AQUATIC WEEDS, THEIR CHARACTERISTICS AND EFFECTS ON GROWTH OF *CATLA CATLA* HAMILTON - A REVIEW

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ABSTRACT : Important parameters that are analyzed while studying the growth of rearing organisms, including fishes are Specific Growth Rate (SGR), Feed Conversion Ratio (FCR) and Survival Rate (SR). Apart from these another important morphological aspect in terms of growth analysis is the Net Weight Gain (NWG) by the fish. Various aquatic weed organisms being used as one of the fish feed ingredients and their respective effects on growth of *Catla catla* Hamilton have been studied due to their appreciable nutritional content that are intended in order to replace the fishmeal based diet in a complete or partial manner. This article presents some significant nourishing attributes of the weed organisms and their specific consideration for fish feed detailing including important parameters that are mulled over while studying the growth of fish. The prime contribution of this communication is to review the exploitation of different aquatic weeds viz. *Spirogyra* sp., *Spirulina platensis*, *Ipomoea aquatica* and *Hydrilla verticillata* (L.F) Royle; taken as fish feed and their respective effects on growth of *Catla catla*.

Key words : *Catla catla*, *Spirulina*, *Spirogyra* sp., *Hydrilla*, *Ipomoea*.

INTRODUCTION

In business aquaculture firms, the growth and development of organisms is the most significant affecting factor with respect to financial advantage (Baer *et al.*, 2011). Carp cultivation has been practiced for business and economic reason in India. *Catla catla* Hamilton, is one of the Indian Major Carps (IMCs) that is cultured due to its high food value and good growth. IMCs contribute around 75% of the aquaculture generation in India (FAO, 1997). Good growth of fishes is very important from economic and commercial perspective of practicing fish culture.

A balanced fish feed usually contain deoiled cake, fishmeal and rice bran. Out of which the fishmeal is an extensively used protein element of artificially formulated fish feed in aquaculture industry, contributing to the variable generation cost due to its non-availability. As a result, there is an increase in the costs which are particularly acting as a threat to the manageability and development of the aquaculture industry. And therefore, a substitution of fishmeal with elective protein sources becomes essential in way of preparing a balanced fish feed.

Catla catla is one of the most cultured and relished fishes not only in India but countries like Nepal, Bangladesh, and Myanmar. And because of its high market value and consistent demand, the requirement of artificially formulated fish feed increases to meet the supply of fish. Several works have been done to find out the effect of different organisms of plant origin on the growth of *Catla catla* (Adikari *et al.*, 2017; Kumar *et al.*, 2004 and Nandeeshha *et al.*, 2001). Due to increasing cost and uncertainty of constant supply of normal feed ingredients, several attempts had been made to establish alternative sources of feed ingredients in order to formulate the fish feed. As compared to the animal products, plant products contain large amount of protein, different types of amino acids including the fatty acids (Mondal *et al.*, 2015).

Various algal genera can be applied in aquaculture industry in a financially savvy way (Roy and Pal, 2015). Aquatic weeds, grasses, vegetables, plant leaves, stems, seeds and seed extracts are commonly used in the industry of fish feed (Mondal, 2015).

Aquatic macrophytes had been used as alternative feeds in the farming of fish since long time back *i.e.* since early times of freshwater fish culture (Courtenay *et al.*, 1973). A wide variety of macrophytes playing role as food and feed for different types of fishes have been reported (Hasan *et al.*, 2009). In order to obtain high rates of growth in IMCs fry or advanced fry have to be fed on supplementary diets with an approximate protein content of 40% preferably of plant origin (Kalla *et al.*, 2004).

1. Fish growth parameters :

Following are some of the important parameters that play key role in determining the growth of fishes in culture system. Growth is defined as a steady increment in a living system in some amount over the period of time (Von Bertalanffy, 1934).

a. Absolute growth rate :

One of the simplest, scientifically least complex and every now and again utilized methods in determining the growth is the absolute increment in units estimated. It is thus expressed by the following mathematical expression as :

$$\Delta w = w_f - w_i$$

Where, w_f is the final weight/length and w_i is the initial weight/length. This expression is simply used on harvesting and stocking data.

The above information is not sufficient and is shallow if not related with respect to the time. Therefore, the time frame is needs to be an inclusion of the absolute growth rate (AGR) as :

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$$AGR = (wf - wi) / t$$

Where, t is time or number of days considered.

b. Relative growth rate :

It is based on the absolute growth rate displaying the absolute increase in relation to the initial weight/length being reported as increase in percentage over time. Therefore, the relative growth rate (RGR) is expressed mathematically by the following formula as :

$$RGR = (wf - wi) / t \times 100$$

c. Instantaneous growth rate :

This growth rate also relies on the absolute growth rate but instead of calculating the absolute values, the natural logarithm is used as follows :

$$IGR \text{ (Instantaneous growth rate)} = [\log(wf) - \log(wi)] / t$$

In the above equation, log represents the natural logarithm.

d. Specific growth rate :

In analogy to the change between the absolute growth rate and the relative growth rate, the instantaneous growth rate can be moved into the specific growth rate (SGR) by multiplying it by 100. And being expressed as under

$$SGR = [\log(wf) - \log(wi)] / t \times 100$$

e. Net weight gain :

Net weight gain (NWG) is the simplest method to calculate the weight gain by the fish and is mathematically expressed as :

$$NWG = wf - wi$$

f. Survival rate :

The survival rate (SR) provides an insight of the fishes survived at the end of the culture or experiment. It is usually expressed in percentage and is expressed by the following formula :

$$SR(\%) = \frac{\text{Number of fish survived}}{\text{Number of fish stocked}} \times 100$$

Feed conversion ratio : Another most important factor that has been studied to estimate the efficiency of the organism converting the feed into the output is the feed conversion ratio (FCR). Or the FCR simply means quantity of feed consumed or required by a fish to attain a size of one kilogram. In fish, one of the factors on which the growth depends is the feed consumption and quality (Rosenlund *et al.*,2004 and Slawski *et al.*,2011). The feed conversion ratio is therefore, calculated as per the following expression

$$FCR = \frac{\text{Dry weight of feed}}{\text{Live weight gain}}$$

or the FCR may be calculated as :

$$\frac{\text{Amount of feed fed}}{\text{Final weight - Initial weight}}$$

In the culture system, the FCR represents the weight gain by the fishes by the consumption of any type of food pro-

vided which could have been formulated or natural. There is multiple importance of feed conversion ratio in the fish culture system. And some of the importance of FCR includes: estimation of feed amount required to feed the fish during its growing cycle, to determine the profitability of a particular type of fish to be reared and to compare the efficiency of different feeds.

2. *Spirogyra* sp. and nutritional content :

Spirogyra sp. is a part of the family Zygnematophyceae (Conjugatophyceae). The genus is a common naturally occurring aquatic weed, generally found in freshwater living spaces including streaming water, permanent ponds, and temporary pools being portrayed by its unbranched fibers made up of elongated tube shaped cells with lace-like chloroplasts that are spirally arranged around the cell membranes.

Biochemical examination has demonstrated the *Spirogyra* sp. to be rich in nutritive value (Pritchard,1995 and Tipnee & Ramaraj,2015); subsequently, could be used as an alternative fish feed ingredient. Freshwater macroalgae are significant sources of bioactive organic stuffs. The natural weed *Spirogyra* sp. is being utilized as supplement dense foods and source of fine synthetic chemicals. It has been utilized as one of the ingredients in both therapeutic and nourishment preparations, traditionally in various areas over the world (Chandini *et al.*, 2008). Macroalgal products were generally taken as foods with low calorie and carbohydrates, minerals, proteins, and vitamins contents (Kumari *et al.*,2010). They are rich in C18 and C20 PUFAs with possessing high nutritional value and are in this way, studied broadly for biotechnological, nourishment, feed, cosmetic and pharmaceutical applications (Chandini *et al.*,2008 and Darcy-Vrillon,1993). Algal derived carbohydrates can give human medical advantages as anticoagulants, antioxidants, antivirals and dietary fibers (Wijesekara *et al.*,2011).

Some studies have clearly shown the application of algae in aquaculture and fish culture (Roy and Pal,2015). And a work on *Spirogyra* sp. (Kumar *et al.*,2004) is one such attempt; where higher FCR was reported in the carp (*Catla catla*) fed with *Spirogyra* sp. and showing a positive correlation between the amount of *Spirogyra* sp. present in the diet and protein contents in muscle of the fish. *Spirogyra* sp. being a natural weed has been suggested as an alternative replacement to the costly feed ingredients used in culture of *Catla catla* (Table.1).

Table. 1 Proximate protein composition and FCR of fish fed with different amount of *Spirogyra* sp. dry powder mixed feed (Kumar *et al.*,2004).

Diets	<i>Spirogyra</i> sp. dry powder (%)	Protein (%)	FCR
1	0	7.8±1.23	0.55±0.04 ^A
2	10	7.6±1.28	0.72±0.02 ^B
3	25	10.1±1.37	0.92±0.05 ^C
4	37	12.0±2.17	0.67±0.07 ^B
5	40	12.8±2.38	0.69±0.01 ^B

Values with superscripts are significantly different (P > 0.05).

3. *Spirulina platensis* and its nutritive composition :

Spirulina platensis is a cyanobacterium (blue green microalga) that has been used as a supplementary food with its due proximate composition. It is usually utilized by humans and animals as protein source. Studies on *Spirulina platensis* have been conducted to verify the possible benefits of *Spirulina platensis* and reports (Colla *et al.*,2007; Derner *et al.*,2006 and Rodríguez-Hernández *et al.*,2001) are available on its key characteristic features such as easy digestion, lack of toxicity and palatability; anticancer activity, anti-inflammatory property, antioxidant actions, antiviral effects, hypocholesterolemic property, including its action as an immunostimulant.

Spirulina platensis contains essential amino acids and has been found to be concentrated with a relatively high content of protein. It is also found rich in antioxidant carotenoids, ascorbic acid, cobalamin, pyridoxine, riboflavin and thiamine (Alvarenga *et al.*,2011 and Ross & Dominy,1990) and may work as a good choice of alternative to replace the fish-meal based diets for fish culture system. As per a study the microalgae can act as a good alternative source of protein in the diet (Rogatto *et al.*,2004). Amino acid profiling of *Spirulina platensis* showed amino acid content *Spirulina platensis* to be nearly the same as found in egg, while being better in cases with varying culture condition (Becker and Venkataraman,1984).

In various fish feed trials with fish, different microalgae have been found to show their effect on increasing of the carcass quality, disease resistance, feed utilization, overall fish growth, physiological activity, starvation tolerance, and stress response (Mustafa and Nakagawa,1995). Fish diets containing *Spirulina platensis* led to an improved growth and protein digestibility (Mustafa *et al.*,1994), starvation tolerance, and stress (Olvera-Novoa *et al.*,1998), along with ameliorated carcass quality (Belay *et al.*,1996 and Floreto *et al.*, 1996).

When specified with the effect of microweed *Spirulina platensis* on the growth performance of *Catla catla*, no significant difference in final weight was observed at every level of *Spirulina platensis* incorporation along with the SGR also being insignificantly different from the control, however, a significantly higher percentage of fat was reported (Nandeeshsha *et al.*,2001) (Table.2).

Table. 2 Overall growth of fish (*Catla catla* Hamilton) as studied by Nandeeshsha *et al.* (2001) on incorporation of *Spirulina platensis* in fish feed.

Diets	<i>Spirulina</i> sp. dry powder (%)	Fat (%)	Mean SGR (%)
1	0	78.39±0.18	1.83
2	25	78.57±0.08	1.83
3	50	83.66±0.10	1.83
4	75	83.41±0.07	1.81
5	100	83.63±0.20	1.82

4. Nutrient profile of *Ipomoea aquatica* and its application in aquaculture :

Ipomoea aquatica is a submerged aquatic tropical plant widely growing as floating plant in water systems like canals, rivers, lakes, ponds, etc in India including many other Asian countries (Austin,2007). It is commonly known in some of its ambiguous names as water spinach, morning glory, river spinach, etc. *Ipomoea aquatica* is a herbaceous and perennial plant belonging the family Convolvulaceae. Being a short duration crop it grows pretty fast and covers most of the spaces of water body within a brief period of time eventually creating a number of problems for fishery management, irrigation, and navigation along with posing many different ecological predicaments in aquatic ecosystems (Chilton,2017). Therefore, practicing the employment of this aquatic weed plant as feed ingredient in fish culture can be expected to serve the dual purpose of eco-friendly management or disposal of the weed as well as a fishmeal replacer during feed formulation.

Profile of chemical and nutritional composition of *Ipomoea aquatica* has revealed its amount and diversity of nutrient contents thereby being recommended for its use in nutritional purposes (Umar *et al.*,2007). Fairly high amount of crude protein (25.60%) and carbohydrate (47.95%) were reported in a recent study (Dewanjee *et al.*,2015 and Dua *et al.*, 2015) that provided valuable information on the nutritional importance of *Ipomoea aquatica* and its possible use in the nutritional and feed formulation industries. In particular its usefulness on growth and raising of *Catla catla* has been studied (Adikari *et al.*,2017) as its positive role in partially replacing the fishmeal based diet.

5. Nutritive value of *Hydrilla verticillata* (L.F) Royle :

Hydrilla verticillata is well known in its common names as hydrilla, water weed, water thyme, Indian stargrass, oxygen weed, etc. A member of family Hydrocharitaceae, it is a submerged, perennial, obligate aquatic, invasive, and a considered noxious weed plant that is herbaceous in nature. It grows rapidly and abundantly to the surface like dense mats thereby posing a problem of light penetration in the medium. Well adapted to almost all types of freshwater, *Hydrilla verticillata* truly meddles with drifting, hinders swimming and angling activities, significant pervasions limit sportfish weight and size (Colle and Shireman,1980). *Hydrilla verticillata* have been reported to play its role as feed for various fishes (Adikari *et al.*, 2017; Carniatto *et al.*,2014; Colle & Shireman,1980 and Rifai,1979).

This invasive weed can be advantageous for aquaculture industry along with the aquaculture feed industry performing a double function in terms of controlling its various negative impacts by frequent harvesting for the purpose of formulating the fish feed and allowing the feed to be cost effective. Furthermore, aquatic weed growing in the same water body could be converted into feed ingredients enabling convenience and competence (Edwards *et al.*,1992). In a few recently published reports (AB *et al.*,2017 and Das *et al.*,2015) on *Hydrilla verticillata*, the nutritional compositions of this weed are well documented, that it is found to be particularly

rich in potassium and calcium with an apt protein content (AB *et al.*,2017). Another work also supports the acceptable nutrient constituents of *Hydrilla verticillata* as 20.15% carbohydrates, 17.82% protein and 2.92% fat (Uktolseja *et al.*,2013) for its application in practical viable purposes. Due to its appreciable nutrient content, a published work on plausible use and effects of *Hydrilla verticillata* as fish feed in culture of *Catla catla* ascertained the cutting down of the fish feed cost by 70% or more without affecting water quality of the pond (Adikari *et al.*,2017).

Conclusion :

Although many reports are available on usage and application of weed organisms as feed ingredient in the farming of fish and fisheries, no much experimentation result information are available to assess the effect on overall growth and development of *Catla catla* in particular. This article makes an effort to provide an overview of the growth of *Catla catla* Hamilton, an Indian Major Carp, by the exogenous incorporation of aquatic weeds, namely *Spirogyra* sp., *Spirulina* platensis, *Ipomoea aquatica* and *Hydrilla verticillata* (L.F) Royle; as one of the ingredients of formulated feed in the culture system. Some details about other parameters involved in overall analysis of fish growth have also been described. The review presented shall gain insights into the four aquatic weed organisms and their use to formulate the fish feed along with the possible future revision and improvement of feed.

Apart from a wide range of variations found while studying the overall growth and morphometric parameters (Adikari *et al.*,2017; Kumar *et al.*,2004 and Nandeeshha *et al.*, 2001) of *Catla catla*, the value of SR was found to be the most

promising being 100% in case of *Spirogyra* sp. mixed fish feed. And from this review, it can be concluded that *Spirogyra* sp. tends to be more acceptable in the culture system of *Catla catla* than *Spirulina platensis*. In spite of *Ipomoea aquatica* being more reliable in terms of SR than *Hydrilla verticillata* (L.F) Royle, both of these aquatic weeds can fairly be exploited as feed for culture practice of *Catla catla* (Table.3).

Table. 3 Comparative effects of macrophytic weed plants on overall growth of *Catla catla* Hamilton (Adikari *et al.*,2017).

Parameters	<i>I.aquatica</i>	<i>H.verticillata</i> (L.F) Royle
Initial body weight (g)	0.1	0.1
Final body weight (g)	2.94	2.70
Net weight gain (g)	2.84	2.6
FCR	0.95	0.98
SR (%)	74.12	73.73

The authors believe that this piece of study shall be helpful for the local and small scale fish farmers with an extended usefulness to the commercial fish producers, in order to select a particular category of weed organism of plant origin to completely or partially replace fishmeal based diet depending upon the availability, accessibility, and suitability of the weed while formulating the fish feed to achieve the better and faster growth of *Catla catla*. Similar studies on different phytoplankton/algal weed and other aquatic weed plants with regard to their respective effects on growth and development of the IMC *Catla catla*, shall be helpful in gaining some other and perhaps better alternatives to formulate the fish feed in order to replace the fishmeal based diet in the culture of aforementioned category of fish.

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