Characteristics of tilapia fish

Tilapia is generic name of an African cichlids endemic group. This group is composed of three aquaculture important kind of Oreochromis, Sarotherodon and Tilapia. Various characteristics differentiate these three genera, but the main critical concerns to reproductive conduct. All species of tilapia are nesting in builders; a brood parent guards the fertilized eggs in the nest. Both species of Sarotherodon and Oreochromis are mouthing incubators; eggs gets fertilized in the nest but the parents instantly pick up those eggs in mouths and keep them through brooding and for many days after hatching. Brooding in mouth is found only in Oreochromis species, while in case of Sarotherodon either male or both female and male are holding brooders (SRAC, 2005).

During the last half of 20th century fish farmers all over the tropical and semi-tropical world have commenced farming tilapia (FAO, 2000). Today, commercial production of important tilapia goes to genus Oreochromis beyond Africa, and more than 90 percent of the farmed tilapia are Nile tilapia outside of Africa. (Balarin and Haller, 1982) reported that Nile tilapia is the most popular tilapia species for aquaculture and is widely distributed in many countries other than native Africa.

Adaptability:

Oreochromis niloticus is a quickly growing species which can live in various types of waters. It is extremely adaptable and can use a wide range of various food sources (along with plants), but feeds mainly on phytoplankton along with benthic algae. Even though Nile tilapia is assumed as a freshwater species it has shown a great margin towards salt and can survive in briny situations (Beveridge et. al., 2000). Stickney et al., (1979) reported that Nile tilapia can tolerate to a wide range of environmental conditions, fast growth rate, efficient to convert organic matter into high quality protein and have a favorable taste.

Feeding Habits:

Tilapia has broad variety food organisms that are natural, along with plankton, some aquatic benthic invertibrates, macrophyte, plank tonic and benthic larval fish, breaking up organic matter, and detritus. With heavy auxiliary feeding, natural food beings typically account for 30 to 50 percent of growth of tilapia. Tilapia is often referred as filter feeders as they can efficiently reap water plankton. The gills of tilapia release a mucous which traps plankton. Then mucous rich with plankton or bolus, is swallowed (EL-Sayed A. F. M., 2006).

Tilapia is an omnivore; means feeds on both plants and animals food sources. However, feeding behavior depends with size and age. Larvae usually feed on phytoplankton (algae), fingerlings feed on zooplankton (artemia, moina, and rotifer), and while adults consume both plants and animal food sources near the surface because are floating feeders. In this regard, Caulton 1976; Saha and Dewan 1979; Brummett 1995; Turker et al. 2003 bumped that little tilapia filtered substantially more phytoplankton regarding than larger ones. In addition, Azim et al. (2003) looked into consequence of periphyton quantity and size of fish (7 and 24 g) on ingestion rate by Nile tilapia, and they observed that ingestion rate between small fish significantly increased with density of periphyton, but not for fish with medium size.

Protein Requirements:

Including Tilapia Proteins are important nutrients for all living organisms for their structure and function. Continual use of protein is being used for maintenance, growth and reproduction. Therefore, continuous supply of proteins or their component amino acids are necessary. Many studies indicated that fish does not have true protein necessity, but instead needs a well equilibrized mixture of dispensable and indispensable amino acids. Insufficient intake of protein will result in retardation of growth due to withdraw of protein from fewer vital tissues to maintain the function of critical parts. Too much supply of protein, however, only part will be used to synthesize new tissues and remainder will be converted to energy (NRC, 1983).

Many findings have been carried out about the optimum dietary protein level for tilapia. This level for tilapia appears to be influenced by size or age of the fish and ranges from 28% to 50%. For fry dietary protein levels ranging from 36 to 50% have been shown to produce best level growth (Davis and Stickney, 1978; Santiago and Laron, 1991; El-Sayed and Teshima, 1992). That for juvenile 29 to 40% has been determined to produce optimum growth (Cruz and Laudencia, 1977; Teshima et al., 1978); for young adult fish up to 40g 27. 5 to 35% appears to be maximum (Jauncey and Ross, 1982; Siddiqui et al., 1988; Wee and Tuan, 1988; Twibell and Brown, 1998).

Practical diets for grow out of tilapia usually contain 25 to 35% crude protein. In ponds, however, fish may have access to natural food that is rich in protein, thus dietary protein levels as low as 20 to 25% have been estimated to be adequate (Newman et al., 1979; Lovell, 1980; Wannigama et al., 1985).

Proteins are made up of amino acids. Arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine are the amino acids have been shown to be necessity for fish (Moyle and Cech 1982). The main problem is that quantity for each type required differs from species, and excessive quantity might be damaging a fish’s health (Moyle and Cech 1982).

Scoliosis (curvature of the spine) can result due to lack of amino acids in fish (Moyle and Cech 1982). Proteins are vital in the fish growth. Research has shown that due to certain proteins lack, growth will be scrawny. In the nature, omnivorous fish generally feed on ample alive organisms, protein enriched, that provide a valuable energy source (Moyle and Cech 1982). However, many commercial foods lack ample protein as it is expensive. Fish use large amount of energy to crush large and complex proteins. Due to this, carbohydrates and lipids are replaced as energy sources (Moyle and Cech 1982).

Lipid requirement:

On other hand, lipids are found in tissues of both animal and plant and are digestible completely (Moyle and Cech 1982). Symbiotic bacteria are present in guts of many herbivorous fish that helps to digest the carbohydrates and liberate its energy to fish. Lipids supply higher energy than do carbohydrates, and also render fatty acids, that are used for the energy construction reserves in fish. Predaceous fish normally have a maximum growth rate due to their diet of live fish, which are naturally high in lipids (Moyle and Cech 1982).

Dietary lipids are the main source of essential fatty acids needed by fish for normal growth and development. They are vital carriers and assist in absorption of vitamins with fat-soluble. Lipids, especially phospholipids, are important for cellular structure and maintenance of membrane flexibility and permeability. Lipids serves as precursors of steroid hormones and prostaglandins, improve the flavor of diets and affect the diet texture and fatty acids composition of fish (Webster I. et al., 2002). Takeuchi et al. (1983) reported that essential fatty acid requirement of Nile tilapia was found to be 0. 5% linoleic acid (18: 2ÏŽ6).

Complete diets and Feeding Levels:

Complete diets are important in semi intensive culture systems of Nile tilapia, for a provision of all essential nutrients to the fish. In order to develop such diets it is also necessary to know the specific nutrient requirements of the animal and optimize feed formulation in order to obtain fast growth of high quality fish at low costs, (Moore, 1985).

Nutrient requirement of supplementary feed for Nile tilapia:

Many studies have been done to find out the suitable optimum nutrient level for tilapia. Fineman and Camacho (1991) observed that 30% protein with 3500 kcal was better than 30% protein with 3000 kcal for supplementary feed for Oreochromis niloticus in brackish water ponds. Watanabe et al. (1990) found that final mean weight were high in 28% protein to 32% protein under all densities. Hanley (1990) found that increasing dietary lipid has no significant effect on growth rate, feed conversion ratio and protein gain. De Silva and Perera (1985) and Siddiqui et al.(1988) cited by Zonnveld and

Fadholi (1991) found that optimum protein levels for fry and young Nile tilapia reared at maximum growth should be 28-30% respectively.

Water Quality Requirements:

Nile tilapia would grow well in water with a temperature range of 20-35°c and optimum between 28° and 30°C and productivity can be assumed at a maximum within this temperature range (Ballarin and Haller, 1982). Tilapia cannot survive at a temperature below 10°c for more than few days. When it exposed to cold water, disease resistance is impaired and death may result in only few days (Lovell, 1989)

The tolerance level of DO for Nile tilapia is as lower as 0. 1 mg/L (Magid and Babiker, 1975). Chevrvinski (1982) reported that O. niloticus could survive by using atmospheric oxygen when dawn DO concentration drops to less than 1 mg/L. Colt (1987) demonstrated that Nile tilapia growth reduces as DO level reaches below 5mg/L.. However, its survival depends on the duration of low dissolved oxygen in the culture system. In tanks, fish survive at the oxygen level of 1. 2 mg/L by gulping oxygen from the atmosphere for up to 36 hours if other water quality parameters remain at an optimum level (Balarin and Haller, 1982). Nile tilapia has a lethal pH limit at approximately 4 and 11 respectively and pH between 6. 5 and 9 is the desirable range for fish culture (Swingle, 1969)

Nile tilapia is more tolerant of high ammonia level than any other species of fish. The lethal ammonia level for tilapia is 2. 3 mg NH3-N/L., but it was reported that by prolong exposure, it can tolerate levels of up to 3. 4 mg/L (Stickney, 1985). A level of unionized ammonia above 0. 5 mg/L frequency results in mortality when fish are further stressed by low oxygen, handling (Ballarin and Haller, 1982).

Nile tilapia is not directly affected by alkalinity and tolerance level as high as 700 to 3, 000 mg/L CaCo3 (Morgan, 1972). A total alkalinity range of 20 – 400mg/L is considered satisfactory for most aquaculture purpose (Tucker and Robinson, 1990 cited by Lawson, 1995).

Phosphorous requirement

The dietary requirement for phosphorus in tilapia varies from 0. 9% (Watanabe et al., 1980), 0. 45-0. 6% (Viola and Arieli, 1983), 0. 3-0. 5% (Robinson et al 1984, Robinson et al., 1987) to 0. 46% (Haylor et al., 1988) depending on species, fish size, food composition or expression of a reported requirement, available or final dietetic phosphorus. The diet containing the complete mineral premix contained 0. 9% total phosphorus, whereas the unbalanced calcium and phosphorus diet contained 0. 5% overall phosphorus.

Although fish could partly absorb phosphorus from its environment (Lall, 1979, Lall, 1989, Lall, 19911, dissolved phosphorus is usually at very low levels of about 0. 005-0. 05 Mg/L, which is inadequate to meet their requirement (Nose and Arai, 1979 cited in Lall, 1991). Hepher (1954) (as cited in Hepher and Sandbank, 1984) noted that even in fish ponds fertilized with phosphates, the level of phosphorus does not increase much above its normal low level due to absorption to soil colloid and precipitation as insoluble compounds.

Phosphorus is a component of phosphoproteins, nucleic acids and phospholipids, which play important roles in energy metabolism. Addition of dietary phosphorus has been reported to decrease the lipid content of muscle and viscera, whereas muscle protein content increased (Murakami, 1970 cited in Lall, 1979; Takeuchi and Nakazoe, 1981 cited in Viola et al., 1986; Shu, 1987; Hung, 1989; Wee and Shu, 1989).

Calcium requirement

The requirement for calcium in tilapia reared in calcium-free water was found to be 0. 65% for 0. areus (Robinson et al., 1984, Robinson et al., 1987). In the calcium and phosphorus uncomplemented diet, the calcium level was about 1%. At this level, even without supplementation, it appears that the calcium level in the soybean-based diet would be sufficient to meet the requirement. The availability of dietary calcium to fish has not been studied. Furthermore, under normal conditions, one cannot demonstrate a calcium requirement in fish (Cowey and Sargent, 1979; Robinson et al., 1984, Robinson et al., 1987; Yarzhombed and Bekina, 1987) because of calcium uptake from the water (Dabrowska et al., 1989; Luquet, 1991).

In Nile tilapia, calcium uptake takes place in the skin, particularly by the opercular membrane (McCormick et al., 1992). In contrast to phosphorus, it seemed, therefore, that the calcium requirement could be met from the rearing water. Activities such as liming of ponds are likely sources of calcium. The similarity of calcium levels in the final carcass of fish fed the calcium supplemented, calcium non-supplemented diets and the non-fed fish further support the likeliness of calcium uptake.

The calcium is a must in the fish diet for balancing the calcium and phosphorus ratio. Maintaining an optimum Calcium and Phosphorus ratio is important in diets for red sea bream, eels, and brook trout but not for catfish, carp, and rainbow trout (NRC, 1973, NRC, 1983; Ogino and Takeda, 1976; Viola et al., 1986; Hepher, 1988; Lall, 1991). In tilapia, the role of the Ca: P ratio is not well defined and merits further study (Robinson et al. 1987). However, noted that in freshwater fish, dietary Ca: P ratio does not generally impair growth or tissue concentration as long as dietetic phosphorus is adequate and calcium is present in the rearing water.

Feeding standards of supplementary feed for Nile tilapia

This is a set of tables, which include the quantity of each dietary component required for each age and species of fish for different levels of production and maintenance. When complemented by tables of feeds composition, then it is possible to formulate accurate rations for individual or fish groups, an essential process for a least-cost ration feeding program operation. Marek (1975) composed a feeding chart of common carp and tilapia. The chart was having estimation of natural food in the pond and subtracted from the calculated feed requirements for maintenance and expected growth. The charts are based on the weight of fish, and changes are adjusted according to the daily growth of fish. In most cases, therefore ration is fixed for a longer period of time (Hepher, 1982).

Feeding rate of Nile tilapia

Underfeeding of fish can result in production loss. Overfeeding will cause a costly feed wastage and a potential cause of water pollution in addition, a condition ensuing loss of animals or needing expensive corrective measures.

Hence, both overfeeding as well as under-feeding has serious economic effects that affect the farm viability. Bard et al (1976) stated that most of the supplemented feed is not fully eaten by fish; some drop to the bottom of the water contributes to development of phytoplankton, hence promoting growth of fish both direct and indirect way.

Sometimes a vague instruction might be read, like ‘ feed 5% of biomass per day’ as a dry feed. This might be applied during whole growing cycle. This would most likely result in near famishment in the early stages and gross excessive feeding and later water quality problems. Feeding rates must not be steady throughout the whole of the growth cycle till table size. They must be changed according to the fish age and its size to conditions of water. Brown et al (1979) demonstrated that it is uneconomical to balance diets fed to fish in ponds according to the absolute nutrient requirement of the fish.

Stocking density and size

Feeding level of fish in the semi intensifier system increases with the increase of density of fish. As t density of fish in the semi intensive culture increases per unit area, the food requirement of fish also increases. This increase of biomass does not relate with the increase of raw food and in many cases is associated with a decrease in the production of food from nature due to limited supply to the overgrowing biomass stated (1979) that when the biomass of fish increased, each fish gets a smaller amount of natural food, which may not meet its nutrition requirement. This deficit can be covered by supplementary feed.

Natural Food in a semi intensive culture

Algae or “ phytoplankton” is an microscopic weeds form the base of the fish food chain. Adequate temperature, sunlight, and nutrients are basic for all green plants needed for growth. In presence of the sufficient light and proper temperature, chemical fertilizers (nitrogen, phosphorous and potassium) nutrients are readily assimilated by phytoplankton and increasing their abundance. Manure comprises the same nutrients, is released and present to phytoplankton during and after decomposition. As phytoplankton absorbs fertilizer nutrients and reproduces to create dense communities pond water changes to brownish or greenish color. This is known as phytoplankton bloom.

There are three basic feeding pathways by which input of fertilizer in the pond provides nutrition for fish:

- Direct consumption of organic matter by fish
- Autotrophic productivity of algae pursuant to fertilization and their consumption by filter feeding fish.
- Heterotrophic productivity of micro organisms and benthic micro organisms from manure inputs and their successive consumption by fish.

These three basic feeding pathways can operate in a single aquaculture system, even though their relative importance still a subject of intense debate Colman and Edwards, (1987). In Israel experimental work reported that the heterotrophic pathway of organic manure was found to be more efficient than an autotrophic pathway, Schroeder (1980). It was stated that low fish production by an autotrophic food chain was due to the sunlight limitations of phytoplankton with filter feeding fish mainly depend on heterotrophic organisms that are not light dependent. Therefore, the autotrophic food chain is required to provide the necessary DO which limit to the heterotrophic feed chain Colman and Edwards, (1987).

The fertilized ponds with nutrients stimulate the microscopic plants growth in the water (phytoplankton). Phytoplankton is food for other water creatures (zooplankton and larger animals) that fish eat. Water becomes turbid or greenish color (called a “ bloom) Martin et al (1999) because of abundant growth of microscopic plants. Evaluation of the nutritional value of natural food is a difficult because each fish species has its own nutrition requirement from its diet Determination of biomass of phytoplankton, zooplankton and benthos in the fish pond must be related to the food requirement of fishes. Until now, there is not a reliable method developed for determination of secondary production, although primary production can be estimated. Spataru et al (1979) reported that supplementary feed can replace some of the natural food. Aquino and Neilso (1982) supported that Oreochromis niloticus grow well in cages on food.

The primary producers’ which are sourcing of food to different type of fish are not digested equally by fish. Blue green algae Anabaena, Microcystis, Oscillator was reported to be indigestible because they have copious moulage, cellulose wall, or firm periblast, (Zhang, 1989). Recent research work in China indicated that Tilapia can digest green-algae (Zhang, 1989).

Mellamena, (1990) reported that algae contain protein, fat, Carbohydrates varies 22% to 48%, 2% to 16%, and 14% to 24% respectively. Zooplankton has more protein and fat content than any other phytoplankton except one gabber. Diatoms which have the more silicious cell wall contain higher quantities of inorganic matter. Tamiya, (1975) found that the average protein content of algae is about 50% on a dry matter basis. The biological value of algae is about 81. 5% meaning that 124gram of algal protein corresponds to 100 grams of egg protein. The amino acid composition of algae is similar to that of FAO reference protein except, there is a slight deficiency in cystine and methionine.

Lipids found in phytoplankton are typical ester of glycerol and fatty acids having a carbon number from C14 to C20. The major acids in diatoms are palmitic (16: 0), hexadecanoic (16: 1), Becker (1989). Blue green algae have a larger amount of polyunsaturated fats (25% to 68%) oftotaltriglyceride up to 80% of the totalalgae lipids. Lipid content of Cyanobacteria and green algaein outdoor mass culture is 7% to 15% lipids (Becker, 1989). (Nostocsp., Calothrex sp., Oscallaria and Spirulina sp., Urenima sp.) and 20% to 25% lipids in green algae (Scenedesmus), to 10% in dry weight.

All plankton feeders' fish reported to digest diatoms such as Silver carp and tilapia (Power, 1960, 1966). Tilapia zillii in Israel revealed that it had a capacity to disintegrate after gelatinous matrix colonies of blue green algae, especially Microcystis (Spataru, 1978).