Feeding Cockles with Detritus Balls

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Abstract

The 'aging' of the farm may affect cockle's growth as it gradually lacks the necessary nutrients and organic matter. In recent years, the annual national cockles' production has shown a descending trend. Although pollution, stocking density, predation and mangroves destruction may also affect cockles' growth, this study attempted the prospect of increasing the organic detritus in the cockle's area as food for the cockles. For this purpose, a laboratory experiment was conducted with the objective to create 'detritus balls' suitable to be submerged in the muddy soil and after time releasing decomposed detritus to be consumed by the cockles. Green leaves were buried under the soil for three weeks for decomposition process to take place and later mixed with clay to form several balls .The purpose of the balls is to hold the decomposed leaves and simultaneously heavy enough to be able to submerge in the muddy soil. There were six aquarium tanks in use, each was filled with filtered sea-water, aerated and introduced 30 live cockles. In each of the three tanks, eight detritus balls were placed while the other tanks served as control without the detritus balls. The detritus balls were found to hold intact the decomposed leaves if the leaves composition was between 5-11 % and submerged in mud at about 6 cm. At the end of the observation period, 70 % of the cockles placed together with the detritus balls survived while none survived in the control tanks. The stomach of the surviving cockles was examined and found filled with detritus and other organisms in contrast to the dead cockles. From the results obtained, it indicates that detritus balls can be used in the field to increase organic detritus and thus improve cockles' growth.

Keywords: detritus balls, mangroves leaves, ammonia, *anadara granosa*

Introduction.

Many factors contribute towards cockles (*Anadara granosa* Linnaeus 1785 of family Arcidae) declining population. The main cause of the declining production of cockles in recent years remains inconclusive but several studies provide an insight of what may actually happened in Malaysia. Study by Din & Ahmad (1995) in polluted cockles' area in Kuala Juru, Penang suggested that the growth is correlated to some environmental parameters. A study on the trace element contents of the Malaysia cockles *Anadara granosa* by Ibrahim, (1995) obtained results that showed a linear relationship between metal concentration and body weight of cockles. Adequate food supply and stocking density may also affect the cockle growth. Study by Pathansali & Soong (1958) and Pathansali (1966) indicates the stocking density plays important role in cockle's growth. Working on two natural population, Broom (1985) found that one population the mean wet weight of species *A. granosa* in a sample was negatively correlated with density. Farmers are also facing the cockles mortality caused by invertebrate's predators such as finfish, crustaceans, gastropods, echinoderma and polychaete worms (Tiensongrusmee & Ponjoprawira, 1988). Major and important predators of Malaysia mudflats feeding on *A.granosa* are gastropods *Natica muculosa* and *Thais carinifera* (Broom, 1985). However, the future of cockles culture in the country is being endangered by human activities along the coastline whereby the breeding grounds of the cockles are being threatened by the removal of mangroves, coastal reclamation, environmental degradation and pollution. It has been estimated that between 1979-1986, the loss of mangroves in Malaysia is about 21% (Mastaller, 1996). Cockle seeds smuggling to neighbouring country is also another factor that could greatly affect national cockles' production (Izura & Hooi, 2008).

The declining trend of cockles production in Malaysia is a great loss since it is a good revenue source for local population (Ibrahim, 1995) and a popular high protein seafood (Min, et al.,2011). In recent years, the annual national cockles production (Anom., 2011) has shown a descending trend (see figure 1). In year 2010, the production has reduced to about 78,000 mt compared to 100,000 mt in 1995. On the contrary, in term of areas utilized for cultivation, figure 2 shows that it has increased from 4,753 hectares (ha) in 1995 to 10,000 ha in 2010. Although the area expansion is over twice the 1995 size (210%), the cockle production is 22 % reduced. It also indicates, the production in relation to area is only 10 mt per ha in 2010 compared to 21 mt per ha in 1995.

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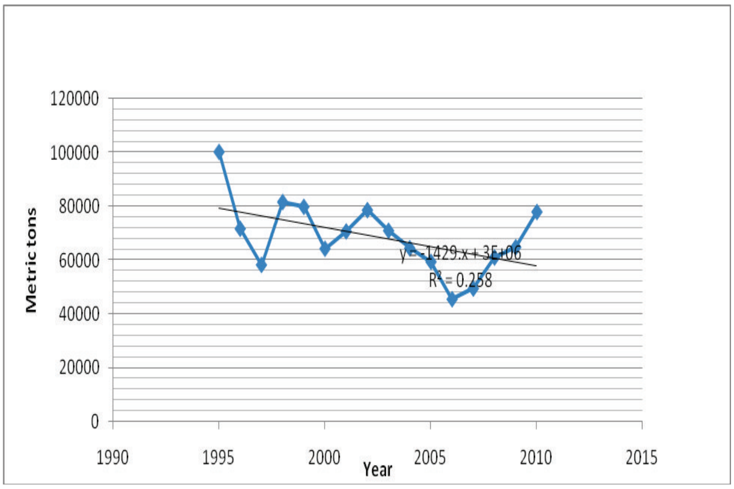

Figure 1: Cockles production in Malaysia from 1995-2010

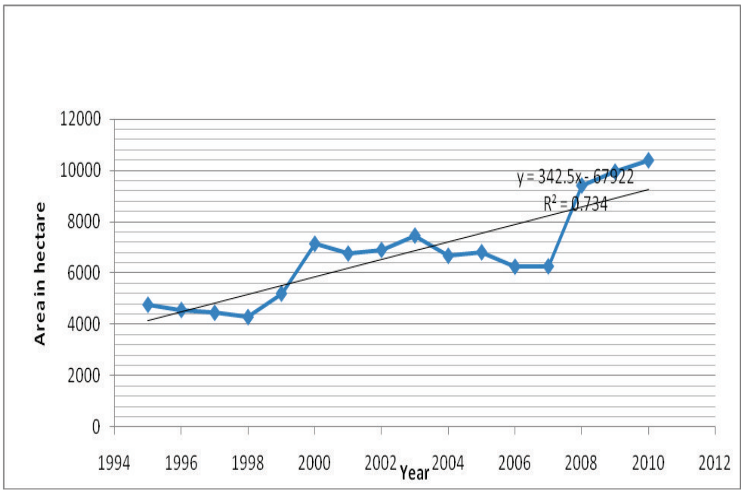

Figure 2: Cockles culture areas in Malaysia from 1995-2010

In monetary term, the loss can be gauged by assuming the production potential of 21 mt per ha (as in 1995) and then multiplying by the present farm area, i.e. 10,000 ha giving the total potential production estimated to be 210,000 mt. The difference between the actual production (78,000 mt in 2010) and the potential production (210,000 mt) is 132,000 mt or at ex-farm value of RM 155 millions, which is the loss of the country per annum.

Cockles are filter feeders that feed on organic detritus (98% found in the intestines) and microalgae (Anom., 1997).Since cockles are mainly found in mudflats of the inter-tidal or neritic zones (Reven & Johnson, 2002) and close to shore, they rely on detritus made of dead plants of mangroves species. The abundance of microalgae on the other hand depends on the nutrients from the soil underneath the water and sufficient light for photosynthesis to take place. During the decomposition process of the dead organic matter, nutrients that fertilize the soil such as nitrogen, phosphate and phosphorus are released. These nutrients are used by algae for tissue growth. In environmentally suitable condition, there will be sufficient food supply for benthos to live. However, food availability may be hampered by several factors including the 'aging' of cockle's beds which may contribute significantly to the declining production of cockles (Tiensongrusmee & Ponjoprawira, 1988). Unlike most culture system, cockles are not fed but left to survive on the natural supply of food such as phytoplankton and detritus. The soil infertility is made worst as farmers do not practically fertilize their farms. Over the years, extensively used cockles farm may lack the necessary nutrients and organic matter. As proposed by Tiensongrusmee & Ponjoprawira (1988), the organic detritus should present between 6–11 per cent after ignition at 475^{0}C for 7 hours. While studies on the biology of cockles (Pathansali, 1964, Broom,1985,Tookwinas, 1985[1], Tookwinas, et al.,1985,Tookwinas, 1985[2], Oon, 1986 & Richardson, 1987) and culture aspects (Chen, 1976, Hansopa, 1986 & Tiensongrusmee & Ponjoprawira, 1988) are numerous, study on the fertility restoration of the beds is limited.

The objective of the study is to create clay balls that enclose laboratory prepared detritus and simultaneously heavy enough to be able to submerge in the muddy soil. The balls should crack open once submerged in the mud thus slowly releasing the detritus that can be consumed by the cockles. The survival rate of cockles treated with detritus balls and a control group is compared.

Materials and Methods

For the preparation of detritus, mangroves leaves were collected, shredded and buried under the soil for about three weeks. To assure the rate of decomposition is expedited, the burial site was exposed to direct sunlight as the higher temperature, the quicker is the decomposition process (Liu, et al., 2005). The decomposed leaves were then blended to make it into smaller pieces for easy consumption by the cockles. Mechanical reduction in size of leaf material generally increased the rate of decomposition (IIarrisod & Mann, 1975) **.**In the study of the size of detritus consumable by the mussel *Cromytilus meridionalis* , the size ranged from 1-100µm and particles exceeding this size are rejected as pseudofaeces (Griffiths, 1980).The components of detritus ball are clay and blended leaves where clay enclosed the leaves to form a ball shaped object. Several ratios of clay and detritus were tested for its strength and ability to remain whole before reaching the bottom of the sea. The purpose of the balls is to hold the decomposed leaves and simultaneously heavy enough to be able to submerge in the muddy soil. There were six aquarium tanks in use, each was filled with filtered sea-water and aerated. In each of the three tanks, eight detritus balls were placed while the other tanks served as control without the detritus balls. After five days, 30 live and healthy cockles at the average size of 25 mm were introduced in all tanks. According to Kimio, et al., (1981), the maximum heterotypic bacteria plate count occurred after 5 days providing ample time for decomposition to take place in water. Salinity of all tanks was kept almost constant at 28 ppt. The salinity on natural habitats of cockles had been investigated by (Sandra, 1977, Tookwinas, 1985[3], Davenport & Wong, 1986, & Soto, et al., 2011 &). However, based on experiments carried out by Jalal, et al., (2009), when salinity decreases to 23 ppt mortality will occur. Surface water temperature was kept between 25^0C -28^0C where sometime submersible heater was used during cold weather. Dissolved oxygen was kept no less than 11 mg/L by use of aerator. In a study carried out by Jalal, et al.,(2009), at Pahang estuary, they found out that *A. granosa* survived with dissolved oxygen between 6.80 -7.50 mg/L with temperature of 29-30^0C. Ammonia (NH_3-N) levels were measured daily since it may be the limiting factor for cockles' survival. For example, ammonia toxicity (96-h, LC 50) to marine species is between 0.09 mg/L – 3.35 mg/L (Eddy, 2005). Death of the cockles was confirmed upon its inability to close the shells when applied mechanical stimulus (Reddy & Menon, 1979). Stomach contents of dead cockles in all tanks were examined and at the end of the observation period, all surviving cockles were examined.

Results and Discussion

The clay chosen follows definition by Stephen & Martin, (1995) which describes clay as naturally occurring materials composed primarily of fine grained minerals which is generally plastic at appropriate water contents and will harden when dried or fired. Several compositions of detritus: clay were tested to obtain the best combination that has the required properties; 1) remains whole throughout handling, and 2) upon submerged in the mud will crack open in a short time. Table 1 shows that the ball containing detritus of more than 25 % became soft and disintegrated during handling. It is concluded that detritus content of between 5-11% had maintained the plasticity property of the clay and submerged to about 6 cm in the mud. Time taken to crack open was between 90-105 minutes.

Table 1 ; Detritus compositions in relation to clay ball properties (500 g)

Test no.	detritus weight (g)	clay weight (g)	% of detritus	observations	depth submerged (cm)
1	250	250	50	soft, disintegrate	_
2	200	300	67	soft, disintegrate	_
3	150	350	43	soft, disintegrate	_
4	100	400	25	soft, disintegrate	_
5	50	450	11	hard	6
6	25	475	5.3	hard	6

At the end of the 12-day observation period, on the average, 70 % of the cockles treated with the detritus balls survived while none survived in the control tanks. Figure 3 shows the results of treated Tank A1 (one of the three tanks introduced with detritus balls) which indicate cockles' mortality occurred only on the ninth day. It is suspected the sudden increase of ammonia from 0.4 mg/L to 1.2 mg/L is the cause of the mortality. In Tank B1 (one of the three control tanks), mortality occurred on the fifth day (figure 4). Again, high level of ammonia is suspected of causing the mortality. However, when the stomach of the surviving cockles was examined, it was found filled with detritus and other micro-organisms in contrast to the dead cockles of Tank B1.Therefore, starvation may also contribute to the mortality of the cockles. Mass mortality did not occur in *A. granosa* upon encountering toxic level of ammonia since individuals tolerance level may differ. A study on *Perna viridis* exposed to different levels of ammonia shows that at 5 mg/L concentration, 20% death was observed and 100% mortality was only observed at 11 mg/L after a 96-h exposure (Reddy & Menon, 1979).

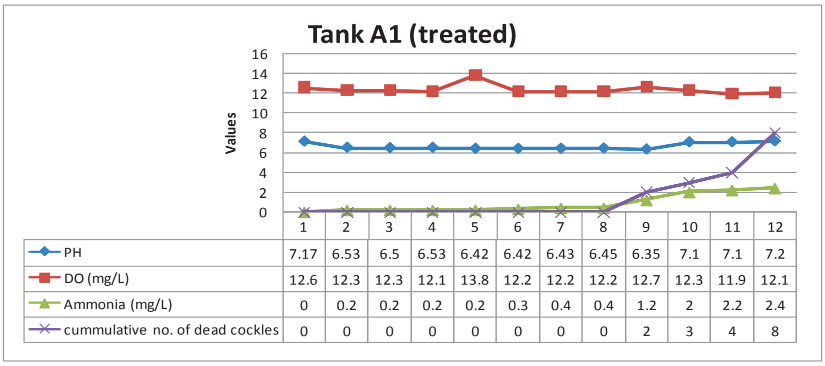

Figure 3: Mortality of cockles treated with detritus balls

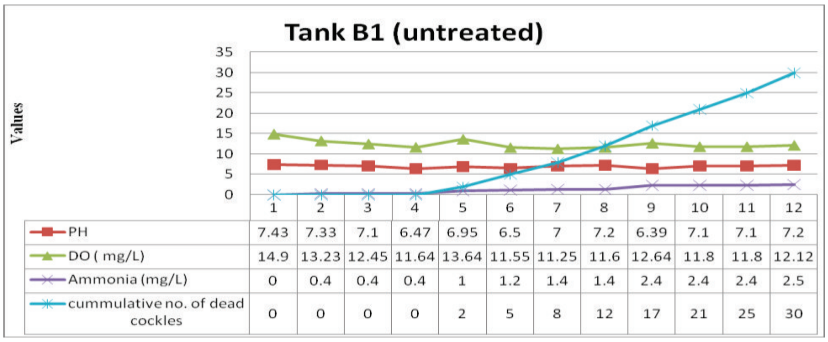

Figure 4: Mortality of cockles untreated with detritus balls

It has been shown that cockles kept in captivity do survive on detritus prepared in the laboratory, although some of them died after the 9-day period. However, 100% mortality was observed in tanks not fed with detritus. This suggests that cockles in the farm can be fed with detritus prepared in the form of detritus balls. The given food supply may increase growth rate and sustain the tolerance levels of the cockles. However, the increase of ammonia levels due to cockle's faeces may speed up mortality in Tank B concurrently starvation was in progress. According to Brown & Russell, (1994), ammonia excretion rates were higher for starved clams than for fed clams at all sizes which is consistent with the ammonia levels in Tank B compared to Tank A. Dead cockles left over-night (only to be removed in the morning) may increase the ammonia level in the tank. The study by Cherry, et al., (2005) indicates that NH_3-N levels produced by Asian clam die-offs have the potential to exceed acute effects levels for at least some species of unionid mussels. Further study is to administer detritus balls in the cockles farm and observe growth rate, mortality rate and the presence of ammonia in the open sea.

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