Spore Discharge And Development, And Carrageenan Content Of Seaweed *Kappaphycus alvarezii* Illuminated With Different Light Colours

Rajuddin Syamsuddin[1]

[1)]Faculty of Marine Sciences and Fisheries, Hasanuddin University
Campuss of UNHAS Tamalanrea, Jl. Perintis Kemerdekaan, km 10 Makassar
Email: rajuddin_syamsuddin@yahoo.com

ABSTRACT

Kappaphycus alvarezii is tropical seaweed, the main carrageenan producer in the global trade. Study on the Spore Discharge and Carrageenan Content of Seaweed Kappaphycus alvaerzii Illumintaed with Different Light Colours was conducted in the Wet Laboratory, the Faculty of Marine Sciences and Fisheries, Hasanuddin University, Makassar, Indoneisa, and in the Seawater Recirculating Installation operated by CV. Rezki Bahari, Makassar, respectively. Carrageenan content of the algae was analyzed in the Water Quality Laboratory, Faculty of Marine Sciences Hasanuddin University. The study on the spore release discharge was considered as a preliminary attempt to produce high quality of K. alvarezii seeds in the coming years, while study on the carrageen content objected to produce K. Alvarezii with high carrageenan content through Indoor culture system. All light colours tried (white, red, yellow, green, and blue) resulted the spore discharge on the fifth day of the exeperiment. However, there was none plantlet produced with the green light. Carrageenan content tend to high with white light (68.71%) as well as green light (61.47%), followed by yellow light (54.09%). The lowest were with blue and red lights. Different on carrageenan content at different light colours due to the different on energy content of each light exposed as well as different in composition of photosynthetic pigments of Kappaphycus alvarezii (Eucheuma cottoni) in response to different energi of differs incoming light colours.

Keywords: Kappaphycus alvarezii, indoor system, light colour, photosynthetic pigments, spore discharge

IINTRODUCTION

Kappaphycus alvarezii is tropical carrageenophyte seaweed which is nasionally and internationally utilized within various industry. Global market demand on this commodity was increase 5% every year. Total production in the early year of 2.000 was not less than 58.930 ton. However, high demand of this commodity is always accompanied by low quality and obstacle on production continuity (SEAplant.Net, 2006), and scarcity on good quality of seed (Doty, 1987; Ask and Azansa, 2002). .

Seed production through developing spores production could be an effective technique in the seaweed production in coming years. This technique would be influenced by ecological factors especially light quality and quantity absorbed by the plant cells. Light quality influence algal cells biosynthesis (Staedler, 1987). Physiologically, light indirectly influence the plant development (Fitter and Hay, 1991). Manipulation of light exposure, both quality (colour or wave length) and quantity (intensity) is one technique which could be applied to stimulate spore discharge and development. Light quality also affect the photosynthetic product (carrageenan content) of seaweed. Therefore, studies on how effective of several light colours on spore discharge and development, as well as carrageenan content of *Eucheuma cottoniii* (*Kappaphycus alvarezii)* should be intensively undertaken. Development of spores in seed production of seaweed could insure good seed quality, and accompanied with good indoor culture techniques would increase high quality and production of seaweed *K. alvrezi*i in coming years.

MATERIALS AND METHODS

Light colours tried in this study were white, green, yellow, blue, and red. To obtain those colours.

Spore release and Development

Experiment regarding the effect of light colours on the spore release and development was conducted at the Wet Laboratory, Faculty of Marine Sciences and Fisheries, Hasanuddin University of Makassar, South Sulawesi Province, Indonesia. Glass aquaria were batch used in the study. Water height in each aquarium were maintained at 10 cm with salinity 35 ppt during experiment. To stimulate the seaweed metabolism, culture media was enriched with commmercial fertilizer which nutrients distribute evenly in the water media, thallus (with cystocarp) used were hunged in

each aquaria with their lowest tips were positioned 2- 3 cm above of each glass slide which were functioning as sbstrate for spore(s) attachment. Those substrates were placed in petridishes on the bottom of each aquariu. Twenty watt TL lamps were used as light sources. The lights were placed approximately 10 cm above the top of each aquariaum to expose the thallus with 5,000 – 10,000 lux light intensity. This light intensity is suitable for algal growth (Supriono, 1990). To expose the thallus with different light colours, plastic colour sheets were placed between the thallus and the inner side of each aquarium (Figure 1). The photoperiodism applied was 14 : 10 (14 light hours and 10 dark hours).

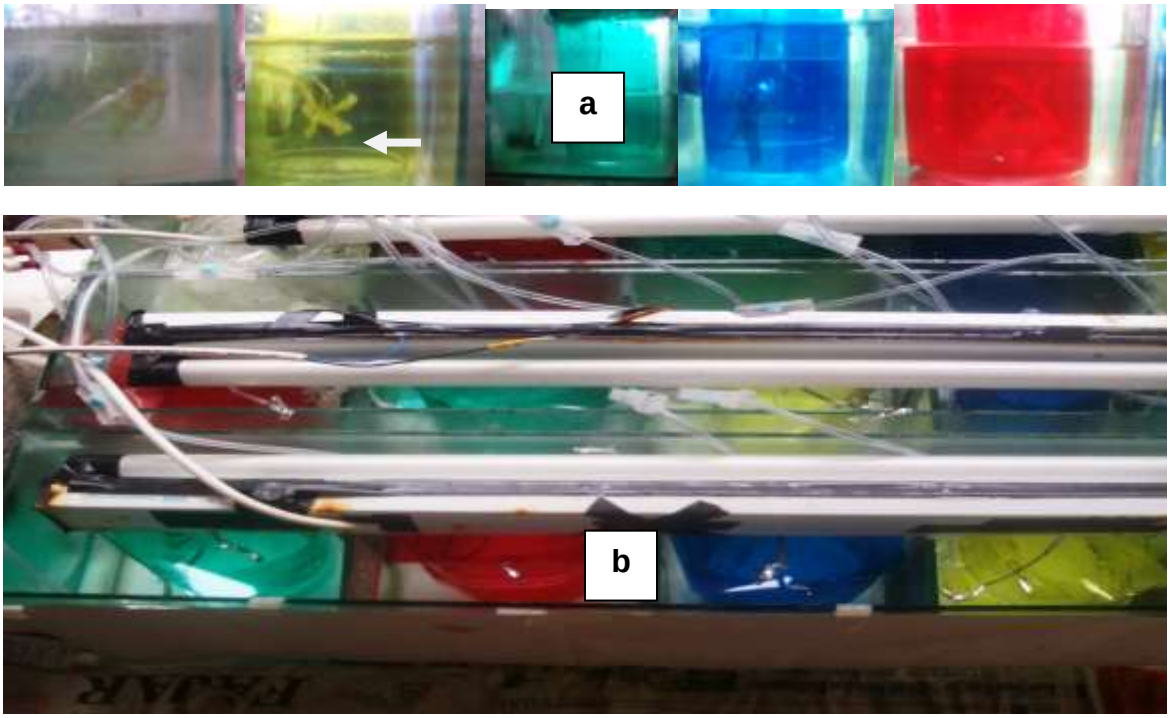

Figure 1. Experiment condition on dpore Release and development (arrow showing the position of tallus in the aquarium

Spore release and development were monitored using compound microscope with 100x and 400x magnification. Obyek figures were taken (recorded) using digital camera.

Carrageenan Content

Study on the effect of light colours on the carrageenan content was done at the seawater recirculation system of CV. Rezki Bahari, Makassar, South Sulawesi, Indonesia. As part of the closed recirculation system, a series of aquarium were used as culture basins. Sand and coral fragments filtered seawater with 30-35 ppt salinity was used as culture media. Water volume in each aquarium was 1.8 m^3 with 36 cm depth. Water was flowed from the tap at a rate of 1 liter/second, so that water volume in the culture basins were raplaced 100% within 30 minutes.

Seaweed seeds used in the experiment were taken from the fishermen (aquaculturist) at Takalar Regency, South Sulawesi Province, Indonesia. Fifty grams of thallus were placed in plastic baskets. The baskets were covered with different colour (yellow, blue, green, and light) of plastic sheets (Figure 2).

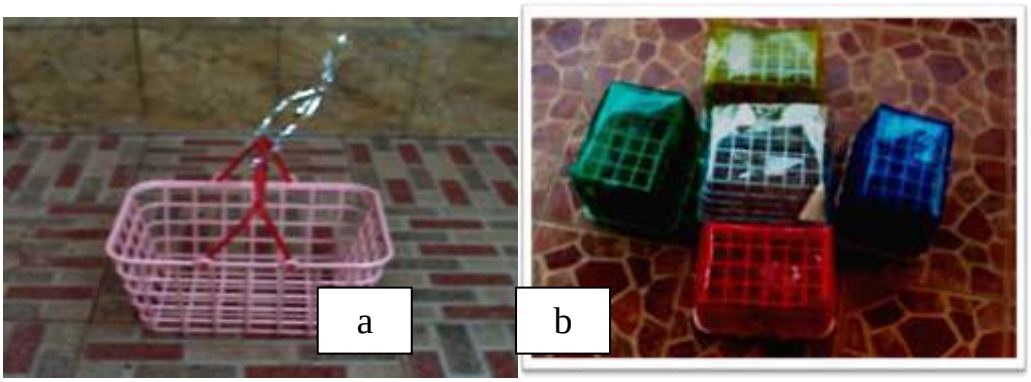

Figure 2. Plastic basket to place the thallus (a) covered with different colour of plastic sheets (b).

The containing thallus baskets were hunged on the each aquaria. Spot lights with 13 watt intensity were used in the study. The lights were placed in the perforate of each aquarium cover exactly 20 cm above the water (media) surface (Figure 3) to obtain 5.000 – 10.000 lux light intensity reach the thallus surface with maximum colour exposure. To maximize the light reflection reach the thallus, outer part of the aquarium were covered with aluminum foil (Figure 4). The photoperiodism applied was 14 : 10.

Figure 3. Position of light in the lighting spaceperforate

Figure 4. Outer part of the aquarium covered with aluminum foil

Carrageenan content of the algae was analyzed in the Water Quality Laboratory, Faculty of Marine Sciences and Fisheries, Hasanuddin University, and was computed using the following formula :

% carrageenan = (carrgeenan weight/seaweed weight) x 100%

RESULTS

Spores Release and Develoipment

With uniform salinity (35 ppt), light intensity of 5.000 to 10.000 lux light intensity (optimal), and room temperature, spores (karpospora) were discharged on the 5th day of the experiment with green light (Figure 5), blue light (Figure 6), and red light (Figure 7), tetraspores with germ tube were also discharged at green light (Figure 8); at blue light (Figure 9), and at red light (Figure 10). Plantlets were formed with white light (Figure 11), yellow light (Figure 12), blue light (Figure 13), and red light (Figure 14) on the 5th day of the experiment, but none with the green light.

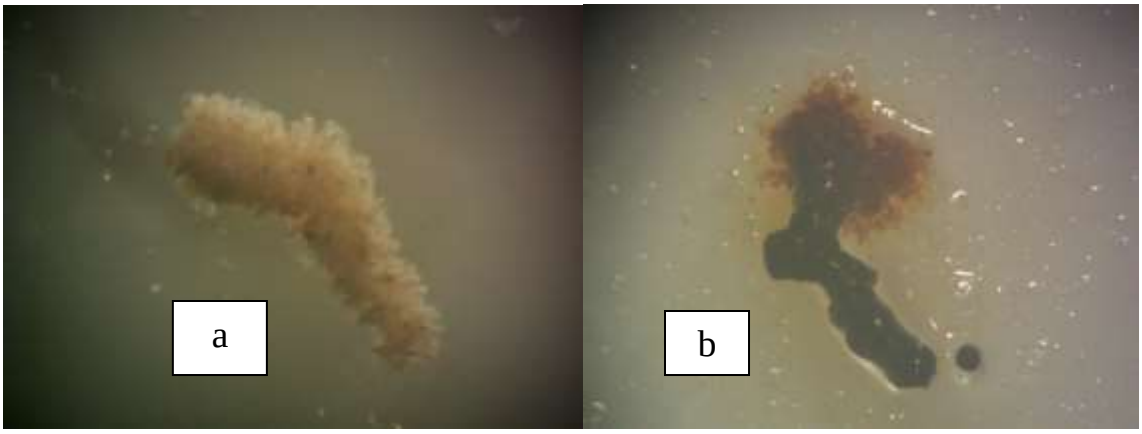

Figure 5. At green light : the carpospore was released (a); carposporangium on the tip of thalli was releasing carpospores (b)

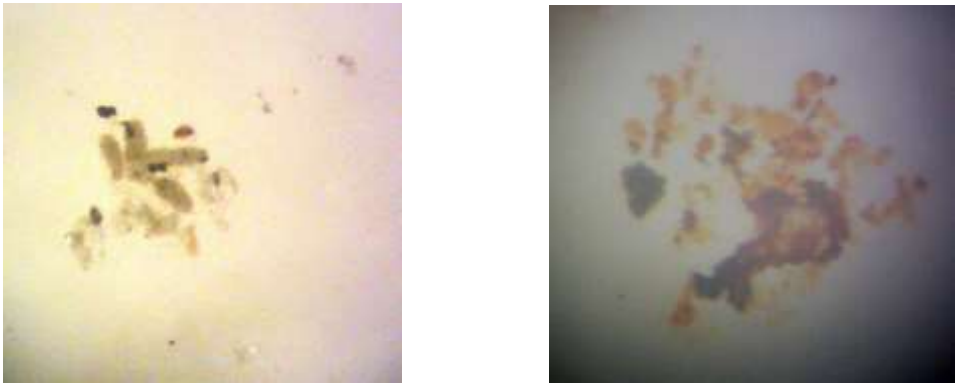

Figure 6. At blue light: carpospores were released

Figure 7. At red light: carpospores were released

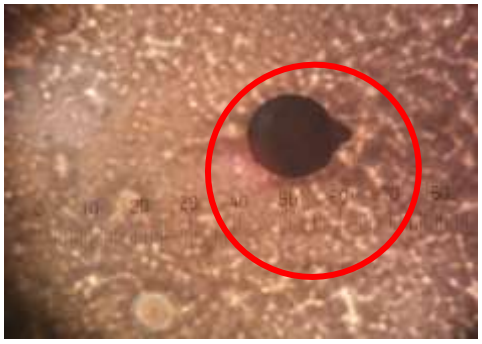

Figure 8. At green light ; a tetraspore with germ tube released

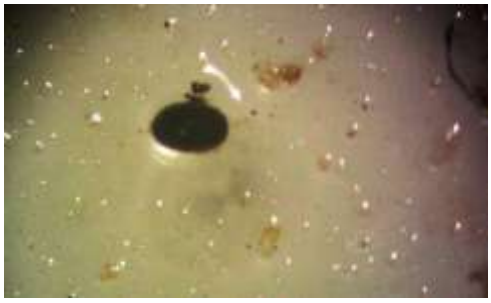

Figure 9. At blue light : a tetraspore with germ tube is released

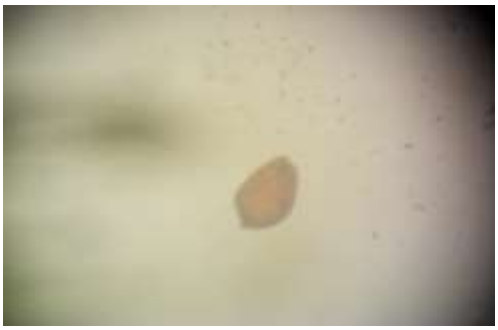

Figure 10. At **red light** : a tetraspore with germ tube is released

Figure 11. At white light : a plantlet was growing longer

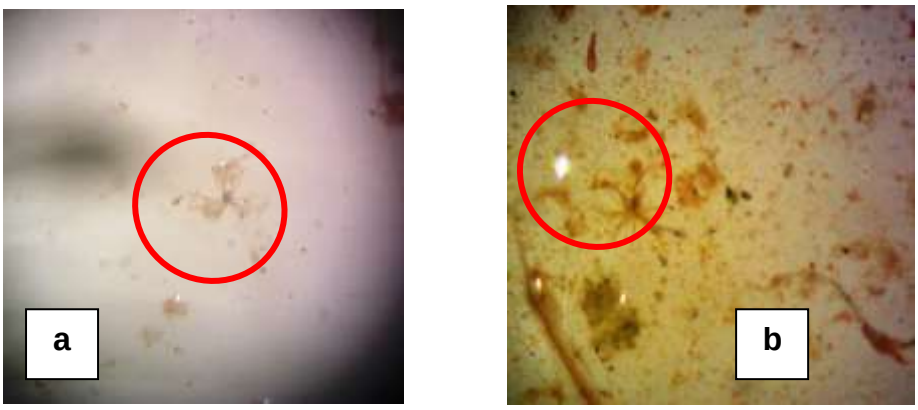

Figure 12. At yellow light : plantlets were formed

Figure 13. At blue light : a plantlet was formed

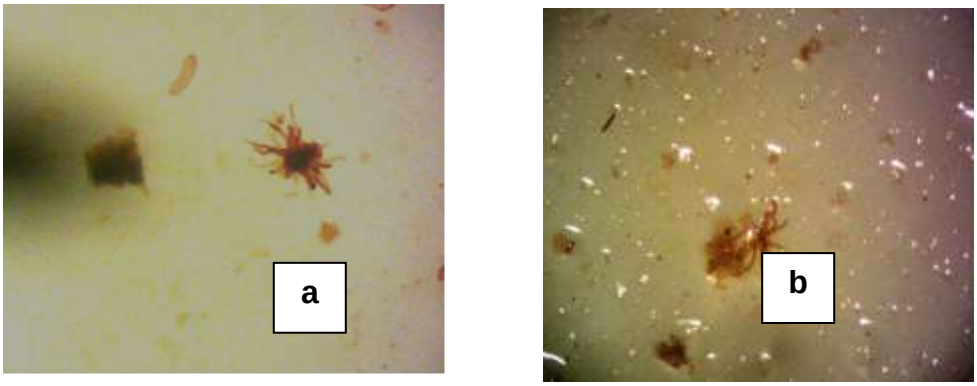

Figure 14. At red light: more lots of plantlet were formed

Carrageenan Content

Carrageenan content of *K. alvarezii* tend to high when the plants exposed to white colour (68.71%) and the green lighty (61.47%), followed by yellow light (54.09%). The lowest was with red light (51.30%)(Table 6).

Table 6. Mean Carrageenan Content of *K. alvarezii* with Different Light Colours

Light Colours	Mean Carrageenan Content (% ± sd)
Putih	68.71±18.88
Hijau	61.47± 5.80
Kuning	54.09±11.14
Biru	51.90± 8.96
Merah	51.30±13.27

DISCUSSION

Spore Discharge and Development

The short wave length of green light of Photosynthetically Active Radiation (PAR) has high energy content was effetively absorbed by plant (red algal) cells then govern the photosynthesis (Salisbury and Ross, 1995). This light colour was most potential in stimulating biological reaction such as reproduction and spores development of the seaweed. Yellow and red lights have long wave length were absorbed by the photosynthetic pigments, but have a relatively low energy, although both light colours were also able to stimulate spores release and development.

Carrageenan Content

Reserve carbon in the form of polysaccharides (carrageenan in the case of *K. alvarezii*) is influenced by photosynthetic rate (Lobban et al, 1985). Light directly influence photosynthesis (Fitter dan Hay, 1991). Chory (1997) stated that wave length (light colour) in addition to intensity, light exposure and direction influence plant growth and photosynthesis.

High carrageenan content of *K. alvarezii* under green light indicating the carbondioxide (CO_2) fixation as raw material for carbohydrate (carrageenan) synthesis was taken place more effectively under green light exposure. Short wave light of green light has high energy for photosynthesis (Lee, 1974). Cells and photosynthetic pigments of the red algae possibly more effective in absorbing green light during photosynthesis (Salisbury and Ross, 1995). This is approved by Haxo and Blinks (1950 *cited by* Nielsen, 1975) that red algae have maximum spectrum on green light.

Yellow light was also relatively effective in stimulate photosynthesis (Salisbury and Ross, 1995 ; Lakitan, 2004) because this light colour is repeatedly reflected from chloroplast to chloroplast in the photosynthesizing plant cells and tissues (Salisbury and Ross, 1995).

Carrageenan content of the algae illumintaed with the short wave blue light was low and relatively equal to the carrageenan content of those plants which were illuminated with the long wave light red. Red light has low energy, so that has low effectivity in photosynthesis. In addition, the phycoerythrine (anotther photosynthetic pigments) of red algae was not absorp red and blue light (Yokin and Blinks, 1958 *cited by* Nielsen, 1975), and, several carotenoid can absorb blue light but can not transfer the absorbed light energy into the chlorophyll for governing the photosynthesis (Clark dan Lister, 1975, *in* Salisbury and Ross, 1995).

CONCLUSION

Green, blue, yellow, red, and white lights were effectively stimulate spores discharge and development of seaweed *Kappaphycus alvarezii* on the fifth day at indoor culture system, within salinity level of 35 ppt, water temperature of 28^{o}C, 5,000 – 10,000 lux with 14 : 10 hours photoperiodism. However, plantlet was not produced by plant exposed to green light. Carrageenan content of plants were relatively high when they were exposed to white, green, as well as yellow light, but low with blue dan red lights.

RECOMMENDATION

To produce spores of *K. alvarezii*, white, green, blue, yellow, and red colours can be utilized, accompanied by 35 ppt salinity level, 28^{o}C water temperature, 5,000 to 10,000 lux light intensity, and 14:10 hours periodicity. High carrageenan content of *K. alvarezii* could be obtanined by illuminatiing the plants with white and green lights with 5,000 – 10,000 lux light intensity.

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