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Diets and Feeding Regimes of Poeciliid Fishes in Singapore

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Abstract

The guppy, *Poecilia reticulata*, molly *(P. sphenops* and *P. latipinna)*, swordtail *(Xiphophorus helleri)* and platy *(X. maculatus* and *X. variatus)* are livebearing fishes of the family Poeciliidae. They account for about 30% of ornamental fishes that are cultured in Singapore for export. Local farmers daily prepared feeds for guppies, swordtails and platies. Guppy feeds consisted of 70-80% ground wheat bran or oats, 10-15% fish meal, poultry starter crumbles or ground dried shrimp and 5-20% skimmed milk or buttermilk. The crude protein (CP), nitrogen-free extract (NFE) and crude fat (CF) levels of these diets ranged from 15 to 34%, 48 to 77% and 3 to 7%, respectively, of the total dry weight. Platy and swordtail feeds consisted of 60-80% wheat bran and 20-40% fish meal, with CP, NFE and CF levels of 18-26%, 53-63% and about 5%, respectively. Natural organisms in ponds formed an essential part of the molly diet. Ponds were fertilized with chicken, duck or pig manure. Bread crusts and ground wheat bran supplemented these natural foods of molly fry and adults. The fry of all species were given live *Moina* sp. and broodstock live tubificiids. Formulated diets were given once or twice each day; supplementary items usually once.

Introduction

The livebearing ornamental fishes belonging to the family Poeciliidae are native to South and Central America (Rosen and Bailey 1963). Recent statistics showed that about 15% of the total quantity of ornamental fishes exported from Singapore consisted of guppies *(Poecilia reticulata),* while platies *(Xiphophorus maculatus*

and *X. variatus),* mollies *(P. latipinna* and *P. sphenops)* and swordtails *(X. helleri)* account for about 5% each (Anon. 1988). Some of the reasons for the popularity and commercial culture of poeciliids in Singapore are: suitable climatic conditions; availability of about 20 color and finnage varieties for each group; short generation interval of 3 months (guppy), 4 months (molly) and 5-6 months (platy and swordtail); and hardiness of fish (Fernando and Phang 1985; Phang 1985).

In nature the guppy feeds on small invertebrates, aquatic insect larvae, algae and other plant material (Dussault and Kramer 1981). Analysis of the gut contents of guppies introduced into Australia showed a diet of terrestrial insects, particularly ants, with chironomid larvae dominating the aquatic component (Arthington 1989). The swordtail and platy are found in similar habitats as the guppy (Rosen and Bailey 1963). Gut contents of *X. maculatus* and *X. helleri* introduced into southeastern Australia showed that they are omnivorous, with *X. maculatus* showing a preference for aquatic and terrestrial insects and *X. helleri* for plant material (Arthington 1989). Mollies thrive on filamentous algae, blue-green algae, diatoms, tiny crustaceans, rotifers and protozoans (Axelrod 1968).

Studies on the nutritional requirements for growth of guppies have included the effects of different protein levels (Shim and Chua 1986), vitamin B2 (Shim and Khoo 1987) and magnesium (Shim and Ng 1988). Other studies included the effect of three different dietary protein levels on fecundity in the guppy (Dahlgren 1980), food and feeding behavior of guppies (Dussault and Kramer 1981), and growth rate and food conversion of juvenile guppies cultured on a formulated diet and natural foods (Shim and Bajrai 1982). Boonyaratpalin and Lovell (1977) formulated a flaked diet from fish meal, soybean meal, grain by-product, fish oil and a concentrated pigment source and tested it on the angel fish *Pterophyllum scalare,* tiger barb *Barbus tetrazona* and oscar *Astronotus ocellatus.* The growth rates for these fish were satisfactory. Poeciliid fish diets that are used at local farms have not been documented. This paper describes the diets and feeding regimes of poeciliid fishes in Singapore farms.

Materials and Methods

Farms in Singapore culturing poeciliid fishes were visited and information on the types of feeds, ingredients and proportions of the

formulated feeds, and feeding regimes were recorded. Samples were collected for analyses. The moisture level was determined after heating overnight in a furnace at 105°C. A sample was then used to determine the Crude Fiber (CFiber) level using a Crude Fiber Extractor. Crude fat (CF) and crude protein (CP) levels were determined by the Soxhlet and Kjedahl methods, respectively. The ash content was determined after 48 hours in a furnace at 550°C. For guppy diets, CFiber was not determined and the nitrogen-free extract (NFE) was calculated after CP and CF values had been obtained and subtracted from 100%. Crude fiber levels were determined for swordtail, platy diets and some supplemental feed ingredients. In these cases, NFE was calculated after CP, CF and CFiber levels had been obtained and subtracted from 100%.

Results and Discussion

Guppy Diets

Each guppy farm cultures 8-12 varieties in brackishwater in large concrete tanks and net cages suspended in ponds (Fernando and Phang 1985). Guppies were fed with formulated diets prepared daily. The ingredients (Table 1) were mixed into a paste with water and stirred continuously over a high flame. When cooled, the cooked mixture was scooped into lumps by hand and thrown into each fish tank. The diets of fry from birth to 3-4 weeks at 4 farms were supplemented with the live cladoceran, *Moina micrura*, while adult diets were supplemented with live tubificiids, food flakes and floating pellets (Table 1).

The crude protein (CP) was supplied by 10-15% fish meal at 6 farms, 10-15% poultry starter crumbles (farm E) and 10-15% ground dried shrimp. *Acetes* sp. (farm B). Buttermilk or skimmed milk in proportions of 5-20% also provided some CP as well as crude fat (CF). The CP, CF and NFE levels of these diets are given in Table 2, with the frequency and times of feeding at guppy farms in Table 3.

Shim and Chua (1986) found that 30% CP level gave optimal growth and feed conversion for adult guppies. Since the formulated diets at 7 out of the 10 farms had CP levels of less than 30%, supplementing with *Tubifex* sp. with a CP level of about 71% (Table 4) would increase the protein required for optimal growth. *Moina* sp.

with a 70% CP level (Table 4) was found suitable as food for fry but not for adults (Shim and Bajrai 1982). Decreased dietary protein levels resulted in decreased ovary weight and volume in the guppy, although fecundity was not significantly affected (Dahlgren 1980). Although vitamin and mineral contents of the formulated diets were not analyzed, Shim and Khoo (1987) showed that 4 $mg \cdot kg^{-1}$ diet of vitamin B2 is essential. Shim and Ng (1988) found that fish fed with

Table 1. Ingredients of formulated diets and supplemental feeds.

Fish group	Farm	Formulated diets	Supplemental foods	
			Adults	Fry
Guppy	A	Skimmed milk, ground wheat bran and fish meal		*Moina* sp.
	B	Skimmed milk powder, ground wheat bran and ground dried shrimp	Tubificiids	*Moina* sp.
	C	Skimmed milk, ground wheat bran and fish meal	Tubificiids	*Moina* sp.
	D	Skimmed milk, ground oats and wheat flour	Tubificiids Food flakes	-
	E	Buttermilk, ground wheat bran and poultry starter crumbles	Tubificiids Floating pellets	*Moina* sp.
	F	Buttermilk, ground wheat bran and fish meal	Tubificiids	-
	G	Buttermilk, wheat flour and fish meal	Tubificiids	-
	H	Skimmed milk, ground wheat bran, wheat flour and fish meal	Tubificiids	-
	I	Skimmed milk, soya bean and wheat flour and fish meal	Tubificiids	-
	J	Skimmed milk, ground wheat bran and fish meal	Tubificiids	-
Platy and swordtail	K	Wheat flour, skimmed milk and fish meal	Tubificiids	*Moina* sp.
	L	Wheat flour and fish meal	Floating pellets	*Moina* sp.
	M	Wheat flour, wheat bran and fish meal	Tubificiids	*Moina* sp. Skimmed milk powder
	N	Wheat flour, skimmed milk and fish meal	Tubificiids	*Moina* sp.

Table 2. Percentage composition of formulated diets (CP: Crude protein, CF: Crude fat, NFE: Nitrogen-free extract).

Fish group	Farm	% Moisture	% Composition of diets on a dry-weight basis				
			CP	CF	CFiber	Ash	NFE
Guppy	A	72.8	29.7	4.6	na	6.6	-
	B	68.6	23.1	5.6	na	6.8	-
	C	74.5	20.0	7.1	na	5.2	-
	D	75.8	15.8	4.0	na	2.8	-
	E	76.4	15.1	6.7	na	3.8	-
	F	53.3	31.6	7.0	na	13.1	-
	G	73.8	22.2	4.7	na	7.9	-
	H	69.7	33.0	3.4	na	16.6	-
	I	69.0	33.5	3.4	na	15.6	-
	J	67.7	25.9	4.2	na	7.3	-
Platy and swordtail	K	9.8	18.3	5.4	8.8	4.9	62.6
	L	10.6	20.8	5.9	6.5	5.9	60.9
	M	59.1	23.2	4.9	2.2	11.6	58.1
	N	36.1	26.3	5.7	7.1	7.2	53.7

na: Crude fiber was not determined for these diets.

Table 3. Frequency and times of feeding of formulated diets and supplemental foods.

Fish group	Farm	Daily frequency and times of feeding	
		Formulated diet	Supplemental foods
Guppy	A	Twice; 0900, 1700h	-
	B	Once; 1200h	Occasionally; 0900h
	C	Once; 0900h	Once; 0900h
	D	Twice; 1200h, 1800h	Once; 0900h
	E	Twice; 1000h, 1700h	Once; 0900h
	F	Twice; 1200h, 1600h	Once; 0900h
	G	Twice; 1200h, 1600h	Once; 1000h
	H	Twice; 1000h, 1800h	Occasionally; 1200h
	I	Twice; 1000h, 1800h	Once; 1200h
	J	Once; 1200h	Occasionally; 0900h

Fish group	Farm	Daily frequency and times of feeding		
		Formulated diet	Adults	Fry
Platy and swordtail	K	Once; 0900h	Once; 1000h	Once; 1100h
	L	Once; 0900h	Once; 1100h	Once; 1100h
	M	Twice; 0900h, 1730h	Once; 1000h	2/3 times weekly; 1000h
	N	Twice; 0930h, 1700h	2/3 times weekly; 0930	Once; 1100h

Table 4. Percentage composition of supplemental feeds and some feed ingredients of poeciliid fishes.

Feed	% Moisture	% Composition on a dry-weight basis CP	CF	CFiber	Ash	NFE
Live feed						
Moina micrura	93.5	70.0	16.4	na	9.9	-
Bloodworm	90.7	62.5	10.4	na	11.6	-
Tubificiids	83.2	71.2	5.4	na	3.6	-
Frozen feed						
Moina sp.	92.0	72.4	16.0	na	9.6	-
Bloodworm	89.5	65.3	10.4	na	11.0	-
Other feeds						
Pellets	11.2	30.3	8.6	na	10.3	-
Flakes	10.7	52.8	7.0	na	5.0	-
Breadcrust	24.2	11.6	5.0	na	2.2	-
Ingredients						
Wheat bran:						
Sample #1	9.7	17.7	4.9	na	5.1	-
#2	10.4	15.0	4.4	8.6	3.2	68.8
#3	11.5	19.4	7.8	8.8	5.3	58.7
Fish meal:						
Sample #1	11.7	55.6	8.2	1.8	24.0	10.4
#2	10.8	56.0	8.4	1.7	24.2	9.7

na: Crude fiber was not determined for these diets.

magnesium-deficient diets showed poor growth, low feed efficiency and high mortality; and 0.5 $g \cdot kg^{-1}$ magnesium in formulated feed was necessary for maximum growth in adult guppies.

Swordtail and Platy Diets

In Singapore each farm cultures about 10 varieties for each group of these poeciliids in freshwater. Platy and swordtail varieties were cultured and fed together at the farms surveyed. The feed was prepared daily, similar to that of the guppy, and consisted of wheat flour, skimmed milk and fish meal (Table 1). CF levels did not differ much from those of guppy formulated diets; CP and NFE levels were lower than guppy diets at some farms and CFiber levels were from 2 to 9% (Table 2).

The frequency at which formulated diets were given to platies and swordtails is shown in Table 3. Fry up to four weeks old were fed with formulated feeds, supplemented with *Moina* daily (Table 4). At farm M the fry were also fed skimmed milk powder. Broodstock were given live *Tubifex* spp. twice or thrice weekly at farms K, M and N as

were imported, floating pellets at farm L (Table 1). Frozen bloodworms could be used as a substitute for live tubificiids as they have a comparable protein level (Table 4). Since there are no published reports on platy and swordtail nutritional requirements or an evaluation of formulated diets on growth and fecundity, it is not known whether protein and carbohydrate levels of these diets are optimal.

Molly Diets

Locally, ponds for rearing mollies are fertilized with pig or chicken manure (Phang 1985) or duck droppings (Ang Y.H., pers. comm. 1987) to promote the growth of zoo- and phytoplankton, small invertebrates and benthic algae (Schroeder 1978). Analysis of the gut contents of sailfin mollies by Phang (1985) showed a predominance of bluegreen algae (Order Chrorococcales) and green algae (Order Chlorococalles) with small organisms such as protozoans, cladocerans and detritus. Small mollies preferred vegetable matter while larger ones fed on zooplankton and detritus as well. The gut was long and coiled as expected of herbivores, with the ratio of gut length/standard length of fish from 1.4-4.7 (Phang 1988). The natural diets of fry, juvenile and adult mollies were supplemented with breadcrusts and ground wheat bran with CP and NFE levels of 15-19 and 59-72%, respectively (Table 4). These foods were thrown into ponds daily at about 0900 hours. Broodstock in the net cages may be given live *Tubifex* spp. once or twice a week. Fry aged 4-5 weeks were given *Moina* spp. on alternate days prior to the breadcrust diet. Fish apparently do not have a carbohydrate requirement, but warmwater fish are generally able to use high carbohydrate levels as an energy source (National Research Council 1983). This is advantageous, since carbohydrate sources are inexpensive and practical formulated feeds for warmwater fish may contain 35-40% carbohydrate (Robinette 1984).

The formulated diets of poeciliid fishes have no feed antioxidants, growth stimulants, vitamin or mineral supplements. There is little variation in the ingredients used, but their proportions may vary slightly from day to day which may result in variation in nutritional value. Since diet and meal frequency affect growth, vigor and fecundity of fish, and there may be different requirements for each stage of the life cycle, there is a need to look into diet

formulations for each stage of the life cycle. As Singapore moves into intensive ornamental fish farming with the setting up of Agrotechnology Parks in the Sungei Tengah and Murai districts (Fernando and Lim 1989), quality-controlled diets for commercially cultured fishes will become imperative to increase productivity.

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