รายงานการวิจัย

เรื่อง

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หมวดเงินทุนอุดหนุน

งบประมาณประจำปี 2532

โดย

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การศึกษาเบื้องต้นเกี่ยวกับการกินอาหารของหอยเป๋าฮื้อ, *Haliotis ovina*

THE PRELIMINARY STUDIES ON ABALONE (*HALIOIS OVINA*) FEEDING

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การทดลองเรื่อง การศึกษาเบื้องต้นเกี่ยวกับการกินอาหารของหอยเป๋าฮื้อ, *Haliotis ovina* เป็นการทดลองในโครงการวิจัยเรื่องการศึกษาการเลี้ยงหอยเป๋าฮื้อ ปีงบประมาณ 2532

ข้าพเจ้าขอขอบพระคุณมหาวิทยาลัยบูรพาที่ได้จัดสรรงบประมาณส่วนหนึ่งมาให้ข้าพเจ้าได้ทำการศึกษาและวิจัยเรื่องนี้ ขอขอบพระคุณ ดร.ทวี หอมชง ที่ได้มอบหมายให้ข้าพเจ้าทำการทดลองในเรื่องนี้ และขอขอบพระคุณ ข้าราชการ และเจ้าหน้าที่ของสถาบันวิทยาศาสตร์ทางทะเลทุกท่านที่ให้ความร่วมมือในการทำวิจัยครั้งนี้จนสำเร็จลุล่วงไปด้วยดี

THE PRELIMINARY STUDIES ON ABALONE (*HALIOTIS OVINA*) FEEDING

by

Saowapa Sawatpeera[A]

ABSTRACT

The Haliotis *ovina* were collected from Samae-sarn Island, Cholburi Province. The sizes of sample were 9.99-63.19 g in weight, 3.11-5.54 cm in width and 4.06-6.98 cm in length. Feed treatment was *Gracilaria salicornia*, as control and two types of artificial diet. Diet 1 has protein source from dry *Porphyra* sp. and spirulina and diet 2 that has protein source from casein. The experiment was done in 8 weeks. The abalone were cultured in semi-flow-through system. Water qualities during the experimental period were salinity 33-35 part per thousand, temperature 25.5-29.0 degree Celsius, nitrite 0.007-0.112 mg per liter, nitrate 0.131-0.423 mg per liter, ammonia 0.026-0.260 mg per liter and phosphate 0.034-0.089 mg per liter.

The growth of abalone in diet 1, *G. salicornia*, and diet 2 treatments were increase 23.71%; 9.74% and 8.76% in weight; 7.97%, 4.82% and 4.14% in width and 10.20%, 5.45% and 7.38% in length. The survival rate of abalone were 48.33%, 36.67% and 23.33% in *G. salicornia*, diet 1 and diet 2 treatment

Crude protein was high in diet 2 (40.9%), subsequent with *G. salicornia* (16.4%) and diet 1 (15.0%). Carbohydrate and fat were high in diet 1 and diet 2. Fiber, ash and moisture were high in *G. salicornia*.

Feeding amount and food conversion efficiency can not determine in this experiment, because the growth of abalone was very low and their mortality rate was very high.

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การศึกษาเบื้องต้นเกี่ยวกับการกินอาหารของหอยเป๋าฮื้อ,*H. ovina*

โดย

เสาวภา สวัสดิ์พีระ[A]

บทคัดย่อ

หอยเป๋าฮื้อ *H. asinina* ที่ใช้ในการศึกษาครั้งเก็บมาจากบริเวณเกาะแสมสาร อำเภอ สัตหีบ จังหวัดชลบุรี ตัวอย่างหอยเป๋าฮื้อเมื่อเริ่มต้นการทดลองมีน้ำหนักระหว่าง 9.99-63.19 กรัม ความกว้าง 3.11-5.54 เซ็นติเมตร และความยาว 4.06-6.98 เซ็นติเมตร อาหารที่ใช้ในการศึกษาครั้งนี้ได้แก่ *Gracilaria salicornia* และอาหารสำเร็จรูปสองสูตร สูตรที่หนึ่งมีแหล่งโปรตีนมาจาก *Porphyra* sp. ตากแห้งและผง spirulina ส่วนสูตรที่สองมีแหล่งโปรตีนมาจาก casein ระยะเวลาในการทดลองแปดสัปดาห์ ระบบการทดลองเป็นระบบกึ่งปิด (semi-flow-through system) โดยระหว่างการทดลองมี ความเค็ม 33-35 ส่วนต่อพัน อุณหภูมิ 25.5-29.0 องศาเซลเซียส ปริมาณไนไตรต์ 0.007-0.112 มิลลิกรัมต่อลิตร ไนเตรต 0.131-0.423 มิลลิกรัมต่อลิตร แอมโมเนีย 0.026-0.260 มิลลิกรัมต่อลิตร และ ฟอสเฟต 0.034-0.089 มิลลิกรัมต่อลิตร

H. ovina ที่เลี้ยงด้วยอาหารสำเร็จรูปสูตรที่หนึ่ง *G. salicornia* และอาหารสำเร็จรูปสูตรที่สอง มีอัตราการเจริญดังนี้ น้ำหนักเพิ่ม 23.71 เปอร์เซ็นต์ 9.74 เปอร์เซ็นต์ และ 8.76 เปอร์เซ็นต์ ความกว้างเพิ่ม 7.97 เปอร์เซ็นต์ 4.82 เปอร์เซ็นต์ และ 4.14 เปอร์เซ็นต์ และมีความยาวเพิ่มขึ้น 10.20 เปอร์เซ็นต์ 5.45 เปอร์เซ็นต์ และ 7.38 เปอร์เซ็นต์ ตามลำดับ

อัตราการรอดของ *H. ovina* ที่เลี้ยงด้วย *G. salicornia* อาหารสำเร็จรูปสูตรที่หนึ่งและสูตรที่สองเท่ากับ 48.33 เปอร์เซ็นต์ 36.67 เปอร์เซ็นต์ และ 23.33 เปอร์เซ็นต์ ตามลำดับ

คุณค่าทางอาหารของอาหารที่ใช้ในการทดลองพบว่า อาหารสำเร็จรูปสูตรที่สองสูงที่สุด (40.9 เปอร์เซ็นต์) รองลงมาคือ *G.salicornia* (16.4 เปอร์เซ็นต์) และอาหารสำเร็จรูปสูตรที่สอง (15.0 เปอร์เซ็นต์) อาหารสูตรที่หนึ่งและสูตรที่สองมีคาร์โบไฮเดรตและไขมันสูง ส่วนเยื่อไยและความชื้นมีค่าสูงใน *G. salicornia*

สำหรับอัตราการกินอาหาร และ ค่า FCE ในการทดลองครั้งนี้ไม่สามารถหาได้ เนื่องจากอัตราการเจริญและอัตราการรอดต่ำ.

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INTRODUCTION

The abalone are marine gastropods that belong to order Archaeogastropoda, family Haliotidae and genus *Haliotis*. They have nacreous; spiral shell; dish shaped body whorl and a row of perforations above outer margin. The columellar margin is produced into a flattened spiral and has a horseshoe-shaped impression with the left branch inside columellar plate. The right branch is very large rounded and central to the aperture. They are no operculum (Dance, 1974).

Abalone are marine seaweed eating gastropods that inhibit open water rocky coastlines in many parts of the world. There are approximately 70 species worldwide (Lindberg, 1992) and about 25 are of commercial value (LaTouche et al., 1993 and Hensey, 1990). Abalone sizes are vary depend on species. Some species are very large such as California red abalone (*H. rufescens*) which grows to a size of 260 mm in shell length, whilst some non-commercial species measure only a few centimeters (LaTouche et al., 1993). The maximum size for intensive cultivation would be 70-90 mm or 3-3.5 inches (Wray, 1989).

The general opinion within abalone's' culture is that the market for abalone will be under supplied in the future. The price of abalone is high because the high price of juvenile, approximately 1 pound per mm per individual and long grows out period, around 2-3 years (LaTouche et al., 1993). In Europe the abalone was attracted to the farmer because they are high price, the another attractive aspect is that their feed

(seaweed) can be kept fresh and even growing in the grow out cages or tanks thus avoiding one of the problems with finfish culture in which uneaten food sinks to the sea floor and decomposes causing localized pollution. Also since abalone occur naturally along exposed rocky shorelines and like oceanic water (clear water), they can be farmed in areas that do not compete for space with bivalve (clams and oysters) culture. There are also no major disease problems with these shellfish and consequently the insurance companies regard abalone farming as an acceptable risk (LaTouche et al., 1993).

In Thailand has 3 species of abalone, *H. asinina*, *H. ovina* and *H. varia* that distribute along the coral reef, the rocky shore near coral reef and in the tidal zone (Tookvinart et. al. 1986, Nateewatana and Hyldenberg, 1986). Two of them can be promoted to economic aspect. They are *H. asinina* and *H. ovina*. At present the demand for abalone is increase, especially in Thailand the abalone import is increase every year (Singhagraiwan, 1989). The Eastern Marine Development Center was the first places that success in abalone, *H. asinina*, culture in Thailand (Singhagraiwan, 1991a; 1991b; 1992; Singhagraiwan and Sasaki 1991a; 1991b; Singhagraiwan and Doi, 1992; Singhagraiwan, Doi and Sasaki, 1992). Singhagraiwan and his groups (1993) were study the growth of *H. asinina* and found that they can grow to the market size in 1 years. It showed that they had a shorter period for culture than temperate abalone species. However, they are a few data of abalone's culture in Thailand. So, it was a few data for aquaculture aspect. More over the most abalone feed in macro algae that has

seasonal limiting especially in Thailand. So, the study of abalone culture in Thai species is necessary for future development of abalone culture in Thailand. For abalone, *H. ovina*, still not succeed in culture and they also the tropical species and has the distribution in the same area with *H. asinina*. So that this project was the preliminary study for the feeding of abalone, *H. ovina*, in laboratory that may use as the basic information for abalone culture in the future.

MATERIALS AND METHOD

Sample collection

The abalone, *H. ovina*, (figure 1) were collected from Samaesarn Island, Chonburi Provinces. The samples were acclimated in 500 litters' fiber tank (figure 2) about 2 weeks before the experiment. During acclimatization period the abalones were feed with *G. salicornia* (figure 3) and 180 abalone samples were used for this experiment. The average size of abalone sample at beginning experiment was 33.71±11.63 g in weight, 4.42±0.44 cm in width and 5.90±0.58 cm in length.

Feeding preparation

There were 3 types of feed; *G. salicornia* that collect from the pond at Eastern Marine Development Center (EMDEC), diet 1 and diet 2 that had the different protein sources. The ingredient composition of diet 1 and diet 2 were showed in table 1. Casein, dry *Porphyra* powder and *Spirulina* were source of protein; dextrin and ethyl cellulose were carbohydrate source; and sodium alginate as binder. The vitamin and mineral mixture composition were showed in table 2 and 3.

All dry ingredients were mix well together before adding oil, then add oil and mix again. Gradually add approximately 350-400 ml distilled water per kilogram of diet mixture. Kneaded the moist mixture until it was smooth. The moist mixture should have a stiff, plastic

consistency when compress. Be careful about the water content, because too much water will cause sticking in the food container or very small amount of water will cause the easily breakdown of feed. Flatten the mixture to 0.5 cm thick and cut it to 1.0 x 1.5 cm pieces. The feed was emerged in 5% calcium chloride ($CaCl_2$) about 3 hours for convert sodium chloride to calcium chloride that it was more stable in water. Put the feed in plastic bag and freeze in refrigerator (figure 4).

The experiment system

The experiments were done in 30 litters' glass tank with the flow-through system for avoid the decrease of water quality (figure 5). The flow rate was 80-100 ml per minute and water floods out from the tank at the top. The experimental tank was cover with nylon net for protected the abalone escape from the tank. There were 3 replications for each treatment and each replication has 20 abalone samples. Whole water was change after feed everyday.

The temperature, pH and salinity were checked everyday before and after collected the feces and remained food.

Nitrite, nitrate phosphate and ammonia were analyze every two week follow technique of standard method of seawater analysis (Strickland and Parson, 1972).

The abalone were fed at 6:00 a.m. and collected the feces and remain food at 6:00 p.m.

The abalone samples were weight before the experiment and reweight every 2 week. Survival rate was checked everyday when collect the remained food and.

All food was analyzed for protein, fat, fiber, ash and moisture with standard method of AOAC technique.

Feeding method and determination of feeding amount

The abalone were fed in the evening and remain food was collected in the morning and dried to constant weight for determine consumption. The feeding amount, F (g) was calculated by the following equation (applied from Uki and Watanabe, 1992):

$$F = G - R$$

Where G = diet supplied in gram of dry weigh

R = diet remaining in gram of dry weight

Food conversion efficiency (FCE)

Food conversion efficiency (FCE) was calculate from the equation below (Uki and Watanabe, 1992):

$$F.C.E = \frac{\text{Total wet weight gain (g)}}{\text{Feeding amount, F (g)}}$$

Figure 1 *Haliotis* ovina collected from Samaesarn Island, Chonburi Province.

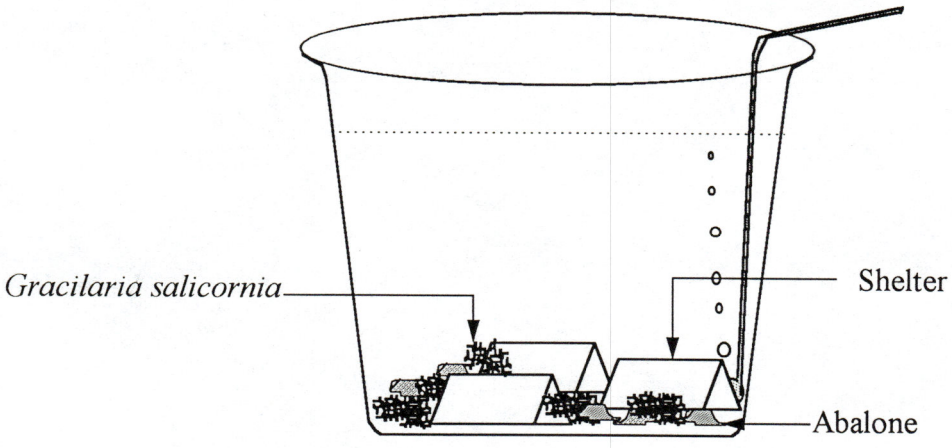

Figure 2 Drawing of the 500 liters acclimatized tank of *H. ovina* at Institute of Marine Science.

Figure 3 *Gracilaria salicornia* use as *H. ovina* food during acclimatized period.

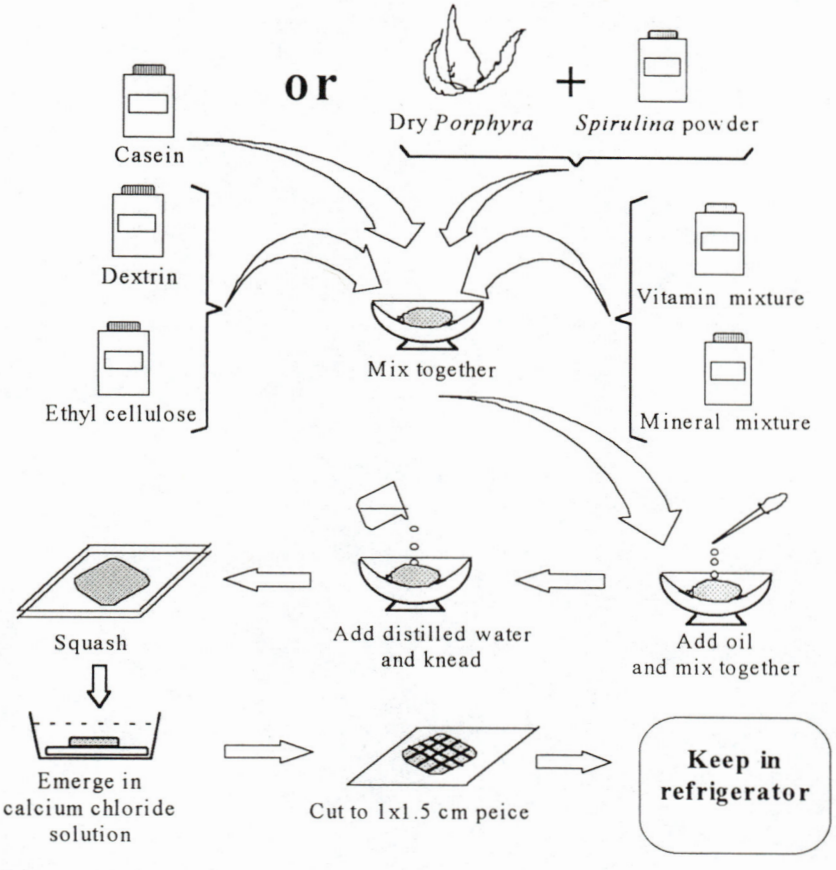

Figure 4 Step of abalone food preparation.

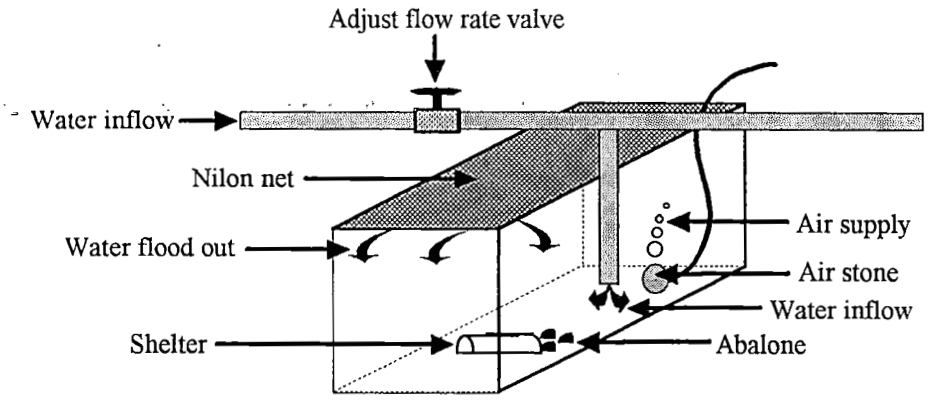

Figure 5 Diagram of flow-through system that used in this experiment

Table 1 The composition of ingredients in diet 1 and diet 2.

	% ingredient	
Contents of ingredient	**Diet 1**	**Diet 2**
Porphyra sp. (dry)	20	-
Spirulina sp. (powder)	10	-
Casein	-	30
Dextrin	23	23
Ethyl cellulose	5	5
Vitamin mixture	3	3
Mineral mixture	4	4
Sodium alginate	30	30
Lipid*	5	5

Note: * = Soybean oil 2 ml and cod liver oil 3 ml
Each 100 g of diets 1 and diet 2 was adds more 25 mg of vitamin E

Table 2 The composition of mineral mixture in Premix 1,000 g from Chanaphant Industry Co., LTD. Thailand.

Composition	**Weight**	
Manganese	5.400	g
Iron	14.200	g
Copper	1.000	g
Zinc	2.900	g
Sodium	3.300	g
Iodine	0.019	mg
Potassium	0.900	g
Cobalt	1.100	g
Medium	971.181	g

Table 3 The composition of Vitamin mixture in Cetavit 1,000 g from Eastern Marine Co., LTD. Thailand.

Composition	Quality	
Vitamin A	15,000,000	units
Vitamin D_3	3,000,000	units
Vitamin C	83.00	g
Vitamin E	27.50	g
Vitamin K	4.67	g
Vitamin B_1	25.00	g
Vitamin B_2	25.00	g
Vitamin B_6	5.00	g
Vitamin B_{12}	0.05	g
Nicotinamide	20.00	g
Calcium D-Panthothenate	5.00	g
Folic acid	0.40	g

Result

Distribution

The pattern of size distribution of abalone during the experimental period was showed in figure 6-8. The size distribution (weight, length and width) in each treatment was statistical significant different ($p<0.05$). Every treatment had a trend toward the larger size and *H. ovina* that fed with diet 2 had trend toward larger size more than *G. salicornia* and diet 1 treatment.

Growth rate

Weight

Weight growth of *H. ovina* during 8 weeks of experimental period was statistical significant different ($p < 0.05$) and can separate into 2 group. The first group was *G. salicornia* treatment and the second group was diet 1 and diet 2 treatment. When compare weight growth in each time of measurement, it found that the statistical significant different was showed in week 8, while week 0, 2, 4 and 6 were not significant different. The weight increase was highest in diet 1 treatment (23.71% and 8.06 g) and lowest in diet 2 treatment (8.76% and 3.15 g) (table 4-5 and figure 9).

Length

Length growth of *H. ovina* in all treatment during the experimental period was not significant different ($p>0.05$). However, the graph showed that in the first 4 week diet 2 treatment had the highest length increase, but after week 6 the diet 1 treatment had the higher length increase than *G. salicornia* and diet 2 treatment (table 4-5 and figure 10).

Width

Width growth of *H. ovina* during the experimental time was statistical significant different ($p<0.05$). It can separate into 2 group, the first group was *G. salicornia* and diet 1 and the second group was diet 1 and diet 2. The highest width increase was diet 1 treatment (10.20% and 0.45 cm) and the lowest width increase was *G. salicornia* treatment (5.45% and 0.23 cm) (table 4-5 and figure 11). When compare in each time of measurement it found that the statistical significant different was showed in week 6 while week 0, 2, 4 and week 8 were not significant different.

Survival rate

Total survival rate of *H. ovina* during 8 week of experiment was not significant different ($p>0.05$). All treatment had a high mortality rate. When test by Duncan test with significance level 0.05, it found that the survival rate of *H. ovina* was begin to significant different in week 4-8. Homogeneous subsets (highest and lowest means are not

significantly different) of survival rate of *H.* ovina in week 4-8 were as follows:

Week 4:

Subset 1: Diet 2 (58.33%) and diet 1 (65.00%)

Subset 2: Diet 1 (65.00%) and *G. salicornia* (70.00%)

Week 6:

Subset 1: Diet 2 (38.33%)

Subset 2: Diet 1 (50.00%) and *G. salicornia* (56.67%)

Week 8:

Subset 1: Diet 2 (23.33%)

Subset 2: Diet 1 (36.67%)

Subset 3: *G. salicornia* (48.33%)

When considered the decrease line of survival rate of *H.* ovina, it was showed that the survival rate still had a trend to gradually decrease of survival rate in all treatment (figure 12).

Nutritional composition

The artificial diet of this experiment was same batch with the diet that use in *H. asinina*. The nutritional composition abaone's food that used in this experiment was already showed in table 7 and figure 13. Moisture of abalone food was analyze separately from other nutritional contents (protein, carbohydrate, fat, fiber and ash).

Protein

Protein content among abalone's foods was statistical significant different ($p<0.05$). The Duncan test with significance level 0.05 showed that homogeneous subsets (highest and lowest means are not significantly different) of protein content were as follows:

Subset 1: *G. salicornia* (16.40%) and diet 1 (15.00%) treatment.

Subset 2: Diet 2 (40.90%) treatment.

Carbohydrate

Carbohydrate was come from 3 source. There was dextrin, cellulose and alginate. Carbohydrate contents among abalone's foods had statistical significant different ($p<0.05$). The Duncan test with significance level 0.05 showed that homogeneous subsets (highest and lowest means are not significantly different) of carbohydrate content had 3 group corresponding with 3 food types (table 7 and figure 13).

Fat

Fat content among abalone's foods was statistical significant different ($p<0.05$). The Duncan test with significance level 0.05 showed that homogeneous subsets (highest and lowest means are not significantly different) of fat content were divide into 3 group corresponding with 3 types of food (table 7 and figure 13).

Fiber

Fiber among abalone's foods was statistical significant different ($p<0.05$). The Duncan test with significance level 0.05 showed that homogeneous subsets (highest and lowest means are not significantly different) of fiber content were as follows:

Subset 1: Diet 1 (2.31%) and diet 2 (2.70%) treatment.

Subset 2: *G. salicornia* (5.50%) treatment.

Ash

Among abalone's foods, it was statistical significant different in ash content ($p<0.05$). The Duncan test with significance level 0.05 showed that homogeneous subsets (highest and lowest means are not significantly different) of ash can divide into 3 group corresponding with food types (table 7 and figure 13).

Moisture

Moisture was highest in *G. salicornia* (90.70%) and lower in diet 1 (55.40%). All types of abaone's food had statistical significant different ($p<0.05$) and he Duncan test with significance level 0.05 showed that homogeneous subsets (highest and lowest means are not significantly different) of moisture were divide into 3 group corresponding with food types (table 7 and figure 13).

Feeding amount and Food conversion efficiency.

Feeding amount and food conversion ratio of *H. ovina* can not calculate, because the growth and feeding is very low. So we were not sure that all lost food was eat by *H. ovina* or they were dissolve in water. We were not confident to use these data for feeding amount and food conversion efficiency calculated, because it seems to have very high error. However, from 3 times of experiment, we found that they had the trace of grassing that may cause theirs a little growth.

Water quality

The nutrients in water, nitrite, nitrate, phosphate and ammonia, were analyzed every 2 week, before feed and after feed. The result was showed in table 8. After feed 12 hours, the concentration of all nutrient was increase. Nutrient in diet 2 treatment was higher than the other, especially nitrite and ammonia (table 8).

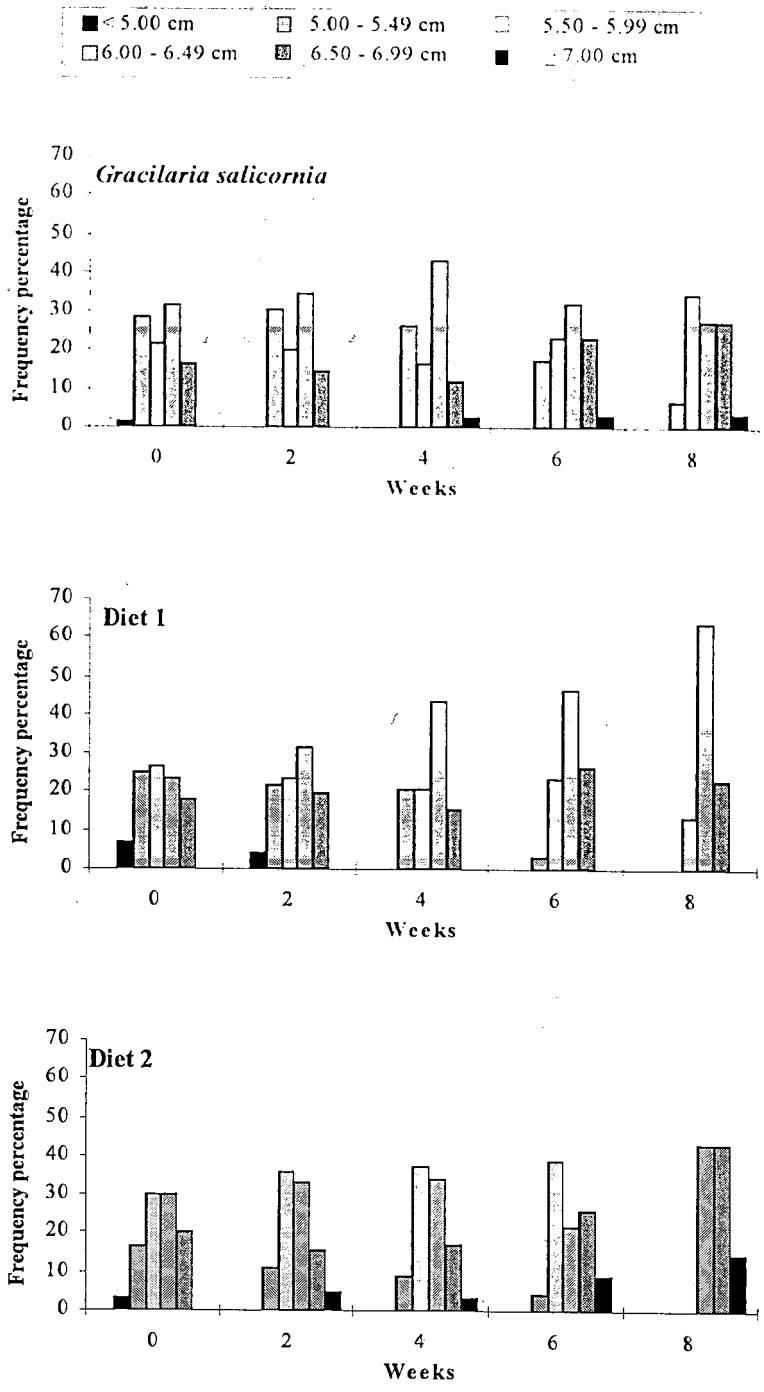

Figure 6 Graph showed the length distribution percentage of *H. ovina* that feed with *G. salicornia*, diet 1 and diet 2.

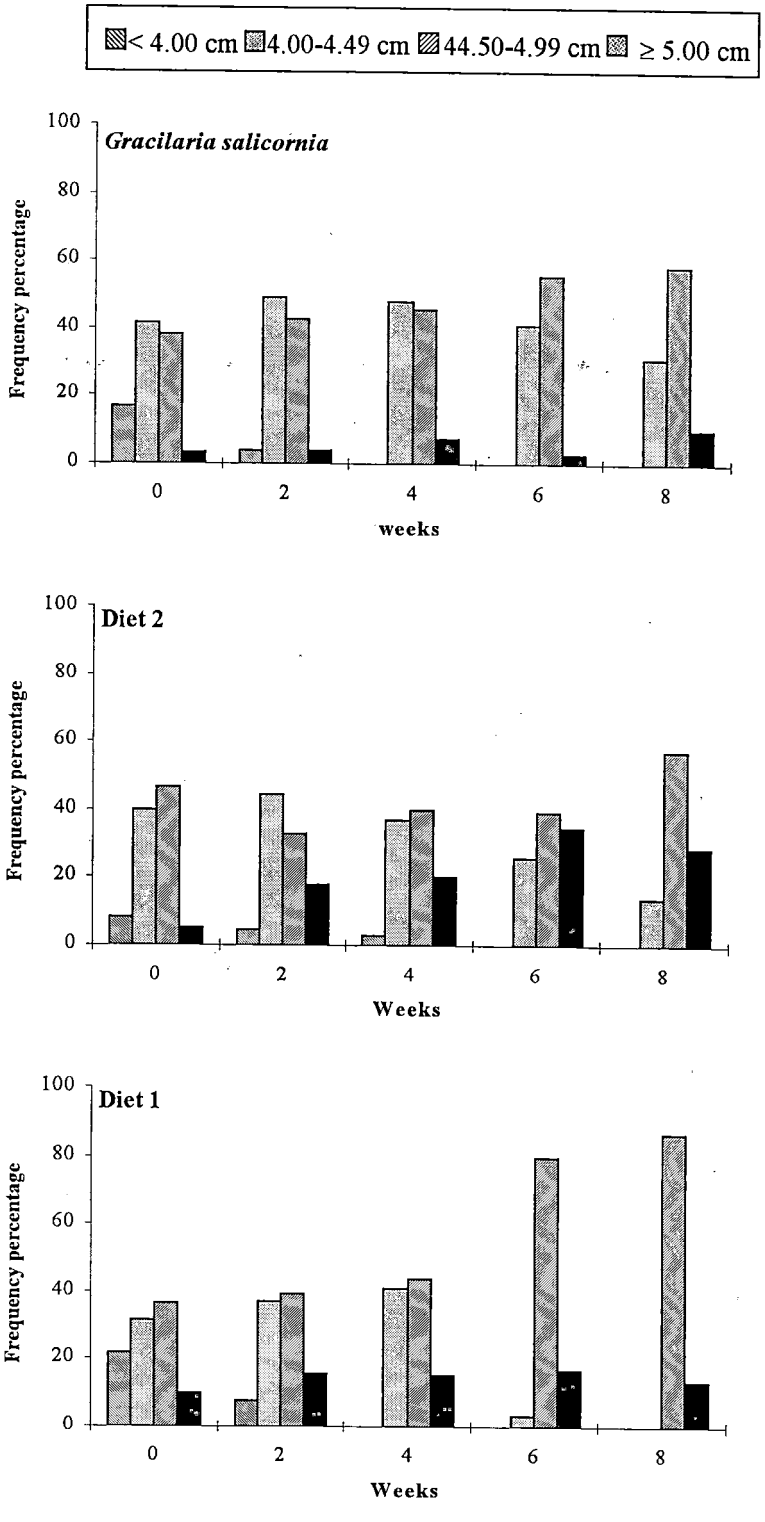

Figure 7 Graph showed the width distribution percentage of *H. ovina* that feed with *G. salicornia*, diet 1 and diet 2.

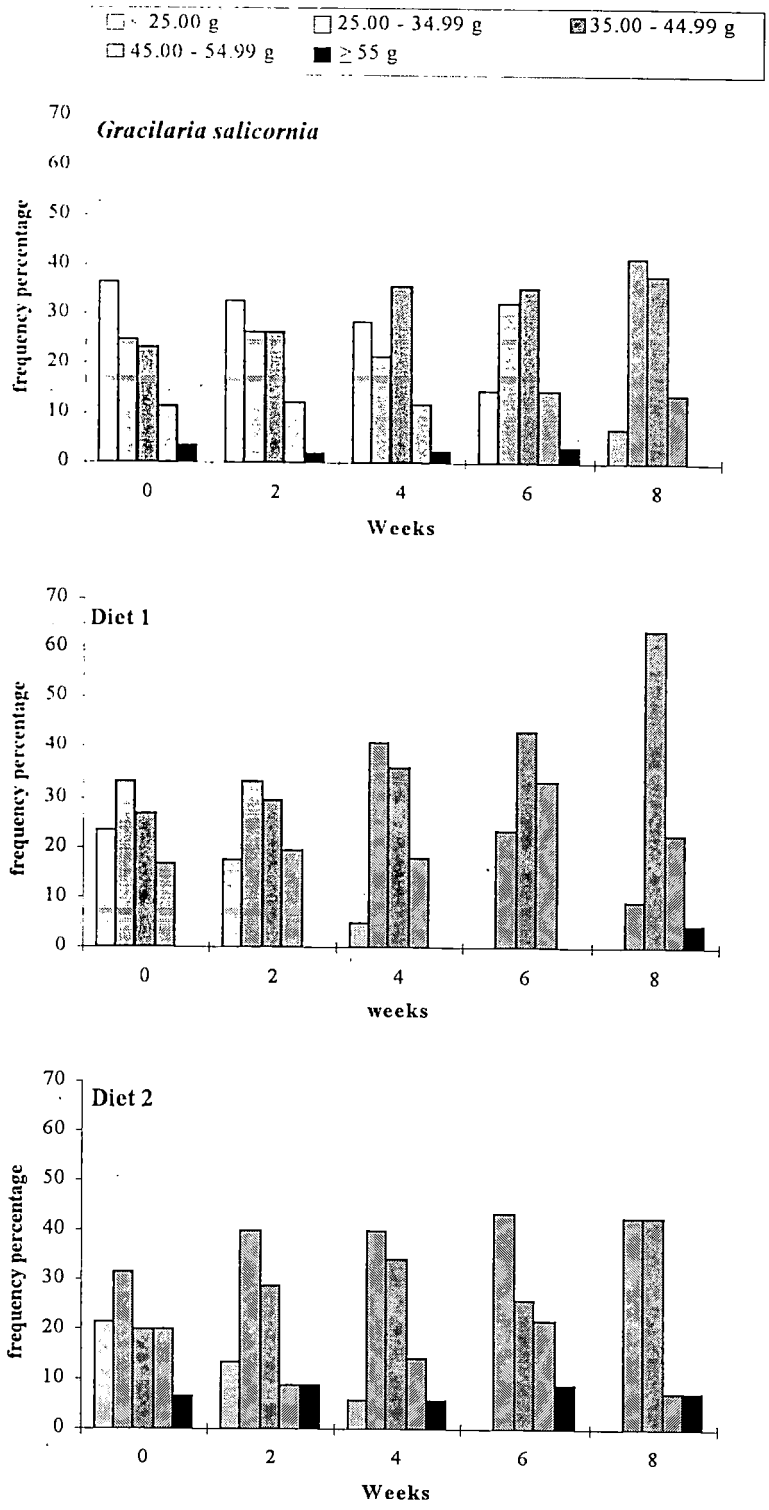

Figure 8 Graph showed the weight distribution percentage of *H. ovina* that feed with *G. salicornia*, diet 1 and diet 2.

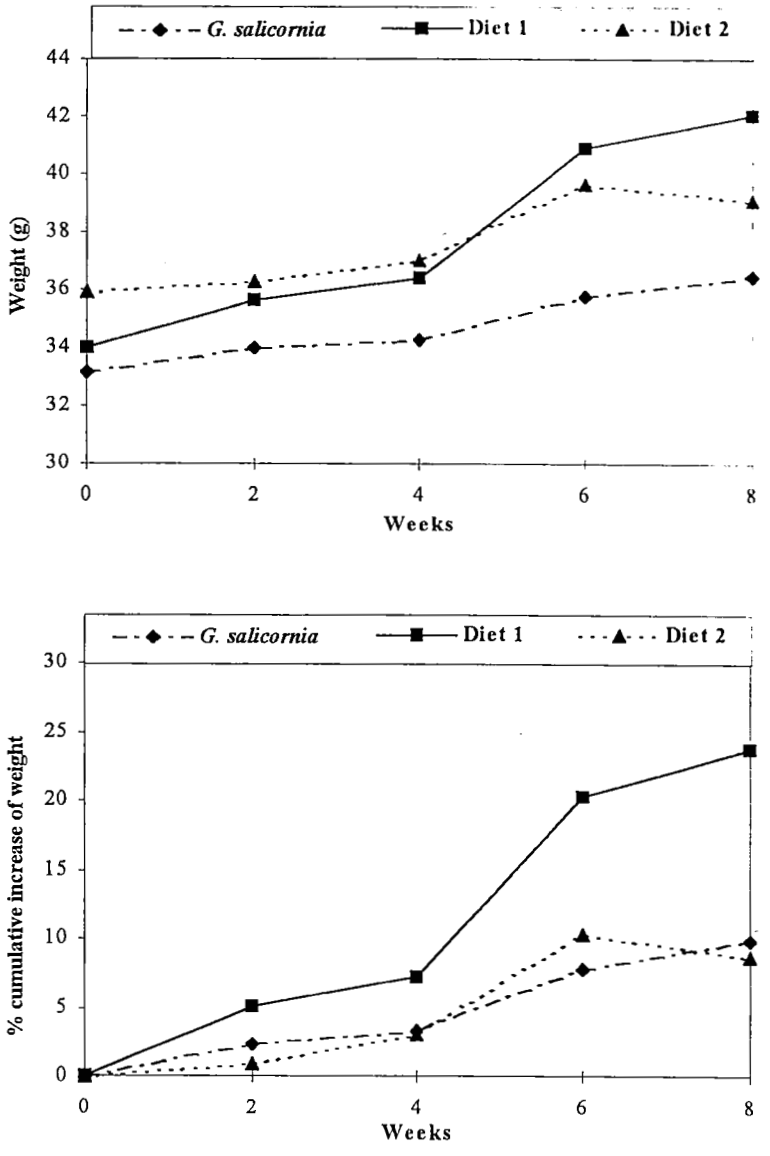

Figure 9 Graph showed (a) the average weight (g) and (b) cumulative increase percentage of weight of *H. ovina* in each feed treatment (*G. salicornia*, diet 1 and diet 2) during 8 weeks of experiment.

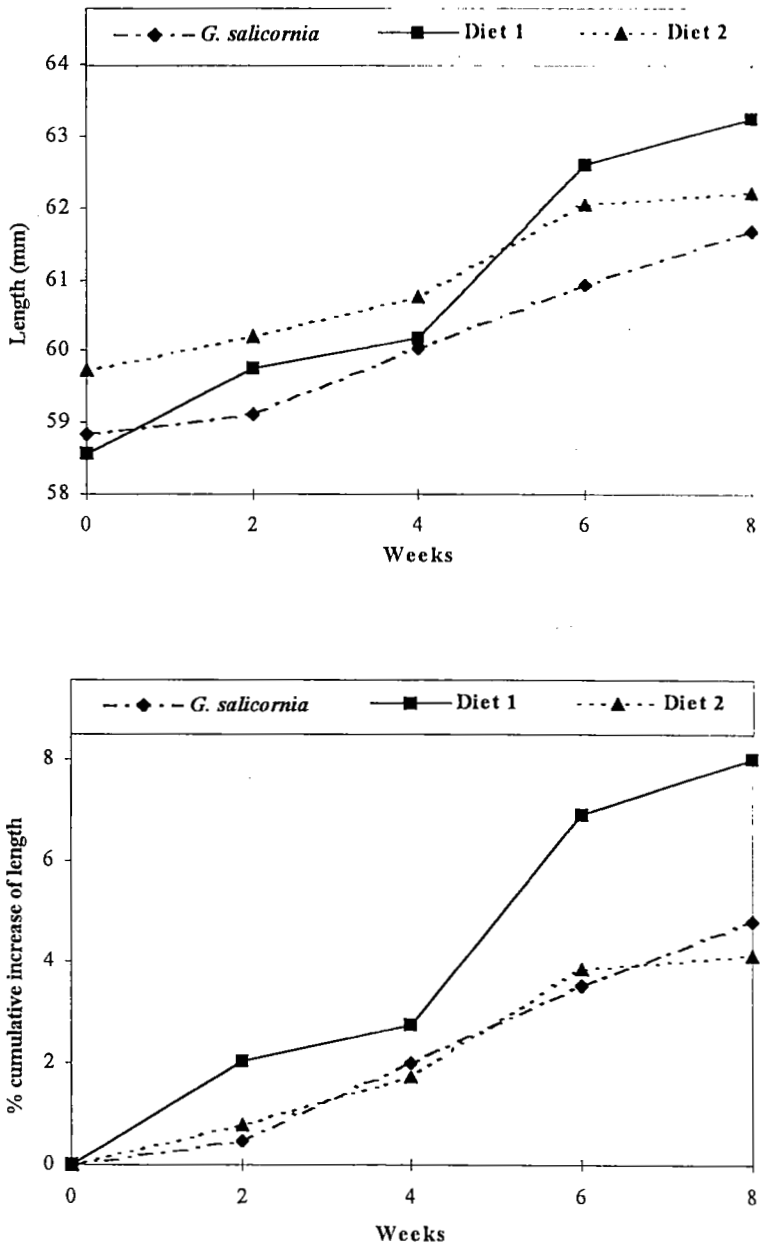

Figure 10 Graph showed (a) the average length (cm) and (b) length increase percentage of *H. ovina* in each feed treatment (*G. salicornia*, diet 1 and diet 2) during 8 weeks of experiment.

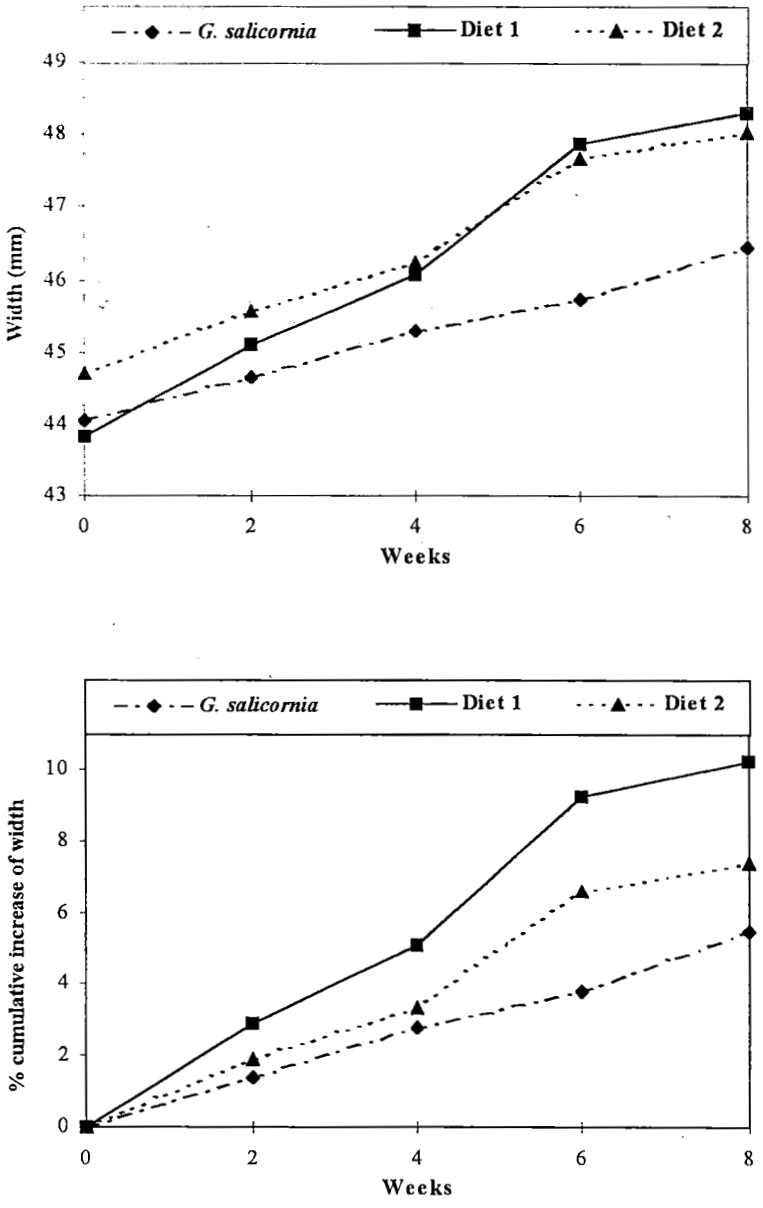

Figure 11 Graph showed (a) the average width (cm) and (b) cumulative increase percentage of width of *H. ovina* in each feed treatment (*G. salicornia*, diet 1 and diet 2) during 8 weeks of experiment.

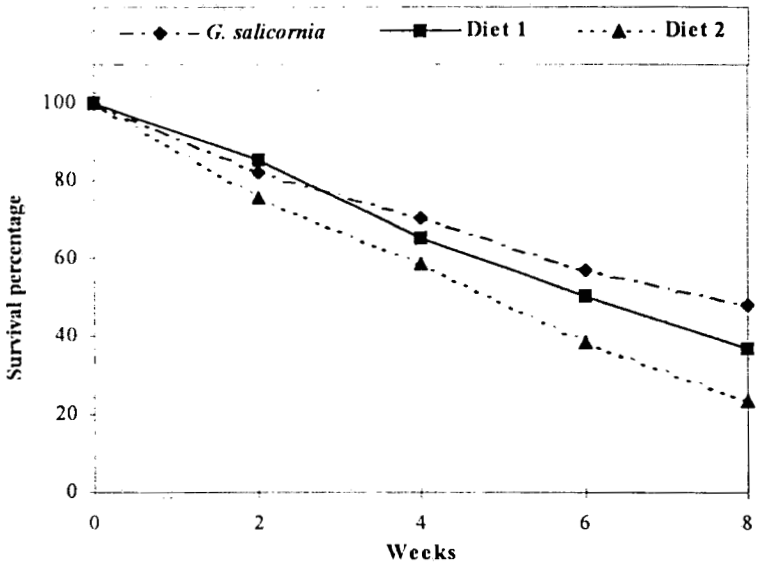

Figure 12 Graph showed the survival rate percentage of *H. ovina* in each feed treatment (*G. salicornia*, diet 1 and diet 2) during 8 weeks of experiment.

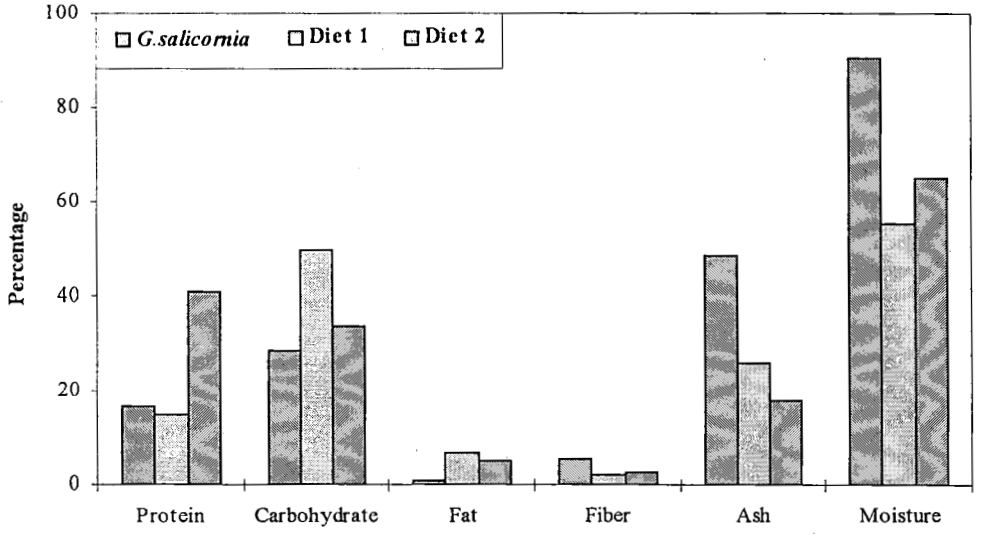

Figure 13 Graph showed moisture and content of protein, carbohydrate, fat, fiber and ash in *G. salicornia*, diet 1 and diet 2.

Table 4 The average weight, width and length of *H. ovina* during the experimental period.

	Average size				
	Week 0	**Week 2**	**Week 4**	**Week 6**	**Week 8**
Weight (g)					
G. salicornia	33.20±11.12	32.98±10.94	34.29±10.87	35.81±0.44	36.47±9.00
Diet 1	33.99±11.53	35.69±9.80	36.43±9.00	40.87±6.74	42.05±5.55
Diet 2	35.94±12.23	36.24±10.96	37.06±9.88	39.63±10.23	39.09±7.85
Length (cm)					
G. salicornia	5.88±0.54	5.91±0.51	6.00±0.51	6.09±0.49	6.17±0.46
Diet 1	5.86±0.62	5.98±0.54	6.02±0.48	6.26±0.34	6.32±0.28
Diet 2	5.97±0.59	6.02±0.52	6.08±0.47	6.20±0.47	6.22±0.44
Width (cm)					
G. salicornia	4.40±0.41	4.44±0.35	4.53±0.31	4.57±0.28	4.64±0.25
Diet 1	4.38±0.47	4.51±0.37	4.61±0.29	4.79±0.19	4.83±0.16
Diet 2	4.47±0.43	4.56±0.43	4.62±0.38	4.77±0.38	4.80±0.35

Table 5 The increase percentage of weight, width and length of *H. ovina*, during the 8 weeks of experiment.

	Increase percentage				
	Week 0	**Week 2**	**Week 4**	**Week 6**	**Week 8**
Weight					
G. salicornia	0.00	2.36	3.29	7.83	9.84
Diet 1	0.00	5.00	7.18	20.24	23.71
Diet 2	0.00	0.83	3.11	10.25	8.76
Length					
G. salicornia	0.00	0.49	2.03	3.55	4.82
Diet 1	0.00	2.06	2.75	6.9	7.97
Diet 2	0.00	0.79	1.73	3.87	4.14
Width					
G. salicornia	0.00	1.38	2.82	3.82	5.45
Diet 1	0.00	2.89	5.08	9.21	10.20
Diet 2	0.00	1.90	3.36	6.60	7.38

Table 6 Percent survival rate of *H. ovina*, during the 8 weeks of experiment.

	Week 0	**Week 2**	**Week 4**	**Week 6**	**Week 8**
G. salicornia	100.00	81.67	70.00*	56.67*	48.33*
Diet 1	100.00	85.00	65.00*	50.00*	36.67*
Diet 2	100.00	75.00	58.33*	38.33*	23.33*

Table 7 The nutritional compositions; protein, carbohydrate, fat, fiber, ash and moisture; of *G. salicornia*, diet 1 and diet 2.

Nutritional composition	*G. salicornia*	Diet 1	Diet 2
Protein	16.40	15.00	40.90
Carbohydrate	28.60	49.90	33.70
Fat	0.80	6.80	5.00
Fiber	5.50	2.30	2.7
Ash	48.70	26.00	17.70
Moisture	90.70	55.4	65.1

Table 8 The average concentrations of nitrite, nitrate, phosphate and ammonia during the experimental period, before and after feed 12 hours.

	Concentration (mg/L)					
	G. salicornia		Diet 1		Diet 2	
Nutrient	**before**	**after**	**before**	**after**	**before**	**after**
Nitrite	0.007	0.016	0.017	0.051	0.047	0.112
Nitrate	0.136	0.218	0.131	0.228	0.145	0.423
Phosphate	0.034	0.031	0.060	0.050	0.061	0.089
Ammonia	0.033	0.068	0.026	0.057	0.037	0.260

Discussion and conclusion

The distribution of *H. ovina* is the same area with *H. asinina*, but the habitat is different. In day time when we go out to collect the abalone for stocking, we found that *H. ovina* usually found in the crevice of rock or dead and live corals that expose to surface of water, while *H. asinina* is habit under the rock or dead corals. Because of they usually attach on the surface of rock that direct to the sun, so that we usually found many micro organisms on their shell such as benthic diatom, small macro algae, mollusk larvae, foraminiferan group, small tuff algae, copepod, crustacean larvae etc. *H. ovina* is slow creeping while *H. asinina* is faster creeping. The percentage of flesh was 22-36% is smaller than *H. asinina* that had 48 - 57% of flesh. However, Singhagraiwan and Doi (1993) reported that *H. ovina* had 40% of maximum flesh and *H. asinina* had 85% of maximum flesh.

The growth of *H. ovina* during 8 weeks of this experiment or in about one month of 3 more experiment were very low. It was only 9.84-23.71% in weight, 4.14-7.97% in length and 5.45-10.20% in width (table 4-5), while *H. asinina* in the same method of experiment, but the experimental period was 9 weeks. The growth fo *H. asinina* was about 35.6-64.7 % in weight, 7.5-18.6% in length and 4.9-16.9% width (Sawatpeera, 1988). The size measurement increase may be come from the more survival of larger size.

When considered the survival rate of *H. ovina*, we found that all treatment diet has very low survival rate. Their survival rate in *G. salicornia*, diet 1 and diet 2 treatments were 48.33% or 29 individuals, 36.67% or 22 individuals and 23.33% or 19 individuals (table 6). After week 6 *H. ovina* in diet 1 and 2 had rapidly increase of mortality (table 6 and figure 12). High mortality rate in diet 1 and 2 may come from the water quality. The diet 2 was lower stable than diet 1 and causes the water quality is more worth than diet 1 treatment (table 8).The toxic substances, such as nitrite and ammonia, in water of diet 1 and diet 2 treatment tank during 12 hours after feed was little higher than *G. salicornia* treatment (table 8) and it may stress to *H. ovina* and cause high mortality. When compare with *H. asinina* we found that *H. asinina* was more tolerant than *H. ovina* in the similar environment change.

The survival rate of *H. ovina* among diet treatments was significant different. But the graph of survival rate showed the linearity decrease gradually (figure 12). It seems that if the experiment was carry on, the survival of *H. ovina* may gradually decrease until all of them was die.

There were many reasons that can cause the mortality of *H. ovina* in this experiment. First, *H. ovina* in this experiment was come from the nature, their distribution usually in the clear and clean water. The second the size of sample for the experiment quiet large that they cannot adapt to the laboratory conditions. The last *H. ovina* quiet delicate or less tolerant to a little environmental change when compares

with *H. asinina* especially in diet 1 and diet 2 treatment tank the water was turbid after feed them around 12 hours, because of the dissolve of the diet when compare with *G. salicornia* treatment tank.

So We would like to recommend that the experiment with *H. ovina* in the future should carry after we can maintain them in culture conditions and use the crop that breeds in culture conditions like *H. asinina* for the experiment.

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