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EFFECTS OF FEEDING RATES AND STOCK DENSITY ON FOOD CONVERSION, PRODUCTION AND BODY COMPOSITION OF GROUPER (*Epinephelus bleekeri*) RAISED IN SEA CAGES IN SABAH

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ABSTRACT. *Juveniles of grouper (Epinephelus bleekeri) were reared in net cages in Mengkabong coastal bay, west coast of Sabah for study of the effect of ration size and stocking density on food conversion, production and proximate body composition. Ration size was found to influence the food conversion ratio (FCR). The fish seemed well adapted to make use of proteinaceous diet. Production resulting from 14 week culture varied between 2.712 - 3.084 kg/m^3 under the three feeding treatments (5%, 7.5% and 10% ration sizes). There was no significant difference (P>0.05) in FCR at stock densities of 30/m^3 and 60/m^3. A production of 3.426 kg/m^3 was attained at the higher stock density. The gross body composition was not significantly influenced by variations in ration size and stock density.*

INTRODUCTION

Groupers are a group of commercially important and highly priced marine food fish. Their market demand far exceeds the supply from natural sources in the Asia-Pacific region. Sea cage culture seems to be one of the practical and feasible means of stepping up production. The commonly cultured species of grouper (*Epinephelus bleekeri*) selected for the study is carnivorous and thrives on minced meat of trash fish. It is hardy enough to stand rapid changes in salinity which generally occur in estuaries. In this study attention was focussed on the effect of ration size and stock density on food conversion, production and proximate body composition of the fish reared in sea cages in the east Malaysian state of Sabah.

MATERIALS AND METHODS

Observations were made on grouper specimens stocked in net cages installed in Mengkabong bay at Trayong Aquaculture Station. The area is located in the South China Sea along the north-west coast of Sabah. The cages were similar in size and were constructed of plastic mesh. Each cage measured about 2m^3. The assembly of cages was anchored to a raft and moored in inshore water 5 - 8 m deep. The wooden raft rested on strong bars and held at least 30 cm above the high tide mark. Upper ends of the cages and raft were kept at the same level. The raft infrastructure was connected to a jetty and had elaborate passageways providing easy access to the cages. Young specimens of the grouper measuring 13 - 15 cm formed the basis of the investigation. Stocking was done at the rate of 30/m^3 (cage A1) and 60/m^3 (cage A2). Caged fish were given minced meat of trash fish at the rate of 10% body weight, BW once in every 2 days. In a parallel set of experiment 3 groups of fish were maintained in separate cages at similar high stock density (60/m^3) and supplied different feeding treatments in the form of minced meat of trash fish at the rate of 5%

BW (treatment A), 7.5% (treatment B) and 10% (treatment C) once in every 2 days. The experiment continued for 14 weeks. Dietary treatments were replicated. Water temperature ranged between 27.7 - 31.7° C. Salinity which was recorded using a refractometer varied between 29 - 33.5 ‰. FCR was evaluated as a ratio of the total weight (g) of food fed to the fish to the total gain in fish body weight (g). After 4 weeks of trial, the fish were weighed for the calculation of biomass production, and analysed for proximate chemical composition according to the techniques described in Mustafa and Jafri (1978). Muscle samples were excised from a fixed epaxial region in trunk for the biochemical assays. Chemical constituents were expressed on wet weight basis.Food Conversion Ratio (FCR) and production were determined by the methods followed earlier by Rahman and Mustafa (1989).

RESULTS AND DISCUSSION

Data on FCR, production and proximate body composition for the groupers maintained at different ration sizes and stock densities are presented in Table 1. Supply of minced meat from the same source and rearing of the fish in the same farm complex eliminated the possibility of any appreciable difference in food quality or environment influencing the FCR. The food conversion data revealed that the grouper due to its carnivorous habit was quite capable of digesting a high protein diet and dealing with large ration size. The three feeding treatments produced no significant difference in biomass production, with production values just 0.144 kg/m^3 and 0.372 kg/m^3 higher in R2 and R3 than R1 treatment in the respective order. The fact that doubling of ration size increased the production by 13.716 %, the limit of increase in yield by enhancing the rate of feeding is obvious. The economic feasibility of increasing ration size will depend on cost efficiency of the artificial nutrition.

Table 1. Food conversion, production and muscle composition of grouper in cage culture. Values in parenthesis indicate standard error of mean.

Parameters	Feeding rate (%body wt.)			Stocking density (number/m^3)	
	5.00	7.50	10.00	30.00	60.00
Food conversion ratio	2.96 (0.35)	4.37 (0.41)	5.69 (0.51)	5.13 (0.40)	5.08 (0.30)
Production (kg/m^3)	2.7 (0.20)	2.8 (0.40)	3.0 (0.30)	1.7 (0.60)	3.4 (0.70)
Protein (%)	18.20 (0.48)	19.10 (0.34)	19.50 (0.75)	19.80 (0.21)	18.80 (0.34)
Fat (%)	1.22 (0.70)	1.32 (0.20)	1.15 (0.15)	1.05 (0.32)	1.36 (0.28)
Water (%)	75.20 (1.8)	74.50 (1.50)	76.60 (0.90)	73.40 (1.10)	75.80 (0.80)

No significant difference ($P>0.05$) was observed in food conversion at the two stocking densities. Evidently, a high density of 60/m^3 did not put population stress on the caged fish. In other words, one cubic meter space was adequate for 60 specimens of fish when food supply was managed from outside and physical processes of the inshore environment prevented fouling of the medium. It was interesting to note significantly greater production (92.5%) in the higher stock density culture. Data presented in Table 1 indicated that the 14-week production of 1.779 kg/m^3 could be raised to 3.426 kg/m^3 by increasing the stock density from 30 to 60/m^3. Presumably, the grouper did not require very discrete feeding territories for optimal growth. It would be profitable to use cage space more efficiently through intensive culture of groupers.

No significant difference (P>0.05) in percentages of proximate chemical constituents was found in specimens given either A1 and A2, or R1, R2 and R3 treatments. Webster *et al.* (1992) also observed that the body composition of channel catfish was not affected by feeding the fish with different rations. Lack of significant difference in protein level in fish given A1 and A2 feeding treatments pointed to the grouper's tendency to partition off and retain a certain level of protein into skeletal musculature. The other possible reason might be that the muscle was less sensitive to dietary restriction, and could hold out the proximate chemical profile under conditions of limited variability of dietary treatments and stocking rates. It hardly changed when feeding was done at low (5%) or high (10%) levels. Such a stability of muscle protein in the face of quantitative dietary modification was important for normal metabolism and mechanical role of musculature. This can not be said of visceral protein. Storebakken *et al.* (1991) noticed a definite gain in carcass protein in rainbow trout but a negative gain in visceral protein when feed supply was reduced to near maintenance level (0.3% BW/day). Hung *et al.* (1993) also reported that under sub-optimum feeding conditions the striped bass retained more protein into muscle to save it from mobilization whereas the protein in viscera and liver were vulnerable. These authors observed that the liver-somatic and viscera-somatic indexes declined by 29% and 25%, respectively when feeding was halved from 1% to 0.5% BW/day. In case of *E. bleekeri* the supply of non-formulated diet such as the minced meat of trash fish which was composed of normal proportions of chemical constituents, not exclusively protein, the full capacity of fish to hydrolyse protein remained untapped. Out of the numerous biochemical components of the diet the fish might selectively partition off the protein to conserve it in tissue growth. The limited changes, though not significant, seen in other proximate constituents revealed an inverse relationship between fat and water in both the feeding and stock density treatments. Accumulation of one displaced the other. This 'tie' between the two nutrients perhaps spared the protein. It should be interesting from consumers' viewpoint that groupers raised under varied culture conditions, either at reasonably low food intake or moderately high stock density would remain an equally good source of protein.

CONCLUSION

Findings of this study suggest that the grouper culture is a profitable venture in the tropical equatorial environment of Sabah, north-east Borneo. The fish easily acclimatises to cage environment, and can stand stocking at a moderate density. The fish's ability to partition off protein from dietary intake and conserve it for biomass growth stands it in good stead under conditions of nutritional impoverishment. The negative fat-water relationship may enable the fish to maintain a more stable protein profile and use this constituent for tissue building.

While it is economically viable to culture grouper in sea cages with non-formulated ration but such a diet's growth-stimulating potential is limited. For achieving spurt in production a high protein feed formulated to contain required types and quantities of nutrients will be required.

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