North Central Regional Aquaculture Center

Fact Sheet Series

Understanding Fish Feed Labels

The United States Food and Drug Administration (FDA), in cooperation with state and local partners, is responsible for the regulation of fish feeds. Working with the Association of American Feed Control Officials (AAFCO) and the states, the FDA implements policies to regulate fish feed products. Part of this cooperation entails creating feed ingredient definitions as well as establishing maximum and minimum safe nutrient concentrations suggested for feed ingredients and finished feeds, to assure fish perform satisfactorily in accordance with their different productive stages.

While the FDA regulates the use of feed ingredients and complete feeds, it is up to feed manufacturers to make sure their products comply with these regulations before they enter the food chain. Adequate feed labeling, then, is not only a requisite for commercialization but also serves as a guideline for the fish farmer. The fish performance expected with a certain feed is a function of:

1. **The feed manufacturer** (e.g., type and quality of ingredients and their processes) and

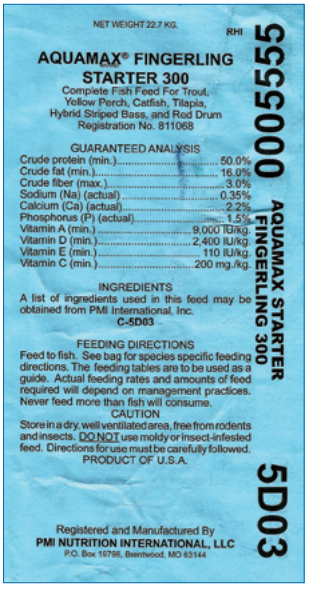
2. **The fish farm** (e.g., adequate feed storage and feeding for its intended purpose)

The feed tag

Fish feed tags or labels are used to register, identify, and market a complete feed or ration. In reality, the tag is also a legal binding document by which the feed manufacturing company guarantees the product contains the ingredients declared, as well as certain concentrations of key nutrients. The fish farmer can then make a more informed decision of which type or brand of fish feed to buy based on the growth stage for a particular species, ingredients, maximum and minimum concentrations of essential nutrients, and – very importantly – price.

Reducing feed costs positively impacts fish farming. With feed costs in fish farms usually above 50% of total costs of production, it is critical for the farmer to select a feed with an optimum compromise between price and quality that will not hamper fish performance. Adequate fish feed quality also results in less waste, helping maintain water cleanliness, and reducing negative impacts on fish health and the environment.

Feed bags, or any other containers, come with a label from the manufacturer. Some bags have a stitched paper label, some have it printed on the side, and some have both. The label has the information required by federal regulations from the FDA, in coordination with the Center for Veterinary Medicine (CVM), following guidelines from the AAFCO. Feed labels must show the name and address of the manufacturer, a description of the contents (ingredients and key nutrient concentrations), date of processing, and guidelines for the feed's use for a certain species and productive purpose (e.g., starter, growth, finishing). Fish feeds have different presentations (e.g., crumbs, pellets, flakes) and properties (e.g., floating, sinking) suited for different fish species or growth stages. Within each presentation, particle size must be in accordance with the preference of the growth stage of the fish to be fed.



EXTRUDED SINKING

50 lbs. Net

Salmon

2.0 mm

Guaranteed Analysis

Crude protein, not less than 45.00%
Crude Fat, not less than 15.00%
Crude Fiber, not more than 3.00%
Ash, not more than 12.00%
Sodium, not more than 2.00%
Phosphorus, not less than 1.40%

Ingredients: Fish Meal, Wheat Whole, Poultry By-Product Meal, Blood Meal, Feather Meal, Fish Oil, Poultry Oil, Mono Calcium Phosphate, DL Methionine, Choline Chloride, Calcium Propionate, L-ascorbyl-2-Monophosphate (75% C). A VITAMIN PREMIX CONTAINING: Vitamin E Supplement, Stabilized Ascorbic Acid, Inositol, Niacin Supplement, d-Calcium Pantothenate, Pyridoxine HCL, Riboflavin Supplement, Thiamine Mononitrate, Vitamin K (MSBC), Folic Acid, Vitamin A Supplement, Biotin, Vitamin D3 Supplement, Vitamin B12 Supplement. A MINERAL PREMIX CONTAINING: Zinc Sulfate, Manganese Sulfate, Copper Sulfate, Ethylenediamine Dihydriodide, Sodium Selenite. Ethoxyquin, a preservative.

JOHN DOE MILLS
1600 Pennsylvania Ave NW,
Washington, DC 20500

Recommended use within six days of production Date. Store in a cool dry place.

When selecting a fish feed one has to consider the nutrient needs of the species being fed, the quality of its ingredients, the adequacy of its processing, and ultimately the feed price, in that particular order. Since feed costs represent more than 50% of the cost of production, it is very tempting to reverse the order and choose first based on low price. Regrettably, there is no magic in feed formulation, and economies of scale aside, a lower price is in general not associated with higher quality or choice ingredients. Having explained this, the opposite does not always hold true, either: A more expensive feed does not guarantee higher quality.

An almost foolproof method to guarantee quality is to measure fish performance; how well did fish do when fed ration "x"? It can be a personal experience or that of another fishery (or better yet a soundly-designed feed trial conducted by the manufacturer in cooperation with a well-known research institution). This is how well-known feed manufacturers usually build their reputations.

There are a few key components that determine fish performance. Some are associated with the formulation of the diet, and some with the processing methods in the feed mill. First, fish feeds should be balanced by a knowledgeable fish nutritionist, who takes good care of making sure all nutrients the fish need are present in the finished product. However, it is difficult to learn this from the feed tag exemplified shown above; we only know which feed ingredients are included but not in what proportions. Again, the producer should rely on the reputation of the manufacturer and the expertise of its nutrition consultant(s). The same applies to how well the fish will eat this feed (palatability). Fish fed two different complete feeds with the same ingredients can perform differently, depending on the proportions of each ingredient, their amino acid balance, and palatability. There are limitations to how much of each ingredient fish will tolerate in a feed without having negative impacts on acceptance. This is also something a highly-skilled nutritionist should be aware of, and formulate accordingly. Finally, and further complicating this issue, is the presentation of the feed, such as pellets or flakes and their size, as well as their density.

Now, take a look at the feed label shown in Figure 1 and analyze it item by item.

Protein

This feed tag declares a minimum of 45% crude protein. Because of the high cost of the ingredients that supply protein to fish diets, one can be assured that if practically possible this ration would contain exactly 45.00% crude protein or even 44.999%. However, there will always be a safety margin for the feed mill (included to assure compliance), and the diet will likely be formulated to contain 1-2% units of crude protein above 45% (46-47%). Regrettably, the amount does not say anything about the quality of a protein, which is determined by the balance of its essential amino acids. What is known from the ingredients listed is that the amino acid profile will be a combination of the proteins in fish meal, poultry by-product meal, blood meal, feather meal, whole wheat, and DL Methionine (an often-deficient amino acid). Again, the producer depends on the nutritionist and the formula used in this instance.

As strange as it may sound, the best amino acid profile in a single protein fed to a given animal species is the protein present in the tissues of that same species or even related ones. Fish is no exception, and the best amino acid balance in protein concentrates is that found in fish meal. The amino acid availability (digestibility) of the other animal proteins included in this ration will be highly dependent on aspects of their processing, such as drying temperatures (affects all), the processes used (hydrolyzed feather meal) or the inclusion of different animal parts (poultry by-product meal).

How much fish meal, poultry by-product meal, blood meal, and feather meal are included depends on the amounts necessary to formulate according to the requirements of the particular fish species and the price and availability of each feedstuff. Table 1 shows likely concentrations of protein, fat, fiber, and ash of the ingredients declared in this feed tag:

Table 1. Protein, fat, fiber, and ash of selected ingredients.

Category	Crude protein*	Crude fat**	Crude fiber**	Ash**
Fish Meal	65%	10%	2.5%	19.0%
Poultry By-Product Meal	60%	10%	2.5%	10%
Blood Meal	85%	–	1.0%	4.5%
Feather Meal	80%	–	4.0%	3.0%
Wheat, whole	13%	2.0%	3.0%	–

SOURCE: International Feed; *minimum value; **maximum value

Because of their predatory nature, salmonids require high protein and high energy diets. Animal protein concentrates are usually ingredients of choice to formulate their feeds because of their excellent amino acid balance as well as energy content. Plant protein concentrates (e.g., soybean, distillers dried grains) can still be used to successfully formulate diets, although there are claims that their palatability is lower. Good quality fish meal is highly palatable, has excellent nutritional properties such as high protein digestibility, and contains most essential amino acids in the concentrations fish require. Rendered animal proteins such as poultry by-product meal are also sought as a more economical fish meal replacement. Poultry by-product meal is considered today in the formulation of cost-effective, low fish meal aquaculture feeds. Modern standardization of the rendering process has resulted in new generation products with higher digestibility and less variability than in the past. Research has shown they can successfully replace, at least partially, the more expensive fish meal. As a result, a producer can expect the feed represented by this feed tag to contain a significant amount of this animal byproduct. Typical diets for salmon can contain up to 40-55% fish meal. It would not be unusual, however, to have poultry by-product meal substitute up to half of it.

Feather meal is another byproduct of the poultry industry that is declared as an ingredient in this fish tag and which has received significant attention lately. Feather meal is very rich in sulfur-containing amino acids and can thus be used also as a complementary protein for this purpose, particularly in diets where plant proteins are also used. Blood meal is another complementary protein which helps add lysine to the diet. Feather meal has been used at much higher concentrations than blood meal, which should not usually exceed 2-3% of the total ingredients.

Crude Fat

While protein quality and individual amino acids are very important for adequate salmonid performance, crude fat and the presence of essential fatty acids are critical not only for fish performance but also fish health. Crude fat in the diet adds to its flavor, provides needed energy, and provides essential nutrients such as long chain omega-3 polyunsaturated fatty acids (eicosapentaenoic acid, docosahexaenoic acid), and vitamins (A, D, K, etc.). In salmonid diets as well as other fish diets we need to differentiate between total crude fat (as reported in the tag) and oil in the diet. If crude fat is a good indicator of the energy added to a diet, the presence of oil (degree of unsaturation of that fat) is a good indicator of the presence of essential fatty acids in that diet. There are concerns that high replacement of fish meal protein with poultry by-product meal protein can adversely affect fish flesh quality, due to lowered fatty acid content (particularly eicosapentaenoic and its ratio with docosahexaenoic acid).

Suppose the formulation of this diet included 25% fish meal and 25% poultry by-product meal (50:50). Both have approximately 10% crude fat with the rest of the ingredients supplying very little. The total fat added with these two ingredients would be 5% (50%*0.10); however, the ration calls for not less than 19%, thus there will be a need for 14 percentage units more of crude fat that need to be added to the final feed. But not any fat – from the ingredients we know that it would be unsaturated fat (fish oil or poultry oil) rich in polyunsaturated fatty acids.

One of the main concerns with fish or poultry oil added as ingredients in fish diets is precisely their strength, or their high concentration of polyunsaturated fatty acids. The presence of these double bonds (unsaturation) in their molecules makes them very susceptible to rancidity. There are two types of rancidity: oxidative and hydrolytic. Although both can be of concern, with oils added to fish feed, oxidative rancidity is the most frequent. Also known as auto-oxidation, it happens when unsaturated fats in the presence of oxygen and ultraviolet radiation break down in primary oxidation products (peroxides) and subsequently secondary non-palatable and toxic oxidation products such as aldehydes and ketones.

Key environmental conditions that promote rancidity are temperature, time, light, water, and some metal catalysts. One additional problem is that natural antioxidants present in feeds are vitamins such as A and E. So oil rancidity can lead to induced deficiency of these vitamins even when added to the feed. Key management strategies are to store fish feed in cool places away from direct light exposure, and use it within a reasonable period of time after the manufacture date. In addition, synthetic antioxidants such as Ethoxyquin are routinely added to feeds, as can be observed in this feed tag.

Related to this is another important piece of information from the feed tag: the date of manufacture. Needless to say, producers want freshly manufactured food. The longer the food stays in a warehouse after processing, the greater

the chances that rancidity can begin to occur. Even then, if at all possible, one may want to schedule a visit to the manufacturer's plant to verify their protocols and how long ingredients stay in the warehouse before processing. It does not matter that the feed has been very recently processed if the ingredients have been stored for a long time or under questionable conditions. It is enough to always keep in mind the conditions that can lead to the rancidity of an ingredient or finished ration: time, temperature, light, and water.

Crude Fiber

Crude fiber in a ration consists of structural carbohydrates arising mostly from plant sources; this feed tag reports 3% crude fiber as a maximum. Depending on the species, some fish can utilize fiber to variable extents. There are apparently endogenous (from the fish metabolism) chitinases and cellulases in some fish. Feed and intestinal microbes may be the source of polysaccharidases in fish feeding on nutrients containing non-starch polysaccharides. Salmonoids can use starch to a limited extent (approximately 9-10% of the diet) but being a carnivorous species, their non-starch polysaccharidase activity is likely negligible; thus, fiber in the diet should not exceed 3-4%. Whole wheat contains roughly 3% and some of the other ingredients also report similar values as maxima. A cereal grain such as whole wheat is oftentimes used to improve the extrusion process because of starch content. In addition, and since more ingredients have way more than the 45% protein required, wheat is used to bring the total protein down, closer to 45%.

Minerals Vitamins and Other Additives

Minerals and vitamins are usually purchased by the feed manufacturers and added as premixes at the moment of mixing the ingredients. Very large feed manufacturers oftentimes make their own premixes. This practice, however, requires maintaining additional inventories and the need for special equipment, making the purchase of premix a more convenient method of adding these ingredients. Whatever the choice, it is very important for the vitamins (particularly A, D, and E) to be protected from rancidity as suggested above for other ingredients. Macro-minerals (e.g. calcium and phosphorus) are also provided through the ingredients. The advantage is that the chemical forms they are found in, within animal products, have greater bio-availability for the fish than those present in plant concentrates. Phosphorus in plant-derived ingredients in particular is in the form of phytate, which is not utilized by the fishes' enzymes. This poses a two-fold concern. First the fish will not receive adequate phosphorus for its metabolism, and secondly, there will be more phosphorus excretion in the water, which leads to more contamination and eutrophication (excessive algae growth).

Final comments

Feed tags can provide good information, provided the producer has an idea of the requirements of the particular species. They are an express guarantee for the fish farmer as to the ingredients used in the formulation of the feed. Granted, there are some aspects out of the control of the end user, particularly as related to the formulation using ingredients that take into consideration fish performance and not just price. Aspects that are within the fish farmer's control are the use of the feed for the intended species/purpose, and storing it in a way that will protect it from rancidity. This includes not storing fish feed for an unusually long time and always keeping in mind the time, temperature, light, and water rule.

The length of time a fish feed can be stored without problems depends on its fat content. This salmon diet is an extreme example of a ration that should be in storage for as little time as makes sense from a practical standpoint. The main reason that it contains a very high concentration of polyunsaturated fats that can become rancid sooner compared to other, lower-fat rations. Expiration dates for rations are not set in stone, as they depend on the initial freshness of the ingredients and the conditions during storage. The first signs that something is not quite right are feed refusal (decreased palatability caused by rancidity end-products), lower performance, and unexplainable higher death rates.

Author

Alvaro Garcia, Director, Agriculture and Natural Resources program with SDSU Extension.

United States Department of Agriculture
National Institute of Food and Agriculture

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2014-38500-19550. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.