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A Supplementary Feed Design for Mullet Pen Culture in Tongatapu Island, Kingdom of Tonga

I. An elemental study of feed composed of local products for mullet, *Liza macrolepis* (Smith)

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Abstract

Mullet feeding experiments were carried out for 14 days under laboratory conditions using 200 mullets, divided in four lots, weighing from 10.3 to 10.8 g in mean weight among lots. The relationship between daily rate of feeding (r) and daily rate of growth (g) was presented by the formula r = 0.04251f - 0.002926 and the rate for maintenance of the body weight was m = 6.88% of body weight when fed the experimental feed composed of yam, copra meal, tuna meat and wheat flour in the relative amounts of 47.3, 43.4, 7.9 and 1.4 % respectively. The daily cost to feed this diet to maintain the body weight of mullets of 100 g, was estimated at T$0.0034. The fish lost 0.29% of body weight each day under the condition of starvation during the experimental period.

Introduction

This study was undertaken as the first step in determining supplementary feed for mullet extensive culture by penculture trial on the coastal zone of the Fanga'uta Lagoon. This is one of the projects of the JICA Aquaculture Research and Development Project in cooperation with the Ministry of Fisheries, the Kingdom of Tonga.

The supplementary feed should be low cost feed, made predominately of low cost local products which are in constant supply. This feed should serve to maintain, at least, the body

weight of the fish population in the pen by one daily feed of adequate quantities. This might be less than the satiation amount so the fish can also feed off the natural foods that they encounter in the interior of the pen (Ishiwata, 1969). The yam and the coconut were selected as main components of the feed, as they are abundant in this area and available all year round at a low price.

Materials and Methods

Experimental diet

The local products yam and coconut (copra) meal were selected as the main components of the feed. Tuna meat, was selected as the animal protein source and was rationed so that the estimated total crude protein rate of the diet was approximately 4% and the price for one kg of the diet is about T$0.5[1]. The price of each material obtained in the local market, the composition of the experimental feed and estimated protein level are presented in Table 1.

Table 1. Local market price of each item in Nuku'alofa and composition and estimated protein content of the diet.

Item	Price (seniti/g)	Weight (g)	Protein (%)*1) content/item	Price/Item (seniti)	Proportion of Feed (%)	Protein content (%)
Yam	0.042	47.4	2	1.9908	47.9	1.0
Copra meal	0.013	43.4	2.8*2)	0.5642	43.8	1.2
Tuna	0.3	7.8	25	2.34	7.9	2.0
Flour	0.125	0.2	12	0.025	0.2	0.02
Salt	0.317	0.2	0	0.073	0.2	0.00
Total	-	99.0	-	4.99	100.0	4.2
				Total Price seniti/kg		50.42

*1) South Pacific Commission, 1973 and Suehiro *et al.*, 1980.
*2) Calculated with a loss of 29% occuring when coconut flesh passed through the juicer.

[1] T$1.00 = US$0.77 (100 seniti/T$)

The yam was grated manually and the cocunut embryo was squeezed by a juicer eliminating the majority of the liquid content (approximately 29% of the total wet weight of embryo). The copra was processed to an extremely fine meal using a domestic food processor (National MK-K 55).

The tuna meat was processed to a paste using a food processor. A small quantity of salt was added to it. All of the materials were then mixed in a rice cake making machine (National SD-M1860) for 10 minutes and steamed for 8 minutes.

The fish

Liza macrolepis was used in this experiment and were captured ten days prior to commencement of the experiment. They were caught in the coastal zone near Sopu on Tongatapu Island using a tidal set net and transported to the fisheries laboratory in three 100 L containers .

The fish were starved for five days and from the 6th day were conditioned to the experimental diet for five days. The fish were fed by placing their diet in a net bag made of two mm mesh, crushing the food slightly by hand and then putting the feed bag in the tank.

When the fish were well accustomed to being fed by the feed bag, and began to attack it with strong activity, the experiment was started. The fish were given 24 hours starvation, then they were lightly anaesthetized by eugenol, 200 ppm, and weighed, measured and distributed into four experimental lots. The same process of measurement was used at the end of the experiment. The weight composition range, mean body weight, variance and standard deviation of each experimental lot are presented in Table 2 and Figure 1. The fish weight composition of each lot were controlled so as to be approximately equal by distributing them into each lot depending on their weight, to give a density from 49 to 53 fish/lot.

Rearing method

The fish with initial mean weight 10.7, 10.5, 10.3 and 10.8 g were distributed into four identical octagonal concrete tanks with seven m^3 water capacity, corresponding to experimental Lot No.s 1, 2, 3 and 4 respectively, and reared for an experimental period of 14 days.

The fish were fed once daily. Experimental feed was: one satiation, 2/3 satiation, 1/3 satiation and nil in Lot No.s 1, 2, 3, and 4 respectively. The satiation amount is the amount consumed until the fish school lose interest to feed at each feeding. This value was observed daily in Lot No. 1 and the amount for Lot No. 2 and No. 3 determined accordingly. An open circuit system with a daily water exchange rate of 1.5 cycles was utilised for the rearing. Temperature and salinity of the sea water used fluctuated during the experimental period between 23.5°C to 25.2°C and 36.0‰ to 39.0‰ respectively.

Fish that died during the experimental period were weighed; the weight values and total number thereof were deducted from the initial total fish weight and initial total number respectively for each tank.

Results

The calculated values of daily rate of feeding (f), daily rate of growth (r), gross efficiency (r/f) and net efficiency (r/f - m) when fed the experimental diet are presented in Table 3. As the value of (f) increased from 0.001, 0.017,0.035 and 0.053, the daily rate of growth increased to the order of -0.0029, -0.0022, -0.0014 and -0.00072 respectively.

The relationship between daily rate of feeding (f) and daily rate of growth (r) fits well to the lineal regression with the formula (1) indicated below and shown in Figure 2.

$$r = 0.04251f - 0.002926 \text{ ———— (1)}$$

The value of (f) obtained from formula (1), substituting 0 for (r), became 0.06883, 6.883% of the body weight, which represents the amount of this diet needed to maintain the body weight. Therefore the cost of this diet to maintain the total mullet body weight of 100 g for a day can be calculated as follows:

$$100 \text{ (g)} \times 0.06883 \times 0.05(\text{seniti/g}) = 0.34 \text{ (seniti/day)} \text{—(2)}$$

The values of net efficiency in each experimental lot were calculated substituting this value for (m) in (r/f - m) in Table 3 obtaining the values 0.045673, 0.042056, 0.042231 and 0.042574 in Lot No.s 1, 2, 3 and 4 respectively. The formula (3) was obtained as follows by modifying formula (1).

$$r/f = 0.04251 - 0.002926/f \text{ ————(3)}$$

In formula (3), as the value (f) becomes larger, the value r/f approaches its limit value of 0.04251, which approximates the value of net efficiency obtained in each lot of this experiment. When substituting 0 for (f) in formula (1), the value r = -0.002926 is obtained. Therefore, in the case of starvation, the fish lost 0.29% of their body weight each day under the laboratory conditions.

Discussion

Ogino (Ogino *et.al.*, 1980) experimented using carps obtaining the result that to maintain the body weight of each 100 g of carp population, it needed 0.106 g of good quality protein each day (measured using the diet with 10% protein content, with BV value 80 and 98% in digestibility). Ogino also mentioned that this value arises when the proteins with lower BV values are used. In this experiment the daily feeding rate of 6.883% seemed to be the minimum amount for maintenance of the body weight, while the

estimated protein content should be around 4.2% in this feed (Table 1). For the maintenance of the body weight of 100 g, around 0.289 g of protein should be used. Sato (1983) mentioned the lack of some amino acids in copra meal such as tryptophan, lysine, methionine and histidine; although it was used as a poultry feed, mixing it 15~30% with artificial feed .

It is known that the lack of the above amino acids in the feed can cause rodosis or stop of growth in fish. Therefore, a negative effect in the body protein assimilation of mullet can be assumed when they are reared under laboratory conditions using a feed with a high copra meal content. In a natural environment such as pen culture, the mullet experimental feed may play a secondary role by accelerating the growth of the benthic micro fauna and flora which then becomes a natural food source for the mullet. The data obtained in this experiment is hoped to become the basis for feed comparisons for the penculture in the near future.

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Table 2. The weight range, mean body weight, variance and standard deviation of the fish in each lot.

Body Weight Range (g)	LOT NO. 1		LOT NO. 2		LOT NO. 3		LOT NO. 4	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
5.0-7.0	4	5	2	3	8	9	3	5
7.0-9.0	18	16	21	19	16	16	20	18
9.0-11.0	9	12	13	14	9	10	11	11
11.0-13.0	6	6	7	6	7	5	6	7
13.0-15.0	5	3	2	3	2	4	5	4
15.0-17.0	5	5	3	3	3	1	0	0
17.0-19.0	0	0	2	2	2	2	3	4
19.0-21.0	0	0	0	0	1	1	1	1
21.0-23.0	0	0	1	1	1	1	1	1
23.0-25.0	1	2	0	0	0	0	1	0
25.0-27.0	1	0	0	0	0	0	0	0
Total	49	49	51	51	49	49	51	51
Mean Body Weight(g)	10.7	10.6	10.5	10.3	10.3	10	10.8	10.4
VARIANCE	17.537	15.554	11.332	10.75	14.922	13.526	15.96	13.976
SD	4.188	3.944	3.366	3.279	3.863	3.678	3.995	3.738

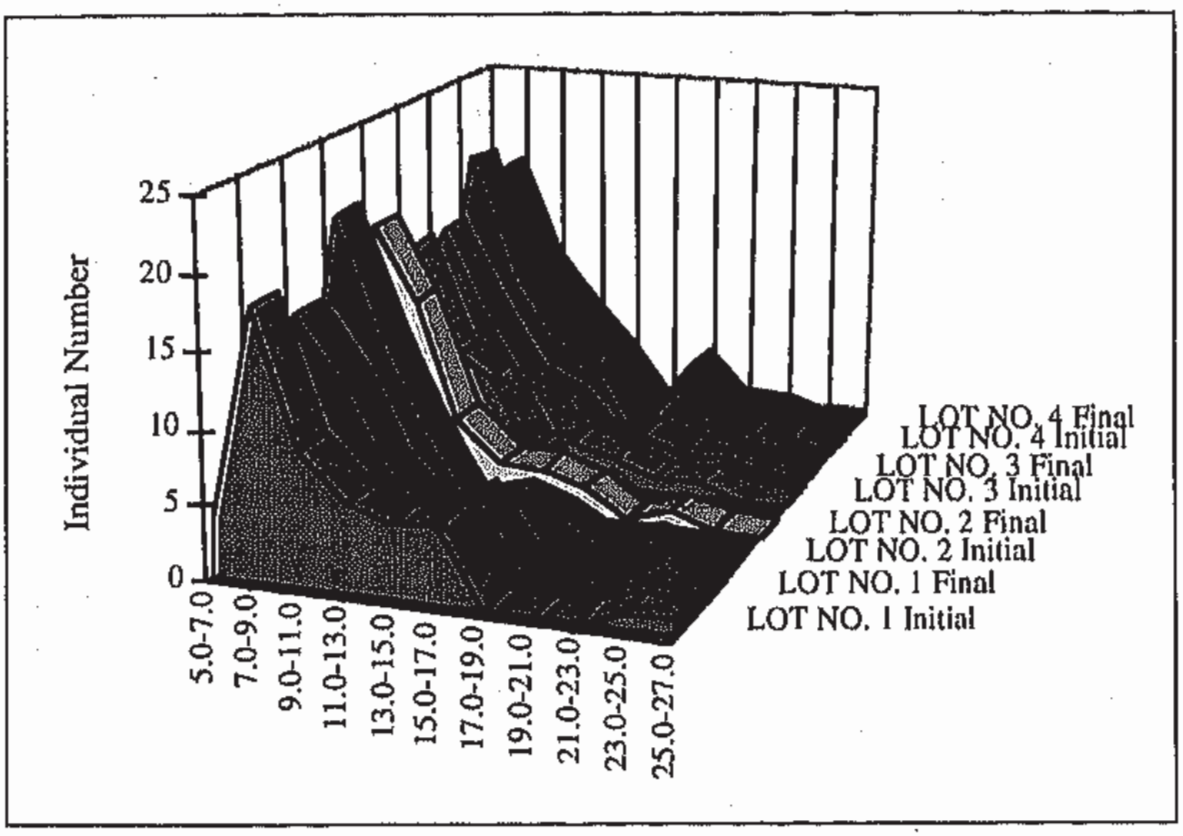

Figure 1. Weight composition of fish in each lot

Table 3. Calculated value of daily rate of feed (f), daily rate of growth (r), gross efficiency and net efficiency when fed Exp. Diet 1 (Lot No. 1-3) and starvation (Lot No. 4).

Lot No.	Initial body Weight(g) W0	Individual number N0	Mean body weight(g) W0/N0	Final body Weight(g) Wt	Individual number Nt	Mean body weight(g) Wt/Nt	Total food intake (g) F	Daily rate of feeding f*1	Daily rate of growth r*2	Gross efficiency r/f	Net efficiency r/f - m*3	Experimental period T (days)
1	525.1	49	10.7	519.8	49	10.6	387.4	0.053	-0.00072	-0.01368	0.04567262	14
2	535.1	51	10.5	524.4	51	10.3	256.1	0.035	-0.0014	-0.04179	0.04205626	14
3	506.8	49	10.3	491.6	49	10.0	121.1	0.017	-0.0022	-0.12550	0.04223123	14
4	551.2	51	10.8	529.3	51	10.4	6.2	0.001	-0.0029	-3.53226	0.04257423	14

*1: f=F/T(W0+Wt)/2. *2: r=(Wt-W0)/T(W0+Wt)/2. *3: m: Daily rate of feedning for weight maintenance.

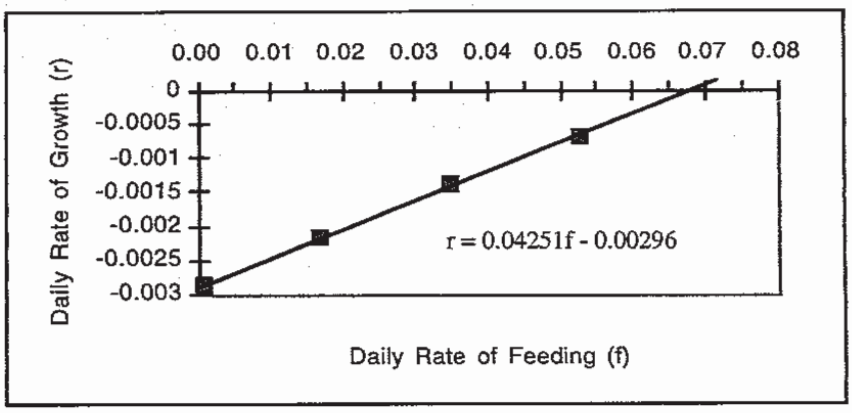

Figure 2. Relationship between daily rate of feeding (f) and daily rate of growth (r)