EFFECT OF VARIOUS DIETARY SEAWEEDS ON THE GROWTH OF GOLD-MOUTH TURBAN (*Turbo chrysostomus* L., 1758) AT LOMBOK, INDONESIA

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ABSTRACT

Gold-mouth turban (*Turbo chrysostomus* L., 1758) is an important source of protein for coastal people in Lombok, West Nusa Tenggara, Indonesia. In order to acquire its seed production technique, research on the culture of the species was carried out since 2012. Feed source is a key concern when culturing animal, including turban snail. Growth of gold-mouth turban fed with seaweed *Gracilaria* sp., *Ulva* spp., and *Kappaphycus alvarezii* was evaluated. Each diet was randomly assigned to triplicate groups of 30 snail juveniles with an initial body weight and shell length of 4.65 ± 0.00g and 24.55 ± 0.08mm, respectively. After six weeks feeding trial, snails fed with *Gracilaria* sp. diet had significantly higher ($P<0.05$) in final weight, final shell length, weight gain, specific growth rate (SGR) and food intake compared to snails fed with *Ulva* spp. or *K. alvarezii* diets.

Keywords: Turbo chrysostomus, snail, growth, seaweed, diet.

INTRODUCTION

Gold-mouth turban or *Turbo chrysostomus* is a marine gastropod belongs to family Turbinidae. Turbinid species have been identified as herbivorous marine invertebrates (Kikutani *et al.*, 2002; Quiñones and Michel-Morfín, 2006), and consumes macroalgae around their habitat (Wernberg *et al.*, 2008). This species was collected as a protein source by local people living in the coastal area of Lombok island, West Nusa Tenggara, Indonesia. To acquire its seed production technique, research on the culture of the species was carried out since 2012. Knowledge of suitable feed is an important aspect in the success of animal culture practice. Gut content analysis of *Turbo brunneus* showed that their diet comprises mainly of Rhodophytes such as *Hypnea* sp., *Ceramium miniatum* and *Gracilaria* sp. (Ramesh and Ravichandran, 2008). Juvenile of *Turbo sarmaticus* could consume and digest red algae (*Gelidium pristoides* and *Corralian* spp.), green algae (*Ulva rigida* and C*odium extricatum*) and brown algae (*Ecklonia radiate* and *Inyengaria stellata*) at the rate of 1.45% to 9.5% of body weight per day (Foster and Hodgson, 1998).

Numerous seaweeds have been reported to affect growth of marine gastropods including abalone (Capinpin and Corre, 1996; Naidoo *et al.*, 2006; Setyono, 2006; Angell *et al.*, 2012; O'Mahoney *et al.*, 2014), marine snail, *Norrisia norrisi* (Wakefield and Murray, 1998), *Lithopoma undosum* (Cox and Murray, 2006) and green snail, *Turbo marmoratus* (Setyono and Dwiono, 2003). Among macroalgae, *Gracilaria* sp., *Kappaphycus alvarezii* and *Ulva* sp. have been reported as potential feed sources for marine gastropod (Granado and Caballero, 2001; Dang *et al.*, 2011). The mass cultivation technology of *Gracilaria* sp. and *Kappaphycus alvarezii* have been well developed due to increasing demand of seaweeds for agar and carrageenan industries

Table 1. Design for feeding trial

Diets	Replicate			Control
Gracilaria sp.	G1	G2	G3	CG1 CG2 CG3
Ulva spp.	U1	U2	U3	CU1 CU2 CU3
K. alvarezii	K1	K2	K3	CK1 CK2 CK3

(Santelices and Doty, 1989; Ask and Avanza, 2002). So far, a study on the utilization of seaweed to feed marine snail, particularly for a gold-mouth turban, have rarely been performed.

Preliminary observation showed that gold-mouth turban consumed *Gracilaria* sp., and general preference of turban shells indicated that turbo could eat Rhodopyhta, Chlorophyta or Phaeophyta (Foster and Hodgson, 1998). Therefore, this study is intended to examine the effect of different dietary seaweeds or algae (*Gracilaria* sp., *Ulva* spp. and *Kappaphycus alvarezii*) on the growth of gold-mouth turban.

MATERIALS AND METHODS

Experimental Diets

In this study, *Gracilaria* sp. and *K. alvarezii* were purchased from a local farm in Sekotong, West Lombok, and *Ulva* spp. were collected from Gerupuk waters in Central Lombok, Indonesia. Juvenile gold-mouth turban were fed with the algae every two days at a level of 40% of the total body weight within six weeks of feeding trial.

Feeding Trial

Two hundred and seventy hatchery-reared juvenile gold-mouth turban (*Turbo chrysostomus*) of six months old was used in this study. Those juveniles were produced in the hatchery of Mataram Marine Bio Industry Technical Implementation Unit, Indonesian Institute of Sciences (LIPI). The feeding trial was carried out for six weeks from 4 November to 18 December 2014. Juveniles were divided into three groups of 30 individuals for three replicates of each treatment. Juveniles have an average of initial body weight and shell length of 4.65±0.00g and 24.55±0.08mm. Juveniles were placed into nine experimental plastic tanks containing 10L of filtered seawater. A set of control for each diet was established, i.e., a reservoir containing diet without any juvenile, intended to monitor growth and decomposition rates of the diet (Table 1).Each tank was equipped with continuous aeration, placed in the outdoor laboratory with a natural light cycle, and covered with 3mm mesh size plastic netting to reduce the sunlight and prevent the juvenile creeping out from the tank. Two-inch PVC pipe that cut longitudinally were placed in the bottom of the tanks, provided a shelter for the snails. The tanks were cleaned every two days to remove uneaten diet and fecal material, and at the same time, 75% of the water were changed. Uneaten diets were weighed to calculate food intake. During the study, water temperature and salinity were recorded periodically. Every two weeks, all snails were weighed individually with a digital balance (0.01g scale) and shell length measured using an analog caliper.

Growth Performance

Growth performance was evaluated based on weight gain (WG), specific growth rate (SGR), food intake (FI), food conversion ratio (FCR) and survival rate (SR). Growth performance parameters were calculated according to Bautista-Teruel *et al.* (2003) with equations as follow;

$WG\ (\%) = 100 \times (W_t - W_0) / W_0$
$SGR\ (\%\ day^{-1}) = 100 \times [(\ln W_t - \ln W_0)/t]$
$FI\ (g\ ind^{-1})$ = total food intake (g) / N
FCR = total food intake (g) / total wet weight gain (g)
SR (%) = 100 x Nt / N0

Where W_o (g) is the initial mean body weight, W_t (g) is the final mean body weight, t (day) is feeding period, N is number of snail in each tank, N_0 is number of snail at the start of trial and N_t is number of snail at the end of trial.

Statistical Analysis

Data were analyzed by one-way analysis of variance (ANOVA) using SPSS 18 software

program at a significant level P<0.05. The Further Tukey test was completed when there were significant differences between trials.

RESULTS

Water quality measurements during the study showed that the water temperature in the experimental tanks varied from 23 to 26°C, while the salinity ranged from 30 to 40‰.

The growth data of gold-mouth turban (*T. chrysostomus*) fed with different seaweed diets were presented in Table 2. Final weight, final shell length, weight gain, specific growth rate (SGR) and food intake of snails fed with *Gracilaria* sp. were significantly higher (P<0.05) than the other diet treatments. Snails fed with *Ulva* spp. and *K. alvarezii* showed a decrease in weight gain and SGR. However, the growth of snails fed with *Ulva* spp. were slightly (40%) higher than snails fed with *K. alvarezii*. The maximun food intake was achieved in snails fed with *Gracilaria* sp., while food intake of Ulva spp., and *K. alvarezii* were 92% and 75% lower than food intake of *Gracilaria* sp., respectively. Survival rate (SR) of snails fed with *K. alvarezii* was significantly lower than those of snails that received the other two diets.

DISCUSSION

In the present study, *Gracilaria* sp. promotes positive effect on the growth of snail *T. chrysostomus* during six weeks of feeding trial with the average weight increase of 0.08g or 1.72% of initial weight. Previous study on abalone *Haliotis asinina* showed that *Gracilaria heteroclada* could increase the weight up to 2g in 45 days of feeding trial (Capinpin and Core, 1996). The same trend of weight gain has also been found in abalone *H. tuberculata* coccinea Reeve fed with *G. cornea* reared for sixty days resulting in increase of more than 0.2g (Viera *et al.*, 2005). It seems that seaweed *Gracilaria* sp. as a feed source was more efficient in abalone than in gold-mouth turban. However, weight gain of gold-mouth turban fed with *Gracilaria* sp. was higher compared to weight gain of gold-mouth turban fed with *Ulva* spp. and *K. alvarezii* in the present study.

Gracilaria sp. indicated to be more palatable for gold-mouth turban than *Ulva* spp. and *K. alvarezii*. High food intake of *Gracilaria* sp. also found in abalone *H. discus hannai* Ino (Qi *et al.*, 2010). Food intake of gold-mouth turban might be influenced by nutritional content of seaweed. Although the nutrition contents of the seaweed were not analyzed in the present study, protein content of *Gracilaria* sp. have been reported in the range of 11.27 to 21.54% dry matter (Capinpin and Corre, 1996; Viera *et al.*, 2005; Viera *et al.*, 2011). Protein from *Gracilaria* spp. has also been reported to be effectively utilized by abalone *H. tuberculata coccinea* Reeve (Qi *et al.*, 2010). Lower protein content in *Ulva* sp. and *K. alvarezii* (2.99 and 5.35% dry matter, respectively) (Capinpin and Corre, 1996; Angell *et al.* 2012) may cause a low effect in the growth rate of *T. chrysostomus* in this study.

Gold-mouth turban consumed red algae *K. alvarezii* four times lower than *Gracilaria* sp. We suspect that feed preference of the snail was

Table 2. Growth performance of snails fed different diets for six weeks.[1]

Diets	Initial weight (g)	Initial shell length (mm)	Final weight (g)	Final shell length (mm)	Weight gain (%)	SGR (% / day)	FI (g/ day/ ind)	FCR	SR (%)
Gracilaria sp.	4.65 ± 0.04	24.56 ± 0.16	4.73 ± 0.14a	27.17 ± 2.82a	1.84 ± 2.69a	0.04 ± 0.06a	12.62 ± 2.26a	11.22 ± 157. 76	97 ± 5.77a
Ulva spp.	4.65 ± 0.03	24.64 ± 0.12	4.57 ± 0.04b	25.26 ± 0.12b	-1.47 ± 1.67b	-0.03 ± 0.04b	1.83 ± 0.29b	-50.54 ± 39.16	99 ± 1.92a
K. alvarezii	4.64 ± 0.05	24.46 ± 0.13	4.51 ± 0.04b	24.96 ± 0.12b	-2.84 ± 1.82b	-0.07 ± 0.04b	3.21 ± 0.57c	-41.84 ± 37.55	70 ± 8.82b

[1] Values are mean ± SD, obtained from three replicates (n=3) with 30 snails for each tank.
Different superscripts in each column indicate significantly different mean values (P<0.05).

also influenced by the degree of toughness of the seaweed. The results of this study were supported by McShane *et al.* (1994) who found that the toughness of seaweed has a significant influence on food intake of abalone *H. rubra*, tough seaweed being consumed less than soft seaweed. The low consumption rate of *K. alvarezii* compared to *Gracilaria* sp. has also been found in abalone H. asinina (Capinpin and Corre, 1996).

The low food intake of gold-mouth turban fed with *Ulva* spp. in the present study might be related to the chemical compound of the seaweed. Some species of Ulva have been reported to produce dimethylsulfide (DMS) that could act as feeding deterrents for marine herbivores (Van Alstyne and Houser, 2003; Erickson *et al.*, 2006). However, the percentage of the final weight of gold-mouth turban fed with *Ulva* spp. was twice as high as snail fed with *K. alvarezii*.

Foster *et al.* (1999) found that enzyme activity of structural polysaccharide carrageenan was low in the digestive gland of marine gastropod *T. sarmaticus* fed with red, green and brown algae. In contrast, Rhodophyta *K. alvarezii* is an excellent source of carrageenan (Hayashi *et al.*, 2007; Hung *et al.*, 2009; Hayashi *et al.*, 2011), and it reflects that low growth performance of *T. chrysostomus* fed with *K. alvarezii* might be related to carrageenan content and low enzyme activity. Foster *et al.* (1999) also showed that digestive enzyme activities of storage polysaccharide of red algae were higher compared to green and brown algae in marine gastropod *T. sarmaticus*. They demonstrated that digestive enzyme activity in the digestive gland of storage polysaccharide glycogen and amylose were 180.8 and 147.9 (μg^{-1} ml^{-1} h^{-1}) mg^{-1} protein, respectively.

Foster and Hodgson (1998) reported that apparent dry matter digestibility of red algae *Gelidium pristoides* and green algae *Ulva rigida* in *T. sarmaticus* ranged from 1.06 to 2.32%, and from 2.85 to 8.91%, respectively. It could be assumed that low growth performance of T. chyrsostomus in the present study is due to low apparent dry matter digestibility of red algae *K. alvarezii*.

CONCLUSION

The present study clearly indicates that seaweed *Gracilaria* sp. is prospective to be used as a diet for gold-mouth turban (*Turbo chrysostomus* L., 1758) without negative effect on the growth performance.

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