

A Comparison Of Soft-shell Crab Production Methods: Autotomy, Herbal Extract and Natural Rearing

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Abstract

Yushinta Fujaya, Nita Rukminasari, Nur Alam, Muhammad Rusdi, Khor Waiho, Hanafiah Fazhan. 2021. A Comparison of Soft-shell Crab Production Methods: Autotomy, Herbal Extract and Natural Rearing. *Aquacultura Indonesiana*. 22(1): 40-47. The world market demand for soft-shell crabs is increasing due to their delicate taste and ease of eating. However, the current production methods of soft-shell crabs (mutilation / limb autotomy) is either considered unethical or the waiting period for molting is too long. Thus, this research assessed the effect of mutilation (removal of all appendages except swimming legs), using herbal extract (Vitomolt™) as a stimulant for moulting, and without stimulation (control) on growth (body size and weight increment), molting period, molting percentage and survival. It was observed that mutilation method stimulated faster molting in crabs compared using herbal extracts and naturals, however, with a significantly lower increase in body size and weight. Molting rate was highest in crabs subjected to mutilation (92%), followed by those injected with than Vitomolt™ (73%) and control (52%). The survival rate of crabs subjected to Vitomolt™ was the highest (94.8%) compared to mutilation group (91.7%) and control (89.6%). Based on these results, mutilation is not recommended for soft-shell crab production due to their lower body size and weight increment (lesser profit for farmers). The use of herbal extract (Vitomolt™) has huge potential as a stimulant for molting in soft-shell crab production as its usage increased survival and molting rate in *S. olivacea*.

Keywords: soft-shell crabs, mutilation, herbal extract, moulting, growth

Introduction

Soft-shell crabs are essentially portunid crabs that have just completed their molting process (Fazhan et al., 2017a, 2017b; Hungria et al., 2017). As the hardening of new carapace requires time (normally 24-48 hours) (Waiho et al., 2015), crabs are

harvested during this small window period as 'soft-shell crabs' (Fujaya, 2011). The world market demand for soft-shell crabs is increasing (Hungria et al., 2017). This is because compared to the traditional form of eating crabs in their hard-shell conditions, consuming soft-shell crabs eliminates the need to manually extract the meat out before eating and soft-shell crabs can be

eaten whole. Its soft-shell condition also allows it to be prepared in more variety of cooking methods, thus increasing its gastronomical and commercial values. There are five categories of soft-shell crabs in the world trade, namely: whales (> 167 g), jumbos (127 - 167 g), primes (93 - 127 g), hotels (71 - 93 g), and mediums (51 - 71 g).

There are two common methods used by farmers in Indonesia to produce soft shell crabs, namely: maintained naturally in ponds without any treatment except adequate feeding and partial or total mutilation (induced limb autotomy) (Fujaya, 2011). Natural maintenance and harvest of soft-shell crabs right after molting requires longer rearing period and this is not economically favourable for the farmers (He et al., 2016). Limb autotomy, especially full (all appendages except swimming legs) limb autotomy, is known to induce molting in crabs (McCarthy & Skinner, 1977). However, the disadvantage of this method is that often than not, the newly-molted individuals exhibited partially grown new appendages which is less appealing and contributes to smaller increase in body weight (Smith, 1990; McCaughy, 1991), subsequently leads to lesser profit margin.

Recently, it was reported that herbal extracts are capable of induce

molting in crabs (Fujaya, 2011; Sorach et al., 2013). This is possible as plants contain ecdysteroids (termed as phytoecdysteroids) that are structurally similar with the ecdysteroids found in insects and crustaceans (Adler & Grebenok, 1999; Bathori et al., 2008). Apart from inducing shorter molting period, phytoecdysteroids also stimulates crabs ovarian maturation (Farizah et al., 2017), an effect similar to that of ecdysteroids found naturally in crabs (Gong et al., 2015). With the benefit of reducing intermolt duration, administration of natural herbal extracts to induce molting ensures that the soft-shell crabs produced possess full appendages, thus heavier body weight and in their natural, healthy and more appealing form. For example, preliminary study using spinach (*Amaranthus* spp.) extract successfully resulted in higher growth (in terms of body weight increment) and higher percentage of molting compared to controls in juvenile mud crab *Scylla* spp. (Fujaya, 2011).

Therefore, as a continuation, this study probed into and compared the effect of traditional molt induction method – mutilation (full limb autotomy), the normal rearing method and the use of herbal extract (Vitamolt™) to induce molting in mud crabs (*Scylla olivacea*).

Materials and Methods

The rearing experiment was carried out at the Hasanuddin University education pond (5,000 m²) in the regency of Barru, South Sulawesi Province, Indonesia. A total of 288 (average carapace width (CW) = 76.40 mm) immature intermolt individuals (*Scylla olivacea*) were obtained from local fishermen were used in this study, namely 96 crabs for each treatment. Crabs were identified to the species level based on the taxonomic keys provided by Keenan et al. (1998).

Three methods of soft-shell crab production were compared in this study, namely (1) mutilation (limb autotomy) (Fig. 1), (2) injection of herbal extract (Vitamolt™) as a stimulant for moulting (Fig. 2), and intact crabs without stimulation (control). For mutilation, all appendages except swimming legs were autotomized by gently applying pressure to the merus segment of the appendage (Smith & Hines, 1991). For second treatment, crabs were injected with 15 ug/g body weight (BW) of Vitamolt™. During culture, crabs were placed individually into a crab box (21 x 15 x 8 cm) (Fig. 3A) and were fed with dried trash fish (3% per body

weight) every two days. Daily observation was conducted every 3 hours for molting or mortality (Fig. 3B). Measured parameters were time and percentage of moulting, mortality, and growth rate (carapace length, CL, carapace width, CW and BW) of crab. A maximum rearing period of 80 days was applied.

All analyses were done using Microsoft Excel (ver. 16.27) and IBM

SPSS Statistic (ver. 25). Data were first tested for normality and homogeneity of variance using Shapiro-Wilk test and Bartlett test. One-way analysis of variance (ANOVA) with Welch's correction (Welch, 1947) was used if homogeneity of variance is violated ($P < 0.05$, followed by subsequent Games Howell post-hoc test.



Figure 1. Mutilation



Figure 2. Injection of Vitomolt™.

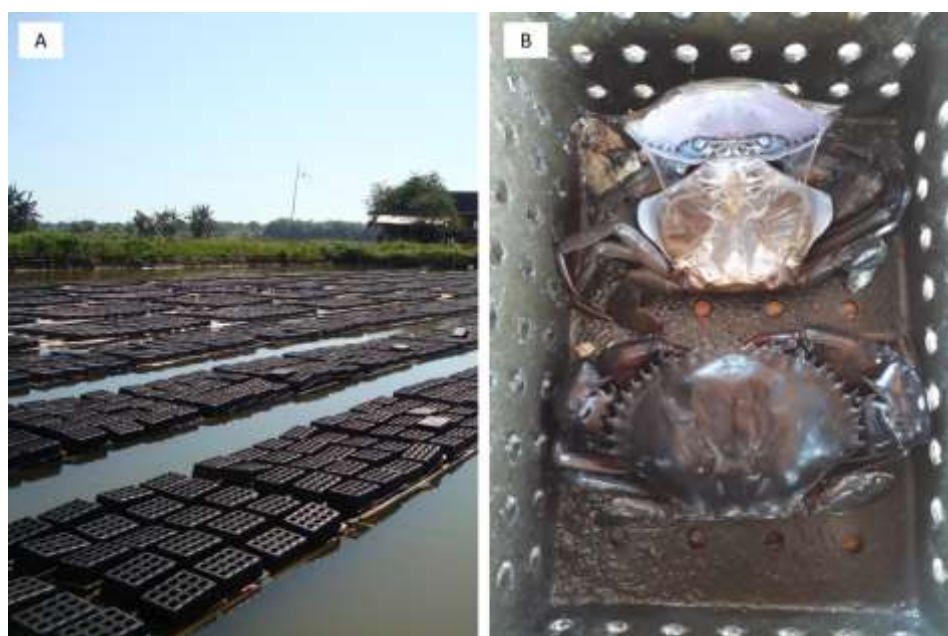


Figure 3. Crab boxes used for housing crabs individually (A) and crab after molting (B).

Result & Discussion

The effect of various treatments on CL ($F = 55.81$, $P < 0.001$), CW ($F = 54.37$, $P < 0.001$) and BW ($F = 240.04$, $P < 0.001$) were significant. Crabs subjected to mutilation had significantly smaller CL, CW and BW compared to controls and those injected with Vitomolt™ (all $P < 0.001$) (Fig. 4). The relative growths of CL, CW and BW, however, did not varied greatly among controls and Vitomolt™-injected crabs (CL: $P = 0.631$; CW: $P = 0.530$; BW: $P = 0.982$). The adverse effect of mutilation (full limb autotomy) on growth was also reported in other economically important crab species, such as blue crab *Callinectes sapidus* (Smith, 1990) and Chinese mitten crab *Eriocheir sinensis* (He et al., 2016). It was observed that the specific growth rate positively correlated with the number of appendages autotomized (He et al., 2016). We postulate that after subjected to mutilation, especially all appendages except swimming legs as in this study, crabs directed most of their energies into the regeneration of new

appendages and molting (Smith, 1990), whereas growth is comparably less important to survival and thus resulted in a lesser body size and weight increment. Also, Darnell et al. (2018) reported that mutilation would negatively affect crab's feeding behaviour, as observed in fiddler crab *Leptuca pugilator*. This would also explain the lesser growth of *S. olivacea* after mutilation although the effect of mutilation on feeding behaviour of *S. olivacea* needs further validation.

As expected, crabs subjected to mutilation of appendages exhibited shorter duration to next molt, whereas the effect of Vitomolt™ in hastening the molting process in *S. olivacea* was not that obvious (Fig. 5). Mutilation and regeneration of lost appendages in decapod crustaceans is known to cause a reduction in molt inhibiting hormone (MIH) (Mykles, 2001). As MIH negatively regulates ecdysteroids, increase in ecdysteroid levels in haemolymph follows (Techa & Chung, 2015). Ecdysteroids are hormones produced by the Y-organs and directly involved in

promoting ecdysis (molting) (Thompton et al., 2006). Thus, after mutilation, crabs often exhibit faster molting compared to control. It was reported that the duration to the next molt is negatively correlated with the number of appendages autotomized, i.e. more appendages lost resulted in faster

molting (He et al., 2016). Future studies could probe into the correlation between number of appendages lost and days to molt in *S. olivacea* to validate if this – faster molting in severely autotomized crabs – occurs in this species as well.

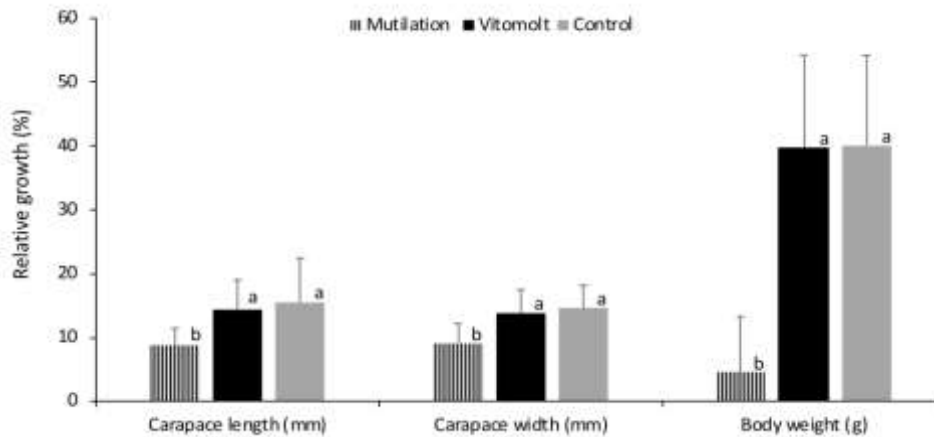


Figure 4. The relative growth of carapace length (CL), carapace width (CW) and body weight (BW) of immature intermolt *Scylla olivacea* subjected to mutilation, Vitomolt™ injection and control treatments. Superscript alphabets indicate significant difference among groups in each treatment ($P < 0.05$).

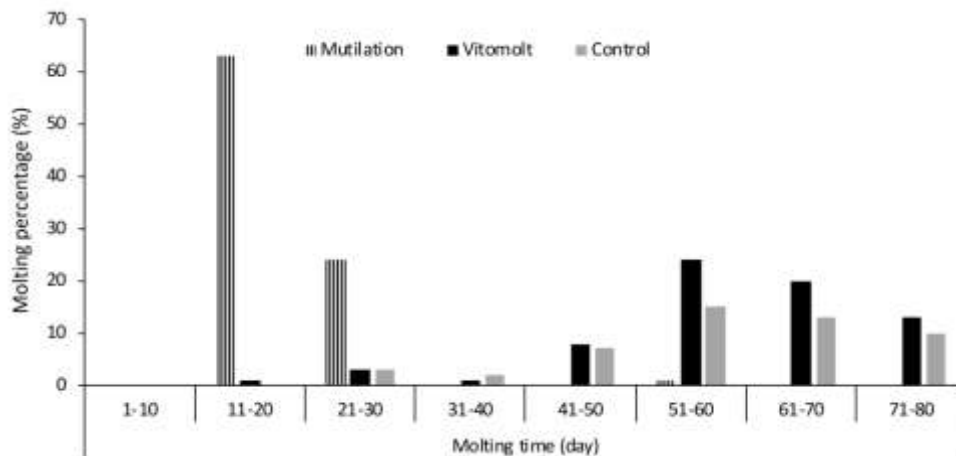


Figure 5. The molting percentage (%) and molting time (day) of immature intermolt *Scylla olivacea* subjected to mutilation, Vitomolt™ injection and control treatments.

In terms of molting percentages, mutilation group had the highest percentage (91.7%), followed by Vitomolt™ group (72.9%) and finally the control group

(52.1%). The survival rate of crabs subjected to Vitomolt™ was the highest (94.8%) compared to mutilation group (91.7%) and control (89.6%). The higher

molting percentage in mutilated crabs is expected due to the positive effect on ecdysteroid production after mutilation (Techa & Chung, 2015). It is, however, interesting to note that injecting crabs with herbal extract (Vitomolt™) resulted in higher molting percentage than control. In addition, crabs injected with Vitomolt™ also showed higher survival compared to both mutilation and control groups. Similar effect of higher survival rate compared to control was also observed in the blue swimming crab *Portunus pelagicus* when they were subjected to injection of phytoecdysteroid derived from *Vitex glabrata* during post-molt and intermolt stages (Sorach et al., 2013). Thus, in addition to increase molting percentage, administration of herbal extract – as shown in this study – could also potentially increase the immunity of crabs, resulted in

higher survival rate. This would be beneficial to soft-shell crab farmers, reducing their losses during culture.

In this study, stimulated moulting by autotomizing crab's appendages resulted in soft-shell crabs with disproportionate appendages (Fig. 6A) or no appendages at all (Fig. 6B). This is because most crab species could not fully regenerate their appendages after just a single molt, e.g. *E. sinensis* needs at least 2 molt for full regeneration of appendages (He et al., 2016) and *C. sapidus* could not even full recover their appendages to full size three molts after autotomy (Smith, 1990). In the contrary, naturally moulting (control) and herbal extract treatment produced soft-shell crabs with a proportional body shape (Fig. 6C), resulting in heavier BW and more appealing appearance, thereby increasing their market values.

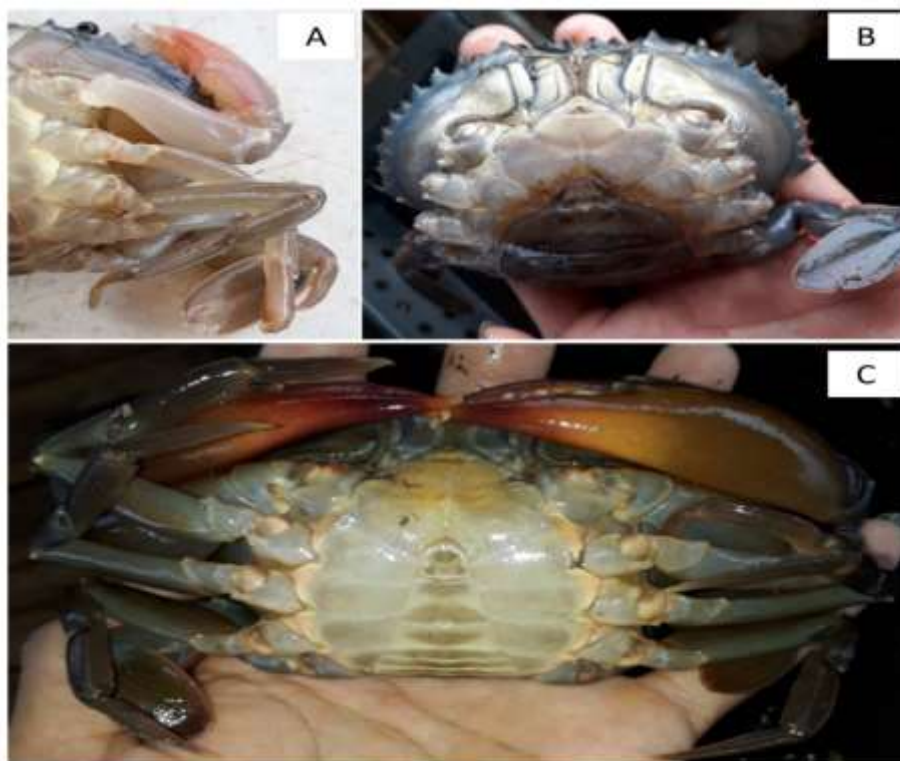


Figure 6. Crabs subjected to mutilation showed disproportionate (smaller) regenerated appendages (A) or no appendages (B) after molting; crabs subjected to control or herbal extract would produce soft-shell crabs with full-sized appendages.

Further, mutilation results in stress in crabs (Elwood & Adams, 2015). With the knowledge that some crustaceans can experience pain (Magee & Elwood, 2013; Elwood & Adams, 2015), it is ethically unacceptable to conduct inhumane practices on animals before consumption (Elwood, 2012). Coupled with the significantly lower body size and weight increment, mutilation is not suitable for the production of soft-shell crab, economically and ethically.

Conclusion

Although mutilation resulted in faster molting, the soft-shell crabs produced had significantly lower body size and weight increment. In comparison, crabs injected with Vitomolt™ exhibited similar body size and weight increment as control but had a much higher molting percentage and survival rate. From a farmer's viewpoint, the administration of Vitomolt™ would result in higher high quality (crabs with full-sized appendages) soft-shell crab production and thus higher profit.

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