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Influence of Processing Methods on Nutritional Quality of Fish Feed

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Introduction

At global level, approximately 220 species of aquatic animals and plants are being cultured, in a wide range of production systems, ranging from low-input traditional systems to high-input intensive systems. In broad terms, aquaculture production is being carried out in ponds, cages or any other enclosures for rearing of aquatic animals and plants. The production systems can be divided into two systems, namely feed-dependent or fed aquaculture, where commercially important finfish and shellfish were raised using artificial feed, and non-fed aquaculture systems, where culture is predominately carried out in the natural environment using natural food (examples are aquatic plants and molluscs). Feed, a major economic driven input in aquaculture production system, in the modern aquaculture is contributing 60% of the operational cost.

Aqua feed is a processed pellet that contains all the necessary nutrients which are required by the farmed fish. Nutritional requirement of farmed fish varies among the species, life stages and feeding habits. A good feed ingredient contains all the key nutrients (macro and micro) which can satisfy the energy requirement of the culture fish to ensure the normal body function. On the other side, the feed ingredients are selected based on the various characteristics like, to reduce stress, enhance the immune system and minimize autoimmune problems, at the same time, it should improve the flesh quality and flavour of the culture fish. Therefore, a single feed ingredient does not fulfil the nutritional requirement of any fish. Hence, aqua feed is prepared using different feed ingredients which are processed using different methods to make the final shape. During the course of its preparation, feed may get some nutritional benefits as well as defects from the various processing methods.

Nutritional value of feed

In general, nutritional value of any food is simply defined as the quantity, range and quality of energy (calories), vitamins, minerals and phytochemicals. It provides the details about what a food is made of and its' impact on the body. It is also known as nutrient information or composition label. It provides the information about the;

- Energy (calories): It comes from protein, fat and carbs (macronutrients)
- Vitamin: It is an organic micronutrient (meaning they come from living things)
- Mineral: It is an inorganic micronutrient (meaning they come from soil, air or water)

Nutritional value of aqua feed helps to find out the capacity of that feed to nourish the fish with essential substances required by that fish to live and grow. Feed with higher nutritional value contains greater variety of nutrients. Nutrient density and nutritional value are having direct relationship. In a feed ingredient, nutrients are densely packed means its nutritional value is also high.

The five main things that affect food nutritional value of the feed ingredient:

- growing conditions
- variety of ingredient
- food storage and preservation
- whether it's raw or cooked food, and
- the method of processing.

Feed processing

A number or series of actions applied to produce pellet from the soft dough. At

the end of processing, normal feed ingredients are made into standardized product called hard pellets. Based on the culture species, feeding habits and nutritional requirement of the species, the method of processing may vary. Feed processing needs certain standards, guidelines and operating procedure to produce a higher quality aqua feed. In general, any aqua feed industry practices the following feed processing methods, which includes, raw material procurement, grinding, mixing, conditioning, pelleting, cooling, drying, sifting, top-dressing, oil coating and then store the feed

1. Grinding

It is the first step in actual feed processing after the procurement of raw materials. It is a process of particle size reduction in which the feed ingredient is crushed to produce uniform sized and fine shaped feed particles. Because feed materials which are arrived in the feed mill will not be in uniform size and it affects the manufacturing process. Grinding mainly done for mixing the ingredients properly and to avoid blockage of die during pelletizing process.

Reduction of particle size depends on the type feed need to be produced and the pellet die size. High lipid content feed ingredients may block the die, therefore, its need to be mixed with low lipid ingredients. Generally, grinding will be done using hammer mills, pulverizers and attrition mills. It effects on nutritional value includes the reduction of the particle size, increased of surface area and bulk density. During this process a feed may get metal compounds like like Fe, Cu and Zn (Walker, 1980).

2. **Mixing**

In mixing, heterogeneous feed ingredients put together (desired proportion) to obtain a homogenous mixture. Mainly done to produce homogeneity among the feed ingredients. There are two kinds of mixing; premixing where vitamin mineral premix, attractants and other feed additives were mixed and actual blending where the major feed ingredients will be mixed. Particle size, shape, density, hygroscopicity and adhesiveness affect the proper mixing which leads to nutritional imbalance in the end product (hard pellet).

If the grinding process done properly, then the pellets produced from the homogenous mixture contains statistically the same formulation as calculated by the feed formulation methods. Mixing and particle segregation is cylindrical process therefore, time should be standardized to achieve proper mixing. Mixing affects the nutrient availability.

3. Conditioning

Prior step to pelletizing, where the homogenous blend used to be cooked. Generally, thermal and physical processing will be carried out in this process which increase starch gelatinization, remove the moisture content of the feed and control the pellet nutrient density.

4. Pelletizing

It is type of cooking process, where homogenous blend moulded into die to produce a desired size pellet. At the end of this process, soft dough will be converted into small sized hard pellets. Based on the feed manufacturer pelletizer may vary. Generally, four types of pelletizers are used for aqua feed production.

a. Compression type: steam is used to precondition the dough and it is called steam pelleting. In this, the feed mixture exposed to dry steam to increase the temperature about 85°C and moisture content about 16%. The combination of heat, moisture and pressure gelatinize the starch in the feed dough.
b. Extrusion type: it is more similar to compression type but it controls the final feed pellet density. It is more versatile than the compressed type. The working temperature is about 125-130°C and moisture is about 20-24%.
c. Expansion type: In this type steam will be injected into the feed dough during pelletizing. The injected steam helps in expansion of feed and which control the floatability of the feed. It mainly used to produce the salmon and trout feed.
d. **UPC type:** Universal Pellet Cooker. It is the combination of compressed pelleting and extruded type. The equipment looks like a cooking extrusion. In this processing enhanced

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preconditioning with steam helps to gelatinize more starch in the feed mixture.

In general, pelletizing inactivates the anti-nutritional factor, improve the digestibility and palatability, increase the water stability and storage life. It also affects the nutrient retention, decrease the bioavailability and digestibility of EAA, vitamins and fatty acids.

5. Cooling and drying

Immediately after pelleting, the hard pellets are need to be cooled and dried. For this, the pellets were passed through a cooler-dryer. Cool air is blown over the pellets to lower the temperature. The cooler may be vertical or horizontal in type. The pellets always cooled up to ambient temperature and its moisture content used to be 10%. It effects the nutritional value of an aqua feed by removing the moisture content, increase the shelf life and increase the starch gelatinization.

6. Sifting and screening

` Dry pellets usually passed through the corrugated roller to remove the crumbles (fines) and dust particles from the pellets. The crumbles produced during this process normally send back to mixing or used to feed the larval fish. It done twice to remove the excess fine particles from the pellets. Corrugated rollers or shakers with multiple screens are used. Removal of dust and fine particles will increase the feed acceptability.

7. **Oil coating and storage**

The required amount of lipid in feed formulation cannot be mixed during the dough preparation. Because during feed processing, lipid is affected so it used to be coated after the making of pellets. Oil coating helps to add desired lipid level to the feed, pigments and heat sensitive vitamins, which on the other side, increase feed palatability. Addition of lipid to the processed pellets are also called as top dressing.

Storage conditions play a crucial role in shelf life and feed quality. Feed storage time can be affected by type of manufacturing, formulation, use of antimicrobial compounds, storage conditions and source and type of raw materials used. It is recommended that the processed feed or pellets should be stored in control condition to enhance the shelf life and feed quality.

Conclusion

Fish nutrition means providing the balanced diet which contains all the essential nutrients to satisfy the nutritional requirement of the farmed fish. To produce a nutritionally balanced diet two things, play a major role i) quality of feed ingredients and ii) selection of right feed processing technology. The selection of right feed processing technology help to produce a balanced diet with better digestibility, acceptability, palatability, durability and enhanced storage life.

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