Frozen Mysis Part 2: The Science Behind the Food

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In Frozen Mysis Part 1: The Quest For Quality Mysis, we took a look at how to best select quality mysis for our seahorses, and what to avoid. In this long overdue part two, we're going to take a look at why being picky about our frozen food matters.

Just What Does Freezing Do?

We all know that food is frozen to keep it from going bad – but what exactly is it about freezing that preserves food? Contrary to popular belief, freezing does not kill the bacteria that causes spoilage. Rather, it renders bacteria inactive. Which is why we humans have to cook our foods even after freezing.

Slowing bacteria is not the only thing that freezing does; it slows and inactivates enzymes naturally found in meat that causes the breakdown of protein and fat. This is why the quality of food tends to degrade over time. A steak frozen 10 years ago might still be edible, but the nutritional quality (and taste) will have declined significantly.

These enzymes found in meat break down tissue and fat. They are particularly problematic for the fish keeper, because polyunsaturated fatty acids, the "good fats" , found in seafood breakdown very quickly. What surprises most people is that this continues to happen even when frozen. These healthy lipids are unstable, and even at freezing temperatures, can break down. This is why oily fish should be eaten within 3 months of freezing. Other seafood, no more than 6 months.

PE mysis from two different sources appears to have been handled very differently.

Proper Freezing

Most frozen foods for our fish these days are “flash frozen” or exposed to a rapid cooling process, much colder than what you’d find in a home freezer. Blast Freezers, Shock Freezers and Tunnel freezers are used in industrial food operations. These rapidly chill food using fans to blow extremely cold air across food. Some operate at temperatures as low as -150 °F (-101 °C). This is to ensure the highest quality foods; the faster food is frozen, the more nutritional value it retains.

This matters, because “warmer” consumer freezers can never hope to reach those temperatures and keep food at much higher temperatures. In fact, the temperature most likely to cause protein breakdown is still freezing, but just below that point. Temperatures that are frequently seen in home freezers. This is also important for those of you who freeze your own food.

The salts and other compounds naturally found in fish increasing in concentration as the tissue freezes. Salt water freezes at cooler temperatures than the 32 °F (0 °C) freshwater freezes at. The higher concentration of salts, the lower the temperature it freezes at. The end results is that there is always a small amount of unfrozen water with salts, enzymes and other compounds found inside frozen seafood to cause quality loss in frozen fish foods.

Destruction of Protein

While we freeze food to preserve quality, it comes with a cost of it’s own. Freezing is destructive as well as beneficial. The process of freezing food causes protein in muscle tissue to break down. The slower food freezes, the worse the destruction of protein.

The cause of this breakdown is the denaturation of proteins. Proteins are large, ordered chains of amino acids. When protein is denatured, chemical and physical changes cause a destruction of the ordered

shape of the proteins. This causes water loss along with a decomposition some of the amino acids in the proteins.

Why does this happen?

Chemicals and enzymes in the tissue of fish and seafood after death immediately start breaking down the tissue. These chemicals include naturally occurring formaldehyde, which break apart the proteins chemical bonds.

Think of protein as tightly wound shapes made up of amino acids. The reaction with these chemicals in the tissue of seafood cause these proteins to unravel, losing their shape. This causes a loss of water and a change in the quality of protein.

Lipids

Lipids in seafoods break down under adverse conditions. These are often one of the first nutrients that breaks down in seafood. We don't tend to think of the food we feed our fish as seafood, but that's exactly what it is. When you feed your seahorse (and any fish, really) mysis, or krill, or any other crustacean or fish food source, you're offering it an animal high in lipids.

Lipid breakdown occurs even when kept frozen. This is why it's recommended to use seafood within a few months of purchase. The same applies for frozen food for our fish. Storage of seafood up to 12 months can be achieved in very cold freezers; usually those that go down to -30 °F (-34 °C). Most home freezers as part of the refrigerator/freezer combo only get down to a range of 20 °F(-6 °C) to 0 °F(-18 °C) . Most home chest freezers and stand alone freezers get down to negative -10 °F (-24 °C) to -20 °F (-30 °C).

As of this writing, I had some difficulty finding at exactly what temperature the destruction of lipids stops and those lipids stay stable. Several sources suggested that there is no lower limit, only that at colder temperatures, the process of lipids breaking down slows significantly. David Warland, an aquaculturist, has done extensive work in both tuna and seahorse farming has said at -80 °C (-112 °F), you can freeze fatty acids indefinitely (personal comm).

One of the worst temperatures to keep frozen food at is right around the freezing temperature. At just below 32 °F (0 °C), the equilibrium between frozen (safe) and active enzymes causing lipid oxidation is high.

The Essential Fatty Acids

Of particular importance to seahorses is the long chain fatty acid Docosahexaenoic Acid (DHA), followed by Eicosapentaenoic Acid (EPA). Many people know these fatty acids because of their use in human health. DHA and EPA are found in fish oil; they are thought to help with cardiac function as well as brain function and development. The same fatty acids are necessary for fish to thrive in our aquariums, more so seahorses and their relatives.

These fatty acids are not very stable though, and break down easily from enzymes found in the flesh of seafood, and from oxidation by bacteria and naturally occurring enzymes mentions above. The chemicals they break down into not only render them less beneficial, but can break down into mutagenic and carcinogenic compounds.

The term for this process is lipid peroxidation; which is the destruction of lipids due to the changing chemical bonds. It is a chain reaction, as a few lipids break down, they react and break down other lipids and create free radicals that turn the destruction of lipids to a cascading failure.

The end products of lipid peroxidation are suspected to cause numerous health issues in people. They've been linked to a number of diseases in humans. We don't know what problems they cause in seahorses, but it is unlikely they are immune from the mutagenic and carcinogenic effects of these molecules. There is also evidence that either the by-products of these broken down lipids or the free-radicals they produce causes myopathy in the syngnathid family, which can lead to a number of conditions including weak snick, lethargy and ultimately early deaths.

Preservatives can help prevent the breakdown of these lipids; vitamin E being one of the more effective ones for preserving the important polyunsaturated fatty acids seahorses need. Vitamin C can help too. But natural preservatives are short lived, and chemical preservatives, such as ethoxyquin, have been implicated in numerous health issues for pets and has been linked to deaths. This leaves food manufacturers a lack of options for long term lipid preservation.

Lipids and the Seahorse Family

Seahorses and their relatives rely heavily on lipids in their diet. Their diets are naturally high in healthy fats – the same ones we humans take supplements such as fish oil to help us stay healthy. A study of intestinal flora of captive raised Hippocampus kuda showed 70.4% of the bacteria in a seahorses gut is for breaking down lipids. This finding suggests that lipids are vitally important to the diet and seahorses and need to make up a large part of the seahorses diet.

Irradiation

Irradiation is a form of sterilization, and has been linked to the loss of important vitamins. Irradiation is exactly what it sounds like, using radioactive materials to irradiate food. In spite of the dreadful sounding nature of the process, it's actually a pretty sound sterilization practice. It removes the harmful bacteria implicated in spoilage. It also removes any unwanted parasites that may hitch a ride in frozen food. Most objections to irradiation tend to be emotional, people fear the mention of radioactivity.

The big downside of irradiation is that some vitamins and some macronutrients are reduced. Vitamin A is frequently destroyed during irradiation. Knowing that, many food manufacturers supplement the vitamins that are destroyed by irradiation.

However, that doesn't always happen. In 2008, 40 cat deaths in Australia were linked to irradiated food. The manufacturer, Orijen, was unaware that Australia irradiated all incoming pet food. The deaths were thought to be from a lack of vitamin A due to the irradiation process, though different sources disagree on whether or not it was the cause, and if the irradiation used was higher than what is generally considered safe. Because of the incident, Australia banned irradiated cat food in 2009.

Gamma foods are irradiated, and it's unclear if that poses a threat to fish as it does in other animals, or if they are supplementing to replace missing vitamins. The upside is that this should kill any bacteria that may cause spoilage once thawed. However, as that is only part of the problem with the decomposition of mysis, I don't know how much it helps. I would be curious to see a complete nutritional breakdown of their product.

Other Sterilization Treatments

It's not entirely clear what other processes are used by different manufacturers, if any are used at all. We know Hikari uses a 3-step process as advertised on their labels. However, they do not disclose these steps. I attempted to contact them directly to find out the specifics of this process and was told the information is proprietary.

The question whether other companies use similar sterilization techniques still remains. Most of my inquiries to frozen food vendors have gone unanswered. My suspicion is many companies do use a sterilization process, but I can't confirm.

Some possibilities include heat including blanching, uv radiation, antibiotics, chemical treatments. All which can affect the quality of food and destroy different nutrients. Until companies are more forthcoming with their preparation processes, we won't know how much it affects the mysis we feed.

Cumulative Quality Loss

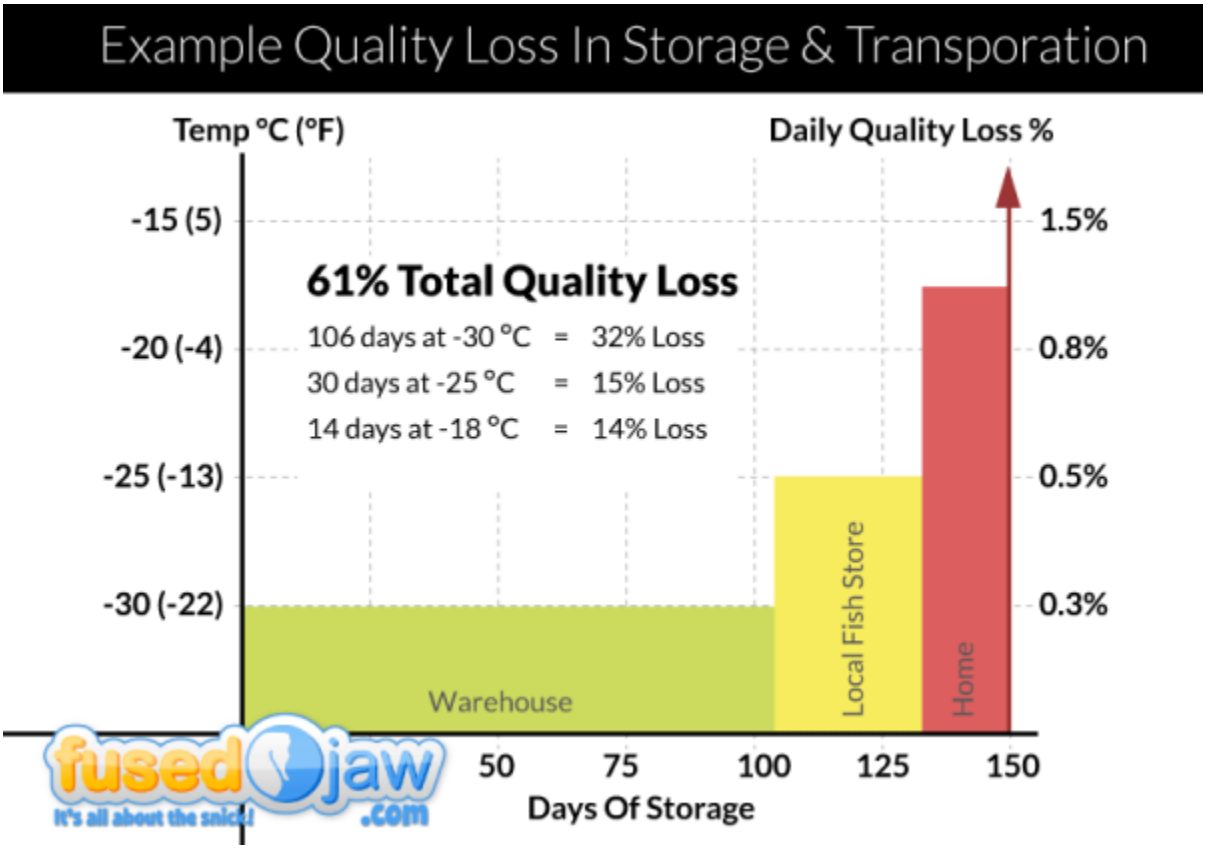
Quality loss occurs even under optimal conditions. Freezing food helps delay the degradation of food, but it doesn't stop it all together. Because enzymes that destroy tissues stay active, even in minuscule amounts, the food continues to decline in quality while frozen. The cooler the temperature, the slower this loss occurs.

We touched on this in part one, but it's a more insidious process than most people realize.

The very nature of transporting frozen foods means that it will likely be stored at different temperatures in it's journey to your aquarium. A processing plant will likely have the freezer type to rapidly freeze and then keep the temperatures at an optimal -22 °F(-30 °C). It can be in cold storage for days or months, but even in under that condition, it's slowly breaking down. Most local fish stores probably do not have these types of freezers, but even those with commercial freezers will undoubtedly have ones with higher temperatures than the manufacturer. And food can often sit some time at a fish store; depending on how it's stocked and what the turnover is.

So what we end up seeing is quality loss over time. This is changes to the product that occur even at normal temperatures and why it's so important to purchase food that is relatively new, and then use it quickly.

Below is an example of what quality loss can look like over time as the food passes through the different "systems" , manufacturer, retailer, and home. In this example, 61% of the overall quality is loss under normal circumstances without any thawing events.



What You Can Do

Talk to your fish stores, and demand a better product. Ask them to talk to their suppliers. But in this age of social media with companies more accessible than ever; reach out to manufacturers about this issue. Ask them to educate their customers, and to put shorter expiration dates that accurately reflect the lifespan of their products.

Until that happens, you can hunt for food that falls within the time the product should still be good. Learn what the “expiration dates” on packages mean; for example, if a brand has a two year expiration date, then subtract that time from date on the package and only buy foods that fall within a year and some change, and use before that time is up. The younger the package, the more time you’ll have.

Only keep enough food for a few months at most as home freezers keep food warmer than commercial freezers. If you have access to it, store in a chest freezer until use.

As mentioned in the previous article, use color to guide you to food that has been handled better. In mysis, general food that has not been subject to temperature swings will show a bright white coloration. White doesn’t necessarily mean good, but tan and brown can almost always be counted on to mean poor handling and a degradation of quality.

Conclusion

Now you know the science behind freezing, storage and thawing of frozen seafood, you can begin to choose foods that are the healthiest for your seahorses. Part One covers the practical overview of what to watch out for with some great pictures for comparison. Part two goes into the science behind what

makes good food. For any fish, really, but seahorses and syngnathids are reliant on frozen food that understanding the basics ensures they get an optimal diet.

Photo Examples

Included are some examples collected of mysis that has been improperly handled and stored. They tend to be extreme examples but are not uncommon.

Bad mysis from Brine Shimp Direct, brown coloration as compared to some okay Hikari Mysis.

Brown Hikari Mysis compare.

Brown Hikari Mysis compared to a better pack.

Mysis totally thawed arriving from a supplier shipping without insulation. Photo courtesy of Louise Hines.

Thawed bad mysis. Photo courtesy of Louise Hines.

Lump of thawed and refrozen bad mysis. Photo courtesy of Louise Hines.

Bubbles in the package show previous thawing, probably partial. Photo courtesy of Louise Hines.

Mysis should not be the color of the box it came in.

No.

Mysis that foams when rinsing is likely bad. The exception so far being P.E. Mysis, which tends to foam a little even when fresh, probably due to the high lipid content. It should not be excessive.

You would not want to feed this to your seahorses.

The Manufacturer's home page featured this beauty. Unfortunately, the only mini=myis I've seen in stores has looked this way too.

Brown, Lumpy package suggests refreezing.

Bend at corner suggests refreezing.

More Brown Mysis

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