# On the use of dry seaweeds and condensed phytoplankton as diets for the clam *Venerupis aurea*, Egypt

**Samya H. Mohammad[1], Gihan A. El-Shoubaky[2] and Fedekar F. Madkour[3]**

1- Department of Zoology, Faculty of Sci., Suez Canal Univ., Port Said, Egypt
2- Department of Botany, Faculty of Sci., Suez Canal Univ., Port Said, Egypt
3- Department of Marine Scie., Faculty of Sci., Suez Canal Univ., Port Said, Egypt

## ABSTRACT

One of the most commercially important species of the marine clam *Venerupis aurea* was fed on dry preparations of seaweeds (*Enteromorpha intestinalis* and *Ulva lactuca*) and condensed preparation of phytoplankton. Daily growth rate (DGR) of clams as live wet weight increase was calculated to determine the effect of different diets. Comparing DGR of feeding bivalves with that of control, some variations were recorded. Higher growth over control was obtained for juvenile *Venerupis aurea* (3-6 mm) fed on phytoplankton and *Enteromorpha intestinalis*. For the clam size 6.1-9 mm, the bivalves fed on *Enteromorpha intestinalis* and *Ulva lactuca* showed higher growth. The largest clam size (9.1-12 mm) which was fed on the previous diets, failed to attain the same growth as control. So, the differentiation in growth was related to size of clam and also to type of the diet.

**Keywords:** Bivalves, *Venerupis aurea*, *Enteromorpha intestinalis, Ulva lactuca,* phytoplankton

## INTRODUCTION

Many species of bivalves are commercially important, playing crucial role in the local economies of many countries. Suspension-feeding bivalves, primarily clams, scallops, oysters and mussels, are a significant element of near-shore communities, which profoundly impact pelagic and benthic processes. Through filter-feeding activity, they can recycle large amounts of particulate matter within the environment, converting some of it into flesh and gametes, depositing varying amounts to the benthos and cycling complex molecules into inorganic forms (Ward and Shumway, 2004).

Family Veneridae has commercial importance and is considered as a successful group of bivalves (Mohammed *et al*., 1992). Many species of this family are cultured as essential source of protein. Bivalves feed essentially exclusively on marine microalgae throughout their life cycle (Benemann, 1992). In addition, variable proportions of detrital particles are used as food for marine suspension feeders. The contribution of detritus to the energy balance of bivalves is unclear since few studies have attempted to analyze the capacity of bivalves to utilize it (Elorza *et al*., 2007). They measured clearance, ingestion and absorption rates in bivalves fed increasing rations of detrital particles obtained from three vegetal species namely: *Juncus maritimus*, *Ulva lactuca* and *Enteromorpha* sp. The two genera *Enteromorpha* and *Ulva* are widespread in Lake Timsah which is considered as eutrophic lake (El-Shoubaky and Hamed, 2006). They accumulate high levels of nitrogen and phosphorus, so, they are rich in protein and carbohydrate (El-Shoubaky and Abdel-Kader, 2007). Artificial and replacement diets for bivalve molluscs have been developed and extensively evaluated (Boeing, 1992 and Jones *et al*., 1993).

*Venerupis aurea* is a suspension feeder, fed on phytoplankton, and is considered as the most popular edible clam of family Veneridae. It is also considered as important bivalve fishery in Lake Timsah, where it is locally consumed and is exported to some European countries (Kandeel, 1992). It is extensively fished in Lake Timsah throughout the year. This leads to the obvious decrease in its size. The aim of this work was to sustain *Venerupis aurea* larger size by feeding it on condensed phytoplankton and artificial diet of dry preparations of seaweeds.

## MATERIALS AND METHODS

Samples of *Venerupis aurea* were collected from Lake Timsah, Ismailia, Egypt during spring 2007. All samples belonged to the same cohort (less than one year). The clams were measured by a Varnier caliper then classified into three size groups: juveniles (3–6 mm), young clams (6.1–9 mm) and large clams (9.1–12 mm). For each size, 1.5 g was weighed by an electro-balance to an accuracy of 0.01g. Two species of subtidal macroalgal species, *Ulva lactuca* and *Enteromorpha intestinalis* (which formed a flourishing seaweed bed in Lake Timsah) were handly collected, then dried at room temperature and ground into powder. For phytoplankton diet, the quantity of phytoplankton was doubled by filtering an equal volume of seawater in the container.

Three sets were performed from the juvenile, young and large clams. For each set, different diets of *Ulva lactuca*, *Enteromorpha intestinalis* and phytoplankton were added separately in three containers and the fourth was for the control without any additional diets. One liter of seawater was added to each container and changed weekly. *Ulva lactuca* and *Enteromorpha intestinalis* diets were added in ratio equals to10% of the bivalve live weight. The period of experiment was 12 weeks.

Mean individual weight of *Venerupis aurea* was estimated by dividing total weight (1.5g) by the number of live bivalve in each container. Daily growth rate (DGR) was calculated as a function of increase in wet live weight per period of experiment in days as the following equation:

$$DGR = \frac{\ln \text{final weight} - \ln \text{initial weight}}{\text{Period of experiment in days}}$$

This equation was multiplied by 100 as a factor.

## RESULTS

In the first set, control clams showed increase in weight from the second to fifth week, and then decreased afterwards (Fig.1). Clams fed phytoplankton recorded the highest weight all over the period (ranged between 2.42% and 3.19%) except during the fourth and fifth weeks. Highest weight percentage was recorded in clams fed on *Enteromorpha intestinalis* (3.37%) and *Ulva lactuca* (3.19%) in the fourth and fifth weeks respectively. Table (1) shows that daily growth rate of clams fed on phytoplankton were capable of sustaining better growth than control. Higher growth over control was also obtained in bivalves that fed on *Enteromorpha intestinalis*.

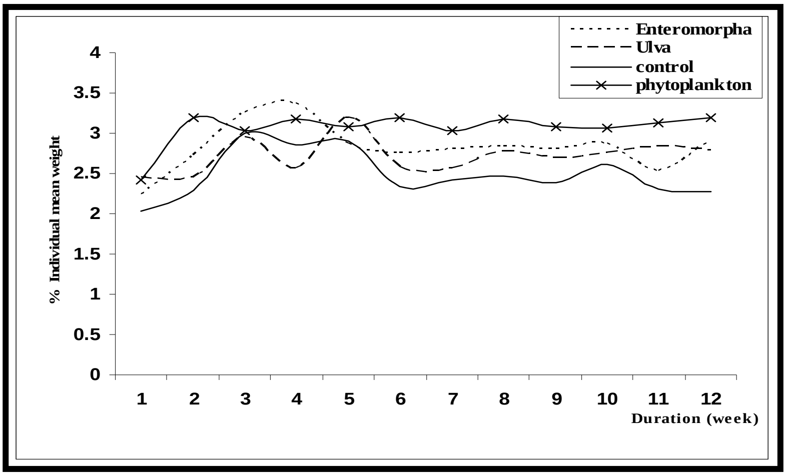


Fig (1): Individual mean weight percentages of *Venerupis aurea* (3 -6mm) fed on phytoplankton, *Ulva lactuca,* and *Enteromorpha intestinalis* in comparison to control.

Table (1): Daily growth rate of *Venerupis aurea* fed on different species of seaweeds and phytoplanktons.

| Species set | seaweeds | | phytoplankton | control |
|---|---|---|---|---|
| | *Enteromorpha* | *Ulva* | | |
| First set | 0.26 | 0.13 | 0.28 | 0.11 |
| Second set | 0.14 | 0.10 | 0.04 | 0.03 |
| Third set | 0.18 | 0.18 | 0.00 | 0.36 |

Different trend in growth of clams was recorded in the second set. Clams of control exhibited lower weights than others except during fifth and sixth weeks (6.95 and 7.52% respectively) (Fig. 2). Young clams fed on seaweeds suffered from decreasing weight after the start of the experiment then increased in weight in a steady manner. Meanwhile, clams fed on phytoplankton directly increased in weight after beginning of the experiment till the eighth week after which its weight slightly decreased. Daily growth rate of clams fed on seaweeds (1.37 & 0.95 for *Enteromorpha intestinalis* and *Ulva lactuca* respectively) exceeded that fed on phytoplankton (0.42), and both were higher than control (0.28).

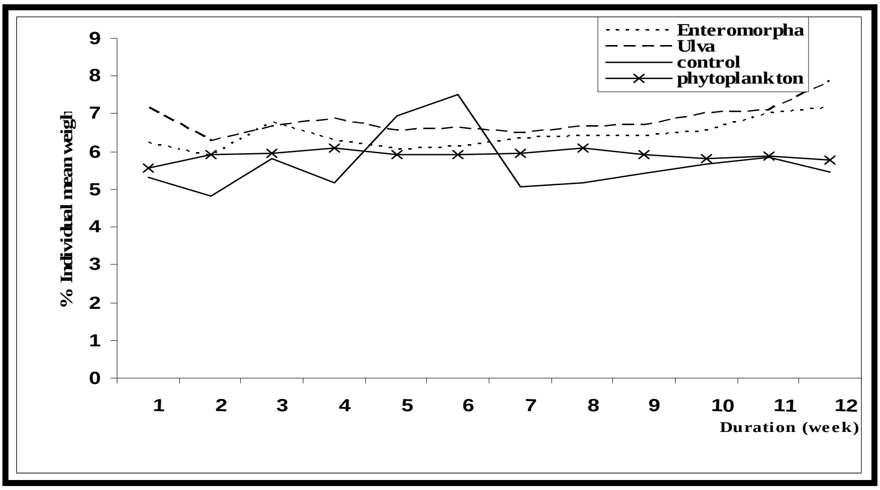


Fig. (2): Individual mean weight percentages of *Venerupis aurea* (6.1-9mm) fed on phytoplankton, *Ulva lactuca,* and *Enteromorpha intestinalis* in comparison to control.

Fig (3) shows that the clams of control in the third set increased in mean weight reaching its maximum value (24.6g) in the sixth week. Then the weight sharply decreased in the seventh week, after that an increase in weight was shown in a steady manner. Clams fed on seaweeds showed fluctuation in weight, ranging from 11.7-15g to 14.4-17.8g, for *Enteromorpha intestinalis* and *Ulva lactuca* respectively. Fluctuation in weight appeared also in clams fed on phytoplankton ranging from 18.7 to 20.5 g. Daily growth rate of control ( 3.56 ) exceeded that of clams fed on *Enteromorpha intestinalis* (1.82 ) and *Ulva lactuca* (1.75 ), whereas DGR of clams fed on phytoplankton equaled to zero as the weight at the end of experiment equaled to that at the beginning.

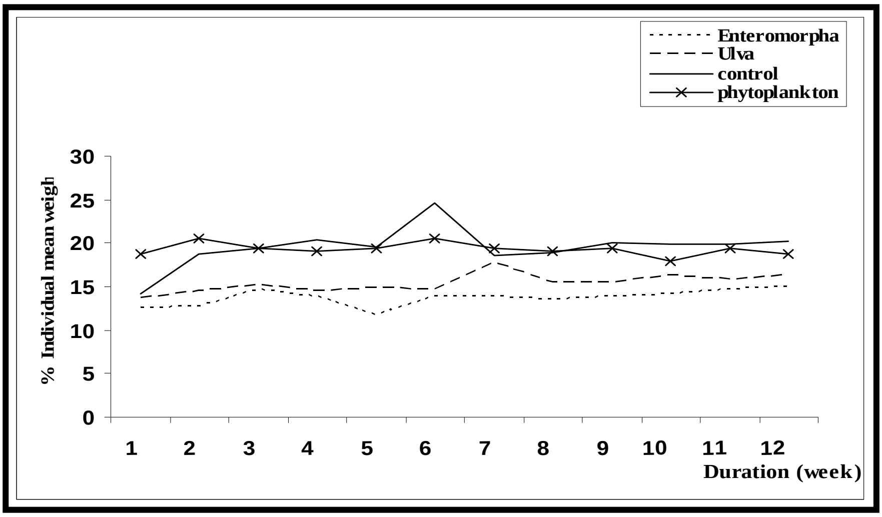


Fig. (3): Individual means weight percentage of *Venerupis aurea* (9.1-12mm) fed on phytoplankton, *Ulva lactuca,* and *Enteromorpha intestinalis* in comparison to control.

## DISCUSSION

In spite of the commercial importance and increasing demand of *Venerupis aurea*, its value may decrease due to the gradual decline in its size. This was clear in the variation of its maximum length from 37 mm (Kandeel, 1992) to 21.9 mm (Mohammad, 2007) and 31 mm (personal communication). This led to the actual demand for increasing the clam size. The present study selected juvenile and young clams of less than one year age, where the largest growth usually occurs in the first year of life.

Comparing the daily growth rate for the used diets with that of the control, each clam size varied in diet preference. In the first set, juveniles fed on phytoplankton, as their natural food, exhibited higher growth followed by these fed on *Enteromorpha intestinalis*. This indicated that clams at juvenile stage prefer its natural food, and the increase in its amount led to better growth. This was confirmed by Beiras *et al.* (1994) who pointed out that an increase in phytoplankton and benthic diatoms enhance bivalve growth. This growth may also result from high feeding rate that is clear in small clams than larger ones as mentioned by El-Moselhy and Yassien (2005).

In the second set, clams fed on seaweeds had higher growth rate than that fed on phytoplankton. This can be attributed to the selective feeding behavior that is very common in benthic organisms. This is in agreement with Lopez and Kofoed (1980) and Harkey *et al* (1994) who found that both filter and deposit feeders are able to select particles of a certain size. Kang *et al.* (1999) suggested that there are 2 major sources of organic matter assimilated by bivalves, phytoplankton and suspended particulate organic matter (POM). They found that adult bivalves exhibited higher dependence on POM variability, while juveniles are more closely linked to phytoplankton. Consequently, the relative importance of the 2 major food sources depends on the age. The selectivity of particles may be on the basis of specific gravity and / or surface texture (Self and Jumars, 1978), as well as on the basis of organic content (Taghon, 1982).

Daily growth rate was decreased at larger clam size. This was clear from the third set in which all clams failed to attain the same size as control. It can be hypothesized that clams larger than 9mm were totally adapted to their natural food in normal quantities. Ward *et al*. (2003) recorded a significant decrease in feeding rates of suspension-feeding bivalve molluscs with increasing diet concentration. On the other hand, decreased in growth may result from a decrease in oxygen demand. This was mostly obvious in clams fed condensed diet of phytoplankton.

Caers *et al.* (2003) indicated that flagellates are also part of intertidal bivalves planktonic food sources, with high level of Chlorophyta fatty acid marker, [GAMMA] 18:2(n - 6) + 18:3(n - 3). They suggested that *Ulva pertusa* (Chlorophyta) seaweed bed supplied important food source to intertidal bivalves. Additionally, the result of stable isotope analysis showed that phytoplankton contributed 86.2 to 89.0% to intertidal bivalves' carbon budget; macroalga *U. pertusa* origin source had a contribution of 8.7% to 11.0%, which indicated its role as an important supplemental food source to intertidal bivalves.

Our results revealed that differentiation in growth were related to size of clam and also to type of the diet. This study provides important information for the future productivity of cultured clams by demonstrating that feeding preferences may differ for clam size.

## REFERENCES

Beiras, R.; Pérez Camacho, A. and Albentosa, M. (1994). Comparison of the scope for growth with the growth performance of *Ostrea edulis* seed reared at different food concentration in an open–flow system. J. Mar. Bio., 191 (2): 227-233.

Benemann, J. R. (1992). Microalgae aquaculture feeds. J. Appl. Phyco., 4: 233-245.

Boeing, P.L. (1992). Polyculture of hard clam (*Tapes semidecussata*) with white shrimp (*Penaeus vannamei*) in shrimp ponds. Project E3-D Regional Program of Technical Co-operation in Fisheries. CEE-PEC-ALA/87/21. Guayaquil, Ecuador.

Caers, M., P.; Coutteau, Sorgeloos, P. and Gajardo, G. (2003). Impact of algal diets and emulsions on the fatty acid composition and content of selected tissues of adult broodstock of the Chilean scallop *Argopecten pupuratus* (Lamarck, 1819). Aquacult., 217:437-452.

Elorza, U. A.; Bellido, I. I. and Barandika, M. B. U. (2007). Differential utilization of detrital particles from *Juncus maritimus*, *Ulva lactuca*, and *Enteromorpha* sp. by the common cockle *Cerastoderma edule*. Aquacult., 604.

El-Moselhy, K. M., and Yassien, M. H. (2005). Accumulation patterns of heavy metals in Venus clams, *Paphia undulata* (born, 1780) and *Gafrarium pectinatum(linnaeus,* 1758), from Lake Timsah, Suez.

El-Shoubaky, G. A. and Abdel-Kader, D. Z. (2007). Biological study on biomass and growth dynamics of *Ulva lactuca* and *Enteromorpha intestinalis* in marine and brackish waters in Egypt. Egypt. J. Biotechnol., 26: 117-129.

El-Shoubaky, G. A. and Hamed, A. F. (2006). The Characteristic Algal Mats and Flora of EL-Timsah Lake. Catrin., 1(2): 75-80.

Harkey, G. A.; Lydy, M. J.; Kukkonen, J. and Landrum, P. F. (1994). Feeding selectivity and assimilation of PAH and PCB in *Diporeia* spp. Environ. Toxico. Chem., 13:1445-1455.

Jones, D. A.; Kamarundin M.S. and Vay L. Le. (1993). The potential for replacement of live feeds in larval culture. J. Wor. Aquacult. Soc., 24: 199-210.

Kandeel, S. K. (1992). Biological studies on the reproduction of some bivalves in Lake Timsah. M.Sc. Thesis, Faculty of Science, Suez Canal University, Ismailia, Egypt.

Kang, C. K.; Sauriau, P.G.; Richard, P. and Blanchard, G. F. (1999). Food sources of the infaunal suspension-feeding bivalve *Cerastoderma edule* in a muddy sandflat of Marennes-Oléron Bay, as determined by analyses of carbon and nitrogen stable isotopes. Mar. Eco., 187: 147-158.

Lopez, J. R. and Kofoed, L. H. (1980). Epipsammic browsing and deposit-feeding in mud snails (Hydrobiidae). J. Mar. Res., 38:585-599.

Mohammad, S. Z.; Gaber, H. R.; Ghobashy, A. F. A. and Brand, A. R. (1992). Species composition and distribution of benthic mollusks in Lake Timsah, Suez Canal. J. Egypt. Ger. Soc. Zool., 7 (B), 161-174.

Mohammad, S. H. (2007). On the distribution and abundance of some mollusks in Lake Timsah, Suez Canal. Egyp. J. Aqua. Res., 33(3) 147-155.

Self, R. F. L., and Jumars, P. A. (1978). New resource axes for deposit feeders. J. Mar. Res., 36:627-641.

Taghon, G. L. (1982). Optimal foraging by deposit-feeding invertebrates: Roles of particle size and organic coating. Ecolog., 52:295-304.

Ward, J. E.; Levinton, J. S. and Shumway, S. E. (2003). Influence of diet on pre-ingestive particle processing in bivalves: Transport velocities on the ctenidium. J. Exp. Mar. Biol. Ecol, 293: 129-149.

Ward, J. E. and Shumway, S. E. (2004). Separating the grain from the chaff: particle selection in suspension- and deposit-feeding bivalves. J. Exp. Mar. Biol. Ecol. 300:84-130.