Fish Feed Technology

PhD. student

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1- **Introduction: Chemical composition and ingredients.**
2- **Feed categories 3**

5- Enzyme Supplements

Enzyme supplements are either single, purified enzymes or crude enzyme preparations containing multiple enzymes that are added to feeds to enhance
the digestion of feed components that the fish either cannot digest or cannot digest efficiently.

Phytase is an example of a single enzyme supplement used in poultry and swine feeds and likely to be used in fish feeds in the near-future. Phytase hydrolyzes phytate, the storage form of phosphorus in seeds, i.e., grains and oilseeds. Phytase liberates phosphorus from phytate, thus making it available to the animal or fish. Enzyme supplements are available to assist in the digestion of complex carbohydrates, collagen in skin and bones, and other feed constituents. Enzymes are typically denatured at temperatures above 65◦C, so adding them to feed mixtures before compression or extrusion pelleting destroys their activity. Thus, enzyme supplements are typically sprayed on feeds after pelleting.

6- Hormones

The use of hormones in domestic animal feeds is no longer permitted in many parts of the world due to concern about hormone residues in food products. The same concerns exist for fish products, and the addition of steroids and other hormones to the diets of fish raised for market will almost certainly never be approved. However, there are some aquaculture situations in which the addition of hormones to fish diets for a short period may pose no human health risk and may prove useful to fish culturists.

Hormones fall into three categories:

(1) those that affect growth and feed conversion,

(2) those that affect sexual development,

(3) those that affect osmoregulation.

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7- Antimicrobial Agents

Microorganisms require unbound water to grow in foods and feeds. Feeds containing more than 12% moisture can support bacterial, mold, and yeast growth unless they are frozen. Microbial growth occurs very rapidly in semimoist feeds, and many molds produce compounds that are toxic to fish. In semimoist feeds at room temperature (22◦C), mold growth is visible within 3 days, while at refrigerated temperatures (1–3◦C), it may not be visible for 10–20 days. During frozen storage, microbial growth is completely stopped.

Thus, if semimoist diets are fed to fish shortly after manufacture, there is no need to use antimicrobial additives in the feed. If longer storage is required, additives and other strategies must be used to prevent feed spoilage. Over 20 compounds are used in the feed industry to inhibit fungal or microbial growth . Some have general and some specific applications in food products.

7- Antimicrobial Agents

The benzoates and parabens are wide-spectrum antimicrobials, which are effective against bacteria, fungi, and yeast. Propionates are used primarily to inhibit yeasts and molds but are also effective against bacteria, fungi, and yeast. Control of spoilage in intermediate moisture products (18–36% moisture), such as semimoist fish feeds, is not simply a matter of adding antimicrobial compounds to the product. The best results are obtained when a combination of approaches is used. The first factor is the microbial load of the product. It is essential that the feed has a low plate count at the start, with no more than 500,000 colony-forming units per g of material. If the microbial load of the starting material is higher than this, it is difficult to control spoilage with antimicrobial compounds alone. A second means of controlling microbial spoilage in feeds is by the use of special packaging that permits the maintenance of a controlled atmosphere after manufacture until feed is used. The aim of this process is to reduce O2 tension in the feed package during storage and thereby restrict the growth of aerobic microorganisms.

The feeds are stored in hermetically sealed pouches or bags that are impermeable to water vapor or atmospheric gases. An inert gas, such as N2 or CO2, is introduced into the bag before it is sealed.

7- Antimicrobial Agents

A third approach to controlling spoilage in intermediate moisture products is by controlling the water activity (*A*w). Microorganisms require an abundant supply of water to grow. Reducing the supply of water in a feed is therefore an effective way to limit their growth. In intermediate moisture products, sufficient water to permit microbial growth is present. However, water exists in feeds in three forms, as a liquid, as a vapor, and as chemically bound water. Control of water activity in intermediate moisture products involves increasing the proportion of total moisture in the product that is chemically bound, thereby decreasing the proportion present as a liquid. This principle is used to preserve many human foods such as jelly. Water activity is defined as the ratio of the water vapor in a feed to the vapor pressure of pure water at the same temperature. The water activity of pure water is 1.0. Water in feeds has an *A*w value of less than 1.0. Small differences in *A*w may result in relatively large differences in the resistance of a product to microbial spoilage. The approximate lower limits of *A*w for microorganism growth are 0.91 for bateria, 0.88 for yeasts, and 0.80 for molds. It is not difficult

to achieve *A*w values in this range in intermediate-moisture products by the addition of compounds such as sugar (sucrose), glycerol, NaCl, and propylene glycol.

8- Antioxidants

Antioxidants are chemical compounds that are added to feed ingredients to control oxidation of lipids. Other food components, such as carotenoid pigments and tocopherols, can also undergo oxidation. The mechanism of highest concern in feed manufacturing is autoxidation, also known as atmospheric oxidation, which is the oxidation of moderately unsaturated fatty acids, resulting in products that produce off-flavors and off-odors. The rate of autoxidation of lipids can be accelerated by an increased radiation level, divalent cation concentration, temperature, and oxygen concentration.

The number of free radicals formed from oxidation of individual fatty acids is related to the number of its double bonds, making oxidation of the fatty acids in fish oils (very unsaturated) a much more rapid process than oxidation of less unsaturated lipids.

9-Fiber

Fiber is the nonnutritive portion of feed ingredients that is measured as crude fiber in proximate analysis. It is indigestible by salmonids and other carnivorous fish, but channel catfish have intestinal microflora capable of digesting a small portion of dietary fiber . Some herbivorous fish, such as grass carp, derive nutrients from fiber but some, such as *Tilapia aurea,* do not . Fiber is added to semi-purified diets to facilitate binding as well as to increase digestion efficiency . Generally, fiber is not added to practical diets; rather it

is avoided because 1- it passes through the fish and 2- adds fecal solids to rearing water and farm effluents. This point is critical in aquaculture systems employing water recirculation and in rainbow trout farming, where high volumes of water are discharged into rivers and lakes. Upper limits for fiber in feed formulations are generally specified, thus eliminating many potential fish feed ingredients and restricting the levels of others. In diets for fish that do not possess the ability to digest fiber, levels of fiber above 3–5% are not recommended (NRC). Fiber levels as high as 8–12% are tolerated by most fish, but such levels often result in growth depression . Fish fed diets high in indigestible fiber increase their feed intake and gastric evacuation time, but the extent to which fish can compensate in this manner is limited

10- Flavorings and Palatability Enhancers

Fish are very sensitive to certain tastes in their feed, a trait that can be both harmful and beneficial in diet formulation and manufacture. For example, chinook salmon fry are extremely sensitive to the presence of low levels of dietary soybean meal and respond to its presence by reducing their intake. Trout are less sensitive to dietary soybean meal, although in semi- purified diets, the addition of a "fishy" component to the diet to mask the taste of soybean meal must sometimes be made to induce trout to consume feed . Flavorings are common feed additives in the food industry but their use in aquaculture diets is only beginning to be investigated. Generally, feed acceptance is not a major problem among cultured species of fish, with the exception of fry and certain species of cold-water fish. Extracts of crustaceans, such as krill, and certain amino acids may increase appetite in fry and crustaceans, respectively.

Unconventional Feed Ingredients for Fish Feed

Alternate Sources of Protein that are Being Evaluated or have Potential as Partial or Whole Replacement for Fish Meal in Aquaculture Diets

Commercialized		Not commercialized
Vegetable	**Animal**	
Soy meal	Poultry byproducts	Insect larvae
Rapeseed meal	Feather meal	Single cell protein
Sunflower meal	Shrimp and crab meal	Grasses
Oat groats	Blood flour	Leaf protein
Cottonseed meal	Fish silage	Vegetable silage
Wheat middlings	Meat meal	Zooplankton (krill, etc.)
		Recycled wastes
		Yeast
		Phytoplankton
		Bacteria
		Algae
		Higher plants
Protein (range), %		
15-50	50-85	4-85

Approximate analysis