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CARBOHYDRATE TO LIPID RATIO(CHO/L) IN PRACTICAL TILAPIA DIETS:

2- RESPONSE OF BODY SIZE IN HYBRID TILAPIA *(OREOCHROMIS NILOTICUS X OREOCHROMIS AUREUS)* TO INCREASED LEVEL OF CHO/ L RATIO IN DIETS.

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ABSTRACT

Four artificial diets were formulated to contain four carbohydrate to lipid ratios (CHO/ L) (2, 4, 6 and 8). The gross energy of each diet was adjusted by balancing the biscuit industry by – product as a carbohydrate source and cotton seed oil mix to provide four tested CHO:L ratios. The diets were used to determine the optimum dietary level of CHO:L ratio for two sizes of hybrid tilpia initially weighing 10.0 and 80.0g for 160 days.

Growth values were better with feed 4CHO:L ratio for the smaller fish, whereas similar (4) CHO:L ratio yielded the highest feed conversion efficiency, protein, energy and lipid retained for the same size (with the starting average weight 10.0g respectively). However, feeds with 6 CHO:L ratio proved better in large hybrid tilapia (initially weighing 80.0g). The hepatosomatic index showed higher values for feeds with 8 CHO:L ratio in the case of small and large fish, but the opposite was observed for liver lipid content which showed a tendency toward higher values for 2 CHO:L ratio in both small and large hybrid tilapia. These data suggest that small hybrid tilapia can perform well with diet containing 4 CHO:L ratio, whereas large fish may be as efficiently at 6 CHO:L ratio .

INTRODUCTION

One of the challenges which face fish nutritionists is to spare expensive dietary proteins with inexpensive non- protein energy sources such as lipids and carbohydrates. Jantrarotai *et al.* (1994)

found that lipids and carbohydrates are added to fish diets to provide metabolic energy and thereby spare dietary protein. The incorporation of high dietary levels of non – protein energy (fats or digestible carbohydrates) might alter body composition, particularly through an increase in lipid deposition (Hillestad and Johnsen 1994). Likimani and Wilson (1982) reported that carbohydrates are more readily available and much less expensive than lipids, but excess dietary carbohydrate may lead to fat deposition by stimulating lipogenic enzymes. The results presented by Lin and Shiau (1995), suggest that malic enzyme, glucose-6- phosphate dehydrogenase and phosphogluconate dehydrogenase activities were higher in hybrid tilapia *(Oreochromis niloticus X O. aureus)* fed the starch diet than in those fed the glucose diet. Tung and Shiau (1993) suggested that hybrid tilapia were better in glucose tolerance in large fish (4.55 ± 0.1 g) compared to small fish (0.46 ± 0.02 g). Furthermore, Arnesen *et al.* (1993), showed that fat- rich diets were found to depress activities of several lipogenic enzyme in Atlantic salmon. However, high- carbohydrate diets stimulated enzymes involved in fatty acid synthesis in channel catfish (Likimani and Wilson, 1982). This study was conducted to elucidate whether hybrid tilapia with two body sizes (10 or 80 g) utilize low CHO:L ratio better than high CHO:L ratio in order to improve the rearing conditions and profitability of cultured hybrid tilapia.

MATERIAL AND METHODS

Four carbohydrate to lipid ratios (2, 4, 6, and 8 CHO/ L ratio) were tested (Table 1). The diets were analysed for moisture, crude protein, total lipid and ash by standard AOAC methods (AOAC, 1995).

Hybrid tilapia with two different sizes were acclimated to outdoor cement pond (subdivided by netting, 10 m^2 / unit) and fed on a commercial pelleted diets for two weeks.

At the beginning of the experiment, four rearing units were each stocked each with 40 small fish (average weight: 10.9 ± 1.6g) and four more rearing units were stocked with large fish (average weight: 80.5 ± 2.4g). Rearing units were supplied with fresh water from Nile River. The water was examined twice weekly for temperature (28.7 ± 3.6 °C), pH (7.3 ± 0.41); Oxygen (5.8 ± 0.46 mg / L) and ammonia (0.33 ± 0.06 ppm); according to the methods described by APHA (1992). The experimental diets were offered at a rate of 5% of the body weight / day on a plastic trays (40 cm diameter) and the tray was placed in each raring unit. Ten minutes after feeding, the tray were taken out of the rearing unit and the ratios left in the tray was filtered, dried in an oven 80°C for 24h, subsequently weight to determine the actual amount of food consumed. All experimental fishes were fed twice daily at 9.0 a.m. and 2.0 p.m. each group of fish was weighed once every twenty days and the amount of diet fed was adjusted accordingly. The fish were fed the test diets for an 160 days period (from 24 April to 30 September, 2000).

At the beginning and end of the feeding trial, fish were weighed and counted. Ten fish were then taken randomly from each rearing unit, for determination of liver weight, chemical body composition (AOAC, 1995) and liver lipid according to Folch *et al.* (1957) and muscle gross energy calculated using NRC (1983) [K cal / 100 g = 5.7× % crude protein × 9.5 × % ether extract] .

In order to detect statistically significant differences, experimental values were compared using one-way analysis of variance (Snedecor and Cochran 1980) and a multiple range test (Duncan's , 1995). The significant level was selected at $p < 0.05$.

RESULTS

During the experimental period, mortality ranged from 3 to 6 fish / rearing unit for both small and large fish respectivaly . Average fish weight continuously increased throught the experiment for both sizes tested (Fig 1 a, b). Growth values were better with feed of 4 CHO:L ratio, although differences were statistically significant ($p < 0.05$) between treatment for the smaller fish (Table, 2, Fig 2). Feeding diets with 6 CHO:L ratio produced the largest weight gain in large hybrid tilapia (with the starting average weight of about 8.0 g) (Table.3).

With respect to diet nutritional utilization (Table 2, fig3) feeding a diet with 4 CHO:L ratio yielded the highest feed conversion efficiency; protein, energy and lipid retention; followed by feed 6 CHO:L ratio for small hybrid tilapia, whereas, feeds with 6 CHO:L ratio proved better than 4 CHO/L ratio in large hybrid tilapia (Table3, Fig3).

In case of the small and large fish, body composition (Tables 4 and 5) was somewhat different but insignificant ($P > 0.05$). The hepatosomatic index values presented in tables (4 and 5) show higher values for feeds with 8 CHO:L ratio, although these differences were significant only for larger fish. The percentage total liver lipid although below statistical significance ($P < 0.05$), showed a tendency toward higher values for 2 CHO/L ratio in both small and large hybrid tilapia.

DISCUSION

The poor ability to utilize CHO:L ratio in small fish than large fish, seems to confirm the minor role played by NFE in large hybrid tilapia nutrition than smaller size of fish (Al- Asgah and Ali, 1993; Tung and Shiau, 1993), where carbohydrate utilization in tilapia differed according to the body size or age of the fish. On the other hand, Nematipour *et al.* (1992) found that weight gain of Juvenile sunshine bass *(Morone chrysops X M. saxatilis)* (1.0 g average initial weight) was relatively unaffected by changes in dietary carbohydrate: lipid ratio, ranging from 25: 10 to 42: 2.5.With advanced Juvenile sunshine bass Hutchins *et al.*, (1998), showed that weight gain was markedly depressed when fed isocaloric diets containing 40% as compared to 20 % soluble carbohydrate. In this connection, Nankervis *et al.* (2000), found that the poor utilization of carbohydrate by Juvenile barramundi *(lates calcarifer)* (50-200g) up to an inclusion level of approximately 17%, but with fingerling barramundi could effectively utilize carbohydrate up to a 20% inclusion level (Catacutan and Coloso, 1997).

As presented in Table (3) the higher SGR recorded for large hybrid tilapia fed 6 CHO / L ratio may be attributed to increase of the total intestinal enzyme activity with fish age due to the increase of the intestinal size and mucosa weight (Kuz' mina, 1980). Ferrairs *et al* (1986), showed that digestibility could increase with size in omnivorous and herbivorous fishes due to the relative increase in intestinal length, thereby prolonging digestion and assimilation time. Also, Rajamani and Job (1976), found that absorption efficiency was directly related to fish size in *Tilapia mossambica* in freshwater. In this connection, Buddington (1985) and Buddington and Doroshov (1986 a, b) observed that both amylolytic and lipolytic activities were very high in digestive tracts of larvae of sturgeon *(Acipenser transmontanus)*, but activities decreased in older fish, while proteolytic activities increased with age. Also these authors found that the availability of carbohydrates to larval lake sturgeon was greater than Juveniles and adults and that the enzyme complement of sturgeon was dominated by proteases reflecting their carnivorous feeding habits. The last explanation might be comparable to the results listed in Tables (2, 3) with different feeding behavior and biochemical composition of the food for hybrid tilapia. The results of Kuz'mina (1996) indicated that changes in digestibility enzymes activity are effected by feeding behavior and biochemical composition of the food as well as the onset of sexual maturity.

In this sense, Hidalgo *et al.* (1999), postulated that amylase activity depends on the natural diet of each species, herbivorous and omnivorous fish having more activity than carnivorous. Though, Ugolev *et al.* (1983), found that the ratio of amylase: protease activity in omnivorous and herbivorous fish was higher than in carnivorous fish. Furthermore Tengjaroenkul *et al.* (2000), showed that Nile tilapia as in other teleosts fish generally absorb carbohydrates in the form of monosaccharides, where (Buddington *et al.*, 1987), found that herbivorous fish typically relying more on this pathway than carnivorous fish because maltase hydrolyses the disaccharide maltose to produce the monosaccharide glucose. Also the same authores show the greatest maltase activity occurring in the gastric loop of Nile tilapia *(Oreochromis niloticus)* which suggests that the middle intestinal region is the most active region in formation of glucose. Also, Nagase (1964) reported the greatest amylase activity from the middle portion of the intestine of *Tilapia mossambica*, similar to that observed by Tengaroenkul *et al.* (2000), in Nile tilapia for maltase.

The increased ability to utilize CHO:L up to 6 in large fish (Table 3) may be due to decrease in dietary lipid, which was more appropriate for tilapia diet. (Tengjaroekul *et al.*, 2000), found that the restricted distribution of lipase enzyme in the Nile tilapia concurs with pervious reports that lipiase activity is lowest in herbivorous fish (Opuszynski and Shireman, 1995), related to the low fat content in plant materials naturally consumed by tilapia (Vonk and Western, 1984; Opuszynski and Shireman, 1995).

The significant differences in growth rate among the four CHO:L ratios within two body size (Tables 2 and 3) may be attributed to enzyme activities stimulated by lipid and carbohydrate of dietary hybrid tilapia. The same trend was also observed by Lin and Shiau (1995), who found that malic enzyme; glucose-6- phosphate dehydrogenase and phosphogluconate dehydrogenase activities were higher in the Juvenile tilapia *(Oreochromis niloticus X O.aureus)* fed on the starch diet than in those fed on the glucose diet. The same authors showed that lipogenic enzyme activity can adapt to dietary carbohydrates in the fish liver. In the common carp, Shimeno *et al.*, (1995), found that the activity of liver glucose-6- phosphate dehydrogenase (G6PD) decreased with increasing dietary fat levels. However, in channel catfish, Likimani and Wilson (1982), reported that hepatic activities of G6PD and malic enzyme increased with increasing levels of dietary dextrin. However, they observed a marked stimulation of hepatic lipogenic enzyme activities by diet containing carbohydrate in catfish and suggested that this observation might explain why catfish can utilize higher levels of carbohydrates than certain other fishes. The results present in Tables (2) and (3); Fig (3) show that feeded conversion ratio and feed conversion efficiency with each body size test in hybrid tilpia were relatively affected by the changes in dietary carbohydrate to lipid ratio. These results are in agreement with that of Hutchins *et al.* (1998), who reported that feed efficiency of advanced Juvenile sunshine bass *(M. chrysops X M. Saxatilis)* were markedly depressed when fed isocaloric diets containing 40% as compared to 20% soluble carbohydrate. In contrast, Nematipour *et al.* (1992) found that feed efficiency of Juvenile sunshine bass (1.0 g average initial weight) were relatively unaffected by changes in dietary carbohydrate: lipid ratio ranging from 25: 10 to 42:2.5. Nankervis *et al.* (2000) suggested that carbohydrate is well utilized as a dietary energy source by Juvenile barramudi (50-200g) *(Lates calcarifer)* up to an inclusion level of proximately 17%. However, Catacutan and Colso (1997) found that fingerling barramundi could effectively utilize carbohydrate up to a 20% inclusion level. Page and Andrews (1973), showed that feed conversion ratios were typically higher for the larger channel catfish (*Ictalurus punctatus*) than for the smaller fish. Also they found that small fish convert fat more efficiency and large fish convert corn more efficiency. These results are comparable to the present results (Tables 2 and 3) which emphasize narrow CHO:L ratio for small hybrid tilapia and higher CHO:L ratio for large fish. In this connection, Baragi and lovell (1986), showed that activity of α-amylase in the digestive tract of larval striped bass beginning at day 4 post-hatch. The principal action of this enzyme is the hydrolysis of dietary starch to maltose and maltotriose (Gray, 1992). The same author found that form of carbohydrates transported across the intestinal membrane are monosaccharides, maltose and maltotriose must be further hydrolyzed via intestinal maltose before transport can ensue. Also, Tung and Shiau (1993), reported that the difference between the carbohydrate source with change in fish size may affect feed efficiency. They found that hybrid tilapia gain significantly more body weight, had a better FCR than small fish when fed a glucose diet. However FCR of the large fish and small fish were similar when the starch diet was fed.

On the other hand, the effect of dietary fat level on carbohydrate digestibility was conclusive as shown by Shcherbina *et al.* (1977). These authores found in parts of the gut of common carp lower amylase activity and lower resumption of easily hydrolyzed carbohydrates when the fish were fed diets containing 5 and 10% fat in comparison with a diet and one containing 7.5% fat. However, Helland and Helland (1997), proposed the negative relationship between carbohydrate level in the diet and fat digestibility.

The results of Table (3) might explain the gradual increase of lipid retained with large hybrid tilapia fed 2 to 8 CHO:L ratio. In this connection, Arnesen *et al.* (1993), showed that fat rich diets were found to depress activities of several lipogenic enzyme in Atlantic salmon. However, high carbohydrate diets stimulated enzymes involved in fatty acid synthesis in channel catfish (Likimani and Wilson 1982). Hung *et al.* (1989), found that the lack of lipogenic effects in sturgeon fed lactose, sucrose or fructose has been attributed to low intestinal lactase and sucrase activity. However, intestinal disaccharidase activities in small tilapia (0.62g) were found to be unaffected when the carbohydrate sources were either glucose, dextrin or starch (Tung and Shiau, 1993).

In the present study, the body fat content increased with body size (Fig 4c). This agrees with Tung and Shiau (1993) who suggested that the body lipid content was higher in large hybrid tilapia than in small fish irrespective of carbohydrate sources. With sharpsnout sea bream *(Diploduz puntazzo)* Hernandez *et al.*(2001) attributed the higher fat percentage in fish to the larger size attained. Also, similar results have been reported by Lie *et al.* (1988) with Atlantic salmon *(Salmo salar)* and Degani *et al* (1986) with European eels *(Anguilla anguilla)*. These studies revealed that lipid deposition is more dependent on fish size than the lipid level in the feed.

The differences in hepatosomatic index (HSI) and liver lipid content of both small and large hybrid tilapia (Table 4, 5 and Fig. 3) fed different carbohydrates to lipid ratios were obvious only when the diets contained high carbohydrate or high lipid (8 CHO/L or 2

CHO/L ratio respectively). Feeding the high carbohydrate diet tended to produce high HSI while feeding the high lipid diet tended to yield a high liver lipid content. Similar observation has been reported for hybrid catfish *(Clarias macrocephalus X C.gariepinus)* (Jantrarotai *et al.*, 1994), for cannel catfish (Garling and Wilson, 1977) and for salmonids (Buhler and Halver, 1961) and were attributed to increased glycogenic processes and deposition of excess lipid, respectively.

From the present results, it can be concluded that dietary CHO:L ratio is well utilized as a dietary energy source by small hybrid tilapia (10.0 g initial body weight) up to an inclusion level of approximately 4 ratio. However, large fish (80.0 initial body weight) could effectively utilize CHO:L ratio up to a 6 CHO:L ratio inclusion level.

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Table (1): Formulation and proximate composition of the experimental diets.

Crude protein level (%)	**30**			
CHO/ L ratio	**2**	**4**	**6**	**8**
Component				
Fish meal (72% CP)	14.8	28.0	21.7	28.0
Soybean meal	38.7	15.0	25.0	13.0
Biscuit industry by-product (1)	26.3	48.0	49.4	54.0
Bone meal	8.68	3.0	-	3.0
Cotton seed oil	9.25	4.0	1.9	-
Vitamin and mineral premix (2)	2.0	2.0	2.0	2.0
Nutrient content				
Moisture	11.7	10.2	11.6	12.2
Crude protein (CP)	29.38	29.76	29.1	29.3
Ether extract (EE)	13.21	9.05	6.7	5.21
Crude fibre (CF)	9.58	7.12	7.33	5.92
Ash	8.09	6.85	4.21	4.76
Nitrogen free extract (NFE)	28.04	37.52	41.06	42.61
Gross energy (3) (K.cal/100g diet)	405.7	404.5	397.3	390.8
Protein energy x 100 / Gross energy	40.9	40.83	40.7	41.6
CHO energy / gross energy	29.0	39.0	43.4	45.8
CHO / L * ratio	2.12	4.15	6.13	8.18

*CHO:L (Carbohydrate –to –lipid ratios diet).

1-Biscuit industry by –product (6.3% Cp; 3.80% EE; 74.2% NFE; 2.0 fiber; 2.4% ash and 11.3% moisture).

2-Vitamin and mineral premix (each 1kg contains: 4.8m. I.U. vit A; 0.8 m.I.U. vit D3; 4.09 vit. E; 0.8g vit K; 4 g vit. B12; 4.0g vit B_2 ; 0.6g vit B6; 4.0 g vit pantothenioc acid; 8.0 g vit Nicotinic acid; 400 mg vit Folic acid; 20mg vit. Biotin; 200g choline chloride; 4.0 g copper; 0.4 g Iodine; 12 g Iron; 22 g Manganese; 22g Zinc and 0.04 g Selenium.

3-Gross energy (kcal /100g diet) Calculate by NRC (1977)= 5.55 X % crude protein + 9.45 X% ether extract +4.2X % nitrogen free extract.

Table (2): Effect of different CHO/L ratios on hybrid tilapia growth and nutrient utilization (small fish).

CHO/ L ratio	**2**	**4**	**6**	**8**
Initial body weight (g)	10.6 ± 1.3	11.0 ±1.5	11.2 ± 1.9	10.8 ± 1.6
Final body weight (g)	71.0 ± 3.7 b	86.2 ± 3.9 a	84.7 ± 4.8 a	77.7 ± 3.1 b
Weight gain (%)(1)	571.4 ± 12.9 c	682.3 ± 14.5 a	657.2 ± 15.6 ab	621.7 ± 16.5 b
Specific growth rate (2)	1.19 ± 0.03 b	1.29 ± 0.05 a	1.27 ± 0.04 a	1.24 ± 0.03 ab
Feed intake (g)	148.6	157.1	156.5	149.8
Feed conversion ratio (3)	2.46 ± 0.25 a	2.09 ± 0.23 b	2.13 ± 0.19 b	2.24 ± .21ab
Feed conversion efficiency (4)	40.7 ± 2.7 b	47.9 ± 2.5 a	47.0 ± 2.2 a	44.7 ± 3.2 ab
Protein efficiency ratio (5)	1.38 ± 0.11 b	1.64 ± 0.20 a	1.58 ± 0.13a	1.52 ± 0.15a
Protein retained % (6)	21.5 ± 1.9 b	26.5 ± 2.1 a	25.5 ± 2.3 a	24.3 ± 1.9 ab
Energy retained % (7)	14.8 ± 1.2 b	17.3 ± 1.6 a	16.4 ± 1.8 a	15.9 ± 2.1 ab
Lipid retained % (8)	18.0 ± 2.5 c	39.0 ± 3.7 a	27.7 ± 3.0 b	44.2 ± 3.5 a

Data represent the mean ± S.E.

a, b and c means in the same row with different superscript are significantly different ($P< 0.05$).

1) WG(%) = *100x (final body weight –initial body weight)/ initial body* weight.
2) SGR (%day) = (Ln final body weight –Ln initial body weight) x100 /days.
3) Feed conversion ratio (FCR) = feed consumption (g)/ weight gain (g)
4) Feed conversion efficiency % (FCE) = (weight gain (g)/ feed consumption (g))x100.
5) Protein efficiency ratio (PER) =weight gain (g)/ protein intake (g).
6) Protein retained % (Pr)= fish protein gain x100 /protein intake (g).
7) Energy retained % (Er) =fish energy gain (Kcal) x100/Energy intake (kcal).
8) Lipid retained %(Lr) = fish lipid gain (g) x100/ lipid intake (g).

Table (3): Effect of different CHO:L ratios on hybrid tilapia growth and nutrient utilization (large fish)

CHO/ L ratio	2	4	6	8
Initial body weight (g)	81.9 ± 2.1	80.5 ± 1.9	79.6 ± 2.8	80.1 ± 2.5
Final body weight (g)	286.3 ± 5.6 b	279.9 ± 4.8 bc	295.2 ± 5.2 a	275.2 ± 5.9 c
Weight gain (%)	249.5 ± 8.5 b	247.6 ± 7.9 b	270.7 ± 8.1 a	243.7 ± 8.4b
Specific growth rate	0.78 ± 0.02	0.78 ± 0.03	0.82 ±0.03	0.77 ± 0.02
Feed intake (g)	639.7	570.1	569.3	579.4
Feed conversion ratio	3.13 ± 0.31 a	2.86 ± 0.22 b	2.64 ± 0.25 c	2.97± 0.24 ab
Feed conversion efficiency	32.0 ± 2.4 b	35.0 ± 2.6 ab	37.9 ± 3.1 a	33.7 ± 2.8 b
Protein efficiency ratio	1.09 ± 0.08 b	1.17 ± 0.11 b	1.30 ± 0.09 a	1.15 ± 0.13 b
Protein retained %	17.0 ± 1.6 b	19.5 ± 2.1 ab	21.3 ± 2.4 a	17.7 ± 1.8 b
Energy retained %	13.7 ± 1.7 b	14.5 ± 1.5 ab	16.0 ± 1.9 a	13.6 ± 1.7 b
Lipid retained %	20.7 ± 1.9 c	29.9 ± 2.4b	44.5 ± 3.3 a	47.4 ± 4.1 a

Data represent the mean ± S.E.

a, b and c means in the same row with different superscript are significantly different (P< 0.05).

Table (4): Effect of different CHO:L ratios on hybrid tilapia body composition and somatic parameters (small fish)

CHO/ L ratio	Initial	2	4	6	8
Moisture	73.1 ± 2.2	72.5 ± 1.7	72.8 ± 7.1	73.6 ± 1.9	73.3 ± 1.6
Crude protein	15.9 ± 0.8	15.6 ± 0.71	16.1 ± 0.94	16.3 ± 1.02	15.8 ± 1.2
Ether extract	5.1 ± 0.42	5.4 ± 0.63	5.1 ± 0.43	5.0 ± 0.46	4.9 ± 0.38
Ash	5.89 ± 0.37	6.5 ± 0.52	5.8 ± 0.52	5.0 ± 0.43	6.1 ± 0.76
Gross energy (Kcal)(1)	139.2 ± 8.3	140.4 ± 6.9	140.5 ± 8.9	139.7 ± 9.8	136.3 ± 7.9
Hepatosomatic index (%)(2)	1.57 ± 0.18	1.98 ± 0.21	2.09 ± 0.23	2.13 ± 0.18	2.25 ± 0.2
Total liver lipid (%)	20.2 ± 2.4	24.2 ± 2.5 a	18.5 ± 1.9 b	19.7 ± 1.5 b	12.3 ± 1.1 c

Values are presented as percentage of wet substances (mean ± S.E).

a, b…. and c means in the same row with different superscript are significantly different (P< 0.05)

(1) Muscle gross energy (Kcal / 100 g muscle) by NRC (1983)
= 5.7 X % crude protein + 9.5 X % ether extract.

(2) Hepatosomatic index (%) = liver weight (g) X 100/body weight (g)

Table (5): Effect of different CHO:L ratio on hybrid tilapia body composition and somatic parameters (large fish).

CHO/ L ratio	**Initial**	**2**	**4**	**6**	**8**
Moisture	73.2 ± 1.4	71.5 ± 7.3	72.1 ± 1.9	71.8 ± 1.6	72.3 ± 1.9
Crude protein	15.7 ±1.67	15.4 ± 1.34	16.2 ± 1.1	16.0 ± 1.21	15.5 ± 1.4
Ether extract	5.6 ± 0.92	7.7 ± 0.85	7.1 ± 0.67	7.3 ± 0.82	4.8 ± 0.67
Ash	5.5 ± 0.61	5.4 ± 0.56	4.6 ± 0.51	4.9 ± 0.39	5.4 ± 0.43
Gross energy (Kcal)	142.7 ± 6.9	161.4 ± 9.5	159.5 ± 8.2	160.1± 6.4	151.9 ± 8.3
Hepatosomatic index (%)	2.05 ± 0.16	2.27 ± 0.14 b	2.31±0.15 b	2.57±0.19 a	2.61± 0.23a
Total liver lipid (%)	22.3 ± 2.5	29.4 ± 2.6 a	25.1 ± 2.1 a	17.3 ± 2.3 b	19.5 ± 1.8 b

Values are presented as percentage of wet substances (mean ± S.E).
a and b means in the same row with different superscript are significantly different ($P < 0.05$).`

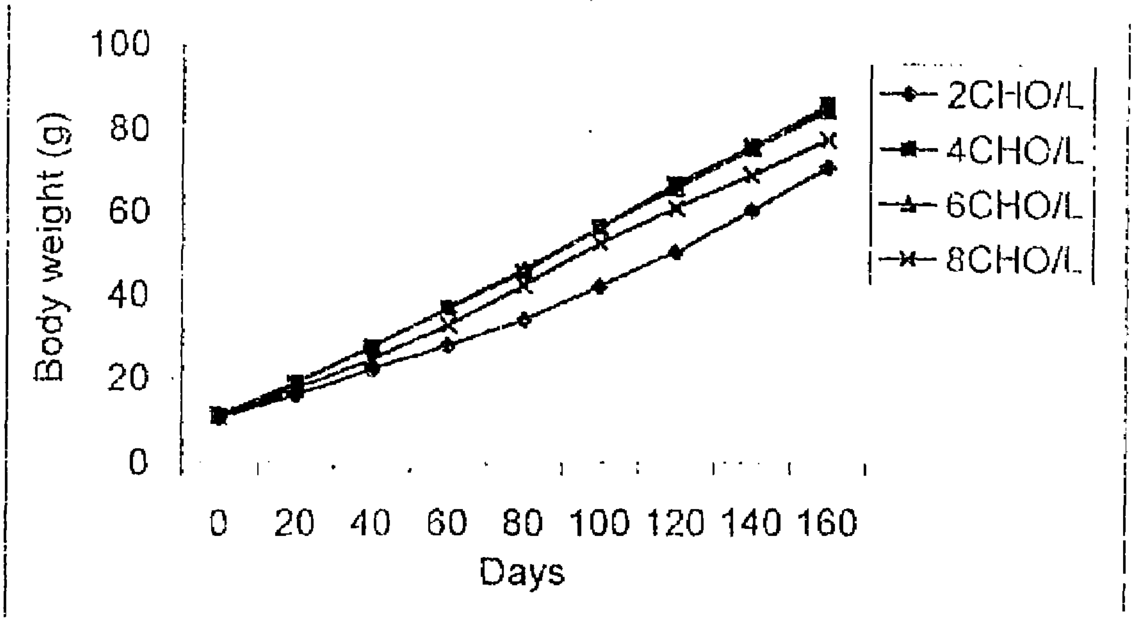

Fig.(1a) : Mean weight (g) variation of small hybrid tilapia fed different CHO/L ratio

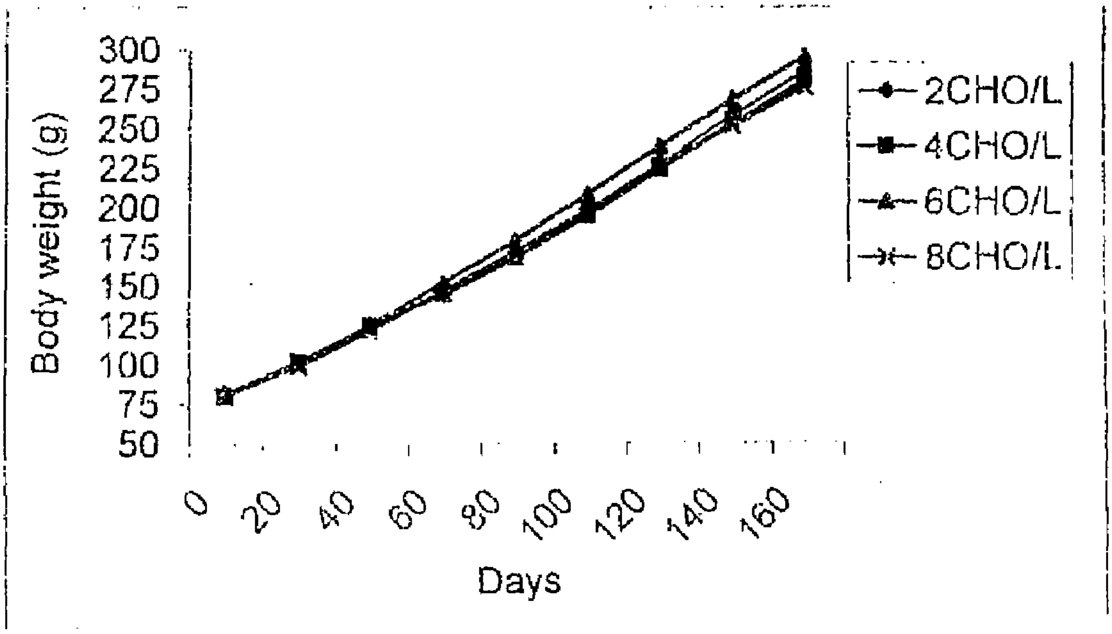

Fig.(1b) : Mean weight (g) variation of large hybrid tilapia fed different CHO/L ratio.

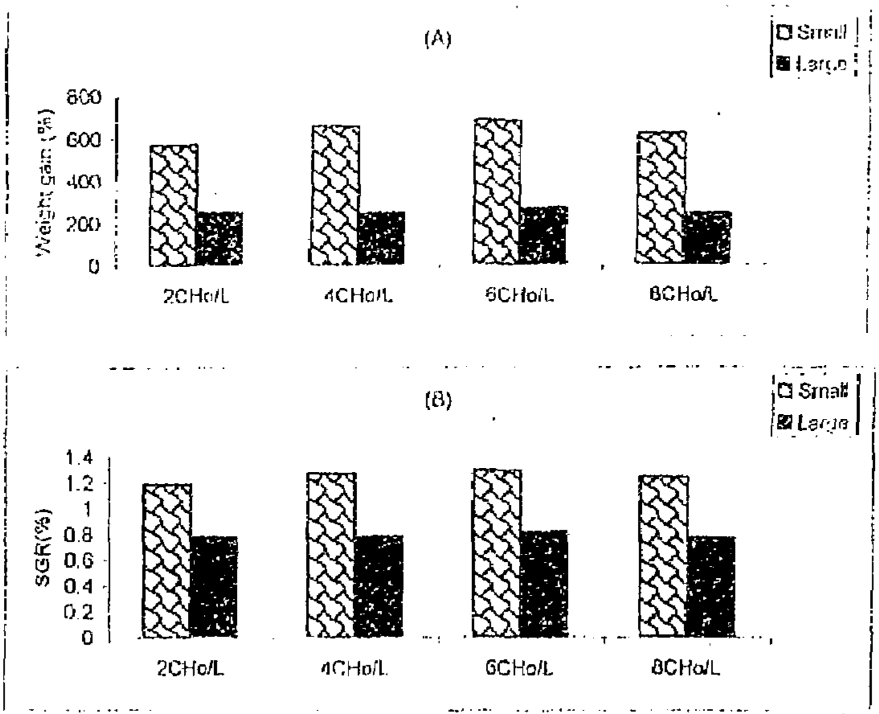

Fig.2(A,B) : Groth performance variation of *hybrid tilapia* fed different CHO/L ratio

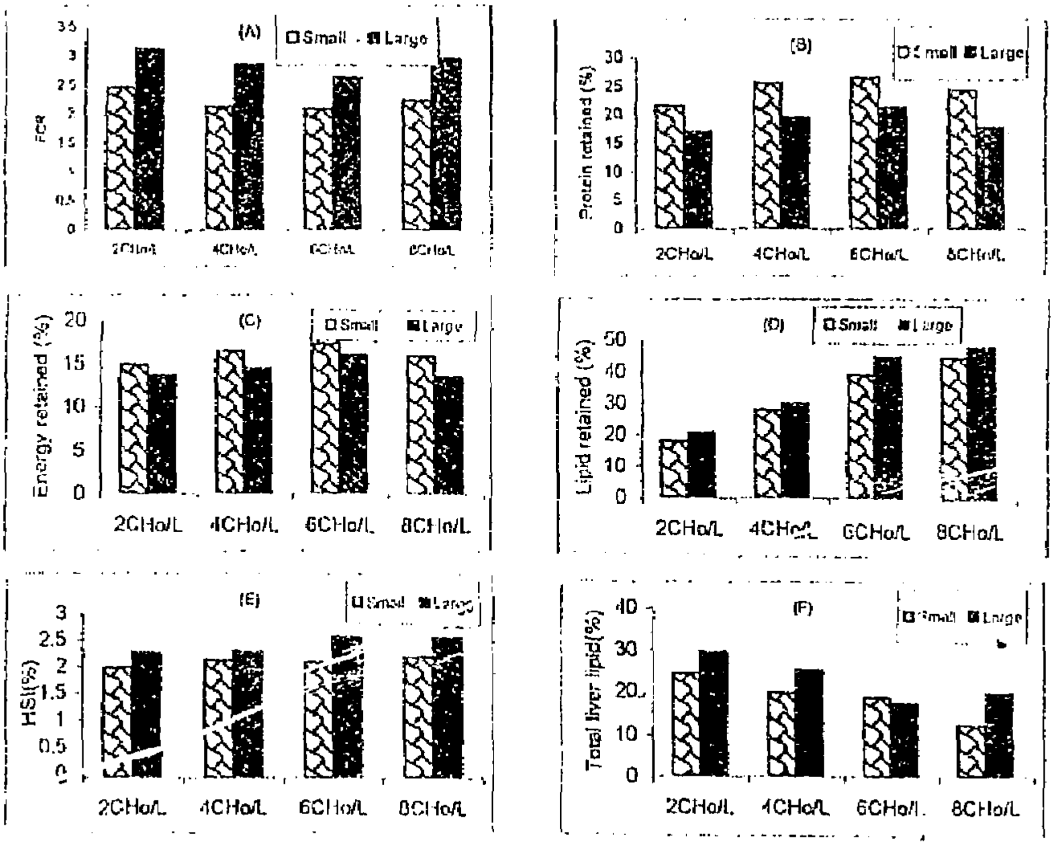

Fig. 3(A...F) : Nutritization variation of *hybrid tilapia* different CHO/L ratio

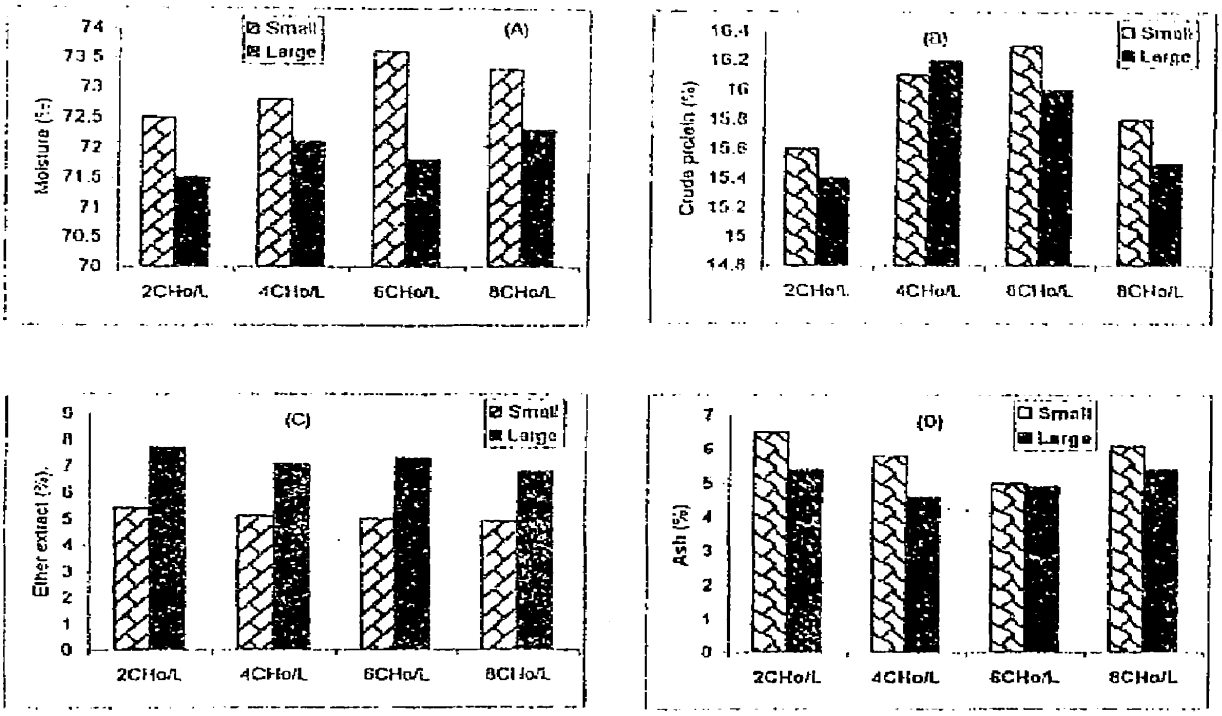

Fig. 4(A,B,C,D) : Chemical body composition of two size hybrid tilapia fed different CHO/L ratio feeds