Malaysian Journal of Science 27 (1): 35 – 45 (2008)

Effect of Two Different Diets on Growth Performance and Carcass Composition in three Tilapia Strains

N. Eriyusni*, T. K. Mukherjee and **I. Noraida**

Institute of Biological Sciences, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia
* eriyusni@hotmail.com
Received in revised from 7th April 2007, accepted 7th March 2008.

ABSTRACT: Effect of diet on the growth performance of three strains of Tilapia; *O. niloticus* local, *O. niloticus* philippines and *O. mossambicus* was investigated. The experimental feed, university feed (UF) contained an energy : protein ratio of 150:1 and was formulated to be isonitrogenous (20% crude protein) and isoenergic (3000 Kcal/kg) compared to that of commercial feed (CF). Fishes were fed with the two experimental diets when they were 10 weeks old at 1.5 x maintenance metabolisable energy for a total period of 32 weeks. Data were analyzed using ANOVA to estimate differences between strains, diets and strain x diet interaction. Mean body weight achieved at the end of the feeding trial with UF vs CF for *O . niloticus, O. ossambicus,* and *O. niloticus* philippines were 92.48 ± 4.80g vs 62.82 ± 1.80g, 72.94 ± 1.84g vs 45.82 ± 1.70g and 90.33 ± 2.22g vs 45.82 ± 1.70g, respectively. Feed consumption and feed conversion ratio of strains fed with UF were found to be better than when the fishes were fed with CF. Interaction effect of diet x strain was significant ($P < 0.001$) for body weight and feed consumption but not for feed conversion ratio. *O. niloticus* strain was better than *O. mossambicus* for body weight and most carcass traits, when analyzed separately for males and females.

ABSTRAK: Penyelidikan mengenai kesan ke atas pencapaian pertumbuhan 3 strain Tilapia, *O. niloticus* local, *O. niloticus* philippines dan *O. mossambicus* telah dijalankan. Penyelidikan pemakanan, pemakan university (UF) mempunyai nisbah:protein sebanyak 150:1 dan diformulasikan menjadi isonitrogen (20% crude protein) serta isoenergik (3000 kcal/kg) telah dibandingkan dengan pemakanan komersial (CF). Ikan yang dikaji telah diberi dua jenis pemakanan tersebut pada umur 10 minggu dengan 1.5 x tenaga metabolisma untuk tempoh 32 minggu. Analisa data untuk menganggarkan perbezaan diantara strain, pemakanan dan interaksi strain x pemakanan telah diuji dengan menggunakan kaedah ANOVA. Purata berat badan pada akhir kajian penggunaan UF dan CF bagi *O. niloticus* local, *O. ossambicus* dan *O. niloticus* philippines masing-masing adalah 92.85 ± 4.86g dan 62.82 ± 1.80g, 72.94 ± 1.84g dan 45.82 ± 1.70g, 90.33 ± 2.22g dan 69.82 ± 1.70g. Pengambilan pemakanan dan penukaran makanan terhadap strain yang diberikan pemakanan UF adalah lebih baik dibandingkan dengan strain yang diberikan pemakanan komersial (CF). Interaksi kesan pemakanan x strain adalah signifikan ($P < 0.001$) bagi berat badan dan pengambilan makanan tetapi tidak signifikan terhadap penukaran makanan. Apabila analisa data dipisahkan antara jantan dan betina strain *O. niloticus* lebih baik dibandingkan dengan strain *O.mossambicus* dari segi berat badan dan kebanyakan trait karkas.

(Tilapia, Growth performance, Diets, Carcass composition, Fishmeal substitute)

INTRODUCTION

Feed is a major cost item (up to 80% of operating cost) for intensive or semi-intensive fish culture. A major determinant of the cost of making fish feed is the type and source of protein used. Protein nutrition plays an important role in tissue elaboration and this has been the main focus of research into the nutrient requirements of tilapia fish under various management systems [1, 2, 3, 4, 5, 6, 7].

Most of the protein components supplied by commercial diets are sourced from fishmeal. Demand for fishmeal over the last five years has increased dramatically as a result of large fishmeal requirement from the poultry, fish, and livestock sectors. Thus, small reduction in the need for fishmeal in the fish feed ingredient may result in substantial savings. There are several sources of non-fish protein and the number of choices increases annually as the type of byproducts from feed industry increases.

This necessitates continuous development of practical diets for fish in which a significant proportion of the fishmeal component may be substituted by protein sources from local industry [8, 9, 10, 11, 12]. However any changes in feed composition must take into consideration the nutritional value of the new diet to ensure optimum growth.

Fish growth rate is determined through the combined effects of good quality genetic factors [13, 14] and the environment in which the fish are kept. The growth patterns of different strains of tilapia are known to be different [15] and this requires systematic search for appropriate feed and feeding regime. The objective of this study was to substitute some of the fishmeal in the local commercial fish feed with locally available plant protein. The effect of fishmeal replacement was evaluated in relation to growth, conformation and carcass composition.

MATERIAL AND METHODS

Preparation of feed

Ingredients used in the university feed (UF) diet were rice bran, fishmeal, corn, palm kernel cake (PKC) and molasses, and these were purchased from local sources. The proximate chemical composition of these raw materials is as indicated in Table 1. Feed ingredients were compounded, without further treatment, in calculated proportions (Table 2) to contain 20% crude protein and energy (ME kcal/kg): protein / (%CP) ratio of 150:1, i.e. similar to that of commercial feed (CF). Moisture, fat and ash content in the UF were subsequently found to contain 9.6, 7.7 and 7.6 % respectively, in comparison to CF feed i.e.11.0, 4.0 and 8.0%. Details on feed ingredients in CF were not available due to the policy of the local company marketing this.

Tilapia fish: grouping, feeding and data collection

The three populations of *Oreochromis* used in this study were bred and maintained in the University of Malaya Experimental Farm. Twenty-four cages (2 x 2 x 1 m) were used for stocking the fries. Four cages each were used to hold *O. mossambicus* (O.m), *O. niloticus* philippines (O.np) and *O. niloticus* local (O.nl) strains fed with CF and UF. The body conformation, growth and feed conversion were studied at four to six week intervals starting from the age at 10 weeks to 32 weeks. Both meristic counts and morphometric measurements including body length, total length, standard length and head length were carried out. Carcass composition of 10 male and 10 female fishes selected randomly from each cage was determined after final grow-out from all 24 cages. Individual fish were killed by severing the neck. The total weight of head, fin, tail, and bones was also recorded. The flesh was removed from the bones and weighed. The flesh was individually wrapped in aluminum foil and weighed and subsequently dried in the oven at 100° C for 24 hours. The protein, ash, fat, and moisture content were analysed according to methods given in AOAC, 1984 [16].

Traits Studies

The body conformation, meristic counts and morphometric measurements were made (Figure 1). Total length (TL), standard length (SL), head length (HL) and body depth (BD) were measured.

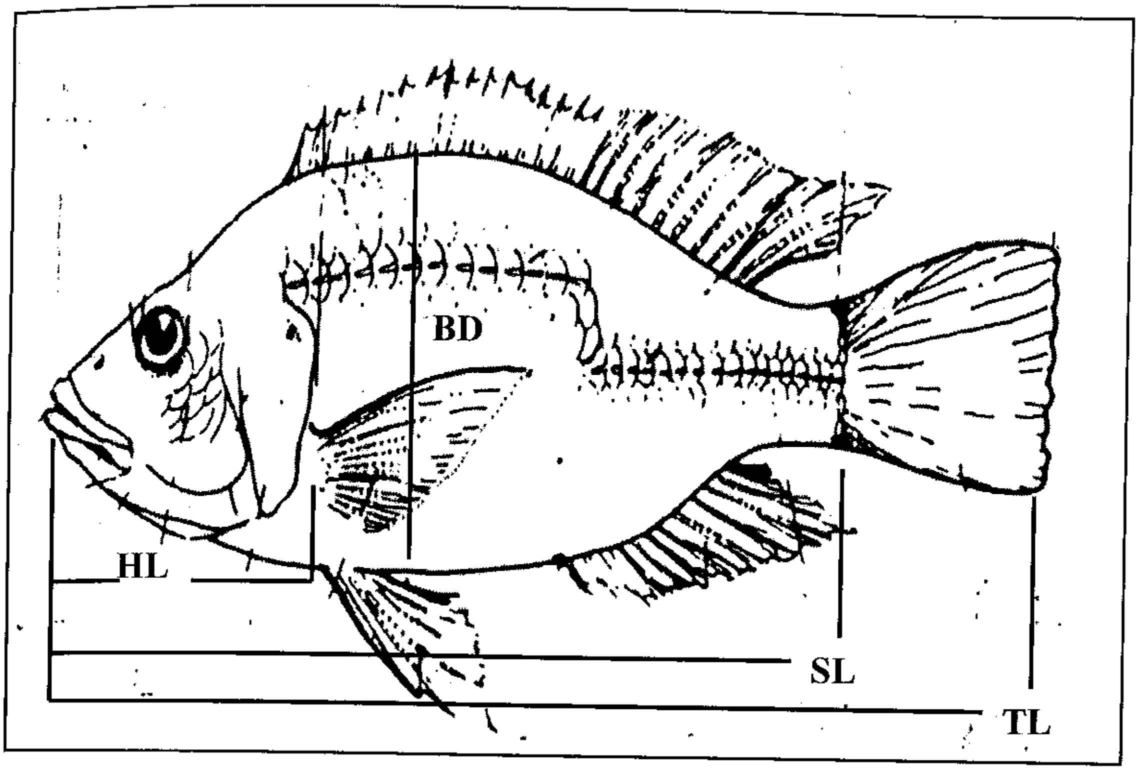

Figure 1. Morphometric measures and meristic counts

Total length (TL):
The length from tip of snout to end of caudal fin.
Standard length (SL):
The length from tip of snout to end of body (i.e. base of caudal fin).
Body weight (BW):
Body weight (to nearest gram) was weighed measured using a pan balance.
Body depth (BD):
The longest depth excluding fins.
Head length (HL):
The longest measurement from anterior edge of the upper lip to the most posterior part of the body opercula edge.

Daily Weight Gain (DWG) = [(W2(g) – W1 (g))] / (T2-T1)

Where W2 is the weight in grams at time T2: W1 is the weight in grams at time T1; and T2 is later than T1.

Specific Growth Rate (SGR) = [(ln W2-ln W1)/(T2-T1)] x 100.

Where W2 is the weight in grams at time T2: W1 is the weight in grams at time T1; and T2 is later then T1.

Feed Consumption (FC) = feed consumption in each of the aquariums was measured daily by deducting the amount of feed not consumed from the total feed given.

Feed Conversion Ratio (FCR) = Weight of feed given (g) / Body weight gain (g).

Table 1. Proximate analysis of feed ingredients used to make the experimental (UM) diet

FEED INGREDIENTS	FISHMEAL	RICE BRAN	CORN	PKC
Moisture (%)	11.80	9.6	11.1	6.9
Protein (%)	57.80	13.1	8.5	13.9
Fat (%)	5.7	15.9	2.8	11.2
Fiber (%)	1.4	6.1	3.1	14.7
Ash (%)	22.0	7.9	1.8	4.5
Calcium (%)	8.37	0.01	0.03	0.18
Phosphorous (%)	2.94	1.58	0.27	0.59
NFE[2] (%)	1.3	47.4	72.7	48.8
Copper (ppm)	20.9	11.3	7.4	38.9
Zinc (ppm)	55.7	63.2	18.4	35.1
Magnesium (ppm)	0.23	0.53	0.11	0.23
Sugar (%)	0.1	2.8	1.65	2.5
Starch (%)	1.3	30.4	64.6	16.3
Metabolizable Energy (Kcal/kg)	3325	4226	2118	2523

PKC: Palm kernel cake NFE: Nitrogen Free Extract

Table 2. Energy and composition of the experimental fish feed

INGREDIENTS	CP (%)	% INGREDIENT IN DIET (Kg)	AVAILABLE ME (Kcal)	AVAILABLE CRUDE PROTEIN (kg)
Fishmeal	57.80	20.63	66500	0.40
Rice bran	13.10	15.87	105650	0.17
Corn	8.50	31.75	74130	0.05
PKC	13.90	23.81	37845	1.68
Molasses		7.94	16975	0.00
Total (kg)		100	301100 Kcal	20.06
			ME Kcal/kg= 3011	% Crude Protein=20.06
				ME Kcal/kg =150:1
				% Protein

CP: Crude Protein ME: Metabolizable Energy

Statistical analysis

Differences were determined by a two way analysis of variance (using Statistical Pakage for Social Science, SPSS), with diet and strain as sources of variation in the model: $Y_{ijk} = \mu + \alpha_i + \beta j + \alpha\beta_{ij} + \epsilon_{ijk}$ Y_{ijk} is the dependent variable denoting the kth measurement from the ith diet and jth strain; μ the common mean; α_i the effect of the ith diet, i = 1 and 2; jth strain, j = 1, 2 and 3, $\alpha\beta_{ij}$ is the interaction between ith strain and jth diet, and ϵ_{ijk} the random residual. Differences between treatments were considered statistically significant at $P < 0.05$ level. Treatment effects on growth performance and carcass composition were compared using the least significant difference method [17].

RESULTS

Data collected during the grow-out periods (ages, 10, 14, 20, 26 and 32 weeks) was subjected to analysis of variance for each character. Table 3 presents the analysis of variance (ANOVA). The growth pattern of all three strains responded differently in the two dietary treatments. Figures 2, 3 and 4 presented to show that there is interaction in relation to body weight at 10 to 32 weeks. At week 14 and 20 the body weight of *O. niloticus* local and *O. niloticus* philippines were not significantly different compared to *O. mossambicus*, but at week 26 and 32 the body weight of *O. niloticus* local and *O. niloticus* philippines were higher than that of *O. mossambicus*.

Differences between strains, diet and between strains and diet interaction was found to be highly significant ($P < 0.01$). Results obtained with 20% protein by De Silva and Perera [13] for growth performance of *O. niloticus* strains were found to be higher (62.82 to 72.94g at 32 weeks) than the present study. This may be due to the differences in strains used in the two experiments

All three Tilapia fish strains fed with UF achieved higher end body weight compared with those fed with CF (Table 4). *O. niloticus* local showed the biggest growth response (95%) followed by *O. niloticus* philippines and *O. mossambicus* when fed with UF. With CF also *O. niloticus* philippines (71%) showed the highest growth respond followed by *O. niloticus* (70%) and *O. mossambicus* (50%). The growth of all three strains responded in similar manner for each dietary treatment. *O. mossambicus* tended to achieve the lowest body weight in comparison to *O. niloticus* philippines and *O. niloticus* local. The feed consumption of *O. niloticus* philippines and *O. niloticus* local were remarkably higher (55 – 65%) than *O. mossambicus* under both feeding regimes.

Table 3. Analysis of variance of body weight at 10, 14, 20, 26 and 32 weeks

SOURCE OF VARIATION		BODY WEIGHT				
	df	10	14	20	26	32
Diet (D)	1	**	**	**	**	**
Strain (S)	2	**	**	**	**	**
D X S	2	**	**	**	**	**
Error	2114	133.718	483.336	128.372	657.730	389.933

**Significance (P≤0.01) Error variance are given

Table 4. Mean and standard error of growth performance at 32 weeks of three tilapia trains fed with commercial (CF) and experimental (UF) diets

DIET	STRAIN	BODY WEIGHT (gm)	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	HEAD LENGTH (cm)	FC (gm)	FCR	SGR	DWG
UF[5]	*O. mossambicus*	72.94^{a} ± 1.87	16.05^{a} ± 0.24	12.56^{a} ± 0.12	4.10^{a} ± 0.05	116.8^{a} ± 8.70	1.60^{a} ± 0.25	2.35^{a} ± 0.01	0.16^{a} ± 0.03
	O. niloticus philippines	90.33^{b} ± 1.69	17.49^{b} ± 0.12	13.55^{b} ± 0.10	4.43^{b} ± 0.03	180.3^{b} ± 4.38	1.57^{a} ± 0.05	2.75^{a} ± 0.02	0.19^{a} ± 0.04
	O. niloticus local	92.85^{b} ± 4.49	17.49^{b} ± 0.27	13.46^{b} ± 0.21	4.44^{b} ± 0.07	188.3^{b} ± 0.10	1.91^{a} ± 0.01	4.50^{b} ± 0.04	0.32^{a} ± 0.01
CF[6]	*O.mossambicus*	45.82^{a} ± 2.00	13.054^{a} ± 0.16	9.72^{a} ± 0.14	3.39^{a} ± 0.04	60.0^{a} ± 5.36	0.89^{a} ± 0.58	1.10^{a} ± 0.46	0.89^{a} ± 0.01
	O. niloticus philippines	69.82^{b} ± 1.85	15.36^{b} ± 0.20	12.47^{b} ± 0.15	4.01^{b} ± 0.03	101.4^{b} ± 8.72	1.28^{a} ± 0.33	2.75^{b} ± 0.01	1.28^{b} ± 0.01
	O. niloticus local	68.00^{b} ± 4.49	15.28^{b} ± 0.49	12.25^{b} ± 0.41	4.28^{b} ± 0.07	107.6^{b} ± 0.05	1.20^{a} ± 0.01	2.40^{b} ± 0.42	1.20^{b} ± 0.04

Data are presented as means with coefficient of variations in brackets.
$^{a, b}$ Mean with the same superscript in the same column within diet are not significantly different (p >0.01)

FC: Feed Consumption
SGR: Specific Growth Rate
FCR: Feed Conversion Ration
DWG: Daily Weight Gain
UF: University Feed
CF: Commercial Feed

The growth pattern of three strains fed with two diets (Figures 2 and 3) generally was different and the mean body weight in three strains was higher in UF than in CF. At 32 weeks body weight in three strains fed with UF, *O. niloticus* attained highest weight of 92.85 ± 4.80g compared to 72.94 ± 1.84g observed for *O. mossambicus*. With CF, *O. niloticus* philippines showed highest growth rate followed by *O. niloticus* local and *O. mossambicus*. Compared to this experiment, the highest weight was obtained for *O. niloticus* philippines (68.00 ± 1.80g) and lowest weight of 45.82 ±1.70g for *O. mossambicus* when fed with CF. Feed consumption and feed conversion was clear (Figures 5 and 6).

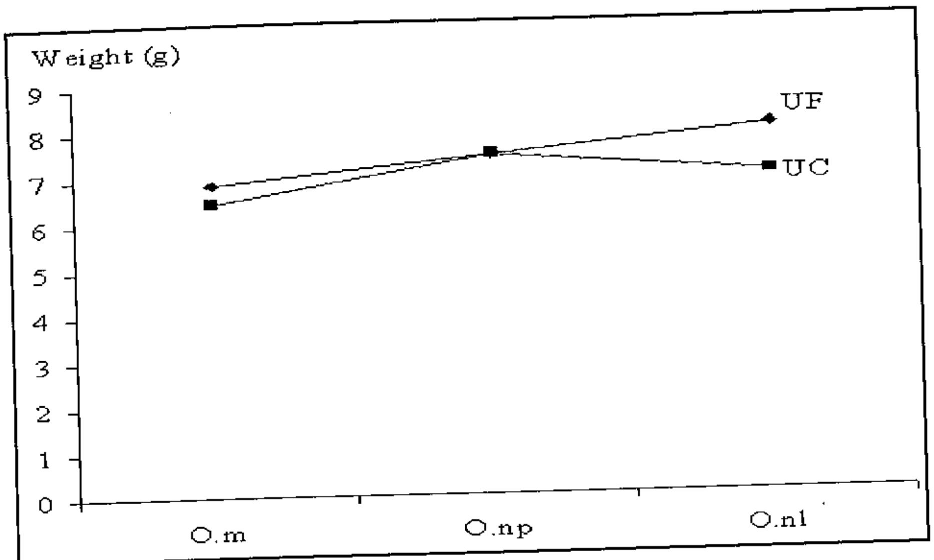

Figure 2. Effect of growth at 10 weeks

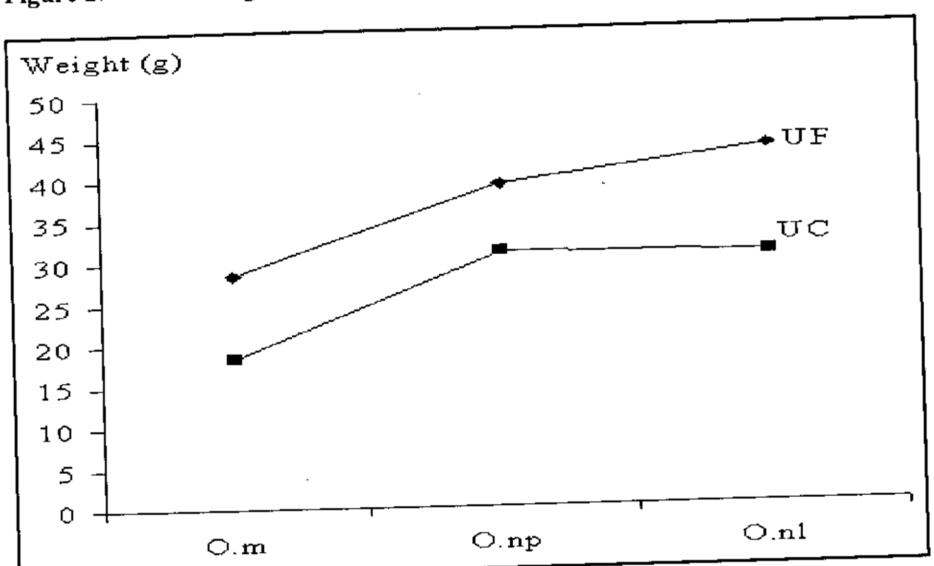

Figure 3. Effect of growth at 20 weeks

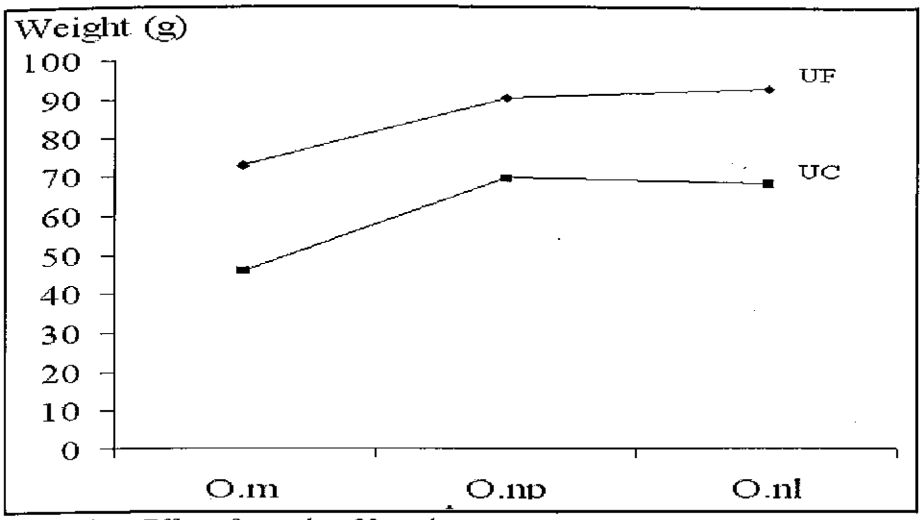

Figure 4. Effect of growth at 32 weeks

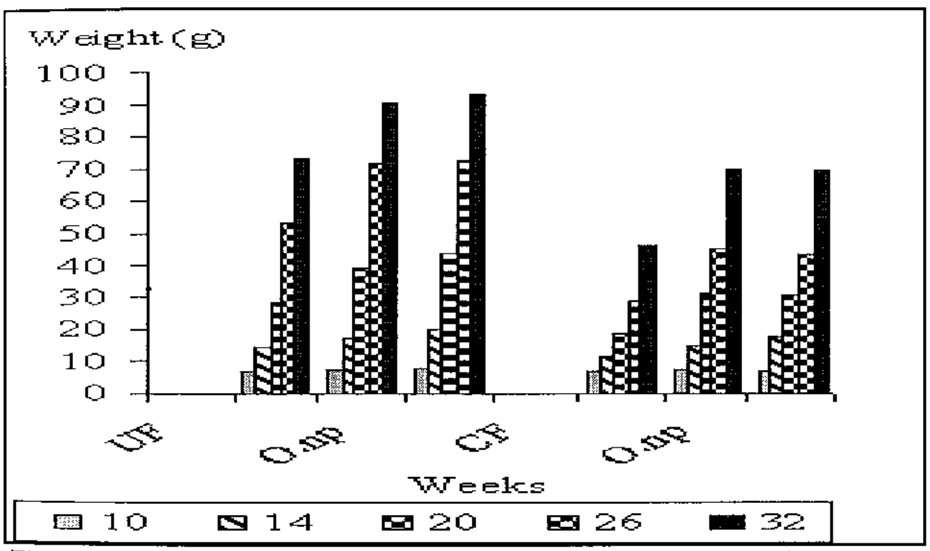

Figure 5. Bodyweight of strains fed with UF and CF at different weeks

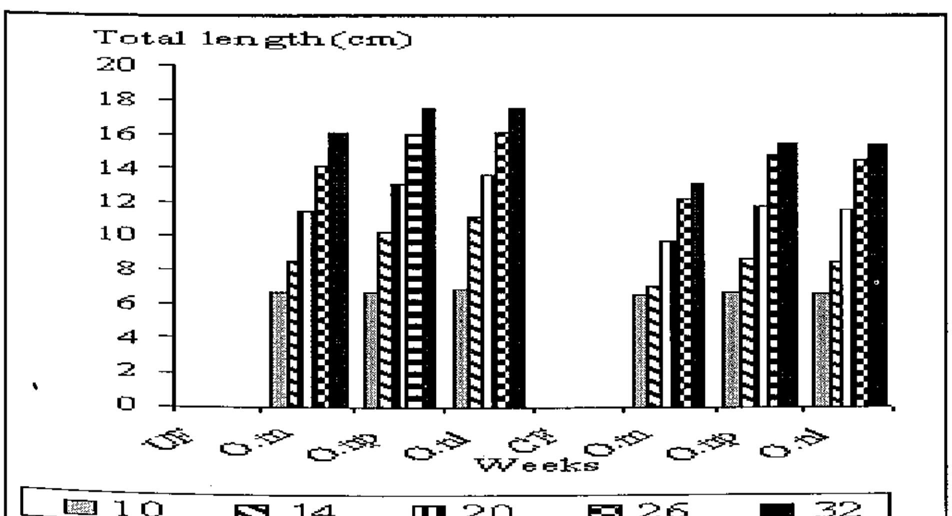

Figure 6. Total length of strains fed with UF and CF at different weeks

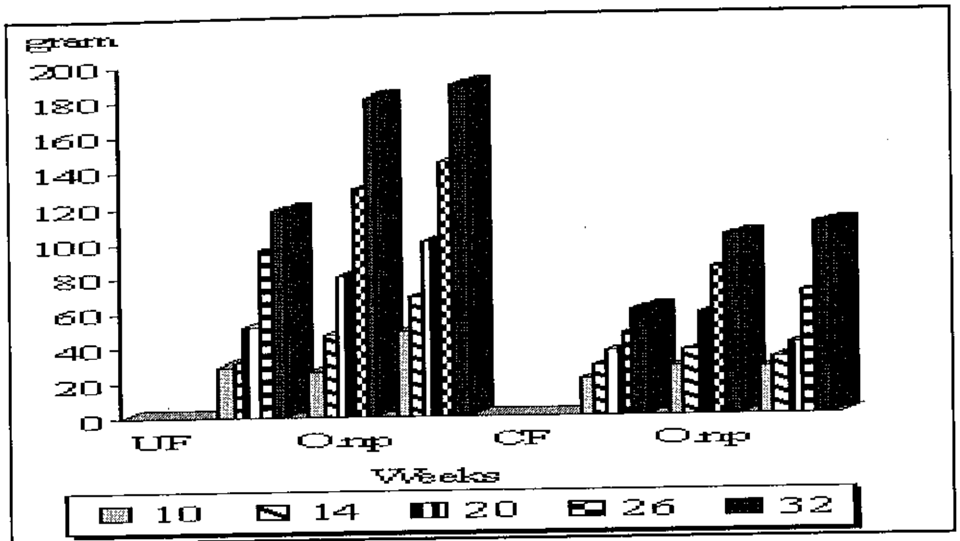

Figure 7. Effect of feed consumption at 10 to 32 weeks

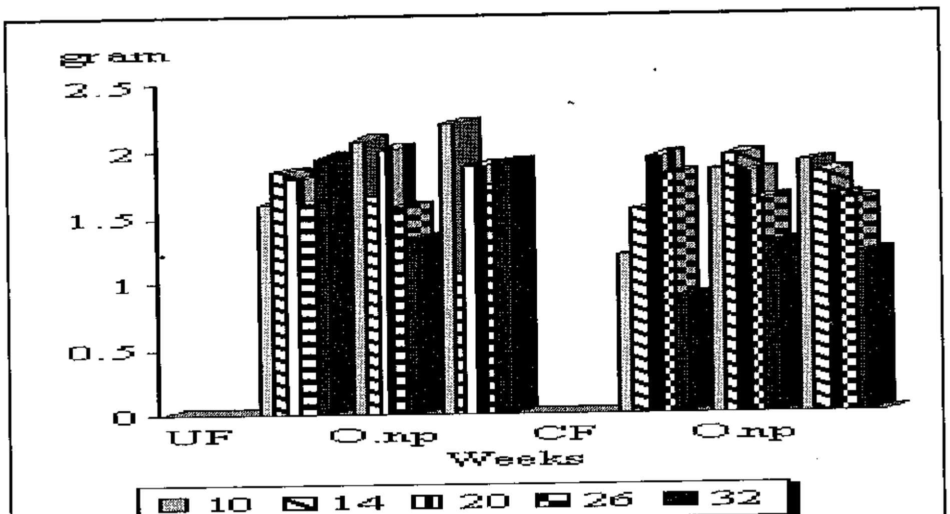

Figure 8. Effect of feed conversion ratio at 10 to 32 weeks

Carcass Composition

Strain and diet interaction effect for carcass composition was significant for lysine and leucine content. This may be due to the result of great variability of these traits which was often encountered at the time of analysis.

Difference due to two types of feed for %CP, Ash and % lysine and strain difference for carcass weight and lysine was also observed. Final carcass weight was presented for males and females given two different diets (Table 5).

Table 5. Mean (%) and standard error of Carcass composition of males and females of two different diets

DIET	STRAIN	SEX	CARCASS WEIGHT (%)	MOISTURE (%)	ASH (%)	CP (%)	LYS (%)	LEU (%)	MET (%)
UF	*O. mossambicus*	Male	65.6^{a} ± 0.20	78.8^{a} ± 1.14	2.63^{a} ± 0.23	16.2^{a} ± 0.10	2.44^{a} ± 0.36	2.20^{b} ± 0.34	1.54^{a} ± 0.38
		Female	43.1^{a} ± 0.21	77.8^{a} ± 0.15	2.84^{a} ± 0.20	15.7^{a} ± 0.16	2.11^{a} ± 0.21	1.80^{b} ± 0.33	1.43^{a} ± 0.37
	O. niloticus Philippines	Male	66.6^{b} ± 0.25	78.1^{a} ± 1.08	2.92^{a} ± 0.27	16.4^{a} ± 0.10	2.05^{a} ± 0.18	2.01^{b} ± 0.19	1.46^{a} ± 0.36
		Female	64.7^{b} ± 0.18	78.8^{a} ± 1.20	2.42^{a} ± 0.39	16.5^{b} ± 0.21	2.02^{a} ± 0.19	2.05^{b} ± 0.47	1.19^{a} ± 0.28
	O. niloticus local	Male	82.3^{b} ± 0.25	78.4^{a} ± 1.19	2.86^{a} ± 0.24	16.2^{a} ± 0.42	2.00^{a} ± 0.19	1.92^{b} ± 0.14	1.30^{a} ± 0.47
		Female	72.7^{b} ± 0.18	78.0^{a} ± 0.10	2.58 ± 0.36	16.0^{b} ± 0.10	2.00^{a} ± 0.18	1.72^{b} ± 0.31	1.36^{a} ± 0.43
CF	*O. mossambicus*	Male	47.1^{a} ± 0.23	73.6^{b} ± 1.23	1.20^{a} ± 0.29	12.6^{a} ± 0.20	1.79^{a} ± 0.23	1.34^{a} ± 0.43	1.17^{a} ± 0.28
		Female	52.6^{a} ± 0.32	76.4^{a} ± 1.32	1.27^{a} ± 0.26	12.8^{a} ± 0.10	1.77^{a} ± 0.20	1.25^{a} ± 0.37	1.12^{a} ± 0.35
	O. niloticus Philippines	Male	75.4^{b} ± 0.18	77.6^{a} ± 1.20	1.83^{a} ± 0.23	13.1^{b} ± 0.23	1.98^{a} ± 0.18	1.88^{a} ± 0.24	1.11^{a} ± 0.26
		Female	74.6^{b} ± 0.23	78.5^{a} ± 0.25	1.71^{a} ± 0.22	13.7^{b} ± 0.25	1.91^{a} ± 0.17	1.71^{a} ± 0.37	1.12^{a} ± 0.33
	O. niloticus local	Male	77.5^{b} ± 0.17	68.0^{a} ± 0.20	1.74^{a} ± 0.24	13.4^{b} ± 0.35	2.06^{b} ± 0.16	1.84^{a} ± 0.35	1.30^{a} ± 0.26
		Female	89.2^{b} ± 0.19	73.4^{a} ± 0.40	1.76^{b} ± 0.24	13.4^{b} ± 0.23	1.96^{a} ± 0.20	1.96^{a} ± 0.27	1.08^{a} ± 0.28

Data are presented as means with coefficient of variations in brackets.
^{a,b} Mean with the same superscript in the same column within diet are not significantly different ($p>0.01$)
CP: Crude protein, Lys: Lysine, Leu: Leucine, Met: Methionine

DISCUSSION

In this study the feed compounded at the university (UF) was found to be better than the commercial feed (CF) with regard to growth and body conformation. Although the two diets were isocaloric and had same protein content, it is believed that the freshness of the feed ingredients in UF has made the above difference. Role of natural food in the ponds, however was not taken into account but no difference growth performance between two diet group were assumed. Growth performance from three strains (*O. niloticus* local), *O. niloticus* philippines and (*O. mossambicus*) during period of 10 till 32 weeks of age showed both *O. niloticus* strains were better than *O. mossambicus* with UF as well as CF. Many other studies reported fast growth of *O. niloticus* compared to *O. mossambicus*. This is in natural feed intake (algae, phyto-and zoo-plankton probably due to some positive response to selection for body weight in the *O. niloticus* strains, whereas *O. mossambicus* has remained uncared in many smaller ponds in rural areas of Malaysia.

In studies involving genotypes and diet for fish growth, possible impact of genotypes by environment (G x E) interaction may be considered. Interaction effect of diet x strain in this study was significant for body weight, body conformation and feed consumption but not for feed conversion ratio. Significant strain differences indicated that *niloticus* strains are better than *mossambicus* because these had been properly maintained in the University Malaya. Improvement in *O. niloticus* has been practiced in the University of Malaya. Carcass composition was measured separately for males and female from three strains in tilapia and the results showed that *O. niloticus* strains were better than *O. mossambicus* for many carcass traits. Improvement in carcass performance is a reflection of improved body weight. Dietary protein quality and quantity may have influenced growth and carcass traits. In view of the small sample size and a short period of study in this experiment, it is suggested that a future experiment of similar nature is undertaken with larger members of experimental fish and a growth period of at least 6 months from 1-2 weeks. A diet with 20% crude protein and (150:1) caloric : protein ratio has been considered for this study. This is in general agreement with most of the previous studies in tilapia, however different protein content and different caloric/protein ratio should be investigated. Cost of feed with higher protein content and calorie : protein ratio is worthwhile to investigate along with the increased income from commercial ponds.

REFERENCES

1. Hanley. F. (1991). Effects of feeding supplementary diets containing varying levels of lipid on growth, food conversion and body composition of *Nill* tilapia *Oreochromis niloticus* (L). *Aquaculture* **93**: 323 - 334.
2. Lin, L. M., Hu, J. C., Hong, H. X. (1994). The most suitable content of protein in the artificial feed to culture *Lateolabrax japonicus. J. Xiamen Fish. College* **16**: 6 - 10 (In Chinese with English abstract).
3. Hu, J., Chen, X., Hong, H. (1995). Evaluation of soybean cake as a substitute for partial fish meal in artificial diets for *Lateolabrax japonicus, J. Oceanogr. Taiwan Strait* **14**: 418 - 421 (In Chinese with English abstract).
4. Gao, C., Liu, Q., Liang, Y., Han, A., 1998. The optimum content of protein and fat in the artificial diet fed to cultured juvenile sea bass (*Lateolabrax japonicus*). *Mar. Fish. Res.* **19**: 81 - 85 (In Chinese with English abstract).
5. Hong, H., Lin, Chen, X., Hu, J., Zhou, L. (1999). Studies on the optimal content and protein sparing effect of lipid in artificial foodstuff for *Lateolabrax japonicus J. Jimei Univ.* **4**: 41 - 44 (In Chinese with English abstract).
6. Pan, Y., Wang, F., Liu, H. (2000). Optimal proportion of fishmeal and soybean cake in formulated diets of juvenile sea perch *Lateolabrax japonicus. J. Dalian Fish. College* **15**: 157 - 163 (In Chinese with English abstract).
7. Ai, Q., Mai, K., Li, H., Zhang, C., Zhang, L., Duan, Q., Tan, B., Xu, W., Ma, H., Zhang, W., Liufu, Z. (2004). Effects of dietary protein to energy ratios on growth and body composition of juvenile Japanese sea bass, *Lateolabrax japonicus. Aquaculture* **230**: 507 - 516.
8. Catacutan, M. R., Coloso, R. M. (1995). Effect of dietary protein to energy ratios on growth, survival, and body composition of juvenile Asian sea bass, *Lates calcarifer. Aquaculture* **131**: 125 - 133.
9. Webster, C. D., Tiu, L. G., Tidwell, J. H. Wyk, P. V., Howerton, R. D. (1995). Effects of dietary protein and lipid levels on growth and body composition of sunshine bass (*Morone chrysops* x *M.saxatilis*) reared in cages. *Aquaculture* **131**: 291 - 301.
10. Tibaldi, E., Beraldo, P., Volpelli, L. A., Pinosa, M. (1996). Growth response of juvenile dentex (*Dentex dentex* L) to varying protein level and protein to lipid ratio in practical diets. *Aquaculture* **139**: 91 - 99.
11. Gropp J. H., Beck, H., Koops, Tiews. (1997). Count Meet LCES Mazi culture Committee F4, 1 - 17.
12. Hernandez, M. D., Egea, M. A., Rueda, F. M., Aguado, F., Martinez, F. J., Garcia, B. (2001). Effects of commercial diets with different P/E ratios on sharp snout sea bream (*Diplodus puntazzo*) growth and nutrient utilization. *Aquaculture* **195**: 321 - 329.
13. DeSilva S. S, Perera, M. K. (1995). Effect of dietary protein level on growth food conversion and protein use in Young tilapia *nilotica* at salinities. *Trans. Am. Fish Soc.* **114**: 584 - 589.
14. Abdelghany, A. E. (2003). Replacement of Herring Fish Meal by Soybean Flour in Practical Diets for Red Tilapia, *Oreochromis niloticus* x *O.mossambicus* Growth in Concrete Tanks. Central Laboratory of Aquaculture Research, Abbassa, Abohamat Sharkia. Egypt, Vol. 14 (1/2).
15. Mukherjee T. K. 1994. Genetics of fish improvement. *Proceedings of the 1st Fish*

Genetics Workshop, University of Malaya, Kuala Lumpur. pp: 44 - 48.

16. Association of Official Analytical Chemists (1984). *Official Methods of Analysis*. Association of Official Analytical Chemists, Washington D.C.
17. Nourisis (1990). *SPSS - PC+ Advanced Statistics Guide*. Second edition. Chicago. SPSS Roy. P. K., S. P.