Asian Fisheries Science 6(1993):249-254.
Asian Fisheries Society, Manila, Philippines
https://doi.org/10.33997/j.afs.1993.6.2.016

Effects of Dietary Carbohydrate Level on the Growth and Conversion Efficiency of the Indian Major Carp Fingerling, *Labeo rohita* (Ham.): A Preliminary Study

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Abstract - Effect of varying levels of dietary carbohydrate on the growth and conversion efficiency of fingerling *Labeo rohita* (Ham.) have been reported. During the 6-week feeding trial, a linear growth pattern (ANOVA $P<0.01$) was noted. The level of carbohydrate that produced maximum growth and the best feed efficiency was 30%, corresponding to an energy to protein ratio of 8.83 kcal·g^{-1} protein. Beyond the above level of carbohydrate incorporation in the diet, various growth parameters of fish seemed negatively affected ($P<0.01$).

Although digestive and metabolic systems of fish are known to be better adapted to use of protein and lipid than carbohydrate for energy, some warmwater species, particularly herbivores and omnivores, digest and metabolize carbohydrates relatively well. The use of dietary carbohydrate and its influence on fish growth have been reviewed (NAS-NRC 1983; New 1986; Cowey 1988). However, carbohydrate nutrition in carps is not clearly understood (Jauncey 1982a). This paper reports the effect of varying dietary carbohydrate levels on the growth and conversion efficiency of fingerling *Labeo rohita*.

Four isonitrogenous, casein-gelatin based experimental diets containing varying levels (20-35%) of carbohydrate were formulated (Table 1), with crude protein fixed to 40% as per the requirement of the species (Khan 1991). Gross energy content of the diets, esti-mated on Gallenkemp ballistic (adiabatic) bomb calorimeter, ranged

Table 1. Ingredient and proximate composition of experimental diets.

	Diets			
Ingredient ($g \cdot 100g^{-1}$ as fed)	I	II	III	IV
Casein (c.p. 84%)	38.09	38.09	38.09	38.09
Gelatin (c.p. 87.6%)	9.13	9.13	9.13	9.13
White dextrin	20.00	25.00	30.00	35.00
Corn oil	5.33	5.33	5.33	5.33
Cod liver oil	2.67	2.67	2.67	2.67
Mineral mix[1]	4.00	4.00	4.00	4.00
Vitamin mix[1]	1.00	1.00	1.00	1.00
Carboxymethyl cellulose	2.00	2.00	2.00	2.00
∝ cellulose	17.78	12.78	7.78	2.78
Proximate composition (%)				
Moisture	7.85	7.88	7.92	7.81
Crude protein	40.00	40.00	40.00	40.00
Crude fat	8.00	8.00	8.00	8.00
Digestible carbohydrate	20.00	25.00	30.00	35.00
Ash	4.05	4.07	4.04	4.08
Fiber	20.10	15.05	10.04	5.11
Gross energy $kcal \cdot g^{-1}$	402.95	422.10	441.25	460.40
Metabolize energy $kcal \cdot g^{-1}$	318.00	335.50	353.00	370.50
E/P ratio	7.95	8.39	8.83	9.26

[1]Halver (1976); [2]Based on estimated fuel values, 5.52, 4.83, 3.83 and 9.0 $kcal \cdot g^{-1}$ for casein, gelatin, dextrin and oil, respectively; [3]calculated using energy equivalents, 4.5, 8.5 and 3.5 $kcal \cdot g^{-1}$ for protein, fat and carbohydrate, respectively (Jauncey 1982b).

from 403 to 460 $kcal \cdot g^{-1}$ dry diet. The proximate composition of the diets was determined according to standard methods (AOAC 1984). The method of preparation of the diet was the same as adopted by Khan and Jafri (1990).

Fingerling *L. rohita* (5.4-6.7 cm; 2.65-2.78 g) were sorted out from fish acclimated on a casein-gelatin (40% CP) diet in the laboratory, and stocked in a set of three replicates of 30 fish each in 70-l high density polyvinyl circular troughs (55 l water) with continuous water flow-through (1-1.5 $l \cdot min^{-1}$). Fish were fed the experimental diets 6 days a week in the form of moist cake, twice daily at 0800 and 1600 hours, at a total rate of 4% of their body weight. Diet leftover, if any, and fecal matter were siphoned off daily before feeding. Weekly scrubbing and cleaning of troughs was carried out. Initial and weekly weight gains were recorded after anaesthetizing

(1:10,000) the fish with Ayerst's Finquel (tricane methanesulfonate). Average water temperature and dissolved oxygen over the 6-week trial, based on daily measurements, ranged between 21-25°C and 6.4-6.8 ppm, respectively. Natural photoperiod (light:dark) was maintained. Growth parameters and food efficiency were calculated using standard definitions. The results were statistically tested by one-way analysis of variance (ANOVA) and the standard t-test.

Table 2 depicts the growth performance and feed efficiency of *L. rohita* at different dietary treatments. Live weight gain percentage in fish varied significantly (ANOVA $P<0.01$) with levels of dietary carbohydrate. The fish registered the maximum gain (65%) in live weight up to 30% dietary carbohydrate intake and thereafter a significant ($P<0.01$; t-test) fall in weight was noted. Specific growth

Table 2. Growth and feed efficiency of *L. rohita* fingerlings fed varying levels of carbohydrate.

	Dietary carbohydrate levels			
	20%	25%	30%	35%
Initial individual wet weight (g)	2.73 ±0.065	2.67 ±0.069	2.73 ±0.058	2.76 ±0.046
Final individual wet weight (g)	4.14[a] ±0.005	4.23[b] ±0.173	4.50[c] ±0.153	4.12[a] ±0.026
Increase in body weight (%)[1]	51.42[a] ±3.52	58.22[b] ±2.38	64.84[c] ±2.18	49.26[a] ±1.58
Specific growth rate (%)[2]	0.986[a] ±0.055	1.091[b] ±0.036	1.183[c] ±0.032	0.953[ab] ±0.025
Food conversion ratio[3]	3.43[a] ±0.19	3.05[b] ±0.07	2.83[c] ±0.08	3.52[a] ±0.09
Protein efficiency ratio[4]	0.732[a] ±0.042	0.817[b] ±0.020	0.881[bc] ±0.045	0.706[a] ±0.019
Survival (%)	100	100	100	100

Results are mean of triplicate runs (±SEM); Values in the same row with the same superscript are not significantly different ($P>0.01$).

[1]Percentage increase in body weight = Fn BW_t-In BW_t/ In BW_t x 100; [2]Specific growth rate (%) = Log_e Fn BW_t-Log_e In BW_t/Duration x 100; [3]Food conversion ratio = Food intake (dry weight, g)/ weight gain (wet weight, g); [4]Protein efficiency ratio = Fn BW_t-In BW_t/protein intake (g), where In BW_t = initial average body wet weight (g); Fn BW_t = final average body wet weight (g).

rate (%) increased almost linearly with dietary carbohydrate up to 30% incorporation. The best food conversion ratio (2.8:1) was also obtained at the above level of carbohydrate intake. At a higher level (35%) of carbohydrate intake, the conversion efficiency was adversely affected. Similarly, protein efficiency ratio increased progressively up to 30% carbohydrate inclusion in the diet.

The optimum levels of dietary carbohydrate for most fishes are reported to be within the range of 10-30% (NAS-NRC 1983), with tilapia perhaps being the only exception where carbohydrate in the diet as high as 40% was not found to depress growth (Anderson et al. 1984). Although carps are known to tolerate and use relatively high levels of carbohydrate incorporation in the diet (Furuichi and Yone 1980), a considerable disparity exists as to the efficiency of their carbohydrate utilization (Jauncey 1982a). More recently, Furuichi et al. (1987) indicated that carps grow well even on diets containing low levels of dietary carbohydrate. In general, warmwater fish have no true carbohydrate requirement (NAS-NRC 1983), but incorporation of a certain level of carbohydrate in the diet influences conversion efficiencies and overall growth of the fish, as is evident from the present study on *L. rohita* fingerlings. These findings seem to conform with the observations on spawn, fry and fingerlings of Indian major carps, including *L. rohita* (Sen et al. 1978; DARE 1984; Swamy et al. 1990). The fall in dietary performance beyond a fixed level of carbohydrate intake observed in *L. rohita* was also evident in common carp (Shimeno 1982) and *C. catla* (Swamy et al. 1990).

Better performance of diet at 30% carbohydrate level in *L. rohita* fingerlings could be the result of sparing action of carbohydrate on protein. Similar sparing action has also been pointed out in tilapia (Anderson et al. 1984) and carp (Shimeno et al. 1981). The pattern of changes in PER of *L. rohita* with varying levels of dietary carbohydrate also indicates better protein use at the above level (30%) of dietary carbohydrate. A corollary to this finding was apparent in the work of Ufodike and Matty (1983) on mirror carp. However, in European eel, the PER was reported to decrease with increased carbohydrate intake (Degani and Viola 1987). The present study strengthens the view that in fishes, carbohydrate use is species specific, and that inclusion of carbohydrate up to a fixed level in the diet may improve growth and feed efficiency, besides making the diet cost effective.

Depressed growth and poor feed efficiency noted in *L. rohita* with diets containing levels of carbohydrate higher than the requirement, point to the fact that this fish is unable to handle over 30% dietary carbohydrate. The reduction of growth at 35% carbohydrate incorporation may also be attributed to altered energy to protein ratio, from 8.83 kcal·g^{-1} protein in 30% carbohydrate diet to 9.26 kcal·g^{-1} protein in 35% carbohydrate diet. Takeuchi et al. (1979) observed optimum growth of carp at almost similar energy to protein ratio. The gross carbohydrate requirement of *L. rohita* at the fingerling stage appears to be 30% of dietary inclusion. It may, however, be pointed out that the overall low growth of fish observed in the present study may be the result of low water temperature, since Indian major carps prefer slightly higher temperature, close to 30°C (Jhingran and Pullin 1988). However, low water temperature during the study did not show any deleterious effects on the survival of the fish.

Acknowledgements

The authors are greatly indebted to Prof. John E. Halver, School of Fisheries, HF-15, University of Washington, USA, for his valuable advice; and to the Chairman, Department of Zoology, Aligarh Muslim University, Aligarh, for providing the laboratory facilities. This study forms part of research (Grant No. FG-IN-645) financed by the United States Department of Agriculture, Office of International Cooperation and Development, Special Foreign Currency Research Programme.

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Manuscript received 20 March 1992; revised ms received 17 December 1992; accepted 28 June 1993.