

Major Influencing Factors in the Feed Intake of Cultured Fish Production in Maharani Lake Species

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ABSTRACT

Maharani lake is one of them situated in the town near Maharani Janki Kuer College named after last queen of the Bettiah Raj. West Champaran is an District of Bihar, located just 60 km west of Birgunj. The cultured fish is negatively influencing the efficiency of fish production from aquaculture. Hence, the major factors influencing feed intake by cultured fish are discussed. These factors include management practices, environment conditions, feed quality, inherent genetic factor and physiological condition of the fish. The review would help to increase basic knowledge on the nutrition (with emphasis on feed intake) of aquaculture species for improved management and productivity.

INTRODUCTION

Aquaculture is one of the fastest growing food production sectors. Fish feed and feeding is an important component of aquaculture as feed account for approximately sixty percent of the variable production cost in intensive aquaculture systems in Nigeria (Ayinla, 2007). Feeding is an important life function which involves hunting, processing and evaluation of food materials (Kasumyan and Doving, 2003). Optimal feeding scheme enhance growth, pond water quality, survival, size uniformity, help in minimizing wastage and eventually upsurge production (Dwyer et al ., 2002; Isyagi et al ., 2009). Growth potential differs across fish species and it is highly dependent on some factors. Furthermore, the degree to which growth potential is realized is highly dependent on feed intake and on how well the feed has been adjusted to the nutritional needs of the fish. Hence, the profitability of an aquaculture venture depends

largely on the adoption of correct feeding strategy. Feed satisfies the nutrient requirements of fish when there is consideration for size of fish, right pellet size for effortless consumption and low wastage, correct quantity and right feeding time. The uniqueness in feeding fish comparatively with domestic animals has led to the observation of numerous problems (Bureau and Cho, 1999). For instance, for the case of land animal, excess feed can be retrieved when the animal is satisfied. However, this practice is somewhat impracticable in fish farming. This results in wastage of valuable feed nutrients, poor fish growth and a high possibility of water quality deterioration which could culminate in fish mortality and reduced profitability. The quality of the feed can influence its intake by the fed fish and management of water quality variables (Thorpe and Cho, 1995; Talbot et al ., 1999; White, 2013). The research would help to increase basic knowledge on fish nutrition with emphasis on feed intake of cultured fin-fish species.

MATERIALS AND METHODS

A comprehensive internet and library search of literatures on feed intake in cultured fish species was undertaken using

Google Search and other search engines. Literatures recovered were analysed in pros and relevant subject matter cited by authors adopted.

RESULTS AND DISCUSSION

Factors that Affect Feed Intake in Cultured Fish: Quantitatively, the most important factors regulating the amount of feed consumed by fishes depends on the species, suitability of the feed, culture environment, stressors (such as pollutants in water), handling and social interactions (NRC, 1987). Although the spectrum of these factors is very broad, the focus of this review will be on management, environment, feed and the inherent genetic factors. Role of Management and Environmental Factors on Feed Intake: Management and environment play important role in controlling feed intake and feed efficiency. Environmental and management factors in relation to feeding condition and Physico-chemical quality of rearing medium have a marked impact on the feed intake of the fish as they can affect the fish physiological condition. sort of stress and neuro-endocrinological imbalance (Wynne et al ., 2005). Fish feeding is one of the enormous tasks that fish farmers are faced with, if the fish must grow. It is important to consider the relationship between feeding and water quality as they affect each other during the cause of management (Ani e t al 2013). A host of management and environmental factors affecting feed intake by fish are considered under the following subheadings.

Feeding Frequency:

Feeding frequency refers to the number of times in a day that fish are fed in culture system (Riche and Garling, 2003). The interval between meals will depend on the returns to appetite. This is because fish will continue to eat available food subject to the available space in the stomach and the duration it takes to empty the stomach content. The speed at which the stomach empties depends on prevailing temperature and other water quality variables, weight of the fish and quantity of feed consumed. Feeding frequency affects the quantity of feed consumed in a day and it is a very essential

considerations in fish feed management as a result of its influence on growth, survival, feed conversion, water quality as well as profit maximization (Jobling, 1995; Goddard, 1995; Ali et al., 2005; Davies et al., 2006; Ndome et al., 2011; Jamabo et al., 2015). Determination of optimum feeding frequency for maximum growth and survival of fish is a function of species, size, environmental condition, diet and knowledge of the previous feeding (De Silva and Anderson, 1995; Lee et al., 2000). Smaller fish have a high energy demand in comparison to their older counterparts. The high energy demand is as a result of energy requirement for rapid growth and development, higher metabolic rates and their small stomach size. Fry and fingerlings can be fed up to 8 times a day (Kaushik, 2013). Frequent feeding can be labour intensive; an option is to feed fry regularly with automatic feeders.

Feed Distribution and Duration of Feeding:

Feeding can be done by hand or with automatic feeders. The automatic feeders are available in different designs and can be adjusted to deliver specific amounts of feed at set intervals (Gatlin, 2010). Depending on the type of feed, size of the culture medium and the distribution method, feed may be applied on the entire lake. Feeding at selected places ease monitoring on food acceptance and intake. Feeding fish requires a high level of experience and patience. Therefore, the longer the time spent on the cultured fish during feeding, better the chance of feed consumption and utilization

Feeding Rate:

Growth strongly depends on the amount of feed supplying all the essential nutrients and energy, maximum growth rate is attained by feeding fish at satiation level (Kaushik, 2013). When access to feed is restricted or the ration size is reduced, increased size heterogeneity due to social hierarchies appears within the group (Houlihan et al., 2001). Feeding rates is also in part a function of fish size and water temperature (Riche and Garling, 2003; Craig and Helfrich, 2002). About 5 % body weight has been found to be sufficient for maximum growth for a number of fish species at the fingerlings and juveniles stages of life (Table 1) (Yuan et al., 2010; Ashley-dejo et al., 2014).

However, there is need to understand the implications of these factors in different fish species and in their stages of development. Commercial fish farmers must address each of these factors when designing environmental friendly and economically sustainable feed management strategies. Feeding rates of fish is also influenced by feeding time of the day, season, and water quality such as temperature, dissolved oxygen levels, and other variables.

Feeding Time:

Each fish species can have an endogenous feeding rhythm controlled by the central nervous system and the entraining endocrine factors, governed by environmental cues (especially photoperiod). Much work has been undertaken to understand the feeding rhythms in farmed fish (Kadri et al., 1997; Madrid et al., 2001; Kaushik, 2013).

Number of Fish Response

On the contrary, fishes in Recirculatory Aquaculture Systems (RAS) can be fed nearly anytime as a result of constant supply of oxygen (Craig and Helfrich, 2002). Most

fish farmers commence feeding in the morning as soon as dissolve oxygen level of the water starts to increase. Although, significant differences were not observed in weight among fish fed to satiation at 8:30 am, 4:00 pm, and 8:00 pm (Li et al., 2006). Ani et al. (2013) have recommended that catfish should be fed twice daily; morning hours (07.30 - 08.30 am) and evening hours (17.00 to 18.00 pm) for a better performance and feed utilization.

Colour of Fish Holding Facility:

Rearing conditions of farmed fish species may negatively affect feeding activity, health, welfare and growth, especially, when culture conditions are stressful (Strand et al., 2007). Therefore, design and setup of optimal species-specific culture conditions are of prime importance for successful aquaculture operations. In visual feeders, feeding success of fish depends on the contrast between the feed and background colour (Üstündağ and Ferit, 2015). Maximizing the contrast between the feed and the background would facilitate feed detection by fish and thereby improve feeding success under culture conditions (Banan et al., 2011).

Water Quality:

Water quality condition of a culture system and the health status of the fish under culture are the twin most important primary causes of poor feed consumption. This is because; the response of pond fish to feed can be used to ascertain the health condition of the fish. In the light of these, the aquaculturist should therefore ensure sustained water of good quality for the fish under culture. Important water quality variables influencing feed intake are considered below.

Temperature:

The prevailing water temperature is listed among the most important variables affecting vital functions in fish (Kasumyan and Doving, 2003). Growth rate, feed intake, feed conversion efficiency (FCE), and stomach evacuation rate were significantly influenced by temperature (Handeland et al., 2008). A study on the effect of varied feeding level and water temperature on feed utilization by Azevedo et al. (1998) revealed that there is a positive relationship between feed consumption and water temperature.

Dissolve Oxygen:

In the absence of deliberate poisoning, dissolve oxygen (DO) is the single most important and critical water quality parameter for fish in pond culture systems (Boyd and Lichtkoppler, 1979).

Reduced oxygen concentration is considered as a foremost factor affecting feed intake in cultured fish species (Morkore and Rorvik 2001; Nordgarden et al., 2003). It is common to see fish at the water surface gasping for oxygen in water of poor quality as a last resort for gaseous exchange. Usually, lethargy and fish going off feed may be an indicator of poor oxygen content in the culture system (Ovie and Adeniyi, 1990). Therefore, it is important to determine the concentration of oxygen in the water as a preliminary step during lethargic condition, fish going off feed or mortality before proceeding on medication. Oxygen depletion in water leads to poor feeding of fish, starvation, reduced growth, vulnerability to diseases and parasitic infestation as well as mortality (Bhatnagar and Garg, 2000). (Tsadik and Kutty, 1987) revealed fastest growth rate in tanks with high DO and

the slowest growth in the low DO. Dissolved Oxygen level greater than 5 ppm is essential to support good fish production (Bhatnagar and Singh, 2010; Bhatnagar et al., 2004). At dissolved oxygen levels between 3.0 – 5.0 ppm feeding should be slashed when DO level is between 3.0-5.0ppm and stopped when below 3.0 ppm (Riche and Garling, 2003).

Ammonia Concentration:

Of the two form of ammonia (unionized ammonia and ionized ammonia) that is present in water, the unionized ammonia is most toxic to fish and other aquatic organisms (Riche and Garling, 2003). Ammonia concentrations in water have a marked and predictable effect on the feed intake. Elevated ammonia level in water leads to a diminution in feed intake in cultured fishes, under otherwise identical environmental condition (Haskell, 1959). The level of ammonia in a culture system is dependent on temperature, feeding type, feeding rate and the size of the fish. Ammonia concentration in the water starts to increase few hours after feeding but peaks at 4 – 6 hours. High temperature as well as increased pH levels favours the unionized form of ammonia in a fish production system.

Stress and Pollutants:

In a broad context, stress can be considered as a biological response that drives physiological systems outside their normal range. Fishes typically respond to short-term or acute stress by mechanisms designed to maintain physiological function; compensating for the stress for a while, and then when the stress is resolved the fish can return to its previous physiological state (Helfman et al., 2009). Also, stress due either to excessive handling, diseases and social interactions do affect fish's appetite. Interest for food reduces when fish are subjected to stress.

Role of Feed Quality on Feed Intake:

Feed quality alludes to the dietary efficiency and objective attribute of a feed which make it suitable for feeding and digestion in the typical fish digestive systems. Efficient feeding levels is attained only when the right supply of energy and essential nutrients is available in the proportions that is adequate to the fish for maintenance and growth (Hepher, 2009).

Feed Types and Sizes:

Commercial fish feed are either extruded (floating) . Both form of feed can yield adequate growth (Craig and Helfrich, 2002). Sinking pellets are cheaper than the floating pellets, but the use of the former requires a greater degree of management (Ayinla, 2007). The preference of extruded feed to sinking feed lies in the flexibility in the adjustment of feeding rate. This is because; farmers can easily monitor the fish behavioural response to feeding. However, its limitation lies in its high cost of procurement occasioned by high cost of machinery and expertise (Abowei and Ekubo, 2011; Helfrich and Smith, 2001). This is because, particles occupies a significant position in the acceptance or rejection of diet, it is more critical for dry diets than for semi-moist or moist diets (NRC, 1981; 1983). For efficient feeding and feed utilization, Craig and Helfrich (2002) suggested that an adequate pellet size should be approximately 20 – 30 % of the mouth gape for a corresponding size and species.

Feed Flavour:

The taste properties of the feed have a high stimulating implication on feed intake and growth (Kasumyan,1997).This is imperative because, despite the digestibility of nutrients and energy composition of a particular individual nutrient, if the ingredient reduces feed intake, it is of limited use in a feed formulation. While there may be stratagems to avert or resolve issues on palatability of feed ingredients using ingredient processing or feeding stimulants, the best practice would be to avoid feeding unpalatable diets (Glencross et al., 2007). Substitution of fish meal with other proteins of plant origin and the addition of certain antibiotics have resulted in the reduction of palatability of fish feed.

Anti-Nutritional Factors:

Some quantities of anti-nutrients may be introduced into feed during preparation of ingredients and feed formulation. These anti-nutrients may result in the contamination of feed and thereby reduces the acceptability and utilization of the diet (NRC, 1993). Examples of anti-nutritional components in ingredients are gossypol, alkaloids, trypsin inhibitors, phytic acid, hemagglutinating agents, thiaminase, etc. Some of these substances have been proven to cause anorexia when present in feed stuffs while others suppress feed intake (NRC, 1981).

Intrinsic Factors and Feed Intake:

A number of intrinsic characteristics of the fish are also instruments for regulating feed intake. The intrinsic factors are usually motivated by genetic composition of the fish, in order word, they are mostly hereditary. The taste bud of the fish and hormones are some of these factors.

Taste Buds:

The primary mode of detecting feed in fish is through olfaction or sight. Although, chemo-reception is most important in locating food since sight is frequently poor in fishes especially in turbid water (Hepher, 2009). It is a major determinant on the acceptance or rejection of food (Adron and Mackie, 1978). Fish are able to taste with their snout, mouth, tongue, and throat. A fish's tongue has taste buds just like in human. However, they are unable to retract their tongue. Catfish whiskers called barbells are also loaded with taste buds.

Hormones:

Several hormones in the fish have been shown to affect feed intake in fishes. It is widely recognized that a number of fish species ceases feeding during the reproductive season. Such periods are linked to changes in feeding behaviour and occur in connection with reproductive cycles (NRC, 1987).

Major effects of hormone on fish:

- (1) hormones could have a direct effect on central nervous system centres, associated with food intake behaviour or via vagal afferent neurons;
- (2) an indirect effect may occur via the gut which slows gastrointestinal transit, thus resulting in stomach distention which activates vagal afferent neurons;
- (3) indirect effect by acting directly on intermediary metabolism via glucose, free fatty acids or amino acids mobilization or storage;
- (4) indirect effect by modifying directly or indirectly secretions of other hormones involved in food intake

control. Some of these hormones (CCK, PYY, glucagon, adrenalin) act as short-term factors which regulate meal ingestion and are generally inhibitory

factors. On the other hand, other hormones (GH, TH and leptin) require more time to modify food intake behaviour, and appear as stored calorie regulators.

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