Endocrinological regulation of fish feeding-nutrition under domesticated conditions

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ABSTRACT: Food identification, acceptance, digestion and assimilation, make up a complicated procedure intending to cover fish demands in energy and nutrients. Physiology of growth and reproduction, tissue biochemical activity and body composition are the results of a combined effect of food intake and neuroendocrine function, regulated by fish genome and depending on environmental factors. The involvement of the nervous system is more obvious in food identification and acceptance (vision, taste, smell), while digestion

Food availability (quantity and quality) interacting and assimilation are mainly performed by the endocrine system. with photoperiod, water characteristics and stress, should be considered as a major factor, in the regulation of fish metabolic hormone secretion and function. Evidences for hormonal involvement in association with fish food intake, mainly include ACTH and catecholamins, CCK, thyroid hormones, insulin, glucagon, growth hormone and IGFs, which express their action through several enzyme pathways.

In terms of both food supply (availability and diversity) and water properties, earth ponds could provide (under certain conditions) a rearing environment close to their natural one for several fish species. On the other hand, tanks are more easily associated with the creation of a stressful environment with numerous physiological effects, caused mostly by catabolic hormones, influencing fish nutritional status. However, it must be addressed that in both rearing cases, fish ecological and food ethological demands should be covered by the provision of high living standards, so that they can develop all their physiological activities.

It is obvious therefore that proper fish-controlled production has to be the outcome of an intentional rearing management, directed to a continuous existence of proper water quality and fish nutritional status, minimizing stress consequences. The understanding of the importance of food composition in the regulation of endocrine function could provide significant clues not only to manipulate water quality, but also to achieve a successful guide for artificial diets formulation, according to the ethology and nutritional habits of each fish species.

1. INTRODUCTION

Food identification, acceptance, digestion and assimilation, make up the successive stages of the complicated procedure of food intake intended to cover fish demands in energy and nutrients. Physiology of growth and reproduction, tissue biochemical activity and body composition are the result of a combined effect of food intake and neuroendocrine function regulated by fish genome and dependent on environmental factors.

In many biological processes the nervous and endocrine systems generally carry out certain functions acting in association, although a clear distinction of their separate involvements is almost impossible in some cases. However, the nervous system is more obviously concerned with food identification and acceptance, making use of the sensory capacities of sight, taste, smell, hearing and touch (the lateral line system). On the other hand, digestion and assimilation are mainly carried out by the fish endocrine system.

Under domesticated conditions and especially during the grow-out periods using formulated diets, the reaction of the fishes' nervous system to the acceptance of food is mainly expressed instinctively. However, the stages that follow food acceptance (digestion and assimilation) are carried out by the activation of several enzyme pathways controlled by the endocrine system reacting to food quality and quantity.

Food intake interacting with photoperiod, water characteristics and stress, should be considered as a major factor in the regulation of fish metabolic hormone secretion and function. Evidences for hormonal involvement in association with food intake, mainly include gastrointestinal endocrine system (CCK, bombesine, gastrine etc), ACTH and catecholamins, thyroid hormones, insulin, glucagon, GH and IGFs.

2. FOOD INTAKE-REARING CONDITIONS-STRESS RELATIONSHIP

2.1. Importance of environment

In general, extensive and intensive production systems make up the two major groups of applied fish controlled rearing conditions. The main recognizable differences between them are the types of food given, the types of construction in use, as well as the method of water manipulation currently employed.

Their specific characteristics in association with the application methods of the production systems, together make up the quality of the external environment of cultured fish, which normally involves fluctuating stress levels. This, in turn, affects food intake, internal environment, health, growth rate and the quality of the final fish product.

It is clear therefore that whatever is expected from the complicated procedure of all food intake stages, could be subjected to numerous alterations caused by environmental stress expressing several endocrinological functions. Thus, the neuroendocrinological regulation of fish feeding and nutrition corresponds to a complex biochemical net, including not only the so-called metabolic but also the stress origin hormones and other substances which act like hormones.

2.2. Extensive production systems

Extensive production systems may include earth ponds or other types of enclosures and apart from the natural food supply they can involve either continuously or periodically added food.

In these cases, the external environment of the fish could be considered as remaining fairly close to the natural one for many fish species, provided that the maintenance of proper environmental conditions is one of the farmer's top priorities. Biological, physical and chemical water parameters should be kept continuously at the most suitable levels. BOD, COD, oxygen and pH levels must be monitored regularly. Water should be free from untreated and unprocessed human, animal and industry waste. Water containing pesticides and related substances, which are usually the cause of a certain amount of stress level as well as a reduction of the quality of final product, should be avoided.

The provision of a natural food supply, ensuring the availability of certain amounts of phytoplankton, zooplankton, aquatic macrophytes, chironomids etc, usually results in an expected metabolic hormone reaction, and this contributes to the establishment of an almost normal fish internal environment. However, alterations should be expected to some extent when improper additional food (in terms of quality and quantity) and water supplies are used.

2.3. Intensive production systems

Intensive production systems are commonly carried out in tanks, raceways, net cages, recirculating systems and with an almost exclusive use of formulated diets.

Water origin and water renewal rates must ensure the appropriate levels of water chemical properties (O_2, NH_3 etc) while size, shape and colour, of rearing constructions and lighting - photoperiod as well as stocking density should cover the specific ethological demands of fish species.

Using only formulated diets, the hormone-nutrient interactions, could be manipulated to some extent by farmers and feed manufactures. This is due to the fact that fish accustomed to feeding for long periods on pellets of the same general external appearance do not easily recognize (if at all) whether the feed so easily ingested is in accordance with their actual needs. Thus, it is up to the farmer to manage the daily amount of lipids (specific fatty acids), protein (amino acids) and carbohydrates (glucose) that cultured fish should ingest according to their feeding habits.

So long as feed-hormone-enzyme and environmental factors interactions are not yet fully understood, fish farming under complete human control will require continuous progress of knowledge and continuous exploration of methods for its application in practice.

Farmers should be aware that in general, intensive production systems are more easily associated with the creation of a stressful environment with numerous physiological effects, caused mostly by catabolic hormones, influencing internal environment and especially fish feeding activity and nutritional status.

3. CONCLUSIONS

Demonstrably, controlled fish production must be carried out using proper management strategies. These must be focused on environmental factors, fish nutritional status and their interactions (the latter however need more clarification and knowledge improvement). Researchers should deal with more specific biochemical pathway investigations and increase the number of fish species studied. It is widely accepted that the acquisition of additional data on the effects of food chemical composition on neuroendocrine stimulation, not only under normal but also under stressed status, is progressively becoming more and more essential. Additional information on the influence of nutrients on neurotransmitters and hormone secretion, blood circulation, receptor binding and function at the cellular level of liver, adipose and muscle tissues, should be considered as most valuable. The understanding of the importance of these interactions could provide significant clues not only in the manipulation of water quality, but also for the development of successful guidelines for artificial diet formulation, according to the ethology and nutritional habits of each fish species. Feed and especially artificial diets should be characterized by anti-stress properties, promoting fish anabolic hormone synthesis and function and by high conversion efficiency, minimizing rearing water quality reduction and increasing farmer profit. It is reasonable to assume that this is an effective way to keep fish populations unstressed, healthy and "happy" and that fish happiness could considerably contribute to farmers and consumers' happiness as well!