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RESEARCH ON THE EFFECTS OF TEMPERATURE, SALINITY AND NUTRITION TO THE GROWTH OF THE *Betaphycus gelatinus* (Esper) Doty

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ABSTRACT

Betaphycus gelatinus (Esper) Doty (BG) is a red seaweed that has been used as a food and a research material. Thus, the study on factors affecting the growth and development of BG is necessary. The present results show that the good growth conditions of BG are 27 ºC, 30‰ of salinity, and add PES or Nitrate-phosphate medium. This research has important scientific significance in preserving and restoring rare and valuable commercial seaweed varieties.

Keywords: Betaphycus gelatinus, growth rate, nutrition, salinity, temperature.

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INTRODUCTION

Betaphycus gelatinus (Esper) Doty (BG) is a red seaweed species that grows mainly in the South Central Coast, mostly in Ninh Thuan province but is at high risk of extinction. It has been used as food and as a raw material for different research fields,…

Studies have shown that *B. gelatinus* has a chemical composition containing mainly βeta Caragennan (Le Nhu Hau, 2010; Nguyen Van Tu et al., 2013; Tsutsui et al., 2005). This red seaweed species grows naturally along the southern coast of Vietnam and only occurs in some coastal areas such as Ba Lang An, Binh Son ditrict, Quang Ngai province, and Ninh Thuan province,… The economic value of this seaweed is high, but it only grows in certain areas of the sea. Therefore, the thorough exploitation of this seaweed by coastal fishermen has made this species increasingly exhausted and scarce. Recently, there have been studies showing that this seaweed inhibits the growth of tumor cells and enhances human immunity (Zhiwei et al., 2019). Prior to the critical application and maintenance problem of BG, the studies on the effects of temperature, salinity and nutrition to the growth of *B. gelatinus* is necessary to provide a scientific basis for building a sustainable farming model, for ensuring raw materials for food processing, and for restoring seeds to the wild.

MATERIALS AND METHODS

Research subject

*Betaphycus gelatinu*s (Esper) Doty, genus *Betaphycus*, family Solieriaceae, order Gigartinales, class Florideae, phyta Rhodophyta.

Seaweeds used for the study were collected from the wild in March 2020 in the sea area of Ninh Thuan province. After that, seaweeds were cultured in the laboratory of the Center for Advanced Research and Innovation at Hon Chong, Nha Trang Institute of Technology Research and Application, Vietnam Academy of Science and Technology (VAST).

The medium used in the study includes nutritional medium PES (Provasoli, 1968), medium MPI (Suto, 1959), Sea water medium add on nitrate and phosphate has rate $NaNO_3$: Na_2HPO_4 of 7:1 concentrate 8 g/l. This is the medium based on the nitrogen and phosphate content of the PES medium combined with the available micronutrients in natural seawater. This medium has the advantage of easy dispensing (Provasoli, 1968).

Research methods

Seaweed seed treatment

Seaweeds harvested in the wild were transported quickly by foam ice-containers to ensure refrigeration to the laboratory. Then seaweeds were cleaned from algae, sand and gravel, and kept in cool water tanks for 2 weeks. The conditions for keep seaweed in the laboratory were as follows: the light has a light intensity of 100 μmol photons. $m^{-2}.s^{-1}$ with the cycle of lighting: 12/12 hours at night, using natural seawater treated without nutritional supplementation, water change mode every 2 days.

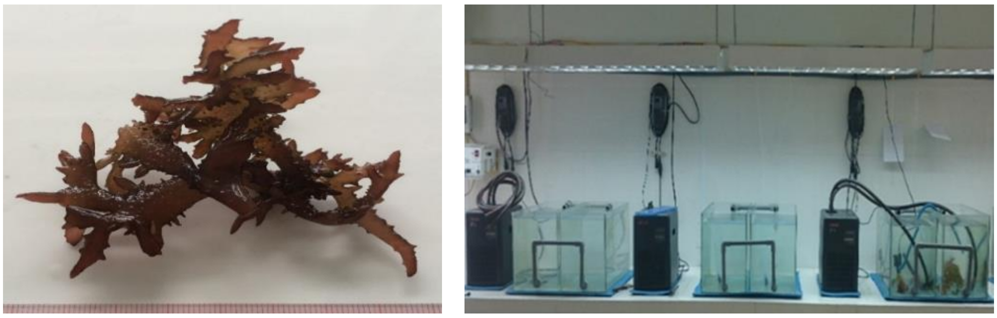

Figure1. Betaphycus gelatinus and experimental system

Seaweeds were collected from the wild and identified by Tran Van Huynh (Department of Organic Materials from Marine Resources - Nha Trang Institute of Technology Research and Application, VAST). The process of keeping seaweed seed and the morphology of seaweed are shown in Figure 1.

Research method affects temperature, salinity, and nutritional salt on the growth and development of BG

The BG after keep 2 weeks was measured for size. Then, we put BG in net cages placed in the aquarium which is thermally stabilized with the size of the aquarium 50 × 30 × 20 cm. Standard culture conditions for the survey of factors affecting seaweed growth: weight of seaweed 6g, the light intensity of 100 µmol photons. $m^{-2}.s^{-1}$, temperature 27 ºC, salinity 30‰, culture period 45 days. Research experiments on environmental factors such as temperature range: 21; 24; 37 and 30 ºC, salinity: 20; 25; 30 and 35‰, Nutrition PES, MPI, Nitrate - phosphate supplemented 1 ml/l after each water change in which the water change time is 2 days/1 time. After finishing the experiment, determine the growth rate of BG, length, and determine the number of branches.

Calculation method

Determine the daily weight growth rate follow to calculation formula of (Brinkhuis, 1985):

$$WGR\ (\%\ d^{-1}) = [\ln (W_t/W_0)]/t \times 100\%$$

Where: WGR - weight growth rate (%/day); Wt and Wo are the final and initial weight. t - time of rearing (days)

Determine the daily length growth rate follow to calculation formula of (Brinkhuis, 1985):

$$LGR\ (cm\ d^{-1}) = (Lt - Lo)/t$$

Where: LGR - The daily length growth rate (cm/day); Lt and Lo are the final and initial length.

Determine the number of branches to increase is conducted according to the direct counting method.

Data processing

The collected data were compared the differences of statistical significance ($P < 0.05$) between the mean values of the experimental treatments with the one way - ANOVA test and the Post-hoc test with Tukey on the soft SPSS.

RESEARCH RESULTS

Effect of temperature on growth of *B. Gelatinus*

The effect of temperature on the daily weight growth rate is shown in figure 2 it showed that, after 45 days of the experiment, the weight growth rate at temperature 30 ºC and 21 ºC was low, only 1.0−1.4%/day. In contrast, the weight growth rate by volume at 24 ºC and 27 ºC is high 1.6−1.9%/day, this also indicates that seaweed grows best at 27 ºC. Figure 2 also shows that the average growth rate of weight with temperature during 45 days is higher than 15 days.

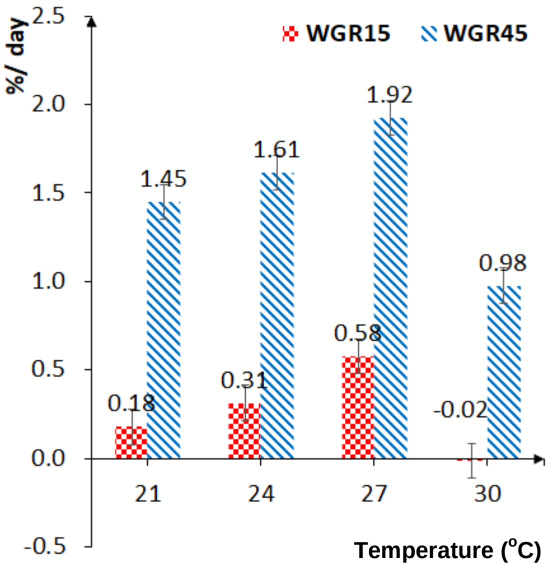

Figure 2. Temperature effect on weigth growth rate

The effect of temperature on the length growth rate is shown in Figure 3: After 45 days of the experiment, high length growth rate at 24−27 °C had growth rate (0.05–0.06 cm/day), in contrast, the low growth rate at 21 °C and 30 °C had the growth rate (0.02–0.03 cm/day). All experiments have statistical differences ($P < 0.05$) when comparing each experiment.

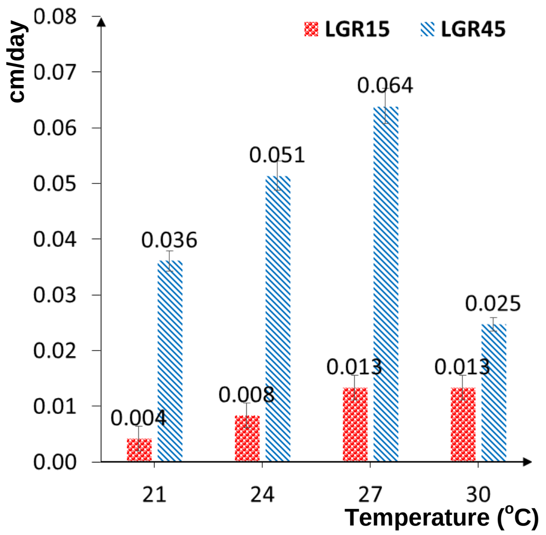

Figure 3. Effect of temperature on length growth rate

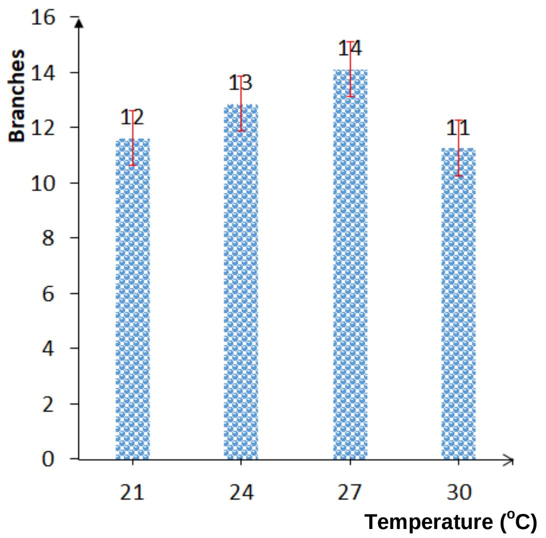

Figure 4. Effect of temperature on the number of newly arising branches

The effect of temperature on the number of newly arising branches is shown in Figure 4 shows that, at 24−27 °C, the number of newly arising branches is high from 13−14 branches. In contrast, at 21 °C and 30 °C, the number of branches with low generation is 11 branches.

Effect of salinity on growth of *B. gelatinus*

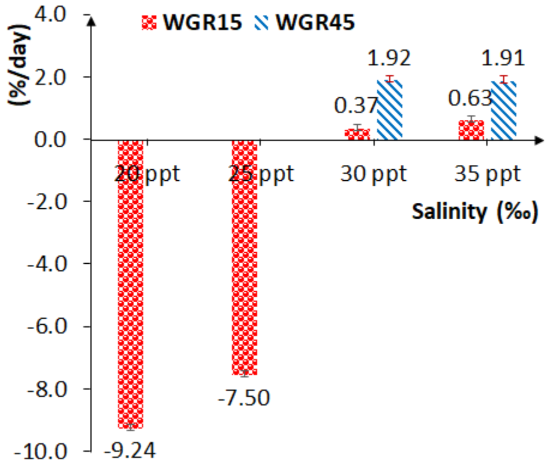

Figure 5. Effect of salinity on weight growth rate

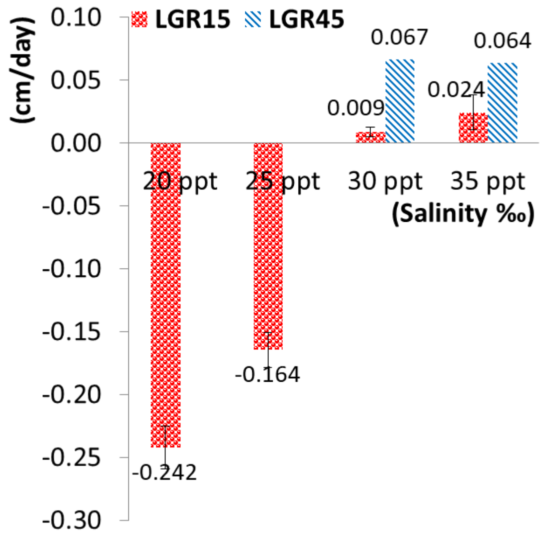

Figure 6. Effect of salinity on length growth rate

The effect of salinity on the daily weight growth rate is shown in Figure 5 showed that, after 45 days of culture, the rate of weight growth according to salinity had many differences. At low salinity 20−25‰, the growth rate is low and negative. Whereas at high salinity 30−35‰ they live well and have a weight growth rate of 1.9−19.2% day. Similar to the results in Figure 6, the growth rate along the length also only increases when the seaweed is grown under stable salinity conditions of 30−35‰, while at lower salinity, the growth rate of seaweed does not increase in length. The results in Figure 7 show that there is an increase in the number of branches at the different salt concentrations. Salinity 20−25‰ has a very low number of branches (less than 1 branch). In contrast, at 30−35‰ the number of branches increases 11−12 branches. Research on the effects of salinity has shown that BG can only survive in stable salinity environments such as marine environments, but it is difficult to grow in pond environments.

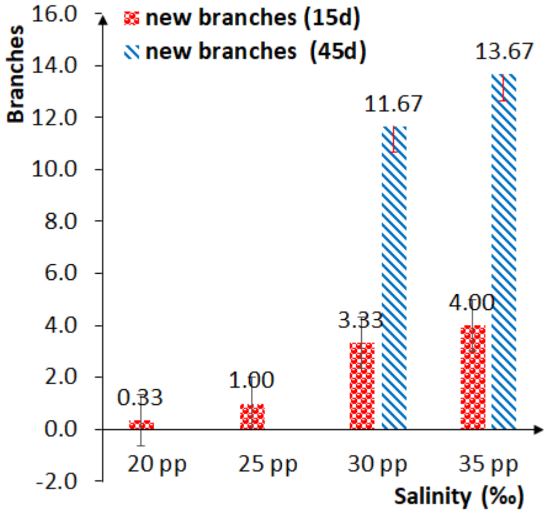

Figure 7. Effect of salinity on the number of newly arising branches

Effects of nutrition on growth of *B. gelatinus*

Effects of nutrition on the growth of rosacea are shown in Figures 8, 9, 10. The results of Figures 8, 9, 10 show that the growth rates of weight, length and number of branches arising of BG for 45 days when cultured in PES and Nitrate-Phosphate medium were better than those in the control and medium MPI. In which, the medium of PES and Nitrate-Phosphate helps to increase the weight of seaweed to increase 2.3−2.5% day, increase the length by 0.08 cm/day, increase the number of branches 15−16.

Whereas if stored for 15 days, the growth rate in weight, length, and number of branches would be only 1/3–1/2 lower than that of storage for 45 days.

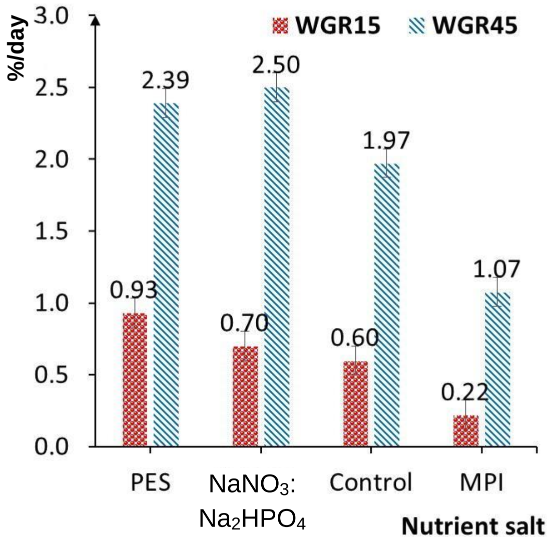

Figure 8. Effect of nutrient salt on weight growth rate

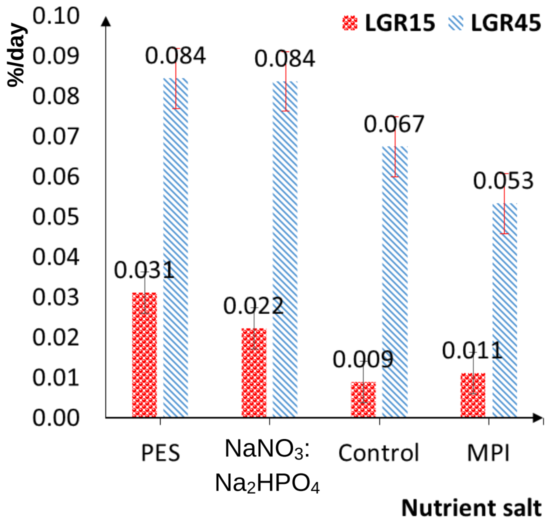

Figure 9. Effect of nutrient salt on length growth rate

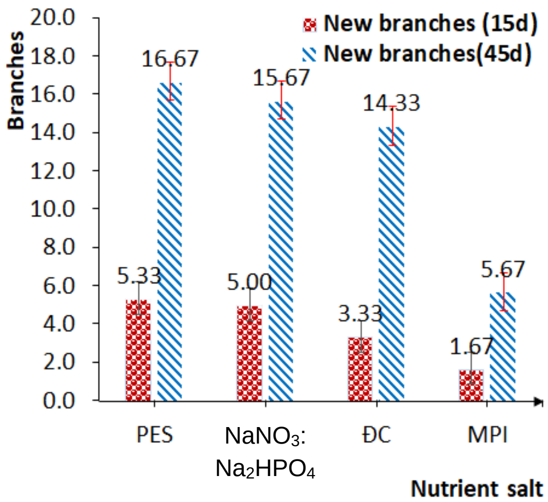

Figure 10. Effect of nutrient salt on the number of new arising branches

DISCUSSION

Temperature is considered to be an important factor affecting the geographic distribution of seaweed (Oliveira et al., 1994). This result is similar to the result of Ryuta et al. (2011) Shixiang et al. (2014) when studying the effect of temperature on the growth of BG, the results of this study show that the highest weight growth rate is at 24 °C and the lowest one is at 16 °C. The results of growth after 15 days of culture at 30 °C can be explained because the algae when put into experimental conditions need time to adapt to the experimental temperature. Therefore, at first, the seaweed thallus was subjected to heat shock and partial body rot, resulting in a negative growth rate. Then they gradually adapt to the environmental conditions and growth. The results of this study are similar to those published by Nguyen Thi Huong et al. (2010) when storing some species of seaweed in the laboratory. The daily growth rate is highest at 27 °C. The above results can be explained that at the beginning of the experiment it took time to adapt to the new environmental conditions, so during the first 15 days the growth rate by day was not statistically different between experiments. But after 45 days, the BG adapted to the temperature conditions, so the length growth rate by day had statistically significant differences between the treatments. Chaoyuan (1989) and Chen (1989) also gave the same results when studying on *Gracilaria tenuistipitata* and *Gracilaria verrucosa*. The optimal temperature for growth of seaweed growth is 28 °C (Brinkhuis, 1985; Lapointe, 1981). The study of Vu Thi Mo et al. (2011) also found that the most suitable for embryo development of *Sargassum polycystum* from 25 °C to 30 °C. During the first 15 days of the BG, the experiment was gradually accustomed to and adapted to the new environment, so there was no significant difference between experiments on day 45. After 45 days, the BG experiment in treatment 27 °C showed the largest length growth; then to 24 °C, 21 °C and 30 °C respectively. Thus, the highest length growth rate is at 27 °C.

The BG is suitable in the conditions of 30−35‰ salinity, when the salinity decreases in the rainy days, the seaweed is shocked, discolored gradually, if the salinity decreases for a long time, the seaweed will die. Thus, the BG died in conditions of salinity below 25‰ lasting for more than 15 days, so when migrating this species, it is necessary to pay attention not to migrate to estuarine areas, where freshwater spills out. only migrating this species to an area salty from 30‰ to 35‰. Thus, in the first 15 days of the experiment with the addition of nutritional salt compared to the control experiment (without nutritional supplementation), the growth rate of day by day was not different, which can be explained by the initial stage. Strolling began to adapt to experimental conditions, so the nutritional requirements were not high for seaweed development. Meanwhile, in the experiment with no nutritional supplement, seaweed took nutrients from seawater with available nutrients (water changes every two days).

Researching the types of seaweed supplements has many differences. The nutrient medium PES and Nitrate-phosphate are suitable for storage of GB, while the MPI medium is not suitable. When keeping seaweed in the laboratory without adding nutritional salt, seaweed is still alive but not enough nutrients for seaweed to grow. Results of the growth rate of BG in this study are higher than that of Ryuta et al. (2011). This is explained, in this study, the time of seaweed culture was 45 days while Ryuta et al. (2011) kept it for 20 days. Prolonged seaweed culture time will help to stabilize metabolism and continue to grow.

In summary, research on storage conditions for BG shows that this species is suitable for living in cool water conditions from 24−27 °C, high salinity 33−35‰, requiring additional nutrition and flow. The above influencing environmental factors have a value that is roughly similar to the natural conditions of the waters of My Hoa, Vinh Hai, Ninh Thuan province, which were mentioned in the study by Le Nhu Hau (2000).

CONCLUSION

Factors affecting the growth of BG in storage conditions have been studied and identified. Adaption and metabolic stability of BG are slow, the growth rate of seaweed in the first 15 days is much lower than that of 45 days of culture.

The temperature of 27 °C gave the highest weight growth, length and number of new emitting arms. The good salinity for the growth of BG is 30−35‰, while this species dies at 20−25‰ salinity.

The medium (PES) and the medium ($NaNO_3$: $Na2HPO_4$) are suitable environments for algae to grow and develop. MPI environment is not good for the growth of BG.

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REFERENCES

Brinkhuis B. H., 1985. Handbook of Phycological Methods, Ecological Field Methods: Macroalgae. Cambridge: Cambridge University Press, pp. 461–477.

Chaoyuan L. R., 1989. Some aspecs of the growth of Gracilaria ternuistipitata in pond culture- *Gracilaria* production and utilization in the bay of Bengal, pp. 27−30.

Chen J. X. 1989. Gracilaria culture in China- *Gracilaria* production and utilization in the bay of Bengal, pp. 5−13.

Lapointe B. E., 1981. The effects of light and nitrogen on growth pigment content and biochemical composition of *Gracilaria foliifera* var. angustissima (Gigartinales, Rhodophyta), *J Phycol*., 17: 90−95.

Le Nhu Hau, Nguyen Huu Dai, 2010. Vietnamese *Gracilaria* resources and used. Natural Science and Technology Publishing of Vietnam Academy of Science and Technology, 247 p.

Le Nhu Hau, 2000. Species composition and distribution of seaweed in Ninh Thuan Province. Marine environmental resources Volume 7: 222−234.

Nguyen Thi Huong, Le Nhu Hau, Vu Thi Mo, 2010. Preliminary study on storage of seaweeds to establish ex-situ conservation. Proceedings of the scientific conference celebrating the 35th anniversary of the establishment of Vietnam academy of science and technology, pp. 254−259.

Nguyen Van Tu, Le Nhu Hau, Lshowe M. L., Frederique S., Olivier D.C., 2013. Check list of the marine macroalgae of Vietnam. *Botanica Marina,* 56: 207–27.

Nguyen Xuan Ly, 1980. Seaweed facility. Nha Trang Fisheries University.

Oliveira E. C., Plastino E. M., 1994. Gracilariaceae. BiolEcon Algae: 185–226.

Provasoli L., 1968. Media and prospects for the cultivation of marine algae. In: Watanabe H, Hattori A (eds) culture and collection of algae. Japanese Society of Plant Physiologists pp. 63−75.

Ryuta T., Lideman, Nishihara G.N., Noro T., 2011. In vitro growth and photosynthesis of three edible seaweeds, Betaphycus gelatinus, *Eucheuma* serra and Meristotheca papulosa (Solieriaceae, Rhodophyta). *Aquaculture Science*, 59(4): 563–71.

Shixiang B., Liang L., Liu M., Lin X., Huang H., Zou X., 2014. Effects of temperature, salinity and light intensity on the growth, pigment and carrageenan of *Betaphycus gelatinum*. *Algological Studies*, 145(1): 135–144.

Suto S., 1959. Skeletonema no tame no jinkou baiyoueki. *Suisan Zoushoku*, 7: 17–19.

Tran Mai Duc., 2005. Morphological description and research on the high temperature tolerance of some strains of Kappaphycus alvarezii (Doty) 1988 in Khanh Hoa province under laboratory conditions'. Master thesis. Nha Trang University, 77 p.

Tsutsui I., Huynh Quang Nang, Nguyen Huu Dinh, Arai S., Tadao Y., 2005. The common marine plants of southern Vietnam, 250 p.

Vu Thi Mo, Le Nhu Hau, Vo Thanh Trung, Nguyen Thi Huong, 2011. The effects of nutrient concentration and salinity on the growth of three species of green algae (chlorophyta) in culture. Proceedings of the National Conference on Marine Science and Technology V: 345−350.

Zhiwei Liu, Tianheng Gao, Ying Yang, Fanxin Meng, Fengping Zhan, Qichen Jiang, & Xian Sun, 2019. Anti-Cancer Activity of Porphyran and Carrageenan from Red Seaweeds. *Molecules*, 24: 4286.