Turnitin.

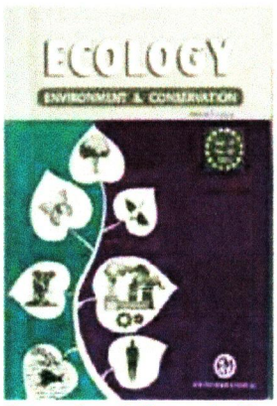
JURNAL_INTERNASIONAL-Q_pdF.pdf

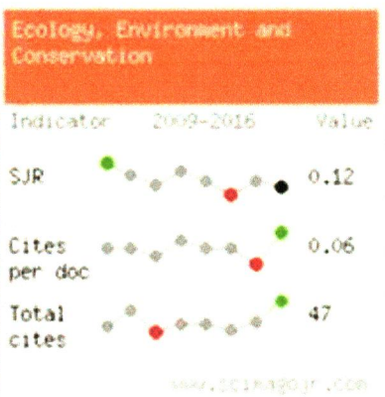
by

FILE	JURNAL_INTERNASIONAL-Q_PDF.PDF (729.63K)		
TIME SUBMITTED	27-JUL-2019 08:00AM (UTC+0700)	WORD COUNT	4755
SUBMISSION ID	1155282458	CHARACTER COUNT	24205

Ecology, Environment and Conservation

UGC, NEW DELHI,INDIA APPROVED JOURNAL





Download Sample Paper

ISSN: 0971-765X

Chief Editor
Prof.(Dr.) R.K.Trivedy, Pune, India

Editorial Board
Download Sample Issue
Subscription Rates
Submit Article

Click here for scimagojr.com **SCOPUS - H Index - 10**
NAAS Rating - 4.89

ECOLOGY, ENVIRONMENT AND CONSERVATION

VOL. 24 (1) : 2018

CONTENTS

Eco. Env. & Cons. 24 (1) : 2018; pp. (232-239)
Copyright@ EM International
ISSN 0971-765X

Morphological appearance of the seaweed *Kappaphycus alvarezii* cultured in different habitats at Arungkeke

Budiman Yunus[1]* and Moh. Tauhid Umar[1]

[1]*Faculty of Marine Science and Fisheries, Hasanuddin University, Indonesia*
Jl. Perintis Kemerdekaan Km.10 Tamalanrea, Makassar 90241, Indonesia

(Received 17 August, 2017; accepted 20 October, 2017)

ABSTRACT

The goal of this research was to explore the morphological appearance of the red seaweed *Kappaphycus alvarezii* when grown in three different coastal habitats, including morphology, growth and carrageenan content. It is hoped that the results will provide information of use in the management and culture of high quality seaweed. The research took place over three months (January - March 2016) at Arungkeke, Jeneponto District, in the coastal waters of the Flores Sea. Carrageenan content was analyzed in the Nutrition laboratory, Faculty of Agriculture, and the Marine Biology Laboratory, Faculty Marine Science and Fisheries, Hasanuddin University. The longline method was employed to culture seaweed in three different habitats (estuarine, seagrass meadows and coral reefs), using a Split Plot Design. Analysis of Variance (ANOVA) was used to analyze the data. The coral reef habitat gave the best results in terms of absolute growth, specific growth rate and carrageenan content, which were 35.14 g, 19.26 % and 9.88 % respectively. Morphological performance was also superior compared to the other two habitats, including thallus color and freedom from pests/disease.

Key words *: Morphology, Seaweed culture, Kappaphycus alvarezii.*

Introduction

Coastal communities are increasingly dependent on the harvest of marine organisms, both for direct consumption and as a source of income, while at the same time market demand has also been rising at regional, national and international levels. The increasing demand for the red seaweed *Kappaphycus alvarezii* has led to levels of exploitation which are causing a decline in natural seaweed resources. In order to balance the high demand with this limited natural production capacity, mariculture is an option which needs to be developed.

In Indonesia, the red seaweed *K. alvarezii* is an important non-finfish fisheries commodity which makes a significant contribution to the external balance of payments. *K. alvarezii* is synonymous with the seaweed *Eucheuma cottonii* which is already well-known in the worlds of business and trade. This seaweed has many uses as a foodstuff, in pharmaceutical products, in cosmetics, and as a gelling and thickening agent.

Seaweed production in Indonesia reached 10 million metric tons/year in 2014. Hira and Julian (2006) reported that, in terms of export volume, Indonesia had become the world leader, contributing 95,588 metric tons/year; however, based on export value, Indonesia was relegated to third place. Indeed, in

*Corresponding author's email: bu_yun@ymail.com

terms of price paid, Indonesia is as low as seventh place (Dahuri, 2010). The low export value of Indonesian seaweed is a result of poor production methods, with farmers generally having minimal information on proper technical procedures or on healthy market chains. Several advances in seaweed farming technology have been exposed in the news media, for example improvements in physical appearance, absolute growth, specific growth rate and carrageenan content, however the quality of seaweed exported often fails to meet the standards set by importing countries such as the United States of America, Canada, China, Taiwan, and Japan.

Success in seaweed production can be achieved by ensuring that seaweed is planted (farmed) in suitable habitat. One key factor in terms of seaweed growth and carrageenan content is water quality, including nutrient concentrations. Water quality also includes light intensity, visibility, turbidity, temperature, currents, salinity and pH. Suitable habitat for the farming of seaweeds, especially *K. alvarezii*, includes coral reef areas where the substrate is dominated by sand, gravel, and coral rubble (Sangil and Hector, 2016). According to Azizah (2006), success or failure in seaweed farming is in large part determined by ecological factors such as substrate condition, temperature, currents, salinity, and visibility. Furthermore, variations in water quality and nutrient content between different habitats can affect the appearance of seaweeds. Arungkeke on the Flores Sea coast of Jeneponto District in South Sulawesi is an area considered to have considerable potential for seaweed production; based on the situation described above, it was deemed important to carry out research on the appearance and characteristics of *K. alvarezii* cultured in the different habitats found at this site.

Research Methods

Time and Research Site

This research took place during three months, from January to March 2016. The field site was at Arungkeke, on the Flores Sea coast of Jeneponto District (Fig. 1). Analyses were carried out at the laboratories of the Faculty of Agriculture and Faculty of Marine Science and Fisheries, Hasanuddin University, Makassar.

Equipment and Materials

Equipment used in this research on *K. alvarezii* included; current drogues, refractometer, Secchi disk, scales, thermometer, motor boat, GPS, sample bottles, stopwatch, tape measure, camera, texture bottles, filters, hydrometer, oven, styrofoam box, hot plate, vacuum pump. The respective uses of these instruments, in the same order, were: to measure currents, salinity, visibility, initial and final weight of the seaweed, temperature, transport to and from the nursery, recording the site coordinates, to collect water samples, to measure time, to measure depth, to provide visual documentation of research activities, to measure soil samples and collect soil samples after weighing them, to filter soil samples, to measure the clay content of the soil, to heat the samples, to store samples, and to extract carrageenan.

Materials used in this research included: substrate samples, seaweed seed, ropes, raffia string, used plastic bottles, flag staff, petrol, seawater samples, pH measuring strips, oxidizing solution, boric acid H_3BO_3, strong solution of sulphuric acid H_2SO_4, Brusin indicator, liquid calgon 20 ml, ice, distilled water, Whatman filter papers. These materials were used for the following purposes, listed in the same order: determination of substrate type, longlines for attaching the seaweed seed, attaching the seed to the longlines, as floats, for marking the ends of the longlines, fuel for the motorboat, to measure seawater quality, to measure pH, liquid reagents for determining phosphate (PO_4) content and nitrate (NO_3) content, to conserve the seawater samples (keep them cool), for use in the laboratory, and to filter the seaweed extract.

Station Selection

The trial stations were determined after the substrate samples had been analyzed in the laboratory. These samples were collected using sediment traps placed in locations considered to be different from one another, using GPS to determine the coordinates of each sample. Substrate texture was analyzed using the soil texture triangle method. Based on the results of this analysis the trial stations at Arungkeke on the Flores Sea coast were marked out using GPS (Global Positioning System). The coordinates of the stations were: estuarine habitat station at S 05° 40′ 47.13″, E 199° 49′ 19.63″, seagrass habitat station at S 05° 40′ 44.62″, E 199° 49′ 00.04″, and coral reef habitat station at S 05° 41′ 00.99″, E 119° 49′ 24.18″. A map showing the research site location is shown in Fig. 1.

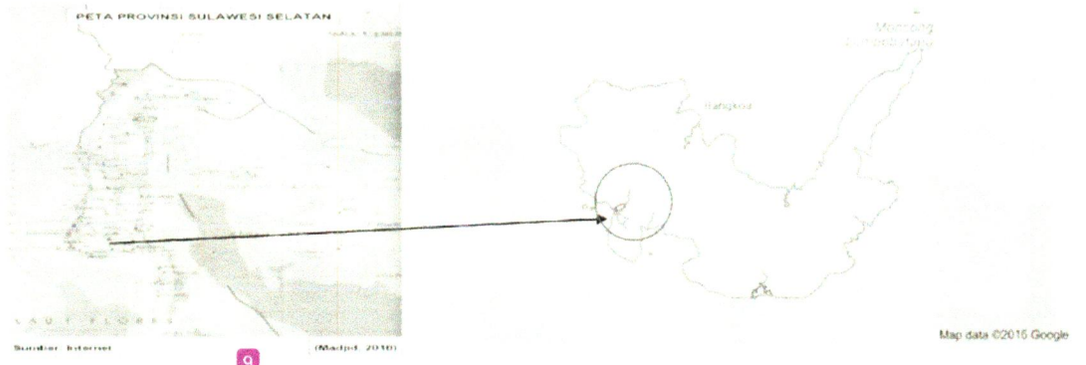


Fig. 1. Map showing the location of the Arungkeke research site

Planting and Measuring Samples

At the designated stations in each of the three habitats, seaweed seeds were attached to three parallel longlines 30 m in length. All seeds were similar in initial weight (20g). In each habitat three treatments were applied: planting distances of 15 cm, 30 cm, and 45 cm, with three replicates. Thus in total there were 27 experimental units. Raffia ties were inserted into the longline ropes at intervals determined by the three treatments in order to attach the seeds.

Experimental Layout

The research design used was a split-plot design with two factors; (i) habitat type, and (ii) planting distance. With 3 units (replicates) for each combination of factors, the layout of the 27 experimental units is shown in Fig. 2.

Water quality

In order to evaluate the environment within each habitat, particularly in terms of water quality, ecological parameters monitored during this research included:

(1) Temperature: measured with a hand-held mercury thermometer dipped into the water until the mercury level stabilized. Care was taken to hold the thermometer in a manner which would not influence the reading.

(2) Visibility: measured using a Secchi disk lowered until the white sections could no longer be seen, at depth d_1; the disc was the raised until the white sections could just be distinguished, at depth d_2. The values d_1 and d_2 were used to calculate visibility, using the equation: visibility = $(d_1+d_2)/2$.

Habitat Replicate group	Station I	Station II	Station III
I	JT_1	JT_2	JT_3
	JT_3	JT_1	JT_1
	JT_2	JT_3	JT_2
II	JT_3	JT_1	JT_3
	JT_1	JT_3	JT_2
	JT_2	JT_2	JT_1
III	JT_1	JT_2	JT_2
JT_2	JT_3	JT_3	
JT_3	JT_1	JT_1	

Notes:
Station I : Estuarine habitat
Station II : Seagrass habitat
Station III : Coral reef habitat
I, II, and III : Groups/Replicates
JT_1, JT_2, JT_3 : Planting distance 15 cm, 30 cm, and 45 cm

Fig. 2. Experimental Plot Layout

(3) Current speed: measured using a floating current drogue with a 5m line. A stopwatch was used to measure the time t (in seconds) from release until the line became taut. Current speed in m/s was calculated as V = 5/t.

(4) Depth: measured with a weighted sounding line. Depth at the planting stations was measured at both high and low tide.

(5) Salinity (ppt): measured with a hand refractometer. Seawater was carefully dripped on to the measuring plate, and the refractometer was pointed towards a source of light in order to read off the salinity on the internal scale.

(6) Phosphate (PO_4): 2 mL of seawater was taken from each water sample bottle and placed in a test tube. Oxidizing solution (3 mL) and 1% H_3BO_3 solution (2 mL) were added before shaking then leaving to settle for 1 hour. The resultant product was placed in a spectrophotometer and the phosphate content was read off (standard laboratory protocol, 2005).

(7) Nitrate (NO_3): 2 mL of seawater was taken from each water sample bottle and placed in a test tube. Sulphuric acid H_2SO_4 (2 mL) and Brusin solution (4 drops) were added before shaking then leaving to settle for 10-15 minutes. The resultant product was placed in a spectrophotometer and the nitrate content was read off (standard laboratory protocol, 2005).

Growth and Morphology

The seaweed seeds were weighed once a week during the full duration of the experiment, and the increase in thallus weight was recorded. The samples were individually released from the raffia ties in a predetermined order, and kept moist in seawater until weighed. Morphology and appearance were observed at the end of the research period, including branches, color, turgidity, fouling, and signs of pests or disease.

Carrageenan content (%)

Carrageenan content was analyzed after harvesting the seaweed thalli. After measurement and observation as above, each specimen was dried in the open air and taken to the laboratory for further analysis. The steps were as follows: the dried seaweed thalli were 1) cleaned with potable fresh water to remove any encrusting salt; 2) dried in the open air; 3) finely chopped; 4) placed in a glass beaker, to which 5) NaOH solution was added until the chopped seaweed was completely covered; 6) heated to 90-100°C by being placed over hot water on a hot plate with constant stirring, until the seaweed disintegrated and formed a gel; 7) filtered while still hot using a muslin *"flash filter"* and a vacuum pump filled with ± 20 ml ethanol; 8) the filtrate was placed in a Petri dish of known weight and heated in an oven at 60°C for 24 hours; 9) once cold the Petri dish was weighed and carrageenan content determined from the following equation:

% carrageenan = (weight of empty Petri dish + sample after heating) – weight of empty Petri dish x 100% (standard laboratory protocol, 2005).

Data Analysis

(1) Absolute growth; based on initial and final weights, determined using the following equation (Effendy, 2003):

$G = 5JWt - 5J_0$

where

G = Average absolute growth (%)

Wt = weight at harvest (g);

W_0 = initial weight (g).

(2) Specific growth rate (SGR): obtained from the weekly measurements of wet weight. SGR was obtained using the Huisman equation (Dawes, 1994):

$SGR = (\ln W_t - \ln W_0) / t \times 100\%$

where :

SGR = Average specific growth rate (%);

W_t = average weight of the seaweed samples at time t_i (g) (i = week 1, week 2,...,t);

W_0 = average weight of the seaweed samples at time t_{i-1}(g);

t = observation period (days).

Results and Discussion

Water quality

Physical and chemical water quality parameter values, comprising temperature, salinity, current speed, visibility depth, as well as nitrate and phosphate content, can be seen in Table 1.

Based on the data in Table 1, water quality parameter values in the coral reef habitat were close to the ideal values for seaweed farming given by several sources (Table 1). Based on these criteria, the coral reef habitat should be more likely to promote good seaweed appearance and performance. According to Sangil and Hector (2016), in general seaweed (algae) tend to grow better in coral reef areas with clear waters, where there is a biological association and corals can filter and take in several kinds of organic and non-organic matter freely suspended in the water column.

Physical performance

The physical performance of the seaweed *K. alvarezii* showed a difference in the changes between the condition before planting out and at harvesting in each habitat (estuary/brackish-water, seagrass meadow, and coral reef) (Table 2).

The appearance of *K. alvarezii* in the coral reef trial plot was superior to that grown in the other two habitats in terms of color, number of branches, tur-

gidity, freedom from fouling and pests/disease. According to Asdam, *et al.*, (2010), color changes often occur in response to environmental factors, due to a chromatic adaptation process where the proportion of pigment is adapted for photosynthesis under particular radiation intensities. Seaweed appearance was also best in the coral reef trial plot in terms of freedom from fouling and clear, clean thalli. According to Suparman (2006), when water movements are sufficiently strong, they can prevent fouling and the deposition/accumulation of dirt on the thalli, increase oxygenation and help avoid excessive fluctuations in salinity or water temperature. Fadilah, *et al.*, (2014) state that currents can clean seaweed thalli, carrying away solid particles which have become attached, and thus promote effective photosynthesis.

Absolute growth (g)

The average absolute growth of *K. alvarezii* for each monitoring period in each habitat is shown in Table 3.

The absolute growth (g) *K. alvarezii* in the estuarine habitat (St. I), seagrass habitat (St. II), and coral reef habitat (St. III) were respectively 30.55 g, 32.14 g and 35.14 g (Table 4). For the planting distance treatments of 15 cm (JT_1), 30 cm (JT_2), and 50 cm (JT_3) the values were 32.67 g, 32.56 g, and 32.58 g respectively, with no significant between treatment difference (Table 5). The best growth of *K. alvarezii* in the coral reef habitat was associated with a relatively wide salinity range of 30 – 34 ‰. According to Faiqah *et. al.* (2013), ideally salinity should be in the range 26 – 33 ppm for the culture of the red seaweed *K. alvarezii*, and the site should be relatively far away

Table 1. Water quality at stations in the three *K. alvarezii* planting habitats at Arungkeke, Flores Sea during this research

Parameter	Water Quality Range by Habitat			Ideal
	Estuarine Habitat	Seagrass Habitat	Coral Reef Habitat	
Temperature (°C)	26 - 29	26 - 30	29 - 31	20 - 28
Salinity (ppt)	21 - 30	27 - 31	30 - 34	26 - 33
pH	5 - 7	6 - 8	8 - 9	7 - 9
Current speed (cm/s)	5 - 7	8 - 10	13 - 15	20 - 40
Visibility (m)	1.5 - 2	1.7 - 3	1.7 - 4	
Depth (m)	4 - 5	3 - 8	5 - 12	5
Nitrates (NO_3) (ppm)	0.05 - 0.27	0.06 - 0.34	0.07 - 0.23	0.10 - 3.5
Phosphates (PO_4) (ppm)	1.30 - 2.34	1.27 - 2.23	1.09 - 2.31	0.10 - 1.68

Table 2. Appearance of *K. alvarezii* before the trials and at harvest

No.	Criteria	Before trial	Seaweed Appearance		
			After trial (at harvest)		
			Estuarine	Seagrass	Coral Reef
1.2.	Branches	few	many	many	many
	Color	brown	dark/dull brown	yellowish brown	clear/bright brown
3.	Turgidity	turgid	flaccid	turgid	turgid
4.	Fouling	clean	some fouling	clean	clean
5.	Pests/Disease	healthy	unhealthy	reasonably healthy	healthy

Table 3. Average growth (g) of *K. alvarezii* during each monitoring period by habitat

Habitat	Monitoring period				
	I	II	III	IV	V
Estuarine	47^{a}±2.4	22.5±2.0	30.5^{a}±3.3	26^{a}±2.3	18±2.0
Seagrass	56.5^{b}±3.0	29±3.1	20.5^{b}±1.6	19.5^{b}±2.7	20.5±2.5
Coral reef	62.5^{b}±2.7	31.5±4.3	21^{b}±2.2	26.5^{ab}±2.2	24±3.3

from sources of freshwater, such as river estuaries, which might reduce seawater salinity.

Specific Growth Rate

The specific growth rate of *K. alvarezii* at Arungkeke in three different habitats can be seen in Table 6. Data in this table show that the fastest growth rates during observation periods I, II, III, IV and V were in the coral reef habitat, at 25.6 ± 0.4%, 23.5 ± 0.5%, 18.9 ± 0.2%, 15.9 ± 0.2% and 12.4 ± 0.2%, respectively, followed by the seaweed and estuarine habitats which had similar specific growth rates for observa-

Table 4. Average absolute growth of *K. alvarezii* at harvesting by habitat type in the waters of Arungkeke, Flores Sea

Main Treatment Factor		Absolute	Average	Tukey
Habitat (Station)	Planting distance (cm)	Growth (g)	(g)	$test_{(0.05)}$ = 1.53
Estuarine	15 3050	30.3629.8731.43	30.55	a
Seagrass	15 3050	32.9832.2431.20	32.14	b
Coral Reef	15 3050	34.7535.5835.11	35.14	c

Table 5. Average absolute growth of *K. alvarezii* at harvesting by planting distance in the waters of Arungkeke, Flores Sea

Main Treatment Factor		Absolute	Average	Tukey
Planting distance (JT cm)	Interaction with habitat	growth (g)	growth (g)	$test_{(0.05)}$ =1.53
15	$ST_1ST_2ST_3$	30.3632.9834.75	32.67	a
30	$ST_1ST_2ST_3$	29.8732.2435.58	32.56	a
50	$ST_1ST_2ST_3$	31.4331.2035.11	32.58	a

Table 6. Average Specific Growth Rate of *K. alvarezii* by Habitat at Arungkeke, Flores Sea

Habitat	Observation Period				
	I	II	III	IV	V
Estuarine	23.4±0.4	13.3±0.3	10.2±0.3	10.7±0.2	11.3±0.1
Seagrass	24.7±0.5	13.9±0.2	12.9±0.7	11.8±0.1	10.7±0.1
Coral Reef	25.6±0.4	23.5±0.5	18.9±0.2	15.9±0.2	12.4±0.2

Table 7. Average Specific Growth Rate (SGR) *K. alvarezii* by Habitat at Arungkeke, Flores Sea

Main Treatment Factor		SGR	Average	Tukey
Habitat (Station)	Observation Period	(%)	(%)	$test_{(0.05)}$ = 3.09
Estuarine	i	23.40		
	ii	13.30	13.78	a
	iii	10.20		
	iv	10.70		
	v	11.30		
Seagrass	i	24.70		
	ii	13.90	14.80	a
	iii	12.90		
	iv	11.80		
	v	10.70		
Coral Reef	i	25.60		
	ii		23.50	
	iii	18.90	19.26	b
	iv	15.90		
	v	12.40		

Table 8. Initial and final (harvest) *K. alvarezii* carrageenan content

Habitat	Carrageenan (%)		
	Initial	Final	Tukey $test_{(0.05)}$ = 3.09
Estuarine	35.87	38.83	2.96
Seagrass	34.37	39.30	4.93
Coral Reef	33.67	43.55	9.88

Pertumbuhan Eucheuma cottoni dengan metode lepas dasar di Perairan Teluk Gerupuk Lombok Tengah Nusa Tenggara Barat. Faculty of Fisheries and Marine Science, Brawijaya University, Malang, Indonesia [Effect of planting distance on the growth rate of *Euchema cottoni* with off-bottom method in Gerupuk Bay, Lombok Tengah, Nusa Tenggara Barat]

Azizah, T.N. 2006. *Percobaan Berbagai Macam Metode Budidaya Latoh (Caulerpa racemosa) Sebagai Upaya Menunjang kontinuitas Produksi*. Journal Ilmu Kelautan vol.11 No.2. Diponegoro University,