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BIOENERGETICS OF THE FRESH WATER FISH *Clarias batrachus* EXPOSED TO TREATED SAGO EFFLUENT

[1]Ramesh Francis, [2]K. Nagarajan, and [1]A. Gracelyn Portia
[1]Department of Biological Sciences, University of Eastern Africa, Baraton
P.O. Box 2500, Eldoret-30100, Kenya
[2]Department of Zoology, Sri Vasavi College, Erode-638 316, Tamil Nadu, India

Abstract

Bioenergetics of the fresh water fish *Clarias batrachus* was studied after exposure to sub-lethal concentrations of treated sago effluent. The concentration chosen were 25%, 50% and 75%. Estimation of growth was calculated by weighing the fish at 7th, 14th, 21st and 28th days of the experiments. The growth rate, conversion rate and conversion efficiency were reduced with increasing concentrations of sago effluent. The study reveals that there are more physiological stresses to the fish exposed in higher concentrations of treated sago effluent than the lower concentrations.
Key Words: *Clarias batrachus*, Sago effluent, bioenergetics.

Introduction

Pollution of aquaculture habitats is an inevitable problem aquaculturist's face. Various pollutants affect survival, growth and reproduction of organisms, particularly those of economic importance (Lourdes et al., 1993)

Bioenergetics provides powerful approaches to study the environmental impact on the cost of life, growth and success of animals (Warren, 1971). Murkarji and Bhattacharya (1977) have reported that metals present in industrial effluent inhibit the food utilization and growth of the organisms. Information on long-term effects of exposure to toxic materials on physiological functions such as growth, reproduction and metabolism are useful to establish safe levels of waste water discharges (Hunter, 1978).

Very few publications are available on the effects of industrial effluents on energy transformation in fish (e.g. Petroleum refinery effluent: Rowe et al., 1983; Distillery effluent: Haniffa and Sundaravadhanam, 1983; Titanium factory effluent: Nair et al., 1985). Baskaran et al., (1989) have found that energetic parameters like feding and conversion rates have negative relationships with increasing concentration of dyeing effluent.

Reduction in food intake in *Mystus vittatus* reared in the chemical factory effluent leads to reduced growth (Palanichamy et al., 1989). Sakthivel et al., (1991) have studied the effect of textiles dyestuff effluent on food utilization of the fish *Cyprinus carpio*. Sheela et al. (1992) have studied the rate of feeding, absorption, growth, metabolism and conversion efficiency of the fish *Channa striatus* exposed to fenvalerate and phosphamidon.

Nagarajan and Ramesh (2001) have studied the growth rate, feeding rate, conversion rate, and conversion efficiency of the fish *Catla catla* introduced in control and sublethal concentrations of sago effluent. Aguigwo (2002) has reported the specific growth rate and food conversion efficiency in the sublethal concentration of cymbush pesticide.

Nagarajan and Shasikumar (2002) have investigated the growth rate, conversion rate and conversion efficiency of the fresh water fish *Labeo rohita* subjected to control and different concentrations of sago industry effluent. Similar observations were made in *Catla catla* exposed to sublethal concentrations of dyeing effluent (Nagarajan & Boopathyraja 2004). The fish *Clarias batrachus* has great economic value and also it is an important food item hence an attempt is made to study the growth with respect to the effect of sago effluent.

On the basis of potentiality in polluting the environment the industries are categorized as Red (High polluting industries), Orange (Less polluting industries) and Green (Non-polluting industries) by the Ministry of Environmental and Forestry, Government of India. Sago industry is between the major water consuming and less polluting industries in India. Sago factories are most commonly found in India and Thailand. In Tamil Nadu (State of India) in and around the city of Salem alone there are over 800 factories are located. It is an agro based industry, which let out lot of its waste water in to the nearby areas. Also it is noted as one of the significant contributors to water pollution by discharging its effluent.

Hence, the present investigation is designed to study the effect of treated sago effluent on the growth of the fish *Clarias batrachus*.

Materials and Methods

The experimental studies were conducted in the laboratory, department of Zoology, Sri Vasavi College, Erode, Tamil Nadu, India. The concentrations chosen for growth studies were 25%, 50% and 75% of treated sago effluent. The experiments were conducted in plastic trough capacity of 20 liters. For each experiment 10 individuals were reared in respective troughs and controls were maintained in effluent free medium. The fish were utilized for the experimental studies only after the acclimatization for a minimum period of 15 days. Four experimental sets were maintained for 28 days by changing the same quantity of effluent to the respective sets. During the period of growth studies, the fish were fed on known amount of fresh goat liver pieces once a day for an hour (9-10am). Care was taken to collect the unfed liver pieces remains with a pipette without causing disturbance to the fish. The rearing medium was changed daily after the feeding hours. Control food was dried in a hot air oven for 24 hours to weight constancy and the water content of the food was estimated. The fish were maintained in these media for 28 days at 25 ±1oC with normal light. After 28 days of rearing, the test individuals were starved for a day to ensure complete evacuation of gut. They were weighed alive and then killed. The killed fish were dried to constant weight at 80^{o}C. The dry weight of the individuals was calculated.

Estimation of growth was calculated by weighing the fish at 7th, 14th, 21st and 28th days of the experiments. On the initial day (0 day) control and experimental fish were weighted and the values were recorded.

Definition of Terms and Calculation Procedure Related to Food Utilization

The scheme of energy balance followed in the present work is that of IBP formula (Petrusewiez & Mac Fadyen, 1970). Quantitative estimations of the 'C' were made in terms of mg, where 'C' is the food energy consumed. The term conversion has been used to refer to growth, i.e. the P of the IBP terminology. The P was estimated by subtracting the initial weight of the individual at the time of commencement of experiment from the final body weight of the individual at the end of the experiment. Rate of feeding and conversion were calculated to the respective amount (mg) per unit initial weight (g) of the fish per unit time (day).

Conversion efficiency was calculated to the respective amount (mg) per unit initial live weight (g) of the fish per unit time (day). The conversion efficiency was calculated in percentage. Standard deviation and standard error were calculated following Bailey (1959).

Calculation

Feeding rate (g/g live fish/day) = Average food consumed (C) (g/ fish /day) / Initial live weight of fish (g)

Conversion rate (g/g live fish/day) = Average food converted (P) (g/day) / Initial live weight of fish (g)

Conversion Efficiency % = Mean food converted (g/fish/day) × 100% / Mean food consumed

Results

The growth rates were recorded in the fresh water fish Clarias batrachus in control, 25%, 50% and 75% concentrations of treated sago effluent for a period of 28 days. The control fish were able to record a growth of 8.952 + 1.207g whereas the individuals exposed in 25%, 50% and 75% concentration of treated sago effluent recorded a growth rate of 5.110 + 0.295g, 4.337 + 0.970g and 4.085 + 0.293g respectively.

The growth rates calculated for the *Clarias batrachus* in control, 25%, 50% and 75% concentrations of treated sago effluent are presented in Table 1 and Figure 1. The feeding rates, the conversion rates and the conversion efficiency recorded for control were higher than the various treated sago effluent concentrations (see Table 1 & 2 and Figure 2&3).

Table 1
Growth rates of Clarias batrachus Exposed to Control and Different Concentrations of Treated Sago Effluent. Each value represents the average performance (±SE) of six individuals for a period of 28 days.

Concentration ofEffluent	Initial Wt.(g)	Final Wt.(g)	Growth rate (g)
Control	7.435±0.563	16.387± 1.687	8.952±1.207
25%	7.941±0.772	13.135±0.991	5.110±0.295
50%	5.783±0.421	10.120±1.355	4.337±0.970
75%	6.613±1.250	10.698±1.462	4.085±0.293

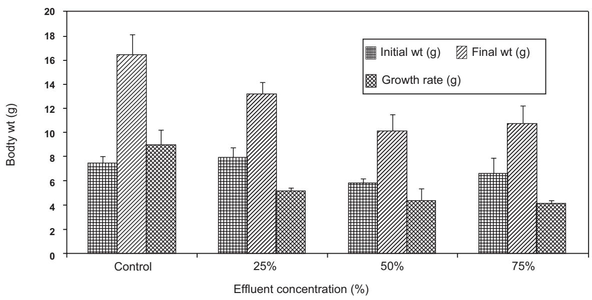

Figure 1

Growth rates of Clarias batrachus exposed to control and different concentrations of treated sago effluent. Each value represents the average performance (+SE) of 6 individuals for a period of 28 days.

Table 2

Feeding rate, Conversion rate and Conversion efficiency of Clarias batrachus Exposed to Control and Different Concentrations of Treated Sago Effluent. Each value represents a mean performance of six individuals (± SE) at 24 ± 1oC.

Concentration of Effluent	Feeding rate (g / g live fish / day)	Conversion rate(g / g live fish / day)	Conversion efficiency (%)
Control	2.543 ± 0.192	1.204 ± 0.090	47%
25%	1.674 ± 0.125	0.643 ± 0.048	38%
50%	2.026 ± 0.151	0.749 ± 0.055	37%
75%	1.768 ± 0.133	0.617 ± 0.046	34%

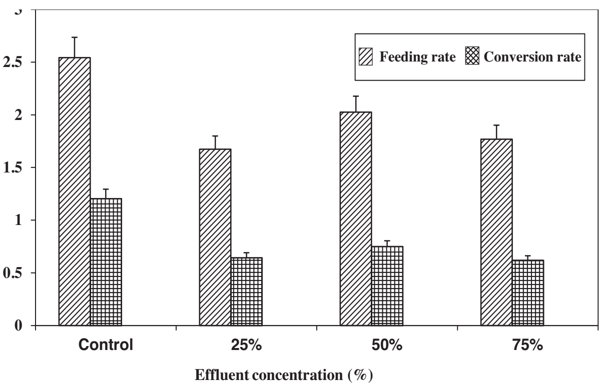

Figure 2

Feeding rates and Conversion rates in the fresh water fish Clarias batrachus exposed to control and differenct concentrations of treated sago effluent. Each value represents the mean performance of 6 individuals (+SE) for a period of 28 days.

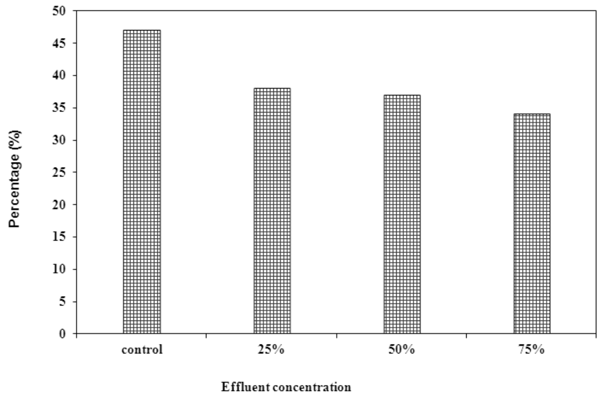

Figure 3

Conversion efficiency of Clarias bactrachus exposed to control and different concentrations of treated sago effluent . Each value represents a mean performance of 6 individuals(+SE) for a period of 28 days.

Discussion

Growth represents the net outcome of a series of biological processes such as food intake, digestion, assimilation, metabolism and excretion. (Brett & Groves, 1979; Beamish et al., 1975).The net energy is partitioned between maintenance activities, metabolism, growth and reproduction. Energy metabolism and growth compete for the net energy. Thus if metabolism is elevated, growth will be limited unless the intake of food is increased. Food intake is an important factor governing growth and reproduction. Certain environmental factors and pollutants influence the feeding rate, growth rate, conversion rate and conversion efficiencies of fish (Webb & Brett, 1972; Palanichamy et al., 1985; Palanivelu & Balasub,ramanian, 1997; Rani et al., 1998).

In the present investigation control group shows more growth rate when compared to other (25%, 50% and 75%) concentrations. Feeding rates, conversion rates and conversion efficiency were also in the higher side in control group. The growth rates, feeding rates, conversion rates and conversion efficiencies of the fish introduced in sublethal concentrations of the effluents recorded decreasing rates with increasing concentrations.

Similar observations were made by Shasikumar (2001) in the fish *Labeo rohita* reared in sago effluent Nagarajan and Ramesh (2001) while studying the influence of sago effluent on certain physiological and histological aspects of the fish *Catla catla* observed reduced rates of feeding, conversion and conversion efficiency when they were subjected to sub-lethal concentrations.

Maruthi et al., (2000) have reported that increasing the concentrations of distillery effluent indicated a decrease in energy supply metabolism through oxidative pathways which ultimately leading to less growth in the *Channa punctatus*. The feeding rate, conversion rate, conversion efficiency and growth rates of the fish *Catla catla* were comparatively reduced in the group exposed to sub-lethal concentrations of dyeing effluent than the control group (Nagarajan & Boopathyraja, 2004).

Baskaran et al. (1989) have found that energetic parameters like feeding and conversion rates have negative relationship with increasing concentrations of dyeing effluent. Reduction in food intake in *Mystus vittatus* reared in the chemical factory effluent which leads to reduced growth (Palanichamy et al., 1989).

Sivakumar et al. (2003) have investigated the decrease in food intake, growth metabolism and conversion efficiency of *Oreochromis mossambicus* reared in different groups of detergents.

Sub-lethal concentration of lead (Pb) on three different size groups of the estuarine catfish Mystus gulio, lead to decrease trend in feeding energetic, growth rate and biochemical composition when compared to their controls (Kasturi & Chandran, 1997).

Sakthivel et al. (1991) have reported that the dye stuff effluent sub-lethal concentrations reduced the food intake and caused a significant reduction in growth rate. Decrease in food consumption, growth and conversion efficiency was observed in the fish *Barbus stigma* reared in the industrial effluent (Haniffa & Sundaravadanam, 1983).

Oncorhyncus nerka reared in bleached Kraft mill effluent the growth rates and conversion efficiency were decreased (Webb & Brett, 1972). Baskaran et al. (1989) had studied the similar phenomenon and reduction in rates of absorption, growth and metabolism were also decreased with increasing concentrations in *Oreochromis mossambicus* when exposed to different concentrations.

Varadaraj et al. (1997) have observed the significant decrease in growth and conversion efficiency of the fish *Oreochromis mossambicus* reared sub lethal concentrations of the tannery effluent

Sheela et al. (1992) have observed the decreased rates of feeding, absorption, growth, metabolism and conversion efficiency of the fish *Channa striatus* exposed to fenvalerate and phosphamidon with increasing concentrations. Similar sequence of events has been reported in the fresh water fish *Rasbora daniconius* exposed to different HCH sub lethal concentrations.

Conclusion and Recommendations

From this investigation, it is clearly evidenced that the higher concentrations of this treated sago effluent have more toxic factor to the fishes than the lower concentrations, All the above findings were in conformity with the present investigation where the toxic effluents impede the food intake and growth. Hence proper dilution of the effluent makes the medium suitable for the survival and growth of the fish *Clarius batrachus*. The present study further recommends that the lower concentrations of treated sago effluent are suitable for aquaculture.

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