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Study of the growth rate, feed conversion ratio, and condition factor of goldfish: *Carassius auratus* under light/dark cycles

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ABSTRACT

An eleven-week experiment was conducted in a laboratory to study the effect of different light/dark cycles on Feed conversion ratio (FCR),Specific growth rate (SGR% day^{-1}), and Condition factor (K) of Goldfish, *Carassius auratus.* Fish were stocked in glass aquariums under four Photoperiodic regimes 18L/ 6D, 10L/14D, 6L/18D, an intermediate photoperiod 12L/12D and a control group was also held in laboratory conditions to compare the results with experimental groups. Application of Long photoperiod (18L/ 6D) resulted in the highest Specific growth rate (SGR % day-^{1}) feed conversion ratio (FCR) and Condition factor followed by other photoperiodic regimes 10L/14D, 6L/18D,12L/12D and Control group. ($P < 0.05$). These results demonstrated that the Feed conversion ratio, Specific growth rate and Condition factor of Goldfish can be stimulated clearly by using a extended light (18L/6D) regime in Goldfish *Carassius auratus*.

KEYWORDS

Conversion;
Carassius;
Specific;
Survival;
Extended;
Photoperiod.

INTRODUCTION

Fish plays an important role in the economy and development of a nation. Apart from being a cheap source of highly nutritive protein, it also contains other essential nutrients required by the body[49].

Developmental and maturational events in animals are influenced by genetic, environmental and nutritional factors. Environmental factors are particularly important in the growth of ectothermic vertebrates such as teleost fish, which rely on temperature and photoperiod[32,53].

Photoperiod, classified as a directive factor, controls growth as a zeitgeber through its influence on endogenous rhythms and circulating levels of growth hormones[50]. Many fish species react to photoperiod treatments. Exposure to extended and constant light photoperiod regimes has been shown to lead to increased growth rates in largemouth bass, *Micropterus salmoides*[41], Japanese medaka, *Oryzias iatipes* Whalibut, *Hippogiossus hippogiossus*[34,38], Turbot, *Scophthaimus maximus*[31,32], Haddock, *AJelanogrammus aegiefinus*[54], European Sea Bass, *Dicentrarchus iabrax*[44] and gilthead sea bream, *Sparus aurata*[36], Atlantic cod, *Gadus morhua*[25] and salmonids, *Salmo saiar*[28,37,40].

There seems to be a synergistic effect between food availability and light that improves the trophic activity of larvae[26] also this factor plays an important role in the growth and survival of larval fish[9,43]. Light regimes that permit rapid initiation of successful feeding should facilitate survival of larvae through early developmental bottlenecks, e.g. the switch from endogenous to exogenous food sources. Light intensity was also reported to affect swimming activity and feeding[3], cannibalism[35], skin color[45], physiological hormones[12], metabolism[5] and initiation of ecdysis[58].

Fundamental biological rhythms in nature are frequently related to the periodicity of light and many animals, including fish, exhibit a 24-hour cycle in their activities[26]. The condition of a fish is frequently used to reflect the overall effects of physiological and environmental factors particularly the nutritional status. Indices of condition which can be determined easily and quickly are needed in routine fisheries surveys and are good predictors of the body composition and growth rate of fish[16].

Photoperiod manipulation has been used successfully to improve the growth of some juvenile fish species[11,50,55,56]. Continuous additional light has also been used on the Atlantic salmon reared in the sea cages, especially during the spring and winter to enhance growth and delay sexual maturation rate[42,52].

The length-weight relationship of fish is an important fishery management tool. Its importance is pronounced in estimating the average weight at a given length group[10] and in assessing the relative well being of a fish population[13].

Condition factor has been used as an index of growth and feeding intensity[23]. Condition factor decrease with increase in length[23]; and also influences the reproductive cycle in fish[59]. Condition factors of different species of cichlid fishes have been reported by Siddique[48]; Fagade[22-24], Dodzie and Wangila[19], Arawomo[6] and Oni *et al.*[39]. Some condition factors reported for other fish species include; Alfred-Ockiya[2], *Chana chana* in fresh water swamps of Niger Delta and Hart[30], *Mugil cephalus* in Bonny estuary, Hart and Abowei[29], ten fish species from the lower Nun River, and Abowei and Davies[1].

The mechanism which regulates that rhythm and produces effects on growth are not completely clear, but photoperiod can influence the release of several hormones that affect fish larvae development and performance[26]. However, the best photoperiod for growth is frequently not the best one for survival[26].

Condition factor is one of the most important parameter, which throws light on the physiological state of the fish in relation to indication of the onset of the sexual maturity[46].

MATERIALS AND METHODS

Experimental fish

Goldfish *Carassius auratus* were collected from commercial dealer (weight 45 to 60 gm) were kept in an aquarium for acclimatization to laboratory conditions until the experiment began in March, then fish were transferred in five glass aquariums size 3 x3 x 2 feet. This experiment was carried out in the Fisheries research Laboratory in the Department of Zoology, Agra college Agra, India.

Environmental conditions

Aerated and dechlorinated water with flow rate of 1.5 L min^{-1} 9 ppm dissolved oxygen, 7.8 pH and 102 mg as $CaCO_3$ total water hardness was used. Experiment lasted for 9 weeks. The fishes were fed twice daily with commercial fish meal based extruded diet (diameter/mm; 55% Crudeprotein 14% Crude lipid, 4296 Cal g^{-1} diet gross energy) at 3.5% body weight at 10:00 am and 14:00 pm. Each aquarium was constantly aerated by electric aerators. The temperature was maintained throughout the experimental period by air coolers. Water was changed regularly in each aquarium after 48 h maintaining the water depth. After 2 hour after feeding uneaten feed were removed by the sandpipe at the bottom of the tank, dried and weighed to calculate net feed utilized by the fish. Each aquarium had 40 L water. Stocking density was maintained at 15 fish.40 l^{-1} water to avoid overcrowding and the fish were treated with tetracycline bath (0.012g.l^{-1}) to prevent the outbreak of bacterial infection. Twigs of *Vallisneria spiralis*, *Pistia stratiotis* and *Jussiaea repens* were arranged properly in the aquaria to present a natural condition.

Experimental design

Five glass aquariums were used size 3×3×2 feet, four for experimental groups and one for control group and each aquarium was stocked with 15 fish. Four photoperiodic regimes were used Illumination was done by fluroescent light done by fluroescent light of 25 lux, Photoperiod was controlled by a timer.

Weighing

To calculate and monitor various growth parameters and predict a daily food ratio, fish were individually weighed and zoometric measurements were taken before the start of the trial and then again every 2 wk.. To carry out the measurements, fish were removed from the aquarium using a net and placed into a holding bucket containing aquarium water. Fish were removed from the bucket individually and placed on laminated graph paper. The Total Length (TL) of the fish was measured from the tip of the anterior or part of the month to the caudal fin using meter rule calibrated in centimeters. Fish were measured to the nearest centimeter. Fish weight was measured after blot drying with a piece of clean hand towel. Weighing was done with a tabletop weighing balance, to the nearest gram. Length, from the mouth to caudal peduncle, and depth, from the deepest point of the body to base of dorsal fin, were measured (mm). Both fish and food weight data were used to calculate the specific growth rate and food conversion ratio, using the equations below[33]:

Specific growth rate (SGR) % =100 ×(1n. Final wt of fish - 1n. Intial wt of fish) / trial days

where ln is the natural log

Feed conversion ratio (FCR) % =Feed intake(g) / body weight gain(g)

The condition factor (k) of the experimental fish was estimated from the relationship:

Condition Factor (K) =100 W (g) / L^3

Where K= condition factor; W= weight of fish; L= length of fish (cm)

Statistical analysis

Data were analyzed by one-way analysis of variance (ANOVA). Significant difference among groups was determined by Duncan's Multiple Range Tests. Data are presented as mean ± Sem. The values of $p<0.05$ were considered significantly different.

RESULTS AND DISCUSSION

The specific growth rate (SGR %), Feed conversion ratio (FCR),Condition factor (K) of Goldfish exposed to different photoperiod regimes are presented in (TABLE 1). Graphic presentation of data of goldfish exposed to different photoperiod regimes are presented in Figure 1.

TABLE 1 : Showing mean ± standard error of mean for, specific growth rate, feed conversion ratio, and condition factor of goldfish (*Carassius auratus*) kept at different photoperiodic regimes.

	SGR (% day^{-1})	FCR	Condition Factor (K)
18L/6D	2.85±0.15	4.18±0.1	2.48±0.2
10L/14D	1.68±0.2	2.18±0.14	1.06±0.24
12L/12D	2.38±0.11	3.24±0.22	1.96±0.1
6L/18D	1.02±0.32	1.5±0.15	0.98±0.3
Control	2.06±0.18	2.75±0.54	1.25±0.28

Mean values with different letters are differed significantly at P ≤ 0.05

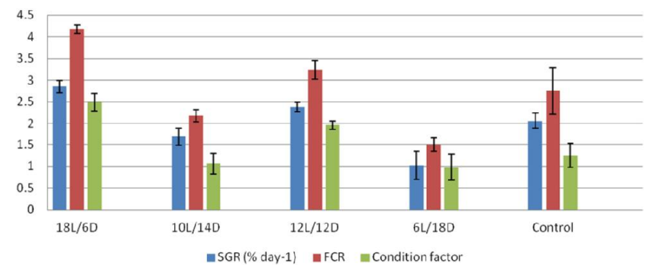

Figure 1 : Specific growth rate, feed conversion ratio and condition factor of goldfish *Carassius auratus* exposed to different Photoperiodic regimes, error bars represents standard error of mean

Environmental and nutritional factors notably influence fish growth. In addition to temperature, light/dark cycle is an important factor that affects organisms including fish. Alteration of artificial photoperiod can induce physiological and immunological changes in fishes[56]. It has been reported that several fish species react to longer photoperiod growth-stimulating light applications[26].

The results of photoperiod trial applied to the Goldfish *Carassius auratus* were significantly affected by the different photoperiod regimes. (SGR%) was significantly greater in group 18L/6D than control group and groups exposed to 12L/12D,6L/18D,10L:14D, Photoperiod regimes (P<0.05) (TABLE 1). Boeuf and Le Bail[26] clarified in their detailed gathering studies that the light has effects on the growth of fish. The 18 light hours produced the best daily growth rate, in comparison with 12,10,and 6 light hours and the control group. Similar results have been reported with several teleost fish, where the growth rates were improved with increasing light periods[26]. the growth of Barramundi *Lates calcarifer*[8] was better at 18 h light periods than shorter light periods. The growth rate of Seabream *Sparus aurata*[51], Salmonids[42] and rabbitfish *Siganus guttatus*[21] increased with extended light periods.

Feed conversion ratio (FCR) was significantly (*p<0.05*) affected by photoperiod treatments, and the best FCR was recorded in the 18 hrs light regime.. The feed conversion ratio (FCR) were increased with extended duration of light regime and significant differences (P<0.05) were found among groups. The feed conversion increased when fish were exposed to long Photoperiod regime 18L/6D in comparison with 10L/14D,12L/12D and 6L/18D light regime and Control group (TABLE 1). The feed conversion of goldfish was lowest when light was reduced to 6L:18D (P<0.05). Feeding frequency is an important consideration as it affects growth, survival and fillet composition[17]. The proper information of FCR on locally available ingredients will provide the basis to develop acceptable feed, though the task of preparing acceptable and suitable artificial feed for Fishes is complicating due to its feeding preference[42].

The best Condition factor (K) was observed in the fish kept at 18L/6D Photoperiod regime followed by those maintained at 10L/14D,12L/12D, 6L/18D and control group, differed significantly (P < 0.05). The better Condition factor in long photoperiods, confirming that presence of light became an important factor for better development of fishes. It is strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to assess the status of the aquatic ecosystem in which fish live. Condition factor compares the well being of a fish and is based on the hypothesis that heavier fish of a given length are in better condition[7].

Furthermore, Vazzoler[57] confirmed that lowest K values during the more developed gonadal stages might mean resource transfer to the gonads during the reproductive period[14], although other authors, showed that the values of condition factor vary according to seasons and are influenced by environmental conditions. Most of the fundamental rhythms in nature (diurnal or seasonal) are related to the periodicity of light. Fish exhibit a 24 h cycle in their activities and they are either more active in light, less active in darkness, or vice versa. Photoperiod cycles play a role in fish growth and metabolism. It is strongly influenced by both biotic and abiotic environmental conditions[4]. Condition factors of different tropical fish species were investigated and reported by Bakare (1970) and Saliu[47]

The present results revealed that photoperiods significantly affect the growth feed intake, and Condition Factor of Goldfish. In conclusion,18L:6D regime is suggested for optimal growth performance, better feed conversion ratio and Condition factor of Goldfish *Carassius auratus*, as, under this Photoperiod, Specific growth rate, Feed conversion Ratio, and Condition factor increased significantly than other experimental regimes. Long photoperiods significantly improve growth, as in *Sparus aurata*[15] *Archosargus rhomboidalia*[20], Solea solea, as our results shows that although the best values were obtained with the 18L/6D photoperiod; this same photoperiod also gave the best results in growth, short light periods of less than 18 hours do not appear to be the most suitable for obtaining a favourable conditions for better development in Goldfish.

Longer photoperiods have been associated with increased growth in fishes of various ages[27]. Therefore, It is supposed that correct application of photoperiod may improve performance, profitability and sustainability of aquacultural practices

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