



# The effect of macroalgal species and content of feed formulation on sea urchin *Tripneustes gratilla* gonad quality

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**Abstract.** Gonad quality of sea urchin caught in nature varies depending on habitat and food types. Therefore, sea urchin culture is more directed to gonad quality development, such as mass, color, texture, and flavor by benefiting local macroalgae as source of carotenoid. The objectives of this study were to find macroalgal species-based feed formulation (fresh pellet) and optimal concentration in artificial feed to increase the gonad quality of *Tripneustes gratilla*. This experiment had two factors, macroalgal species (*Sargassum* sp. and *Ulva lactuca*) and percent concentration of *Sargassum* and *Ulva lactuca* flour in the feed (10, 20, and 30%). Protein concentration of feed of all treatments was the same, 25%. The sea urchins of 50-60 mm diameter were reared in 36 x 25 x 6 cm bucket at the density of 10 ind bucket<sup>-1</sup> and hung over the 300 cm diameter fiberglass tank. They were cultured for 6 weeks. Parameters measured and observed were gonad mass, color, and texture. Results found that the application of 20% *Sargassum* sp. flour in the artificial feed gave the highest gonad weight of 8.6±6.64 g. Gonad color had good quality with mean score of 3±1.73. The gonad texture was good in all treatments, but the highest was recorded in 20% *Sargassum* sp. flour administration, 3.3±1.15. As conclusion, the optimal artificial feed in the form of moist pellet to increase the sea urchin's gonad mass and quality contains 20% of *Sargassum* sp. flour.

**Key Words:** gonad, quality, *Ulva*, *Sargassum*, optimal concentration.

**Introduction.** *Tripneustes gratilla* is one of the sea urchin species mostly found in Kupang Bay waters, East Nusa Tenggara, Indonesia. This species is consumed by coastal villagers in east Nusa Tenggara and harvested from nature. There has been no effort to culture the organisms yet. When the sea urchins of mature gonad are abundant, they are usually sold in traditional market at the price of IDR. 10,000-20,000 per clump (10 ind). This sea urchin is potential to produce good gonad quality (Sonnenholzner-Varas et al 2018) as consumer's demand, reddish orange color, soft and compact texture, sweet taste, and large mass (approximately 10 g) (Shpigel et al 2005; Garama et al 2012; Tjendanawangi et al 2014; Feng et al 2015).

In the wild, mature gonad sea urchin abundance is seasonal and the quality varies, depending upon season, reproductive cycle, food abundance, and predator (Schlosser et al 2005; Shpigel et al 2005; Tjendanawangi et al 2014; Rahman et al 2014; Elmasry et al 2015; Rahim & Nurhasan 2016; Cirino et al 2017; Samuel et al 2017). Therefore, to be able to produce stable gonad quality with time and accelerate the gonad maturity, the sea urchin culture development, particularly *T. gratilla*, are absolutely done.

Tjendanawangi et al (2014) and Cyrus et al (2015) studies found that very good gonad quality can be obtained through the administration of macroalgae, while large gonad mass can be produced through artificial feed application.

Macroalgae, such as *Sargassum* sp. and *Ulva lactuca*, are abundant in Kupang Bay waters, east Nusa Tenggara, and potential to make feed material, but their protein content is low (about 10%). Therefore, it is necessary to make macroalgae-based artificial feed with higher protein content in order to raise the gonad mass, color quality, and to have better texture. This study is intended to know the effect of macroalgae species and

optimal concentration in the artificial feed to increase mass, color quality, and texture of sea urchin *T. gratilla* gonad.

## Material and Method

**Experimental feed preparation.** The experimental feed consisted of *Ulva lactuca*, *Sargassum* sp. flour, bran, tapioca flour, soybean flour, corn flour, agar, fish oil, and vitamins, with 25% protein content. Before mixed, the feed materials were analyzed in the Central Laboratory of Life Science, Brawijaya University. The feed proximate analysis is presented in Table 1.

Table 1  
Proximate analysis of raw materials (%) for the artificial feed

Materials	Protein	Fat	Carbohydrate	Water content	Ash
<i>Ulva lactuca</i>	10.52	0.32	51.96	11.70	25.50
<i>Sargassum</i> sp.	10.78	0.84	38.14	10.04	40.2
Soybean flour	38.09	20.69	29.61	6.85	4.76
Corn flour	9.37	4.97	71.17	12.67	1.82
Bran	13.08	14.88	52.04	9.36	10.64
Flour	13.70				
Agar	11.00				

The feed materials were mixed and evenly stirred. Agar was dissolved in boiled water then mixed to the feed materials and homogenized using a mixer. The dough was printed, cooled, packed in the plastic box, and store in the freezer at -5°C as moist pellet.

**Sea urchin rearing.** A hundred sea urchins of about 50-60 mm mean diameter were collected from nature, held in the fiberglass tank, and then fasted for  $\pm 1$  week. Moreover, 10 individuals were sampled and examine the gonad to see if the gonad was empty. The sea urchins were then reared in 36 x 25 x 6 cm bucket at the density of 10 ind bucket<sup>-1</sup>. The bucket was hung in 300 cm diameter fiberglass tank.

The sea urchins were reared for 6 weeks, and during the culture, they were fed with the treatment feed at the dose of 3% of body mass 2 times a day at 6 am and 6 pm. Water replacement was accomplished every week.

On the 6 weeks of rearing, 3 ind bucket<sup>-1</sup> of the sea urchins were removed, and weighed. The shells were then carefully opened using a scissor that the gonad was not damaged. The gonads were cleaned and observed their color and texture. Gonad color was observed by 3 panelists by comparing it with the indicator paper (painted paper). Afterwards, they were scored following the modified score of Pearce et al (2004) as given in Table 2. After the gonad color had been observed, the weight was recorded using an ACIS precision balance.

Table 2  
Score of color, texture, and gonad taste determination

Color	Texture	Taste	Quality	Score
Brown	Liquid	Bitter	Bad	1
Beige	Soft	Slightly fresh, slightly bitter	Good enough	2
Yellow	Particulate solid	Sweet	Good	3
Orange	Fine solid	Very sweet	Very good	4

This experiment employed factorial design with 2 factors as follows: macroalgal flour, *Ulva lactuca*, and *Sargassum* sp., and concentration levels, 10, 20, and 30%. It had 6 treatment units with 3 replications. Data were analyzed using two-way ANOVA.

**Discussion.** The reared sea urchins with six week feeding treatment yielded gonad weight of 4.70-8.61 g, gonad color quality score of 1.67-3, and texture score of 3.00-3.33. Mean scores of gonad mass, color, and texture for each treatment of *Sargassum* sp. and *Ulva lactuca* are given in Table 3.

Table 3

Mean mass, color, and texture of *T. gratilla* gonad fed with *Sargassum* sp. and *Ulva lactuca*-based moist pellet

Macroalga	Percent (%)	Mass (g)	Color	Texture
<i>Sargassum</i> sp.	10	4.70±0.82	3.00±0.00	3.00±0.00
	20	<b>8.61±6.64</b>	<b>3.00±1.73</b>	<b>3.33±1.15</b>
	30	5.26±2.99	1.67±0.57	3.33±0.58
<i>Ulva lactuca</i>	10	4.01±4.01	2.33±0.58	3.00±0.00
	20	5.92±5.92	2.33±1.53	3.00±0.00
	30	<b>7.30±7.30</b>	<b>2.33±1.53</b>	<b>3.00±0.00</b>

Present findings revealed that the highest gonad mass was obtained at the application of 20% *Sargassum* sp. in the artificial feed, 8.61±6.64 g, while it was achieved at the application of 30% *Ulva lactuca*, 7.30 g (Table 3).

Based on color mean estimation score, good quality gonad was produced at the administration of 10% and 20% *Sargassum* sp. However, the application of 30% *Sargassum* sp. 30% gives bad color quality of the gonad. As much as 66.7% of very good gonad color (score 4) was achieved at 20% *Sargassum* sp. application, and 100% good quality gonad color was found at the treatment of 10% *Sargassum* sp. The application of *U. lactuca* of 10, 20, and 30% gave sufficiently good gonad color.

In this study, all feed treatments containing *Sargassum* sp. and *U. lactuca* at the concentration of 10, 20, and 30% resulted in mean score of 3 on gonad texture assessment reflecting that the gonad texture quality is good, but the feed of 20% *Sargassum* sp. got very good quality of gonad texture as much as 67.7%. Two-way ANOVA showed that application of macroalga species and treatment levels in the feed did not significantly affect the good mass, color, and texture ( $p > 0.05$ ), but effect comparison between *Sargassum* sp. and *U. lactuca* applications in the feed revealed that the administration of 20% *Sargassum* sp. was more optimal in augmenting the gonad mass and produced very good quality of gonad color and good quality of texture.

Very good texture quality was also found in the treatment of 20% *Sargassum* sp. It is in line with color quality of the gonad and influenced by gonad maturity (Tjendanawangi et al 2014).

**Discussion.** Nutrients, such as protein, in the artificial feed will influence the nutritive phagocytic size development that then affect the development and gonad mass (Tjendanawangi et al 2014). The present study found the highest gonad mass of 8.61 g. This gonad mass is larger than that reported by Tjendanawangi et al (2014) who obtained the highest gonad mass of 2.25 g at the application of 5-15% *Sargassum* sp. flour in the artificial feed with feed protein content of 32%. In comparison with Sartori et al (2015) who found gonad mass of 6.59 g in the sea urchin *Paracentrotus lividus* during a 12 week-rearing period, the present study recorded larger gonad mass in only six week-rearing period using 25% protein in the feed formulation. Gonad mass could be controlled not only by protein content, but by carotenoid content and digestibility (Sartori et al 2015) and palatability of the macroalga as well (Cyrus et al 2015).

Very good gonad color quality is brightly yellow or red orange, good quality gonad has pale yellow or orange, sufficiently good gonad has beige color, and the bad quality has brown color. Sea urchin gonad color is influenced by carotenoid stored in the gonad tissue (Garama et al 2012). Echinenon is a dominant carotenoid in sea urchin gonad that is converted from  $\beta$ -carotene (Garama et al 2012; Vizzini et al 2015). In this experiment, the application of *Sargassum* sp. (20%) gave 67.7% of very good quality gonad color (orange), but application of 20-30% *U. lactuca* yielded only 33.3% good

quality gonad color. *Sargassum* sp. holds total carotenoid of 282.42 mg kg<sup>-1</sup> and  $\beta$ -carotene of 246.52 mg kg<sup>-1</sup>, while *U. lactuca* contains total carotenoid of 367.06 mg kg<sup>-1</sup> (Tjendanawangi et al 2019) It indicates that high carotenoid content in macroalgae does not directly give very good color quality of the sea urchin gonad (orange). Dark sea urchin gonad (brown/black), the bad quality gonad, could result from increased number of xanthopils content, such as astaxanthin, canthaxanthin, and fucoxanthin in the gonad (Garama et al 2012). Fucoxanthin is a brown carotenoid mostly contained in brown macroalgae and becomes major food component of the sea urchin. However, this study believed that the orange color of the gonad was produced by the addition of *Sargassum* sp. flour in comparison with the application of *U. lactuca* as green macroalga. It reflects that sea urchin gonad color is not only affected by carotenoid content of the feed. The conversion of feed  $\beta$ -carotene to echinenon in sea urchin gonad is influenced by the bioavailability of the macroalgae fed by the sea urchin. Besides, the gonad color variations are also affected by reproductive stage (gonad maturity) of the sea urchin (Rahman et al 2014; Tjendanawangi et al 2014; Feng et al 2015).

**Conclusions.** The use of *Sargassum* sp. and *U. lactuca* in the feed formulation at the concentration of 10, 20, and 30% did not significantly influence the gonad mass, color, texture. Nevertheless, this study found that the administration of 20% *Sargassum* sp. flour is optimal to produce high mass of *T. gratilla* gonad and gives very good color and texture quality. Addition of *Sargassum* sp. to the artificial feed resulted in better mass, color, and texture of *T. gratilla* gonad than the use of *U. lactuca*. The feed mixed with 20% *Sargassum* sp. gave the highest gonad mass as well.

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