# GENETIC, COLORATION, AND GROWTH PERFORMANCE OF TWO DIFFERENT VARIETIES OF *Kappaphycus alvarezii*

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**ABSTRACT**

Two different colors (green and brown) of *Kappaphycus alvarezii* have been farmed in Indonesian waters for many years. This study aimed at comparing two 'varieties', i.e. green and brown, both genetically and morphologically. Samples for DNA analysis were collected from a farmer in Pinrang Regency, South Sulawesi. Five universal primers i.e. Ca-01, Ca-02, P-40, P-50, and DALRP were selected to obtain DNA genetic markers in differentiating the green and brown varieties. To compare coloration patterns during cultivation and the growth performance of both varieties, a field experiment was performed in a seaweed farming area in Pinrang Regency, during dry season of August-September 2004. The result of genetic assessment showed that the five selected primers revealed different RAPD banding pattern for both varieties. P-50 and DALRP primers demonstrated the greatest amplification in differentiating RAPD fragment between green and brown varieties. Fragment 900 and 1300 bp were consistently generated in the green variety but were not amplified in the brown variety. The result of the field study confirmed that the coloration pattern of green and brown varieties was fixed; no interchange in color occurred during one crop cultivation.

**KEYWORDS: genetic, morphology, *Kappaphycus alvarezii***

## INTRODUCTION

Farmed crops of *Kappaphycus alvarezii* (Doty) are a major source of the commercially valuable hydrocolloid carrageenan. 'Cottonii' is the commercial name for the farmed *Kappaphycus* species that produce kappa carrageenan. Production of commercial *Kappaphycus* (previously known as *Eucheuma*) has increased sharply since the inception of cultivation in 1971 from less than 1,000 tonnes dry weight (Doty & Alvarez, 1975) to approximate worldwide production of over 100,000 tonnes at present. In addition, the number of countries producing commercial quantities of eucheumatoid species, and the number of regions within the countries has greatly increased, particularly in Indonesia and the Philippines (Lim & Porse, 1981; Velosos, 1989).

Cottonii production estimates in the Philippines indicate that productivity is less than 6 tonnes per farmer per year (Alih, 1990; Dawes & Koch, 1991). It appears that global production increases are due to increasing number of farmers, and not an increase in per farmer production as brought about by technological advances.

Although *K. alvarezii* and *Eucheuma denticulatum* are the most commonly farmed carrageenophytes throughout the world, some local strains have been farmed in Indonesia, Malaysia and Tanzania. Two different colors of *K. alvarezii* have been farmed in Indonesian

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waters for many years. Some scientist refer to the difference in coloration of *K. alvarezii* as different variety but farmers in Jeneponto, South Sulawesi believe that the difference is just caused by environmental conditions and that there may be an interchange of green and brown coloration during cultivation. The argument that the color forms are the same variety is supported by the morphological features of both green and brown varieties where a number of characters fit well to the criteria of *K. alvarezii* as given by Doty (1985). Furthermore, to the authors' knowledge, the coloration of seaweeds generally is strongly affected by environmental conditions. The color of *K. alvarezii* can change from pale to dark green or from pale to dark brown for green and brown coloration, respectively, but no scientific information has been found as to whether both colors can interchange. This study aimed at comparing the green and brown varieties in term of genetic, coloration pattern, and growth performance.

## MATERIALS AND METHODS

### *DNA Analysis*

The samples for genetic analyses were collected from farmed *K. alvarezii* in Pinrang Regency, South Sulawesi. The samples were preserved in TNES-Urea buffer prior to the DNA extraction using the phenol-chloroform method. Two universal primers i.e. P-50 and DALRP were selected to obtain the DNA genetic marker in differentiating the green and brown varieties.

### *Growth Rate and Color Confirmation*

To compare coloration pattern during cultivation and growth performance of both varieties, a field experiment was performed in a seaweed farm area in Pinrang Regency, South Sulawesi during the dry season August-September 2004. Salinity level during cultivation was not less than 37 ppt. *K. alvarezii* was cultivated in *tie-tie* system with initial weigh about 50 g per tie per thallus tied in floating long line. Each thallus of green and brown varieties was attached to the line randomly. Color change and growth rate of each thallus were monitored every two weeks for six weeks. Daily growth rate was calculated from changes in mean weight over the time interval between sampling according to Puslitbangkan (1980). Data were analyzed by t-test to compare the green and brown varieties.

## RESULT AND DISCUSSION

### *DNA Analysis*

The genetic assessment using five selected primers revealed different RAPD banding patterns for both varieties. P-50 and DARP primers demonstrated the greatest amplification in differentiating RAPD fragment between green and brown varieties. Fragment 900 and 1,300 bp were consistently generated by P-50 and DARP primers respectively in the green variety but were not amplified in the brown variety (Figure 1). This may indicate that, in addition to the difference in color pattern of both green and brown varieties of *K. alvarezii*,

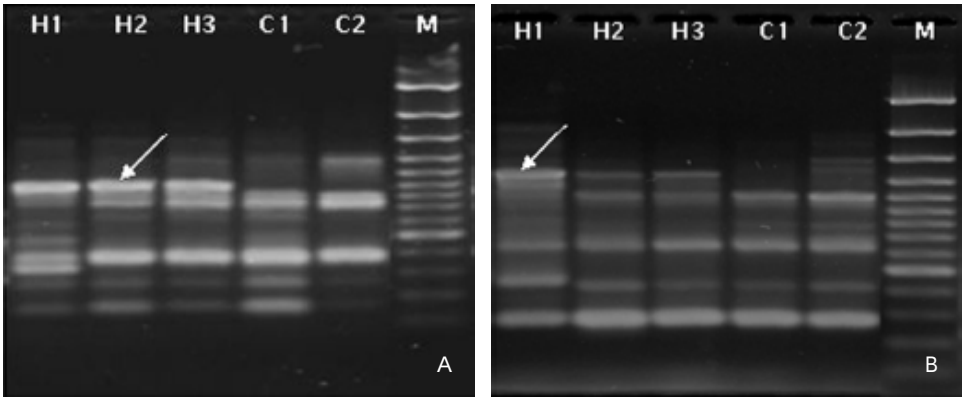


Figure 1. RAPD banding pattern of green and brown *Kappaphycus alvarezii* amplified by primer P-50 (a) and DALRP (b). The arrow indicates different DNA fragment between green and brown varieties

they are genetically different. Even though this study could not explain whether the color pattern was genetically controlled or not and which gene is responsible for each color pattern, this result provides some initial information that may precede more detailed investigation.

### *Growth Rate and Color Confirmation*

The result of the field study confirmed that the coloration pattern of green and brown varieties was fixed. No interchange in color occurred during one crop cultivation. The color intensity may qualitatively be changed from pale green to dark green or from pale brown to dark brown, but from face to face comparison can be seen clearly that brown color could not change to green or vice versa. Beside the different in coloration, both varieties also vary in growth rate. Daily growth rate (Table 1) calculated every second week during cultivation showed that the green variety grew significantly faster than the brown variety ($P<0.05$). The result of this study suggests that despite genetic and morphologic share between green and brown variety of *K. alvarezii*, numerous characteristics could be different. The different colors may have provided different responses to biological activities such as photosynthesis. According to Dawes (1992) photosynthesis efficiency varies between color types of red, brown and green *E. denticulatum*. However, it was not mentioned which color confirms higher photosynthesis efficiency. Since photosynthesis activity is an important determinant of growth rate, differences in color of both green and brown variety of *K. alvarezii* may contribute to the different growth rates.

Another explanation is differential responses by the two varieties to salinity levels. Salinity experienced during the experimental cultivation was not less than 37 ppt and this is considered to be high. This condition is normally seen during the dry season in the area of investigation. Based on the growth rate (Table 1), the green variety is considered has better response to high salinity than that of brown variety. Salinity is an important parameter affecting growth rate of sea weed and is widely vary in different season (Doty & Alvarez, 1975). If this finding is true, instead of brown one, the green variety is recommended to cultivate in dry season.

## CONCLUSION

Both green and brown varieties of *K. alvarezii* are genetically different. Color pattern of both green and brown varieties of *K. alvarezii* are fixed. However, color intensity may change according to the environmental conditions. In dry season, green variety grows better compared to brown variety.

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Table 1. Daily growth rate (%) of green and brown varieties of *K. alvarezii* cultivated during dry season at Pinrang Regency, South Sulawesi (N= number of thallus or tie)

| Variety | 2 -Weeks | | | 4 -Weeks | | | 6 -Weeks | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | Mean ± SD | *P* | N | Mean ± SD | *P* | N | Mean ± SD | *P* |
| Brown | 34 | 3.24 ± 1.58 | 0.01 | 34 | 3.29 ± 0.92 | 0.00 | 32 | 2.75 ± 0.59 | 0.00 |
| Green | 40 | 4.25 ± 1.91 | | 39 | 4.78 ± 1.01 | | 35 | 4.01 ± 0.82 | |

cultured Philippines seaweeds, *Kappaphycus alvarezii* and *Eucheuma denticulatum*. Bot. Mar. 35: 189—195.

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