Journal Of Harmonized Research (JOHR)

Journal Of Harmonized Research in Applied Sciences
4(1), 2016, 01-06

ISSN 2321 – 7456

Original Research Article

INFLUENCE OF UV-B RADIATION ON PIGMENTS AND BIOCHEMICAL CONTENTS OF THREE SPECIES OF *CODIUM* FROM SOUTH EAST COAST OF INDIA.

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Abstract: The effect of UV-B radiation on pigments (Total chlorophyll, Chlorophyll *a* and Chlorophyll *b*) and biochemical contents (Protein and Carbohydrate) of three species of Codium viz. *C.dwarakensis C.decorticatum and C.tomentosum* collected from intertidal and subtidal regions of Valai island, south east coast of India was investigated. The algae were exposed to UV-B (280-315 nm) radiation for 30, 60, 90,120,150 and 180 minutes and analyzed for pigment and biochemical contents. UV- B radiation inhibited 39% of total chlorophyll, 31% of chlorophyll *a*, 44% of chlorophyll *b*, 20% of protein and 10% of carbohydrate contents over control in *C. decorticatum*, . However UV B radiation induced pigments and biochemical contents in *C. dwarakensis* and *C.tomentosum*. In *C. dwarakensis* the maximum increase to the level of 177% of total chlorophyll, 151% of chlorophyll *a*, 221% in chlorophyll *b* , 15% of protein and 115% of carbohydrate contents was observed while in *C.tomentosum*, maximum increase to the level of 217% of total chlorophyll, 186% of chlorophyll *a*, 251% in chlorophyll *b* , 120% of protein and 1365% of carbohydrate contents was observed. The increase in the level of pigments and biochemical contents in *C.dwarkenses* and *C.tomentosum* is due to presence of these algae at intertidal region which may exhibit high tolerance to UV-B radiation. In addition to the position of the algae to the shore, presence of screening substances Mycosporine like aminoacid (MAA) also mitigate the effect of UV radiation.

Key words: Codium, *C.dwarakensis, C.decorticatum, C.tomentosum,* pigments, Ultraviolet-B

Introduction: Depletion in Stratospheric ozone layer causes an increase in penetration of Ultra violet –B radiation (280-315 nm) on earth surface. In the water column, the light penetration depth depends on plankton densities and dissolved organic matter concentration (Lorenzen, 1972; Smith and Baker, 1979). Smith *et al*. (1992) have reported that UV-B radiation may penetrate down to 70 meter in the Antarctic region.

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Received on: December 2015
Accepted after revision: January 2016
Downloaded from: www.johronline.com

UV-B radiation has been reported to affect number of physiological and biochemical processes in algae, such as growth, pigmentation, photosynthetic oxygen production, nitrogen metabolism, phycobiliprotein composition and $^{14}CO_2$ uptake, (Hader *et al* 1995, Sinha *et al*., 1995, 1996) The supplemental or the artificial UV-B radiation affects marine macroalgae in several ways, including effects on photosynthesis, nitrogen metabolism, growth, and DNA damage Bischof *et al.* (2006) UNEP-2015 report.

Sublittoral algae are more sensitive to UV-B radiation than intertidal species. Larkum and Wood (1993) have demonstrated that the intertidal species *Enteromorpha intestinalis* and *Porphyra* sp. had minimum sensitivity to ultraviolet radiation. On the contrary, the sublittoral algal species *Ecklonia radiata* and *Kallymenia cribrosa* subjected to UV-B radiation showed remarkably lower photosynthetic rate (Maegawa *et al*., 1993).

Species of Codium are commonly found in subtidal, intertidal and upper intertidal regions of Gulf of Mannar coast. The algae produce greater number of metabolites including halogenated compounds, terpenoids, oxygenated sterols, glycolipids, sulphated polysaccharides, lectins and proteoglycans, which showed greater antiviral (including anti HIV), antibacterial, antifungal, anti tumor and blood anticoagulant activity . The objective of the present study is to investigate the effect of UV-B radiation on levels of pigments and biochemical compounds viz., Total chlorophyll, Chlorophyll *a*, Chlorophyll *b*, Protein, and Carbohydrate contents in three species of Codium viz. *Codium dwarakensis, C. decorticatum* and *C. tomentosum*

Materials and methods: *Codium dwarakensis, C. decorticatum* and *C. tomentosum* were collected from the intertidal and subtidal regions of Valai Island (09°11.500'N 79°00172'E) south east coast of India. Immediately after transport to the laboratory, the plants were washed many times with sterile seawater to remove epiphytes and silt deposition. Two plastic trays (50 × 20 cm) were filled with filtered seawater. The plants were then spread well on the trays in order to get maximum exposure to UV light. Three artificial UV-B lamps (290 nm) (Philips, The Netherlands) were employed. The lamps were set at 20 cm height above the water surface of the tray. UV radiation as measured at plant surface was 2W m^{-2} the plants were exposed to UV radiations for 30, 60, 90,120,150 and 180 minutes. The control plant was irradiated by three 20 W *Philips* fluorescent tubes. At the end of UV treatment, the plants were taken out and analyzed for pigment and biochemical components. Total Chlorophyll, Chl.*a* and Chl.*b* concentrations were quantified spectrophotometrically according to Arnon (1949). Protein content was estimated according to Lowry *et al* (1951). Carbohydrate content was determined by following the method of Dubois *et al* (1956).

Result: In *Codium decorticatum,* total chlorophyll content increased over control up to 90 minutes of UV-B radiation exposure and maximum increase (76%) was observed at 90 minutes of exposure. There was substantial inhibition in total chlorophyll content during 120,150 and 180 minutes of exposure (Fig.1) and maximum inhibition (39%) was observed at 180 minutes of exposure. In *Codium dwarkense* and *Codium tomentosum* total chlorophyll content constantly increased over control and maximum increase (177%) of total chlorophyll content was observed at 90 minutes of exposure in *C. dwarkense* and 217% increase at 150 minutes of exposure in *C. tomentosum.*

Chlorophyll *a* content in *C. decorticatum,* slowly increased over control and reached to maximum level of 42% at 90 minutes of exposure. When UV-B exposure period increased beyond 90 minutes, inhibition of chlorophyll *a* content was observed and maximum inhibition (31%) was observed at 180 minutes of exposure (Fig.2). In *C. dwarkense* and *C.tomentosum* chlorophyll *a* content increased constantly over control and maximum

increase (151%) was observed at 90 minutes of UV-B exposure in *C. dwarkense* and 186% increase in *C. tomentosum* at 150 minutes of exposure.

Chlorophyll *b* content in *Codium decorticatum,* showed increase over control and reached to maximum level of 145% increase at 90 minutes of exposure. When UV-B exposure period increased beyond 90 minutes, inhibition of chlorophyll *b* content was observed and maximum inhibition (44%) was observed at 180 minutes of exposure (Fig.3). In *C. dwarkense* and *C. tomentosum* chlorophyll *b* content increased constantly over control and maximum increase (221%) was observed at 90 minutes of exposure in *C. dwarkense* and 251% increase in *C. tomentosum* at 150 minutes of exposure.

Protein content in *Codium decorticatum,* showed little increase (12%) over control at 90 minutes of exposure and showed inhibition during higher exposure periods. Maximum inhibition (20%) was observed at 180 minutes of exposure (Fig.4). In *C. dwarkense* and *C. tomentosum* no inhibition in protein content was observed and maximum increase in protein content (15%) was recorded at 90 minutes of exposure in *C. dwarkense* while in *C. tomentosum* maximum increase (120%) in protein content was at 180 minutes of exposure.

Carbohydrate content in *Codium decorticatum,* showed maximum level of increase (165%) over control at 90 minutes of exposure and showed inhibition during higher exposure periods. Maximum inhibition (10%) was observed at 180 minutes of exposure (Fig.5). In *C. dwarkense* and *C. tomentosum* no inhibition in carbohydrate content was observed due to UV-B radiation exposure. Maximum increase in carbohydrate content (115%) was observed in *C.dwarkense* at 90 minutes of exposure and 1365% increase was recorded in *C. tomentosum* at 120 minutes of exposure.

Discussion: Macroalgae form conspicuous source of biomass as primary producers in coastal ecosystem. Unlike phytoplankton, most of the algae are sessile and can not thus avoid exposure to harmful UV radiation at their habitat. Recent investigations showed a pronounced effect of solar UV-B radiation on pigment contents and photosynthetic activity in macro algae. Eswaran *et al* (2002) reported that exposure to UV- B radiation caused drastic changes in pigment and phycocolloid content in *Gracilaria edulis. G*reater reduction in total chlorophyll content was observed in three species of Ulva viz. *U. reticulata, U. lactuca* and *U. fasciata* when exposed to UV-B radiation over 150 minutes (Eswaran *et al.,* 2002). Changes in photosynthetic pigments levels in *Kappaphycus alvarezii* exposed to UV –B radiation was reported (Eswaran and Subba Rao, 2001).

In the present study, three species of Codium have shown different response to UV- B radiation. There was a larger inhibition in pigment and protein contents in Codium *decorticatum* whereas in *C. dwarkenses* and *C.tomentosum* pigments, protein and carbohydrate contents increased while exposed to UV – B radiation. This species-specific response to UV-B exposure is well known from marine phytoplankton species (Dohler and Stolter (1986). However, it is very rare in seaweeds. Species from a same genus, which are having similar morphological and functional characteristics, shown different response to UV –B radiation. Similar observations on different photo response among the intra generic species were reported for *Gelidium sesquipedale* and *G. latifolium* which co-exist at intertidal zones in the Atlantic–Mediterranean transition coast in southern Spain, (Gomez and Figueroa 1998) and species of Porphyra growing at different positions on the shore (Figueroa *et al*. 2003).

UV-B radiation has induced pigment, protein and carbohydrate contents in *C.dwarkenses* and *C.tomentosum* As far as our knowledge is concerned, the induction of pigments and biochemical compounds by UV-B radiation has not been reported from seaweeds even though it has been well defined in higher plants (Hader *et al* 1996) especially UV-B radiation induced the

synthesis of anthocyanins, flavonoids, chlorophylls and carotenoids contents. The sensitivity of algae to UV radiation depends on thickness of the thallus and position of the plant on the shore (Makarov 1999). *C.dwarkenses* and *C.tomentosum* are grown at intertidal region which may show high tolerance to UV-B radiation. In addition to the position of the algae to the shore, presence of screening substances Mycosporine like aminoacid (MAA) mitigate the effect of UV radiation. It has been reported that MAAs were highly stable against UV radiation and heat treatment (Sinha *et.al*. 1996). Sivalingam *et al*.(1998) reported that the MAA is very common among the red algae. Karsten *et al*., (1998) reported the high concentration of MAA in algae from upper intertidal region.

In the present study, UV-B radiation promotes pigment and biochemical contents in *C.dwarkenses* and *C.tomentosum*. These two algae might be an exemption concerning these positive effects because most of the algae are negatively affected by UV-B radiation. However, the mechanism behind the beneficial effects in these two algae has to be studied in detail.

Acknowledgements: The financial support by Council of Scientific and Industrial Research (CSIR, OLP-0075), New Delhi is gratefully acknowledged. The authors thank Director, CSMCRI- Bhavnagar for his encouragement. And also thank Dr. C. R. K. Reddy, Group leader (Seaweed cultivation) for his valuable suggestions and improvement of the manuscript. This contribution has CSIRCSMCRI PRIS registration number 212/2015.

References

1. Arnon, DI. 1949. Copper enzymes in isolated chloroplasts: Polyphenoxidase in *Beta vulgaris*. *Plant Physiol.* 24: 1-15.
2. Bischof K, Gómez I, Molis M, Hanelt D, Karsten U, Lüder U, Roleda ,MY, Zacher K, Wiencke C. (2006) Ultraviolet radiation shapes seaweed communities. Rev Environ. Sci Biotechnol: 5,141–166.
3. Dohler, G . Stolter, H. 1986. Impact of UV-B (290-320 nm) radiation on photosynthesis-mediated uptake of ~SN-ammonia and tSN-nitrate of several marine diatoms. *Biochem. Physiol. Pflanzen:* 181, 533- 538.
4. Dubois, M, Gillies KA, Hamilton JK, Robers P A. Smith F. 1956. Colorimetric method for determination of sugars and related substances. *Anal. Chem.* 28: 350 - 352.
5. Eswaran, K, Mairh, OP. & Subba Rao, PV. 2002. Inhibition of pigments and phycocolloid in a marine red alga *Gracilaria edulis* by Ultraviolet-B radiation. *Biol.Plant*: 45(1); 157-159.
6. Eswaran K, Ganesan M, Periyasamy C, Subba Rao PV. 2002. Effect of Ultraviolet – B radiation on Biochemical composition of three Ulva species from southeast coast of India. *Indian J. Mar. Sci*.: 31(4), 334-336.
7. Figueroa, FL, Nygard, C., Ekelund, N, Gomez, I, 2003. Photobiolical characteristic and photosynthetic UV responses in two *Ulva* species (Chlorophyta) from southern spain. *J.Photobiol., Photochem., B: Biology*: 72, 35-44.
8. Gomez I, Figueroa F, 1998. Effects of solar UV stress on chlorophyll fluorescence kinetics of intertidal macroalgae from southern Spain: a case study in Gelidium species, *J. Appl. Phycol:* 10, 285–294.
9. Hader, DP, Worrest .RC,. Kumar HD, and Smith R.C, 1995.Effects of Increased Solar Ultravtolet Radiation on Aquatic Ecosystems, *Ambro:* 24, 174—179.
10. Hader, DP, Porst M,. Herrmann H, Schafer J, and. Santas R, 1996.Photosynthesis of the Mediterranean Green Alga *Caulerpa prolrfera* Measured in the Feld Under Solar Irradiation, *J Photochem Photobtol B: Biol.:* 37,66 – 72.
11. Karsten, U, Sawall, T, Hanelt, D, Bischof, K, Figueroa, FL, Flores-Moya, A., Wiencke, C, 1998. An inventory of UV-absorbing mycosporine-like amino acids in macroalgae from polar to warm-temperate regions. *Bot. Mar:* 41, 443–453.

12. Larkum, .W and Wood, W.F, 1993. The effect of UV-B radiation on photosynthesis and respiration on phytoplankton, benthic macroalgae and seagrasses. *Photosynth. Res.* :36, 17–23.
13. Lorenzen, CJ. 1972. Extinction of light in the ocean by the phytoplancton. *J. Cons. Int. Explor. Mer.:* 34, 262–267.
14. Lowry, OH., Rosenbrough, NJ, Farr, AI and Randall, RJ. 1951. Protein measurement with the Folin phenol reagent- *J. boil.Chem.* 193: 265-275.
15. Maegawa, M., Kunieda, M. and Kida, W. 1993. The influence of ultraviolet radiation on the photosynthetic activity of several red algae from differents depth. *Jpn. J. Phycol:.* 41, 207–214.
16. Makarov, VN, Makarov, MV. And Shoshina, E.V., 1999. Seasonal dynamics of growth in the Barents Sea seaweeds: endogenous and exogenous regulation. *Bot. Mar:* 42, 43–49.
17. Sinha, R.P, Kumar HD, Kumar A, and Hader DP, 1995. Effects of UV-B Irradiation on Growth, Survrval, Pigmentation and Nitrogen Metabolism Enzymes in Cyanobacteria, *Acta Protozool :* 34, 187-189.
18. Sinha, RP, Singh N, Kumar A,. Kumar HD, Hgder M, and Hader DP. 1996 Effects of UV Irradiation on Certain Physiological and Biochemical Processes Cyanobacterta, *J Photochem Photobrol., BBzology :*32, *107-*120.
19. Sivalingam PM., Ikawa T., Yokohama Y.,. Nisizawa K, 1974 Distribution of a 334 nm UV-absorbing substance in algae, with special regard of its possible physiological roles, *Bot. Mar*.: 17, 23-29.
20. Smith R.C, Baker KS, 1979. Penetration of UV-B and biologically effective dose-rates in natural waters, *Photochem. Photobiol*: 29, 311-323.
21. Smith, R C, Prezehn BB, Baker K S, Bidtgare R. R, Boucher N P,. Coley T, Karen D &.MacIntyre S,. Mathck HA, Menzies D, Ondrusek M. Wan Z, and. Waters K J, 1992.Ozone Depletion:Ultraviolet Radiation and Phytoplankton Biology m Antarctic Waters, *Science:* 255, 952-955.
22. UNEP report 2015. Environmental effects of ozone depletion and its interactions with climate change: 2014 assessment Executive summary. In:. Photochem. Photobiol. Sciences., 14, 7 DOI: 10.1039/c4pp90039a.

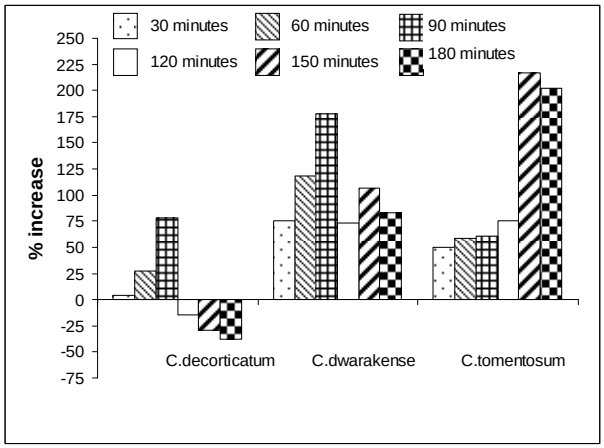

Fig. 1. Effect of UV-B radiation on total chlorophyll content of *Codium decorticatum, C.dwarekense* and *C. tomentosum.*

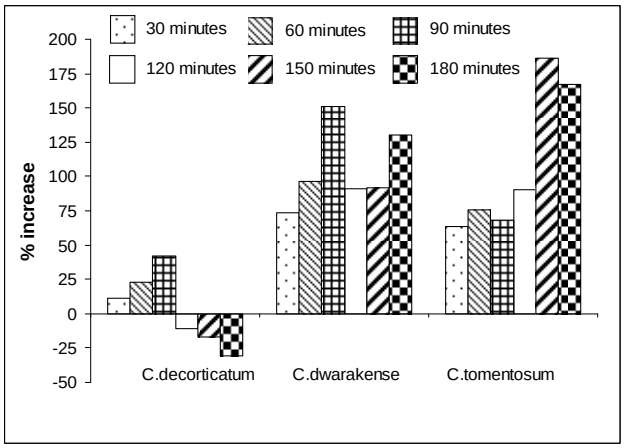

Fig. 2. Effect of UV-B radiation on chlorophyll *a* content of *Codium decorticatum, C.dwarekense* and *C. tomentosum*

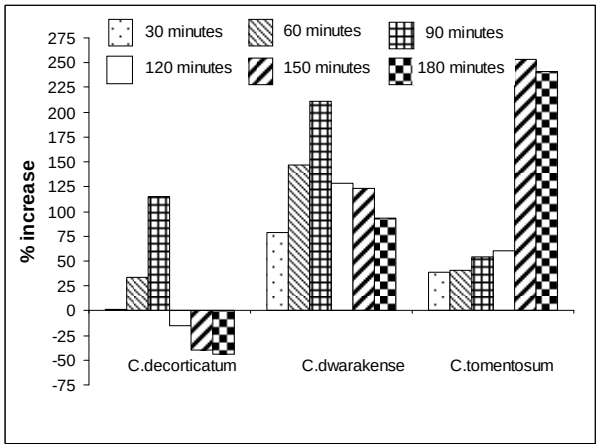

Fig. 3. Effect of UV-B radiation on chlorophyll *b*content of *Codium decorticatum*, *C.dwarekense* and *C. tomentosum.*

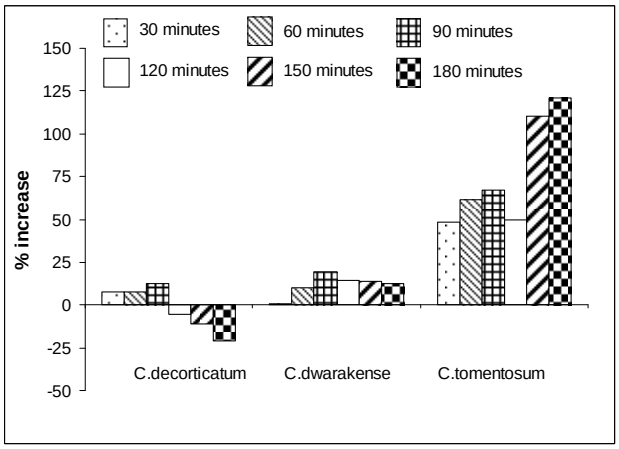

Fig. 4. Effect of UV-B radiation on protein content of Codium *decorticatum*, *C.dwarekense* and *C. tomentosum.*

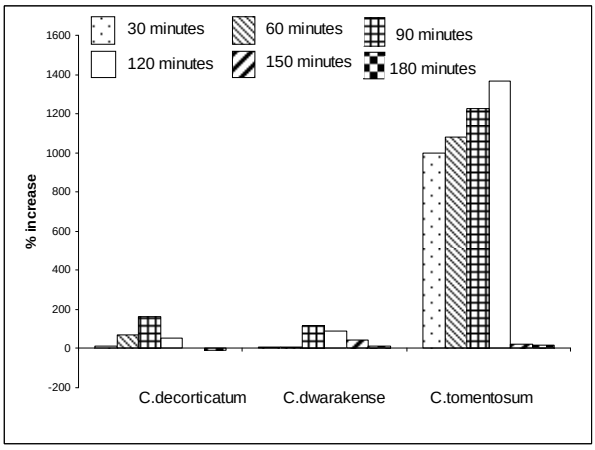

Fig. 5. Effect of UV-B radiation on carbohydrate content of Codium *decorticatum*, *C.dwarekense* and *C. tomentosum*