*Egyptian J. Anim. Prod. (1997) 34 (1):67-74*

# RESPONSE OF TWO SIZE GROUPS OF *SIGANUS CANALICULATUS* TO DIETS CONTAINING VARYING LEVELS OF DIETARY FIBER

**A. A. Anwahi[1], O. M. Yousif[2], M. F. Osman[2], T. Cherian[1] and A. Janahi[1]**

1 Marine Resources Reasearch Center, Ministry of Agriculture and Fisheries, P.O. Box 21, Umm Al-Qaiwain, United Arab Emirates; 2 Faculty of Agricultural Sciences, United Arab Emirates University, P.O. Box 17555, Al-Ain, United Arab Emirates.

## SUMMARY

The effect of three levels of dietary fiber on growth performance and feed utilization efficiency of rabbitfish *Siganus canaliculatus* fry and fingerlings, was studied for 70 days. Alpha- cellulose was added to the experimental diets at 2% (diet 1), 7% (diet 2) and 12% (diet 3) yielding final crude fiber content of approximately 5, 10 and 15%, respectively. In both fish size groups, significant difference ($P<0.05$) were produced in growth response. Also significant differences ($P<0.05$) in feed utilization efficiency and whole body composition were obtained. Both size groups of fish recived diet 2 (10% crude fiber) yielded significantly ($P<0.05$) better growth performance and feed utilization efficiency than the other two levels.

**Keywords:** *Siganus canaliculatus,* growth, dietary fiber.

## INTRODUCTION

Like many other monogastric animals, fish are generally considered incapable of utilizing dietary fiber (Davies, 1985). However, the use of ingredients of plant origin in commercial formulated fish diets, makes the introduction of varying levels of dietary fiber inevitable. Therefore, researchers have concentrated their efforts on determining the optimal fiber levels in diets for different fish species. Excessive fiber levels were found to reduce the binding quality of processed feeds, inhibit feed intake by fish and increase faecal waste production and hence leading to the pollution of the culture medium (Lovell, 1989).

Dupree and Sneed (1966) fed channel catfish *(Ictalurus punctatus)* purified diets containing dietary cellulose ranging from 0 to 51 % and they reported that highest weight gain of fish was attained with 21% level. In contrast, Leary and Lovell (1975) found that increasing alpha cellulose level beyond 2.8% in channel catfish diets and that levels over 14% led to reduce growth rates. Similar results were also reported for common carp, rainbow trout and tilapia (Davies, 1985; Hilton *et al.*, 1983 and Shiau *et al.*, 1989)

The purpose of the present study was to evaluate the effects of three levels of dietary fiber in diets for rabbitfish *Siganus canaliculatus*.

## MATERIALS AND METHODS

Rabbitfish fry averaging 2.47 ±0.19 g (mean ± SD) were stocked in nine 1000 liter outdoor self cleaning fiberglass tanks at a rate of 60 fish fry per tank. Fingerlings averaging 11.49 ± 0.042 g were stocked in nine identical tanks at a rate of 20 fish/ tank. All fry and fingerlinge tanks received a continous flow of filtered and aerated sea water at a flow rate 30 L/min. Water quality was routinely monitored and mean values (± SD) obtained were: max. temperature, 32.57 ± 0.59 C; min. temperature 28.50 ± 1.05 C; dissolved oxygen, 4.92 ± 0.22 mg/L; pH, 7.87 ± 0.10; salinity, 39.03 ± 0.52 ppt.

Three isonitrogenous (45 % CP) and isocaloric (20 kJ/g) diets containing three levels of dietary fiber were formulated (Table 1). To provide the desired level of fiber alpha cellulose was added into the diets. The diets were made isocaloriv by adding sunflower oil to diets two and three. The dry ingredients of each diet were mixed with oil and water, extruded through a laboratory feed pelletizer into two mm diameter pellets, and then sun-dried for 48 hrs. The dry pellets were packed in plastic bags and stored in a freezer at -20° C until used.

Table 1. Formulation and chemical composition of the experimental diets.

| Ingredients(% DM) | Diets | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Fish meal (71% CP) | 44.00 | 44.00 | 44.00 |
| Soybean meal (44% CP) | 33 | 33 | 33 |
| Wheat flour | 10.00 | 10.00 | 10.00 |
| Alpha cellulose | 12.00 | 7.00 | 2.00 |
| Sun flower oil | 0.00 | 5.00 | 10.00 |
| Vitamin-mineral mixture[1] | 1.00 | 1.00 | 1.00 |
| **Proximate composition (% DM)** | | | |
| Moisture | 8.39 | 9.30 | 9.55 |
| Crude protein | 45.55 | 47.97 | 46.11 |
| Crude fiber | 13.20 | 9.57 | 5.52 |
| Crude lipid | 3.96 | 7.76 | 11.14 |
| Ash | 6.18 | 6.48 | 6.53 |
| NFE[2] | 31.11 | 28.22 | 30.70 |
| Gross energy[3] (kJ/g diet) | 19.86 | 20.85 | 21.49 |

1) Vitamine-mineral mixture: Shrimp tonic, JV Marine East. Co. Ltd, Thailand.
2) NFE: Nitrogen-free extracts = 100 - moisture - crude protein - crude fiber - ash.
3) Gross energy: in kJ/g diet; based on 23.86 kJ/g protein; 39.77 kJ/g lipid and 16.74 kJ/g carbohydrate.(Wee and Wang, 1987)

The results of whole body composition of both size groups are shown in table three. The fish fry fed diet containing 10% fiber had significantly less body moistuer than any of the other two fry groups ($P<0.05$). The moisture content of the fry fed diet one and three were similar ($P<0.05$) . There were no significant differences ($P>0.05$) in protein contents among all fry groups. The highest fat content and energy deposition (kj/g wet body) were found in the fry group fed diet one, whilst in the other two groups fed diets two and three, these two parameters were similar ($p<0.05$). The ash values were similar for the three fry groups.

Fingerlings fed diet two had the lowest ($P<0.05$) moisture content. The highest moisture content was observed for fingerlings group fed diet 1. Protein content of fingerlings fed diet two was slightly differnet from that of fingerlings fed diet three. Fingerlings fed diets two and three gave similar results of fat content and energy deposition. Ash contents were similar for all fingerlings groups.

Fry and fingerlings were fed at 7 and 5% of the body weight, respectively. The daily ration was given in three equal portions (8.00, 12.00, and 16.00 hr). Each diet was fed to triplicate groups of fry and fingerlings for 70 days. Every 14 days all fish, fry or fingerlings were removed from all tanks, counted, weighed and feed amount was adjusted accordingly. When fish were removed for weighing, the tanks were completely drained and cleaned thoroughly.

At the begining and end of the experiment samples of fry and fingerlings were collected from each treatment for whole-body analysis. The chemical analysis of diets and carcass were carried out using the standard AOAC (1984) methods.

The results for fish growth, feed utilization efficiency and carcass composition of fry and fingerlings were analysed by one way ANOVA and the differences among the diets tested for significance ($P<0.05$) using duncane's multiple range test (Duncan, 1955).

## RESULTS AND DISCUSSION

Average body weight of both fry and fingerlingw os *S. canaliculatus* at biweekly intervals for each of the three experimental diet over the 10- week growth period is presented in Figure 1. Both fry and fingerlings fed diet 2, containing around 10% crude fiber, attained the highest significant ($P<0.05$) mean body weight over the other groups. Also weight gain percentage and specific growth rate (SGR) of groups fed moderate level of dietary a-cellulose in both fish sizes (fry or fingerlings) were significantly ($P<0.05$) higher among the other groups. These results indicated that growth performance of both sizes of *S. canaliculatus* were affected negatively by increasing the dietary fiber level higher than 10%. Qadri and Jameel (1989) found that the inclusion of α-cellulose in tilapia diets up to 10% has no reduction effect on growth performance.However, at higher fiber levels FCR and SGR were reduced. Dioundik and Stom (1990) obtained reduction in growth rate of *Oreochromis mossambicus* fry fed diets containing 10% dietary -cellulose. Best growth rate, feed conversion ratio and protein efficiency ratio were obtained with 2.5- 5% supplemental α-cellulose. It seems that *S. canaliculatus* tolarate higher dietary -cellulose level than *O. mossambicus* due to its feeding habits as a herbivorous fish. However, Wiesmann and Pfeffer (1987) and Schulz *et al.*(1985) who fed rainbow trout pellets with different

(2-12 %) α-cellulose levels, found no significant effect on growth performance.

Feed utilization efficiency in terms of feed conversion ratio (FCR), protein efficiency ratio (PER), protein productive value (PPV%) and energy utilization (EU%) are presented in Table 2. Fish fry and fingerlings fed diet 2, containing 10% dietary α-cellulose , had significantly (P<0.05) better feed utilization efficiency. Both fish groups fed diet 1, containing 5% dietary fiber, ranked second. The lowest (P<0.05) values were obtained when the level of fiber was increased beyond 10% in diet 3.

Table 2. Means for weight gain (%), specific growth rate (SGR %/d), feed conversion ratio (FCR), protein efficiency ratio (PER), protein productive value (PPV) and energy utilization (EU %) for *S. canaliculatus* fed the different experimental diets.

| Item | Fry diet | | | | Fingerling diet | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | SE | 1 | 2 | 3 | SE |
| Initial wt (g) | 2.29 | 2.47 | 2.65 | 0.077 | 11.48 | 11.48 | 11.50 | 0.017 |
| Final wt (g) | $9.84^{a}$ | $11.97^{a}$ | $9.10^{a}$ | 0.803 | $26.17^{ab}$ | $30.84^{a}$ | $23.67^{b}$ | 1.911 |
| Weight gain[1](%) | $331.26^{b}$ | $386.61^{a}$ | 242.78c | 39.206 | $127.92^{b}$ | 168.63 a | $105.79^{b}$ | 16.560 |
| SGR[2] (%/d) | $2.05^{a}$ | $2.25^{a}$ | $1.76^{b}$ | 0.130 | $1.15^{b}$ | $1.41^{a}$ | $1.03^{b}$ | 0.103 |
| FCR,g feed/g gain | $1.48^{b}$ | 1.30c | 1.72a | 0.089 | $3.88^{a}$ | $2.72^{b}$ | $3.38^{a}$ | 0.419 |
| PER[3] | $1.47^{ab}$ | $1.62^{a}$ | $1.27^{b}$ | 0.082 | $0.61^{b}$ | $0.79^{a}$ | $0.67^{b}$ | 0.075 |
| PPV[4] (%) | $60.37^{a}$ | $60.51^{a}$ | $58.60^{a}$ b | 2.789 | $9.30^{b}$ | $21.88^{a}$ | $10.16^{b}$ | 2.799 |
| EU[5] (%) | $21.61^{b}$ | $28.85^{a}$ | $18.73^{c}$ | 2.296 | $7.55^{b}$ | $24.68^{a}$ | $11.60^{ab}$ | 3.861 |

Figures in the same row (in each fish size)having the same superscript are not significantly different (p>0.05).

1) Weight gain % = 100* Weight gain (g) / Initial weight (g)
2) SGR = 100 * [($Log_e$ Final weight - $Log_e$ Initial weight)/Time, days)]
3) PER = Body weight gain (g)/ Dietary crude protein intake (g)
4) PPV = 100 * Tissue crude protein deposition (g)/ Dietary crude protein intake (g)
5) EU = 100 * Energy deposition (kJ/fish)/ Dietary energy intake (kJ/fish)

Buhler and Halver (1961) found that although chinook salmon *(Oncorhynchus tshawytscha)* grew satisfactory on purified diet alone, the addition of small amounts of cellulose increased growth and protein utilization efficiency. Davies (1985) evaluated the effect of graded levels of α-cellulose on the performance of rainbow trout *(Salmo gairdneri)*. The fish were fed five experimental diets in which α-cellulose was added at various levels of 0, 5, 10, 15 and 20%, yielding final crudfiber content of 0.15, 4.20, 7.77, 12.03 and 16.2 %, respectively. The results of the study showed that there were significant differences (P<0.05) between the weight gain percentage

Table 3 Whole body composition and energy content of *S. canaliculatus* fed the different experimental diets (% wt body and kJ/g wt body).

| | Fry | | | | | Fingerlings | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Initial | 1 | 2 | 3 | ±SE | Initial | 1 | 2 | 3 | ±SE |
| Moisture | 75.93$^{a}$ | 73.97$^{d}$ | 71.69$^{b}$ | 74.15$^{a}$ | 0.636 | 71.24$^{a}$ | 66.09$^{a}$ | 55.00$^{c}$ | 58.73$^{b}$ | 2.114 |
| Cp | 15.21$^{b}$ | 16.51$^{a}$ | 17.06$^{a}$ | 17.06$^{a}$ | 0.329 | 14.18$^{b}$ | 19.14$^{a}$ | 22.65$^{a}$ | 20.30$^{ab}$ | 0.805 |
| Lipid | 1.62$^{c}$ | 4.09$^{b}$ | 6.68$^{a}$ | 4.88$^{b}$ | 0.716 | 7.40$^{b}$ | 7.64$^{b}$ | 10.66$^{a}$ | 12.81$^{a}$ | 1.543 |
| Ash | 4.59$^{a}$ | 4.24$^{a}$ | 4.13$^{a}$ | 4.00$^{a}$ | 0.101 | 3.60$^{b}$ | 5.96$^{a}$ | 6.43$^{a}$ | 5.43$^{a}$ | 0.322 |
| Energy deposition kJ/g | 4.88$^{c}$ | 5.66$^{b}$ | 6.60$^{b}$ | 5.70$^{b}$ | 0.346 | 6.70$^{c}$ | 7.51$^{b}$ | 10.17$^{a}$ | 10.02$^{a}$ | 0.629 |

Figures in each row (in each fish size) having the same superscript are not significantly different ($p>0.05$)

and SGR of fish fed the five diets. However, slightly better FCR, PER, aparent dry matter, protein and carbohydrate digestibility were achieved by the fish fed diets with the highest levels of fiber (12.03 and 16.12%). To explain this, he suggested that α-cellulose improved protein utilization by contributing greater intestinal bulk, maximizing the turnover of muscle cells, inducing enzymic secretion, which in turn might improve the efficiency of protein absorption.

The results of the present study indicated that raising fiber up to 10% in the diet of *S. canaliculatus* significantly improved ($P<0.05$) growth responce of both fry and fingerlings.

Fish groups receiving diet with 12% α-cellulose achived lower ($P<0.05$) feed conversion ratio, protein efficiency ratio, protein productive value and energy utilization. These findings agree with those of Davies (1985). In contrast Schulz *et al.*(1985), found that feed conversion and protein efficiency ratio of rainbow trout were impaired with cellulose regardless of the amount. The differences in feed utilization between rabbitfish and rainbow trout may be attributed to the different feeding habits of the two species.

In conclusion, the findings of the present study, suggested that the herbivore fry or fingerlings of *S. canaliculatus*, have the ability to tolerate up to 10% crude fiber in their diets. Further studies are needed to explain the definite mechanism through which fiber amount in the diet had improved the growth performance and feed utilization efficiency of *S. canaliculatus*.

## AKNOWLEDGEMENT

The authors would like to thank the Scientific Research Council, UAE University and the Ministry of Agriculture and Fisheries, UAE for supporting this work.

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# استجابة حجمين من أسماك الصافي العربي لعلائق تحتوي على نسب مختلفة من الألياف

عبد الرزاق عبد الله أنوهي[1] ، عمر محمد يوسف[2] ، محمد فتحي عثمان[2] ، توماس شاريان[1] ، أحمد جناحي[1]

١ مركز أبحاث الأحياء البحرية ، وزارة الزراعة و الثروة السمكية ، ص ب ٢١ أم القيوين الإمارات العربية المتحدة، ٢ كلية العلوم الزراعية ، جامعة الإمارات العربية المتحدة ص ب ١٧٥٥٥ العين ، الإمارات العربية المتحدة

تم دراسة تأثير ثلاث مستويات مختلفة من الألياف على الأداء الإنتاجي و كفاءة الاستفادة من الغذاء ليرقات و إصباعيات أسماك الصافي العربي لمدة ٧٠ يوما . تم إضافة السليلوز إلى علائق التجربة بمستويات ٢٪ (عليقة ١) ، ٧٪ (عليقة ٢) ، ١٢٪ (عليقة ٣) بحيث يكون المحتوى الكلي من الألياف الخام هو ٥٪ ، ١٠٪ ، ١٥٪ ، على الترتيب . أظهرت كلتا المجموعتين من الأسماك فروقا معنوية ($p<0.05$) في النمو وكفاءة الاستفادة من الغذاء وأيضا في تركيب الجسم بالمقارنة بالمجموعة الشاهد. وكانت هناك أيضا فروقا معنوية ($p<0.05$) في كفاءة الاستفادة من الغذاء و التركيب الكيماوي للجسم في كلتا المجموعتين من الأسماك التي تم تغذيتها على العليقة رقم ٢ ( ١٠٪ ألياف خام) و التي أظهرت تحسنا معنويا ($p<0.05$) في معدل النمو و كفاءة التحويل الغذائي بالمقارنة بالمستويين الآخرين.