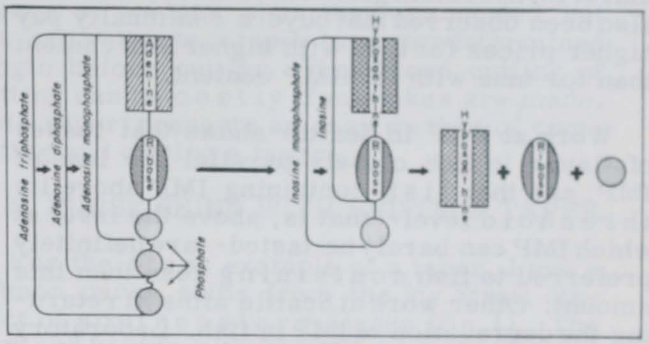
Any weekend fisherman knows that freshly caught fish has a flavor that is both subtle and attractive and that these desirable characteristics are gradually lost as the fish ages. Although the ability to describe and measure these changes in quality has eluded scientists, recent research is beginning to shed some light on them.

Because fish spoil rapidly, most people have associated flavor changes in fish with bacterial growth. So, for years, fresh and frozen fish were evaluated by sensory or objective tests based on the detection of the end products produced by growing bacteria. These tests have been useful but, because they failed to detect the more subtle changes in quality closely related to the acceptability of fish, they have never been considered adequate.

Recently, however, studies of certain biological changes that occur in fish post-mortem have resulted in important contributions to measuring the quality of fish and to understanding the chemical reactions that lead to the loss of quality. After a fish dies, a class of chemical compounds known as nucleotides is gradually broken down in the flesh into simpler chemical constituents. During iced storage, the nucleotides break down at a fairly rapid rate so that measurement of either the remaining nucleotides in the flesh, or their breakdown products, provides a basis to establish the time the fish has been held. Also, the degradation of nucleotides is involved in the changing flavor characteristics of the fish flesh.

The Key to Understanding the Degradation Process

The key to understanding this whole degradation process lies in a knowledge of the parent nucleotide known as adenosine triphosphate (ATP). ATP is a combination of two compounds, adenine and ribose, and of three phosphate molecules (figure). In living tissue, ATP provides the essential fuel for a whole series of life processes. In doing so, it is continually broken down and regenerated.



Complete breakdown of muscle ATP into its final degradation products--hypoxanthine, ribose, and phosphate.

After the death of the fish, it is no longer able to regenerate ATP, and ATP quickly goes through a sequence of reductions to the smaller molecules, adenosine diphosphate (ADP), adenosine monophosphate (AMP), and finally inosine monophosphate (IMP). IMP then slowly breaks down to inosine, and then to hypoxanthine, ribose, and phosphate--all as shown in figure.

The rates at which degradation occurs are different for different species of fish, so these rates must be determined experimentally to derive useful information from the measurement of nucleotides or their degradation products. For example, we have experimentally determined that Pacific ocean perch will lose about 50 percent of its IMP content after 5 days of iced storage and about 85 percent after 10 days of storage. Thus, an analysis of Pacific ocean perch for its remaining nucleotide content, or its hypoxanthine content, will yield a close approximation of the time it has been held in ice.

To date, scientists in the United States, Canada, Great Britain, and Japan have established the rates of nucleotide degradation for practically all commercially important species.

Relation of Nucleotides to Flavor

In addition to its use in developing a quality index, this work on nucleotides has given us

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insight into the chemistry of the flavor of fish. Japanese workers established that IMP is not only a very flavorful compound, but that it enhances the flavors of other compounds. Its flavor-enhancing ability is far greater than that of monosodium glutamate. In Japan, it has also been observed that buyers continually pay higher prices for tuna with higher IMP content than for tuna with low IMP content.

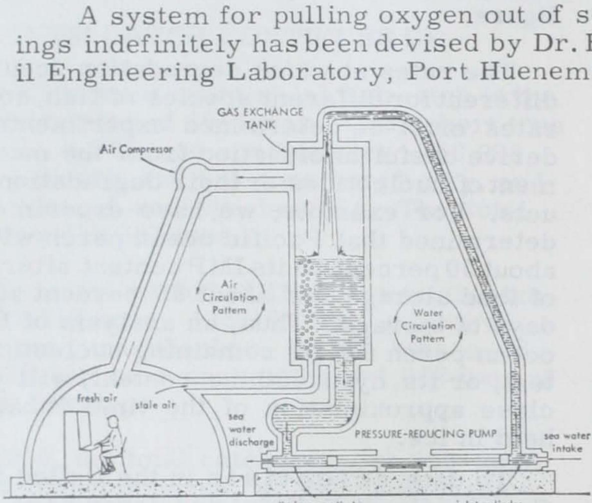
Work at BCF in Seattle shows that losses of flavor in fish closely parallel the loss of IMP, and that fish containing IMP above its threshold level--that is, above the level at which IMP can barely be tasted--are definitely preferred to fish containing less than this amount. Other work at Seattle aims at retarding the degradation of IMP in fish. Laboratory trials show that superior flavor ratings are given to fish that have been treated to prevent the degradation of IMP over fish that have not been similarly treated.

Future Testing of Fishery Products

The implications of these and other findings will undoubtedly influence the way in which commercial fishery products are tested. Today's methods readily distinguish between spoiled and not-so-spoiled fish. New methods will distinguish between fresh and not-so-fresh fish. Though once complicated, the procedures for determining nucleotides and their degradation products have evolved to the point where chemists can do them rapidly and with ease in modest, routine, quality-control laboratories. Through a combination of analytical techniques, a comprehensive quality profile will eventually emerge that will, with much greater accuracy, reflect the attitude of that final judge--the consumer.

AIR FROM THE SEA FOR OCEANAUTS

A system for pulling oxygen out of seawater to supply underwater dwellings indefinitely has been devised by Dr. Harold P. Vind at the U. S. Navy Civil Engineering Laboratory, Port Hueneme, Calif.



The pressure-reducing pump is particularly important, the Navy points out. An ordinary pump would have to be very powerful (and thus bulky) to discharge the water back into the ocean due to the pressure difference between the inside and the outside of the system. The new pump essentially uses the high pressure of the incoming water to push the used water through the discharge valve. Thus, the pump can run on little more power than that needed to overcome the friction of its components.

The inexpensive system uses basically a tank, some tubing and a pressure-reducing pump. In the system, oxygen-deficient stale air is forced into a gas-exchange tank where it meets a continuously circulating stream of seawater. The surfaces of the many droplets and bubbles act as diffusion membranes. The excess carbon dioxide in the stale air diffuses into the seawater, and the oxygen in the seawater diffuses into the air. The revitalized air is returned to the living chamber of the structure.

The Navy is studying the idea for both fixed shelters and undersea vehicles. (Reprinted, with permission from "Science News," weekly summary of current science, copyright 1966 by Science Service, Inc.)