A Comparison of Rearing Costs and Returns of Selected Herbivorous, Omnivorous, and Carnivorous Aquatic Species

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Introduction

It has been said that the cost of culturing staple aquatic herbivorous species (i.e., tilapia, milkfish, carp, etc.) is less than that of culturing more costly carnivorous and omnivorous species (i.e., shrimp, prawn, eel, trout, etc.) because of the savings in feed costs (Bardach et al., 1972; Korringa, 1976). Thus, a nation may encourage the culture of staple aquatic herbivores if its national development policy priority is to augment the low-cost animal protein component in the people's diet.

Also, it is often mentioned that the production of carnivorous and omnivorous aquatic species may generate a higher rate of return than herbivorous species (personal communications with some fishery officials). Therefore, some nations may choose to encourage the culture of such high-value species for export to generate greater returns and provide rural employment.

This paper examines the extent to which protein from selected aquatic herbivorous species is less costly to produce than from aquatic carnivorous and omnivorous species. It will also attempt to answer the question of whether the culture of high market value species leads to a higher rate of return.

Costs of Production

Information on costs of production of selected herbivorous, carnivorous, and/or omnivorous species is available for analysis from Mexico (FAO, 1978) and Taiwan (Taiwan Fisheries Bureau, 1979); the herbivores are tilapia, *Tilapia aurea*, and oyster, *Ostrea corteziensis*, in Mexico, and milkfish, *Chanos chanos*, and oyster, *Crassostrea gigas*, in Taiwan, while the carnivores and omnivores are freshwater prawn, *Macrobrachium rosenbergii*, and marine shrimp (Penaeids) in Mexico, and eel, *Anguilla japonica*, in Taiwan.

Comparing the cost of production per unit of gross weight among species is not relevant in selecting species for culture as a protein source because edible portions and protein content may vary significantly. For example, the refuse (or inedible) portion varies from 31 percent for marine shrimp and milkfish to 85 percent for oysters. Also, protein content varies from 8.3 g per 100 g of edible weight for oysters to 20.6 g for milkfish (Table 1).

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A more meaningful measure would be the cost of production per unit of protein produced, comparing data from the same country and for the same time period. To do that, the unit cost of production, in gross weight, for each species mentioned above is calculated first (Table 1). These calculated costs of production are then adjusted to an edible weight basis and finally they are calculated on a protein basis (1,000 g wet weight).

In terms of gross weight, the unit costs of production of oyster and freshwater prawn are less than those of tilapia and marine shrimp, respectively, in Mexico. However, these values are reversed when costs are compared on a protein basis (Table 1). This is also true for oyster and milkfish in Taiwan. Herbivores cost much less to produce than carnivores and omnivores in terms of protein in both countries, i.e., the cost of producing freshwater prawns in Mexico is more than five times that of tilapia and about three times that of oysters. In Taiwan, the cost of producing eels is more than five times that of milkfish and three times that of oysters. In terms of cost of feed and/or fertilizer per unit of protein produced, again, it costs much less to rear herbivores than carnivores and omnivores. Species in the latter group need high protein feeds which are expensive. As for oysters, no feed costs are involved because they feed directly on algae or phytoplankton.

Actually, herbivores can be cultured in a pond in low density relying on natu-

Table 1. — Estimated costs of production per unit of protein of selected species in Mexico and Taiwan.

Species	Cost/kg[1]	Refuse[2] portion	Protein in[2] edible portion per g	Cost/1,000 g[3] of protein	Cost of feed/[4] fertilizer per 1,000 g protein
			Mexico		
Oyster	$0.17	85%	0.083	$13.65	$ 0
Tilapia	0.60	62	0.188	8.40	3.72
Freshwater prawn (*M. rosenbergii*)	2.92	60	0.160	45.63	9.03
Marine shrimp (Penaeids)	3.33	31	0.160	30.16	9.45
			Taiwan		
Oyster	1.03 (meat)	0	0.083	12.53	0
Milkfish	1.04	31	0.206	7.32	1.94
Eel	4.15	33	0.168	36.87	14.93

[1] Derived from Table 2.
[2] Sources: NIH, 1972, and Anonymous, 1964.
[3] [Cost of production per kg − (1,000 g × edible portion × protein in edible portion per g)] × 1,000.
[4] [Cost of feed and fertilizer per kg − (1,000 g × edible portion × protein in edible portion per g)] × 1,000.

ral food present in the water, or in high density with fertilization and/or supplemental feeding. Excepting the oyster, all of the herbivores mentioned are under intensive cultivation, with fertilization and supplemental feeding. The total cost of fertilizer and supplemental feed of rearing herbivores is usually less than the cost of feed for carnivores. Also, unit costs of rearing these staple species with fertilization and supplemental feeding are usually less than without because of the proportionately higher level of production per unit of pond. However, a steep increase in the prices of fertilizer and feed could change this situation.

Table 2. — Average production costs and returns of selected species in Mexico and Taiwan.

Item	Mexico				Taiwan		
	Oyster (per raft)	Prawn (per ha)	Shrimp (per ha)	Tilapia (per ha)	Oyster (per ha)	Eel (per ha)	Milkfish (per ha)
Revenue	$2,286	$17,333	$5,084	$2,347	$5,756	$55,991	$2,833
Production (kg)	6,428	3,000	800	3,520	[1]3,600	10,800	2,300
Operating cost	$1,113	$ 8,754	$2,668	$2,110	$3,727	$44,851	$2,390
Seed		933	28	136	694	17,369	788
Feed		1,733	811	939		[3]18,158	[3]636
Fertilizer			24				
Medicine						799	26
Labor	239	1,600	640	124	1,590	2,704	355
Fuel and Oil	65		15				
Lease		107	107	107		131	79
Electricity			171			1,869	24
Interest	307	2,293	582	540	47	1,162	29
Maintenance		444			983	717	74
Depreciation	458	1,200	206	175	284	1,277	32
Miscellaneous	44	444	84	89	129	665	347
Profit	$1,173	$8,579	$2,416	$ 237	$2,029	$11,140	$ 443
Average rate of return on operating cost (%)[2]	105	98	91	11	54	25	19

[1]Meat.
[2]The rate of return on initial investment is not calculated due to the limited data available on capital costs in Taiwan.
[3]Total for feed and fertilizer

Sources: FAO (1978), and Taiwan Fisheries Bureau, 1979.

Rate of Returns

From the producer's point of view, the cost of production of carnivorous and omnivorous species is higher than that of staple herbivorous species both in physical terms and in terms of protein. However, the output price is also relatively high for the former. Whether the production of high-priced species yields more profit than staple species, depends upon the relative cost of production per unit of output and the relative farm price of output. In Mexico, the estimated annual rate of return on operating cost averages about 105 percent for oyster (raft culture), 98 percent for freshwater prawn, 91 percent for marine shrimp, and 11.2 percent for tilapia (Table 2). In Taiwan, the average rate of return on operating cost is on the order of 55 percent for oyster, 25 percent for eel, and 19 percent for milkfish.

Though oyster is not the least costly species to produce in terms of protein, it yields the highest rate of return (on operating cost) among other species in both countries. On the other hand, tilapia in Mexico and milkfish in Taiwan are the least costly species to produce in terms of protein but yield the lowest rate of return from a producer/investor point of view.

Summary and Conclusions

The quality of protein is equal between carnivores and herbivores, and the preference for one over the other is very much culture conditioned and economic oriented. If the sole objective of aquaculture development is to improve the animal protein component in the people's diet, species with low production cost in terms of protein should be considered first if it is preferred by the people and if the production of the species is economically feasible. Although the rate of return in producing these low-cost herbivores may be relatively low from a financial point of view, the social benefits derived by such a development, such as providing cheap protein food and creating employment in rural areas, may justify the public support.

Actually, production of herbivorous species may not always yield a low rate of return as exemplified by oyster culture in both countries. In addition, herbivorous species, in many cases, are good candidates for polyculture with carnivorous and/or omnivorous species to increase production and hence profit per unit of pond. This practice has been increasingly adopted in both developing and developed countries.

Production of high-value species in developing countries may also be justified, because it generates a higher rate of return, earns foreign exchange, and thereby creates employment in rural areas.

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