Fish Feed Technology

PhD. student

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

Syllabus of Diet Technology

1- Introduction:
(Chemical composition and ingredients)

2-Feed categories.

3- Diet formulation.

4- Diet manufacture.

5- Types of Machinery & Equipment.

6-Techniques for Measuring Feed Intake.

7- Feeding Rhythms.

8- Feeding Management.

9- Feeding levels.

10-Diet analysis.

11-Calculation of feed requirement .

12-Nutrient Requirements of some fishes.

Ref . Bureau *et al.* –Hepher –Houlihan *et al*. -- Edwards and Allan Halver and Hardy

AQUACULTURE FEED MANUFACTURING

• Although aquaculture dates back from the earliest parts of human history in Asia, Europe and in the Pacific Islands , it is only in the last few decades that aquaculture has begun to catch up with the rest of animal agriculture in terms of the science of feed manufacture and nutrition.

• Aquaculture currently represents the fastest growing segment of agriculture and the animal feed manufacturing industry, particularly in mainland China and the Asian region where over 90% of global aquaculture production is currently realized.

• The manufacture of aquaculture feeds presents special challenges to the traditional feed milling concepts due to the aquatic medium in which the feed has to be delivered and ingested, and to the small size and variety of the animals being cultivated. For example, slow feeding animals like marine shrimp require the production of feeds which are physically stable in water for several hours. Moreover, farmed aquatic animals are generally considerably smaller than their terrestrial counterparts, such as pigs, poultry and cattle; marine shrimp reaching a marketable size at only 20 grams.

It follows therefore, that the production of feeds for aquatic species requires a higher degree of precision be it the particle reduction of ingredients to sizes as low as 50 microns, or the precise mixing of as many as four dozen ingredients in a feed which is of minute size in comparison to its terrestrial counterpart

Diet Formulation and Manufacture

Diet formulation and manufacture are exercises in compromise between the ideal and the practical. The perfect feed formulation that meets the nutritional needs of an animal or fish must always be modified to be less than ideal so that it can be manufactured. Similarly, the perfect feed mixture for producing pellets or some other type of feed particle must always be modified to account for the nutritional needs of the animal. Thus, feed formulation and manufacture, intellectual and physical activities, must be combined to produce animal diets.

Together, formulation and manufacture involve the selection and combination of feed ingredient to form a mixture that can be manufactured into a product that delivers the nutrients needed to meet production goals in animal and fish husbandry. Production goals differ depending on the situation, and, in addition, production goals may be, to some extent, mutually exclusive. For example, production goals may be rapid, efficient weight gain and successful maturation and reproduction. In fish farming, these production goals might have to be attained without adding enriching nutrients to the aquatic environment, necessitating the use of certain ingredients that increase the cost of feed or lower its efficiency.

Diet Formulation and Manufacture

During the last several decades, enormous changes have occurred in the formulation and preparation of efficient feeds for farmed fish, and these changes have been driven primarily by the demands of the farming industry.

1- **New methods of feed and ingredient production.**
2- **Changes in the availability and quality of ingredients used in feeds.**
3- **The development of new feed ingredients.**
4- **The cultivation of new fish species.**
5- **Advances in our knowledge of fish nutritional requirements .**
6- **The effects of fish farming on the aquatic environment.**
7- **The dependence of fish feeds on fish meal produced from fully utilized or over utilized wild fish stocks.**

Further expansion of aquaculture production can occur only if efforts to reduce pollution and to utilize sustainable feed ingredients are successful. Both of these issues greatly affect feed formulation and manufacture. Industry-driven advances in fish feeds over the past decade have significantly improved the efficiency of aquaculture, especially salmon farming. Over the next decade, further improvements are necessary so that society accepts aquaculture as a socially beneficial enterprise.

History of Diet Formulation and Manufacture

Fish diet formulation and manufacture has developed greatly since it began several hundred years ago. Prior to the beginning of the 20th century, fish production was mainly extensive, depending on natural food production, often stimulated by pond fertilization, and on supplemental feeding.

Early studies on trout feeding showed that feeds based on combinations of animal, fish, shrimp, and vegetable meals reduced growth and impaired health 1918 However , when 15% of the feed consisted of fresh liver or kidney, these problems were eliminated. Vitamins had not yet been discovered and were not supplemented to early complete diets; fresh liver and kidney supplied the missing vitamins to early feeds.

In the early stages of diet preparation, biologists investigated the natural diet of trout (which varied somewhat with location and season), enumerating the species of aquatic and terrestrial creatures they consumed, along with the relative proportions of natural prey items in the total diet of the fish. They used this knowledge as a guide to arrive at the proper nutritional profile of artificial diets.

History of Diet Formulation and Manufacture

also calculated the proximate composition of the natural diet of wild trout. The proximate composition was remarkably similar to that of diets fed to young salmon and trout today; i.e., 49% crude protein, 15–16% fat, 8% crude fiber, and 10% ash, expressed on a dry weight basis.

In the 1940s, the demand for ingredients used in wet fish feeds increased due to increased hatchery production and to competition from other users. To extend the traditional ingredients, meat–meal mixtures were developed. These diets were blends of slaughterhouse by-products and dry, commercially available feed ingredients.

During the late 1940s and 1950s, studies were conducted by the Oregon Fish Commission and the Seafood Laboratory at Oregon State University to develop a wet mixture–dry mixture combination salmon feed that would not transmit disease to young salmon. At that time, fish tuberculosis, a disease caused by *Microbacterium pisum,* was a major problem in Pacific salmon hatcheries.

The next stage of development of semimoist feed, now known as the Oregon moist pellet (OMP), involved testing various ingredient combinations to produce a mixture that could be easily formed into feed particles. By reducing the proportions of pasteurized fish waste material and increasing the dry meal, and by using ingredients in the dry mix that held the finished product together, a semimoist (32% moisture) mixture of improved quality was developed.

Oregon Moist Pellet Specifications

Ingredient	Percentage in diet		
	Oregon Mash (OM-3)	OP-4	OP-2 ($\frac{1}{8}$-inch and larger pellets)
Herring meal (or anchovy or hake meals up to $\frac{1}{2}$ fish meals) except mash	49.9	47.5	28.0
Wheat germ meal	10.0	Remainder	Remainder
Cottonseed meal (48.5%)	—	—	15.0
Dried whey product or dried whey	8.0	4.0	5.0
Corn distillers' dried solids	—	—	4.0
Sodium bentonite	—	3.0	—
Trace mineral premix	0.1	0.1	0.1
Vitamin premix	1.5	1.5	1.5
Choline chloride (70%)	0.5	0.5	0.5
Wet fish	20.0	30.0	30.0
Fish oil	10.0	6.5–7.0	6.0–6.75

During the period that semimoist feeds were being developed for salmon, progress was being made in the development of dry compressed pellets for trout. The first report on the successful use of dry pellets for trout rearing appeared in 1956, building on decades of work at the Cortland laboratory.

Open-formula diets for salmon and trout are diets for which the formulations are available to anyone, in contrast to closed-formula diets, which are the proprietary property of feed companies. Open-formula diets are periodically updated and tested by the various governmental agencies that develop them.

Open-Formula Diet Specifications for Salmonid Diets (MNR-98HS)[a]

Ingredient	Percentage in diet		
	Starter (HND)	Grower (HND)	Broodstock (19-2)
Fish meal (70% CP)	30.0	18.0	25.0
Blood meal, animal (>85% CP)	7.0	—	—
Poultry by-product meal (65% CP)	6.0	13.0	15.0
Whey, dried (12% CP)	9.0	9.0	9.5
Alfalfa meal (15% CP)	—	—	11.0
Soybean meal (49% CP)	—	—	13.0
Brewer's yeast (45% CP)	5.0	—	—
Corn gluten meal (60% CP)	25.0	37.6	17.0
Lysine hydrochloride	0.5	1.4	—
Vitamin premix	1.0	0.5	1.0
Mineral premix	0.5	0.5	0.5
Fish oil	16.0	20.0	8.0

Cooking extrusion is the most recent development in pelleted fish feed manufacture. These pellets are formed by extrusion of a moist mixture (20– 24%) followed by drying to reduce the moisture content to 10% or less. Extruded pellets are used by the catfish, salmon, trout, and shrimp industries and by many other sectors of aquaculture, particularly for fish farmed in sea cages. The extrusion process expands starch in the feed mixture, which lowers the pellet density. Extruded pellets can be made to float, sink slowly, or sink rapidly in water, depending on the conditions of manufacture.

Wet Feed

Wet–Dry Feed Mixtures

Semimoist Pelleted Feeds

Dry Pelleted Feed

Extruded pellets

Semipurified Research Feeds

Microdiets: Larval Feeds