

**Proceedings of the Summer Institute in
Recent Advances in Finfish and Shellfish Nutrition**

11 TO 30 MAY 1987



**CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
Dr. SALIM ALI ROAD
COCHIN-682 031**

SUMMER INSTITUTE IN
RECENT ADVANCES IN FINFISH AND SHELLFISH NUTRITION

11-30 May, 1987

MANUFACTURE OF PELLETISED FEEDS, THEIR
STORAGE AND QUALITY CONTROL

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INTRODUCTION

Presentation of feed in its most suitable physical form is key to the successful performance of the feed. The physical design of a feed should be in accordance with the feeding habits of the candidate animal and should not cause any impediment to its feeding activity. It is also important to consider that the design of the feed should have the practicability of inexpensive storage and easy way of dispensing. Involvement of sophisticated processing enhances the cost of production. Finfish generally graze the feed. The convenient way of presenting the feed to them is in the form of wet dough, certain fish can also freely feed upon floating pellets and flaked feeds. In the case of prawns, the larvae are filter feeders and require micro-particle feeds with good suspension quality in the water column. On the other hand, post larvae, juveniles and adult prawns can conveniently hold the feed and nibble on pellets, with suitable diameter, are more suitable form of the feed for prawns. Investigations have shown that moist (with 30-40% moisture) pellets are preferable. But preparation of moist pellets needs cold storage facility which is very

expensive and makes the process cumbersome, especially when large quantities of the feed is required. On the other hand preparation of dry pelletized feed appears to be more practical. The technical procedure involved in the manufacture of pelletized feeds is detailed below.

PROCESSING OF RAW MATERIALS

The raw materials involved in the feed manufacture should be received individually in proper condition. It is convenient to obtain the solid feed materials in dry form. The liquid ingredients such as oils may be procured in proper containers and stored carefully. The quality of the feed materials should be checked before processing.

Grinding: To obtain a homogeneous mixture of the feed, the raw materials should be powdered individually to a specified particle size. Some times it is possible to grind the ingredients together after mixing them according the feed formula. Grinding of ingredients generally improves the digestibility and pelletability of the feed. Grinding of the raw materials to a particle size of about 200 microns, gave the highest digestibility coefficient of the feed, best growth, food conversion ratio and good water stability of the pellets. The feed consisted of prawn heads, mantis shrimp, groundnut cake, fish meal and tapioca powder.

There are different types of machines available for grinding a variety of ingredients. These are pulverizers, hammer mills, attrition mills, roller mills and cutters. The selection of the grinder should be according to nature of raw materials involved.

MIXING AND HOMOGENISING

The powdered ingredients are weighed and mixed according to the formula of the feed. The feed mix should be thoroughly homogenised. This is important to avoid selective feeding of a particular ingredient in the feed, and also to achieve good pelletability. If liquid ingredients are to be added they are also included at this stage and mixed well. It is also possible to spray the liquids like fish oil after the pellets are prepared and dried. Vitamins like Vitamins C, which are heat sensitive can be incorporated after the heat treatment step is completed. When binders like tapioca is used, it can be mixed along with the other ingredients. If chemical binders are used, they must be dissolved/melted in cold or hot water and the solution is then added to the feed mixture.

For mixing of feed in large scale, rotating ribbon type, horizontal or vertical mixers can be employed. Both batch type or continuous mechanical blenders of varying capacity are available for this purpose.

STEAMING

After mixing the feed, it is steamed for a short time of about 15 minutes. Steaming of the feed improves its digestibility and kills the bacteria present and renders it innocuous. The starch content present in the feed gets gelatinized and improves the binding quality. If starch based binders like tapioca are used, steaming is an important step and cannot be avoided. However, cooking at higher temperature and for a longer period should be avoided as it may destroy many important nutrients.

Steaming can also be done after extrusion of the feed. The pellets can be directly steamed and dried immediately.

PELLETING

Feed is pelletised by pressing the material through dies with different size holes. Pellets with 1 mm, 3 mm and 5 mm diameters are suitable for post larvae, juveniles and adult prawns respectively. Pelletization can be accomplished by compression, extrusion and adhesion. Depending upon the procure used, the feed pellets can be hard, non-compact and floating pellets.

Hard pellets: To prepare hard pellets, the feed mixture (dry), is subjected to steaming and the water content is increased only by 4 to 6%. The temperature is increased to 80-90°C and the material is quickly compressed through holes of the die. The friction further increases the temperature to 92°C. The pellets coming out of the machine are air-cooled quickly (within 10 minutes) and further dried to a moisture content of below 10%. The pellets thus prepared are hard and compact. The hardness of the pellet depends upon the nature of feed ingredients and the initial moisture in the feed. Feed mixtures containing large amounts of fibrous ingredients often result in too hard pellets. On the other hand feeds with high fat and excess moisture (water content) result in very soft pellets, which may be called as poor quality pellets.

Feeding hard pellets is hazardous, especially for finfish. It may lead to over feeding resulting in inefficient digestion. Undigested food may cause gastric disturbance in the stomach and some times fish may float upside down with mortality.

Non-compact pellets

Non-compact pellets are light and not compressed as in the case of hard pellets. The advantage of these pellets are that they do not sink rapidly in water.

Non-compact pellets are prepared by spraying water mist on dry feed mix, on an oscillating table. The feed comes out as ball shaped pellets. This technique is used for preparing fertilizers and chemicals into pellets and the methods is called the DRAVO process. This process is directly applicable for making non-compact feed pellets.

The Dravo-pelletizing process consists of a disc that rotates approximately at an angle of 45° . As the feed is tossed about on the disc, a fine spray mist causes the feed to form a ball shape of finely controlled particle sizes. Three metal projections aid in separating the particle sizes. The size of the particle can be decreased or increased by increasing or decreasing the feeding rate of the feed mixture to the disc and increasing or decreasing the speed and angle of the disc. The pellets obtained can be dried to the required moisture (below 10%).

The advantages of this method of pelletization is that the production cost if comparatively less and the problems of like clogging of die is eliminated. Another advantage is that it is possible to prepare the feed in the required particle size directly. However the ingredients should be ground finely to a uniform particle size. Otherwise the denser particles of individual ingredients may separate out during the process and disturb the homogeneity of the feed.

Floating pellets:

Floating pellets are useful only for finfish which come to the water surface, grab the pellets and feed. This will help to control the rate of feeding and also observe the fish stock without sampling.

Floating pellets are prepared by the 'extrusion' process in which the resulting pellet is expanded instead of compression.

The extrusion process could be accomplished by adding 25-30% water to the dry feed mix. The wet feed mixture is placed in a pressure-sealed cylinder and steam is injected. This feed at high pressure is extruded through a die to ordinary atmospheric pressure. Feed almost explodes through the holes of the die and comes out uncompressed. The feed is thus collected in appropriate containers and dried. The digestibility of floating pellets is found to be higher than the compact pellets.

The process of floating pellet preparation is expensive, compared to the other methods of feed manufacture, in terms of equipment, steaming and drying cost.

DRYING

The feed pellets should be dried to a moisture content below 10%, otherwise the shelf-life of the feed will be very poor. The problems of storage are discussed separately. Generally the temperature imparted to pellets in the process of their manufacture will help to remove the moisture by air-drying process. The pellets are spread in thin layers in trays or on the floor of drying chambers and air is blown over them. If the pellets have high moisture, as in the case of floating pellets, hot air is blown to remove

the excess moisture. Both vertical and horizontal cooler-dryers and hot air dryers can be used for this purpose.

STORAGE

Proper storage of feeds and feed ingredients is essential to maintain the quality of the feeds and prevent health hazards to fish. During storage the feed can be subjected to chemical deterioration, infestation by insects and micro-organisms, mould growth and attack by rodents. All these result in loss of nutritive value of the feeds, economic loss and health risks.

Insect and mould growth

Initial moisture content of the feed, temperature, humidity and method of storage determine its shelf life. Moisture content in the feed should be below 10%. The feeds should be stored in polythene lined bags or bins and prevent absorption of moisture from atmosphere. Air tight containers should be used in places where the relative humidity is very high. Steps should be taken to keep the storage facility clean and hygienic to prevent insect infestation.

When the relative humidity goes beyond 70%, mould growth occurs. Some of the fungi like Aspergillus spp can produce mycotoxins. Mycotoxins are metabolites produced by the fungi and are highly toxic and some times carcinogenic. The most effective method of controlling mould growth is to check the rise in the moisture content of feed. Chemicals like propionic acid and its salts upto 1000 ppm, and gentian violet can be used as preservatives to prevent mould growth.

Lipid oxidation

Lipids, especially those which are rich in poly unsaturated fatty acids (PUFA) are highly unstable compounds. These can be easily hydrolysed and oxidised leading to rancidity. Due to atmospheric oxygen, lipids under go auto-oxidation producing hydroperoxides. This is followed by secondary reactions yielding diperoxides and ketoglycerides. The carbonyl compounds produced during the oxidation react with the amino-group (epsilon amino-group) of the amino acid lysine in the protein and render it unavailable to the animals. Light, higher temperature and metal ions catalyse lipid oxidation.

Lipid oxidation can be inhibited by adding anti-oxidants. The common anti oxidants are ethoxy quin, butylated hydroxy anisole (BHA) and butylated hydroxy toluene (BHT). Tocopherols (Vitamin E) are the natural antioxidants.

QUALITY CONTROL

Control of quality of both the raw materials and the prepared feeds is of paramount importance to achieve the expected efficiency of the feed. There are Government regulations and standard specifications for the production of animal feeds. However no such specific standards have been laid down so far for aquatic feeds.

Before processing the raw materials for compounding the feed, the quality of the ingredients should be checked. The feed stuffs should be free from insect infestation, mould growth and extraneous matter such as sand, stones and other impurities. By adopting proper sampling method, the materials should be tested for moisture content, crude protein, fat, crude fibre and ash (minerals). These must also be checked for toxins like gossypol, isothiocyanates and aflatoxin and for urease activity.

During compounding the feed, strict adherence to the ingredient composition of the formula should be made. This will ensure the specified nutrient levels and calorific value of the final feed. During the process of manufacture of the feed, the factors which can affect the quality of the feed or destroy nutrients should be controlled by adopting appropriate methods. Strict hygienic conditions should be maintained throughout the process to preserve the quality of the feed during its storage. Finally the proximate composition of the feed should be analysed by determining moisture, protein, lipid, carbohydrate, crude fibre and minerals using standard methods and tally with the nutritional specifications of the feed. The feed should be properly packed and stored to preserve its quality. Poor quality feed should not be fed to fish because loss of feed is much less costly than loss of fish.

REFERENCES

- Cho, C.Y., C.B. Cowey and T. Watanabe 1985. Fish nutrition in Asia: Methodological Approaches to Research and Development. Ottawa, Ont., IDRC, 1985. 154 p. III.
- Chow, K.W. 1980. Storage problems of feed stuffs. Aquaculture Development and coordination programme. ADCP/REP/80/11: 215-224.
- Chow, K.W. 1980. Quality control in fish feed manufacture. Ibid., 369-385.
- Raven, P. and G. Walker 1980. Material flow in feed manufacture. Ibid., 289-292.
- Hastings, W.H. and D. Higgs 1980. Feed milling process. Ibid., 293-313.
- Pigott, G.M. 1980. The Dravo process for non-compacting feed. Ibid., 316-319.