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Studies on salinity tolerance and acclimatization of some commercially important seaweeds

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ABSTRACT

Studies were made on salinity tolerance and acclimatization of 13 economically important red, brown and green algae at different salinities ranging from 5 to 55‰. *Caulerpa racemosa* degenerated after 3 days in all these salinities. *Hypnea valentiae* tolerated a wide salinity range of 15 to 45‰ and *Gracilaria crassa* and *Acanthophora spicifera* from 15 to 55‰. All other algae tolerated only 25 and 35‰. Experiments conducted on salinity acclimatization showed that *A.spicifera* could be acclimatized at the salinities from 55 to 15‰ and all other algae from 55 to 25‰ except *C. racemosa.*

Introduction

In India seaweeds are used as raw material for the production of agar, alginate and liquid seaweed fertilizer. There are about 30 seaweed industries situated at different places in the maritime states of Tamilnadu, Kerala, Karnataka, Andhra Pradesh and Gujarat. Now the red algae *Gelidiella acerosa, Gracilaria edulis, G.crassa, G.foliifera* and *G.verrucosa* are used for agar manufacture. The brown algae *Sargassum* spp, *Turbinaria* spp and *Cystoseira trinodis* are used for production of alginates and liquid seaweed fertilizer. About 500 tonnes (dry wt.) of agar yielding seaweeds and 5000 tonnes (dry wt.) of algin yielding seaweeds are exploited every year from Gulf of Mannar and Palk Bay areas for these purposes. (Kaliaperumal and Kalimuthu, 1997; Kaladharan and Kaliaperumal, 1999; Ramalingam *et. al.*, 2000). The quantity of seaweeds harvested, particularly agarophytes is inadequate to meet the raw material requirement. To augment the supply of raw materials to Indian seaweed industries, seaweed cultivation has to be taken up on large scale by vegetative and reproductive propagation methods (Kaliaperumal, 1993).

Salinity is one of the important factors which influence the growth of cultured seaweeds (Kaliaperumal *et. al.*, 1993). Knowledge on salinity tolerance and salinity acclimatization is necessary for successful cultivation of commercially important seaweeds. Some information is available on the salinity tolerance limits of *Gelidiella, Gracilaria, Gracilariopsis, Hypnea, Gelidium, Pterocladia, Gelidiopsis, Bangiopsis, Wrangelia, Centroceras,*

Polysiphonia, Amphiroa, Jania, Grateloupia, Ectocarpus, Dictyota, Padina, Sargassum, Ulva and *Enteromorpha* species. (Subbarangaiah *et. al.*, 1975; Subbarangaiah, 1978; Umamaheswara Rao and Reddy, 1982; Umamaheswara Rao and Kaliaperumal, 1983; Shoba, 1985; Rengasamy and Prema, 1986; Umamaheswara Rao and Subbarangaiah, 1986; Naidu, 1987; Datta *et. al.*, 1988; Narasimha Rao, 1989; Umamaheswara Rao, 1990; Sudhakar, 1992; Hemalatha and Rengasamy, 1992; Sudhakar and Subbarangaiah, 1997; Vanilla Kumari, 1997; Srinivasa Rao and Umamaheswara Rao, 1999; Soniya Sukumaran, 2000; Soniya Sukumaran and Kaliaperumal, 2000). In the present study information was collected on the salinity tolerance limits of 9 commercially important red algae, 2 brown algae and 2 green algae and their acclimatization at different salinities. The results obtained on these aspects are presented in this paper.

Materials and Methods

The healthy and young plants of *Gelidiella acerosa* (Forsskal) Feldman et Hamel, *Gracilaria edulis* (Gmelin) Silva, *G.corticata* (J.Agardh) J.Agardh, *G.foliifera* (Forsskal) Boergesen, *G.crassa* Harvey ex J.Agardh, *Hypnea valentiae* (Turner) *Montagne, H.musciformis* (Wulfen) Lamouroux, *Acanthophora spicifera* (Vahl) Boergesen, *Laurencia papillosa* (C.Agardh) Greville, *Sargassum wightii* Greville, *Turbinaria conoides* (J.Agardh) Kuetzing, *Ulva lactuca* Linnaeus and *Caulerpa racemosa* (Forsskal) J.Agardh were collected from the intertidal and subtidal region at Mandapam coast during the period August, 1995 to April,1996. They were thoroughly washed several times in the seawater at the collection localities and brought to the laboratory in plastic buckets containing seawater.

Experiments were conducted in the varandah of the laboratory with all these algae at 5, 15, 25, 35, 45 and 55‰ salinity to study their tolerance limit and acclimatization. For preparing higher salinities, required quantity of common salt and for lower salinities required quantity of freshwater were added to the seawater. The salinity was determined using a salinometer (Atago Hand Refractometer). Fibreglass tanks (75 x 75 x50 cm size) of 250 litre capacity and plastic troughs (58 cm diameter and 30cm height) were used for these experiments. In each tank / trough, 200 g material of *G.edulis* and *T.conoides* and 100 g material of other algae were used. The change of water with same salinity was made at every 3 days intervals in the case of salinity tolerance experiments. For acclimatization experiments of these algae from high salinity (55‰) to low salinity (15‰), the plants were maintained at each salinity for 3 days. These experiments were conducted during the period between August,1995 and April,1996. The experiments were carried out for each species to maximum of 18 days. Replicates were done for each species and the mean values are given in the tables.

Results and Discussion

Data collected on salinity tolerence limits of red algae are given in Table 1 and for brown and green algae in Table 2. The tolerence of wide range of salinity between 5 and 55‰ was found for *G.corticata* (5-55‰), *A.spicifera* (5-55‰), *G.crassa* (15-55‰) and *H.valentiae* (15-45‰). The narrow range of salinity tolerence between 15 and 35‰ was shown by *G.edulis* (15-35‰), *G.acerosa, G.foliifera* and *L.papillosa* (25-35‰) and *H.musciformis* (35‰). In the experiments conducted with *S.wightii,* the plants were healthy for 3 to 9 days at different salinities tested and then degenerated. But there was no increase in biomass. *T. conoides* survived

Table 1. *Data collected on salinity tolerance of red algae*

Species	Salinity (‰)	Initial biomass (g)	No. of days plants healthy	Day in which max. biomass recorded	Maximum biomass (g)	% increase in yield	% increase in wt/day
Gelidiella	5	100	3	-	-	-	-
acerosa	15	100	6	-	-	-	-
	25	100	6	4	110	10	2.5
	35	100	9	4	110	10	2.5
	45	100	6	-	-	-	-
	55	100	6	-	-	-	-
Gaillardia	5	200	6	-	-	-	-
edulis	15	200	6	4	210	5	1.3
	25	200	9	4	270	35	8.8
	35	200	9	4	280	40	10.0
	45	200	6	-	-	-	-
	55	200	3	-	-	-	-
Gracilaria	5	100	9	4	120	20	5.0
corticata	15	100	9	4	130	30	7.5
	25	100	12	8	140	40	5.0
	35	100	12	4	125	25	6.3
	45	100	9	4	120	20	5.0
	55	100	9	4	120	20	5.0
Gracilaria	5	100	3	-	-	-	-
foliifera	15	100	6	-	-	-	-
	25	100	12	4	110	10	2.5
	35	100	12	4	120	20	5.0
	45	100	9	-	-	-	-
	55	100	3	-	-	-	-
Gracilaria	5	100	9	-	-	-	-
crassa	15	100	9	4	120	20	5.0
	25	100	9	8	120	20	2.5
	35	100	9	8	120	20	2.5
	45	100	6	4	120	20	5.0
	55	100	6	4	115	15	3.8
Hypnea	5	100	3	-	-	-	-
valentiae	15	100	6	4	115	15	3.8
	25	100	8	7	120	20	2.9
	35	100	9	4	130	30	7.5
	45	100	6	4	130	30	7.5
	55	100	3	-	-	-	-
Hypnea	5	100	3	-	-	-	-
musciformis	15	100	3	-	-	-	-
	25	100	6	-	-	-	-
	35	100	9	8	130	30	3.8
	45	100	3	-	-	-	-
	55	100	3	-	-	-	-

Table 1. *Data collected on salinity tolerance of red algae* (continued)

Acanthophora	5	100	6	4	110	10	2.5
spiciifera	15	100	9	4	160	60	15.0
	25	100	9	7	135	35	5.0
	35	100	9	4	140	40	10.0
	45	100	9	4	160	60	15.0
	55	100	9	4	130	30	7.5
Laurencia	5	100	3	-	-	-	-
papillosa	15	100	9	-	-	-	-
	25	100	12	10	115	15	1.5
	35	100	15	10	135	35	3.5
	45	100	3	-	-	-	-
	55	100	3	-	-	-	-

Table 2. *Data collected on salinity tolerance of brown and green algae*

Species	Salinity (‰)	Initial biomass (g)	No. of days plants healthy	Day in which max. biomass recorded	Maximum biomass (g)	% increase in yield	% increase in wt/day
Sargassum	5	100	3	-	-	-	-
wightii	15	100	6	-	-	-	-
	25	100	6	-	-	-	-
	35	100	9	-	-	-	-
	45	100	3	-	-	-	-
	55	100	3	-	-	-	-
Turbinaria	5	200	3	-	-	-	-
conoides	15	200	3	-	-	-	-
	25	200	6	-	-	-	-
	35	200	6	4	210	10	2.5
	45	200	3	-	-	-	-
	55	200	3	-	-	-	-
Ulva	5	100	3	-	-	-	-
lactuca	15	100	3	-	-	-	-
	25	100	3	-	-	-	-
	35	100	6	4	110	10	2.5
	45	100	3	-	-	-	-
	55	100	3	-	-	-	-
Caulerpa	5	100	3	-	-	-	-
racemosa	15	100	3	-	-	-	-
	25	100	3	-	-	-	-
	35	100	3	-	-	-	-
	45	100	3	-	-	-	-
	55	100	3	-	-	-	-

only for 3 to 6 days at different salinities tested and slight increase in biomass was recorded only at 35‰. Similar observation was made in the case of *U.lactuca*. *C.recemosa* was healthy only for 3 days in different salinities tested. There was no increase in growth in any of the salinities and the plants decayed after 3 days.

The results obtained on the acclimatization of all the 14 algae are given in Table 3. *G.foliifera, G.crassa, H.musciformis, L.papillosa, S.wightii* and *T.conoides* were acclimatized in the salinities from 55 to 35‰. All other algae were acclimatized in the salinities from 55 to 25 or 15‰ except *C.racemosa,* which decayed at 55‰ after 3 days. Among all the species *A.spicifera* and *U.lactuca* were acclimatized to lower salinity of 15‰.

The results of the present study on salinity tolerence agree with the earlier findings on *Gelidiella acerosa* (Shoba, 1985; Datta *et. al.*, 1988; Srinivasa Rao and Umamaheswara Rao, 1999), *Gracilaria edulis* (Shoba, 1985), *G.corticata* (Subbarangaiah *et. al.*, 1975; Shoba, 1985; Srinivasa Rao and Umamaheswara Rao, 1999), *Hypnea musciformis* (Shoba, 1985, Hemalatha and Rengasamy, 1992), *H.valentiae* (Umamaheswara Rao and Subbarangaiah, 1986), *Sargassum ilicifolium* and *S.vulgare* (Umamaheswara Rao and Reddy, 1982; Umamaheswara Rao, 1990) and *Ulva fasciata* (Naidu, 1987). The present investigation reveals that *Hypnea valentia* and *Acantho-phora spicifera* tolerate a wide range of salinity (15 to 55‰) while other algae, except *Caulerpa racemosa,* a narrow range of salinity (25 to 35‰). The present study also indicates that the salinities between 15 and 45‰ for *Gracilaria crassa, Hypnea valentiae* and *Acanthophora spicifera* and between 25 and 35‰ for all other 9 commercially important seaweeds (except

Table 3. *Data collected on salinity acclimatization of marine algae*

Species	Salinity and biomass (wet weight in g)					
	55‰	45‰	35‰	25‰	15‰	5‰
Gelidiella acerosa	100	100	110	110	80	80
Gracilaria edulis	200	280	250	200	-	-
G. foliifera	100	100	100	90	70	-
G. crassa	100	100	100	90	75	
Hypnea valentiae	100	110	130	100	40	-
H. musciformis	100	90	70	40	-	-
Acanthophora spicifera	100	100	130	125	110	70
Laurencia papillosa	100	100	100	80	80	-
Sargassum wightii	100	100	100	90	-	-
Turbinaria conoides	200	200	180	150	-	-
Ulva lactuca	100	100	140	150	130	-
Caulerpa racemosa	100	-	-	-	-	-

- Salinity at which plants degenerated

Caulerpa racemosa) are suitable for large scale cultivation either by vegetative or reproductive propagation method in the sea, backwaters, estuaries, brackishwater ponds and onshore tanks.

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