# PIGMENTS AND IODINE CONTENT OF SOME SEAGRASSES ALONG THE EGYPTIAN RED SEA COAST

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## ABSTRACT

Pigments (chlorophyll *a*, chlorophyll *b* and β-carotene) and iodine concentrations were determined in five species of seagrasses (*Halophila stipulacea, Halodule uninervis, Halophila ovalis. Thalassodendron ciliatum* and *Thalassia hemprichii*) collected from sixteen sites along the Red Sea, Gulf of Aqaba and Suez Gulf. Chlorophyll *a* has the highest average concentration of pigments investigated (5.066 mg/100gm), while very low contents of β-carotene with an average of 0.0004 mg/100gm were recorded. The minimum concentrations of chlorophyll *a*, chlorophyll *b* and β-carotene were recognized at Ras Abu Somah site, while the maximum was found at El Kafrawy Project (12.158 mg/100gm) *H. stipulacea* had the highest values of Chlorophyll *a*, while *H. uninervis* had the highest concentration of Chlorophyll *b* (10.918 mg/100gm). High significant correlation was found between Chlorophyll *a* and Chlorophyll *b* (r = 0.779). Low iodine contents were found in the investigated seagrass species, ranged from 0.021 for *T. ciliatum* to 0.038 g/100gm for *H. uninervis*, with an average of 0.031 g/100gm. The highest mean of iodine contents within seagrasses species was recorded in *T. hemprichii*. while their lowest mean was recognized in *T. ciliatum*. Except for the highest reading of *T. ciliatum* (0.026 g/100gm) at Ras Burkha (Gulf of Aqaba), all the minimum and maximum values of iodine in the studied seagrasses were recorded at the Red Sea Proper sites.

## INTRODUCTION

Seagrass is an important marine ecosystem that is declining globally (Green and Short, 2003). Much of this decline can be attributed to decreased light availability to the plants because of reductions in water clarity due to degrading water quality (Hauxwell *et al.*, 2001). For these reasons, seagrasses are widely recognized as 'barometers' of estuarine water quality. Seagrasses have relatively high light requirements compared to other marine primary producers and so are more susceptible to low light stress (Dixon, 2000a; Hauxwell *et al.*, 2001).

Seagrasses are direct food source (den Hartog, 1967) for many animals. Wahbeh and Ormond (1980) reported grazing of seagrasses in the Gulf of Aqaba, Red Sea by a common sea urchin *Tripneustes gratilla* and a little grazing by two species of surgeon fish *Zebrasoma xanthurum* and *Ctenochaetus striatus* and the rabbit fish *Siganus rivulatus* in the Gulf of Aqaba.

Many of the biological studies in the Red Sea have focused on coral reefs, in contrast, seagrasses have received less attention. Seagrasses are dominant primary producers that play a main role in the stability, nursery function, biogeochemical cycling and trophodynamics of coastal ecosystems, and as such, are important for sustaining a broad spectrum of organisms (Hemminga and Duarte, 2000). Seagrasses like all other higher plants, contain chlorophylls *a*, *b* and β-carotene (Dennison, 1979). Chlorophylls are Key compounds in plants for trapping light energy for photosynthesis, thus quantitative determination is of great importance in studies of photosynthesis and primary productivity (Jensen and Sakshaug, 1970). Deficiency of vitamin A (β-carotene) is considered as a serious world health problem. Seagrasses, like many other plants, can be served as an important source for vitamin A ( lee, 1975). In some third world countries goiters remains a problem where plants and animals grown far from the sea may be deficient in iodine because of its low concentration in fresh water and atmosphere (Joyce, 1990).

The industrial exploitation of marine natural products has so far only been successful for large-scale products, while the number of easy-to-collect marine macro-organisms that remain to be examined for high added value products is small (Bongiorni and Pietra, 1996).

## MATERIALS AND METHODS

Twenty one samples represent five species of seagrass (*Halophila stipulacea* (Forsskal) Ascherson, *Halodule uninervis* (Forsskal) Ascherson, *Halophila ovalis* (Brown) Hooker, *Thalassodendron ciliatum* ( (Forsskal) den Hartog, and *Thalassia hemprichii* (Ehrenberg) Ascherson) were collected from fourteen sites along the Red Sea proper, one at Suez Gulf and one at Gulf of Aqaba (Fig. 1). Seagrass plants were harvested haphazardly from the seafloor by hand, by free diving or SCUBA diving according to the depth of the meadow. The collected plant materials were washed with seawater at the sampling site to remove sediments, placed in clean labeled plastic bags and stored in a cool dark area. In the lab, the plant samples were separated into different species, air dried in a dark room at room temperature, and grinding to fine powder. The plant samples were identified and separated into different species according to Phillips and Menez (1988); Short and Coles (2001) and Green and Short (2003).

**Pigment analysis**: 0.5 g of the dried seagrass powder was taken for pigment extraction of β-carotene. The method was given by Evans (1988) based on successive extractions using Acetone (90%), Methanol (80%) and Hexane. Another 0.5 g of the dried seagrass powder was taken for pigment extraction of chlorophyll *a* and chlorophyll *b*. The method was given by Jeffrey and Humphrey (1975) based on extraction using acetone (90%). The extinction of the Acetone-Hexane extract for β-carotene was measured at 480 and 661 nm and Methanol extract for chlorophyll *a* and chlorophyll *b* was measured spectrophotometerically at 664 and 647 nm.

**Iodine measurement**: The method of iodine measurement depends on alkali fusion and ashing of dry seagrass powder using Sodium Carbonate, Sodium Hydroxide and dilutes Nitric Acid (Hamdy, 1982). The diluted solution was measured spectrophotometerically at 540 nm according to Rogin and Dubravcic (1953).

## RESULTS AND DISCUSSION

The data of chlorophyll *a*, chlorophyll *b*, β-carotene and total pigment contents in the investigated seagrass species are listed in Table (1). The concentrations of chlorophyll *a* in *H. stipulacea* ranged from 1.08 mg/100gm in Abu Somah site (Red Sea Proper) to 12.16 mg/100gm in El Kafrawy project site (Gulf of Suez). The maximum reading found at Red Sea proper is 9.38 mg/100gm and at Gulf of Aqaba is 4.60 mg/100gm. The average concentration of chlorophyll *a* was found to be 5.06 mg/100gm. The relatively high water temperature in addition to the shallow depth of the water at El Kafrawy site (Gulf of Suez) may lead to an increase in producing of the chlorophyll *a*. In this connection, Patrick *et al.* (2004) analyzed the chlorophyll content of two species of seagrasses, namely *Zostera marina* and *Halodule wrightii,* found that the chlorophyll content of the investigated species vary greatly in response to change in ambient temperature. Thus, their chlorophyll content reached a relatively lower level during the cold winter months and appreciably increased during spring and summer.

Figure (2) shows the lowest, the highest and the average values of chlorophyll *a*, chlorophyll *b*, β-carotene and total pigment. The maximum average values (6.01 mg/100gm) of chlorophyll *a* were noticed in *H. stipulacea*, while the minimum average was recorded in *H. ovalis*. The average concentration of chlorophyll *a* was found to be 5.06 mg/100gm.

The chlorophyll *b* contents fluctuated from 1.96 mg/100gm in *H. stipulacea* at Abu Somah to 10.92 mg/100gm in *H. uninervis* at Baranees at the Red Sea proper, followed by a high content (8.62 mg/100gm) in *H. stipulacea* at El Kafrawy site. The average content of chlorophyll *b* was found to be 4.88 mg/100gm lower than that recorded in chlorophyll *a*. *H. uninervis* has the highest average concentration (5.69 mg/100gm) of chlorophyll *b*, while the lowest average (2.19 mg/100gm) was recorded in *H. ovalis* (Fig. 2).

The seagrass species collected from Abu Somah (*H. stipulacea*) was characterized by relatively low content of chlorophyll *a* and chlorophyll *b*. This may be attributed to: 1) the deeper water from which the seagrasses were collected, 2) thus small amount of light reaching the plant surface, 3) in competency of this species in the biosynthesis of pigments under these conditions. This explanation is in alliance with that provided by Patrick *et al.* (2004) where they noticed that the efficiency of photosystem of seagrasses (pigment-dependent) varies greatly with the irradiance penetrating through the water column and the intensity of solar irradiances. Moreover, Dring (1981) previously found that differences in the light intensity and /or differences in light quality (spectral distribution) are usually associated with appreciable changes in pigment composition of seagrass leaves.

Relatively high levels of chlorophyll *a* and chlorophyll *b* were recorded in *H. stipulacea* at El Kafrawy followed by Baranees sites. This could be explained on the basis of 1) shallowness of the samples collection areas, 2) the high light intensity. Chlorophyll *a* and Chlorophyll *b* represent the major pigments in seagrasses and their concentrations are highly related to each other. High significant correlation at $p < 0.05$ was found between Chlorophyll *a* and Chlorophyll *b* ($r = 0.779$). In this regard, USEPA (2003) found that the high clarity of water had increased the irradiance which was expressed in marked increase in the rate of pigment biosynthesis in *Z. marina*.

The concentration of β-carotene is found to be relatively low. The lowest value was recorded in many species ranged from 0.0001 mg/100gm in *H. stipulacea*, *H. uninervis* at Abu Somah, *H. stipulacea* at Abu Galawa and in *T. hemprichii* at Abu Ghuson port to 0.0023 mg/100gm in *H. stipulacea* at NIOF Hurghada, with an average of 0.0004 mg/100gm. Figure (2) shows the minimum, maximum and the mean values of β-carotene recorded in seagrasses under investigation. The maximum mean (0.0005 mg/100gm) was found in *H. stipulacea* while the minimum one (0.0002 mg/100gm) was noticed in *H. ovalis*. The increase or decrease in β-carotene content is also affected by the degree of light intensity and the depth of the collected sample.

The concentrations calculated for the total pigment contents in seagrass (chlorophyll *a*, chlorophyll *b* and β-carotene pigments) were ranged from 3.049 in *H. stipulacea* mg/100gm at Abu Somah to 20.78 mg/100gm in *H. stipulacea* at El Kafrawy with a mean of 9.954 mg/100gm. As the concentration of β-carotene is found to be very low compared with that of chlorophyll *a*, chlorophyll *b*, this sequence was also found in chlorophyll *a* and chlorophyll *b*.

The maximum mean of chlorophyll *a*, β-carotene and total pigment content were found in *H. stipulacea*. These data indicate that some segrasses species as *H. stipulacea* varied in its ability for pigment production and this variation mainly depend on the changes in environmental conditions as light intensity, transparency of water and water depth. Only one sample of *H. ovalis* was collected at Abu Galawa and so it has all the minimum averages of pigments. Of the three species of seagrasses investigated by Ralph *et al.* (2005), *Z. capricorni* showed the greatest adaptation to high light, maintaining strong photosynthetic activity.The combined effects of contributions due to turbidity, chlorophyll, and color, resulting in significantly reduced light with increasing depth. Additional light attenuation can occur at the leaf surface due to epiphyte fouling (Batiuk *et al.*, 2000). Dixon (2000b) found light attenuation due to epiphytes averaging 34% of all attenuation of light in lower Tampa Bay where chl *a* has an annual average that is less than 5 mg (not heavily eutrophic).

In general, seagrasses adjust their pigment content and stoichiometry to acclimate to the light climate (Dennison and Alberte, 1986). Light harvesting in seagrasses relies on almost all chloroplasts being located in the epidermis, which limits their overall photosynthetic efficiency (Larkum *et al.*, 2004).

The results of iodine content in the seagrass species collected from the different sites were listed in Table (2). The iodine contents in seagrasses varied within small limits and ranged from 0.021 g/100gm in *T. ciliatum* at Ras Banas to 0.038 g/100gm in *H. uninervis* at Abu Shaar with an average of 0.031 g/100gm. Figure (3) shows the minimum, maximum and average of iodine contents in the different seagrass species. The maximum average of iodine (0.035 g/100gm) was recorded in *H. ovalis* and *T. hemprichii* while *T. ciliatum* has the minimum average (0.024 g/100gm) of iodine. In this respect, Amer (1999) measured iodine content in the seaweed collected from the Bitter Lakes (Suez Canal). Its content ranged from 0.009 to 0.11g/100gm. Lower content of iodine was also observed by Saenko *et al.* (1978) and Teodoru and Draghici (1978) on the Black Sea Coast with concentrations from 0.054 to 0.08 g/100gm. On the other hand, Hamdy (1982) found higher concentration of iodine (0.90 g/100gm.) in seaweed collected from the Red Sea. As marine plants absorb iodine released from sediments to seawater, the relatively lower water depth, the increase in water temperature and the presence of some pollutant may lead to a decrease in the water iodine and so eliminate iodine absorption by seagrasses (Amer, 2002).

## CONCLUSION

Due to some characteristics of El Kafrawy and Barances sites; their shallowness and the high light intensity, the seagrasses collected from these locations were characterized by relatively high pigment content (chlorophyll *a*, chlorophyll *b*. and β-carotene). On the hand, the relatively high depth of Abu Somah together with lower rate of penetration of light had affected the efficiency of seagrasses collected from this site in the biosynthesis of pigments. The iodine contents in the investigated seagrasses were fluctuated from low to relatively high iodine values. Only *T. ciliatum* species has little ability to absorb iodine at different conditions. Water temperature and water depth are the main factors affecting the concentration of water iodine and subsequently its absorption by seagrasses. It should be mentioned here that seagrasses in general, are not well exploited in important applied aspects and require extensive investigation to increase their efficiency in the biosynthesis of pigments and the accumulation of iodine.

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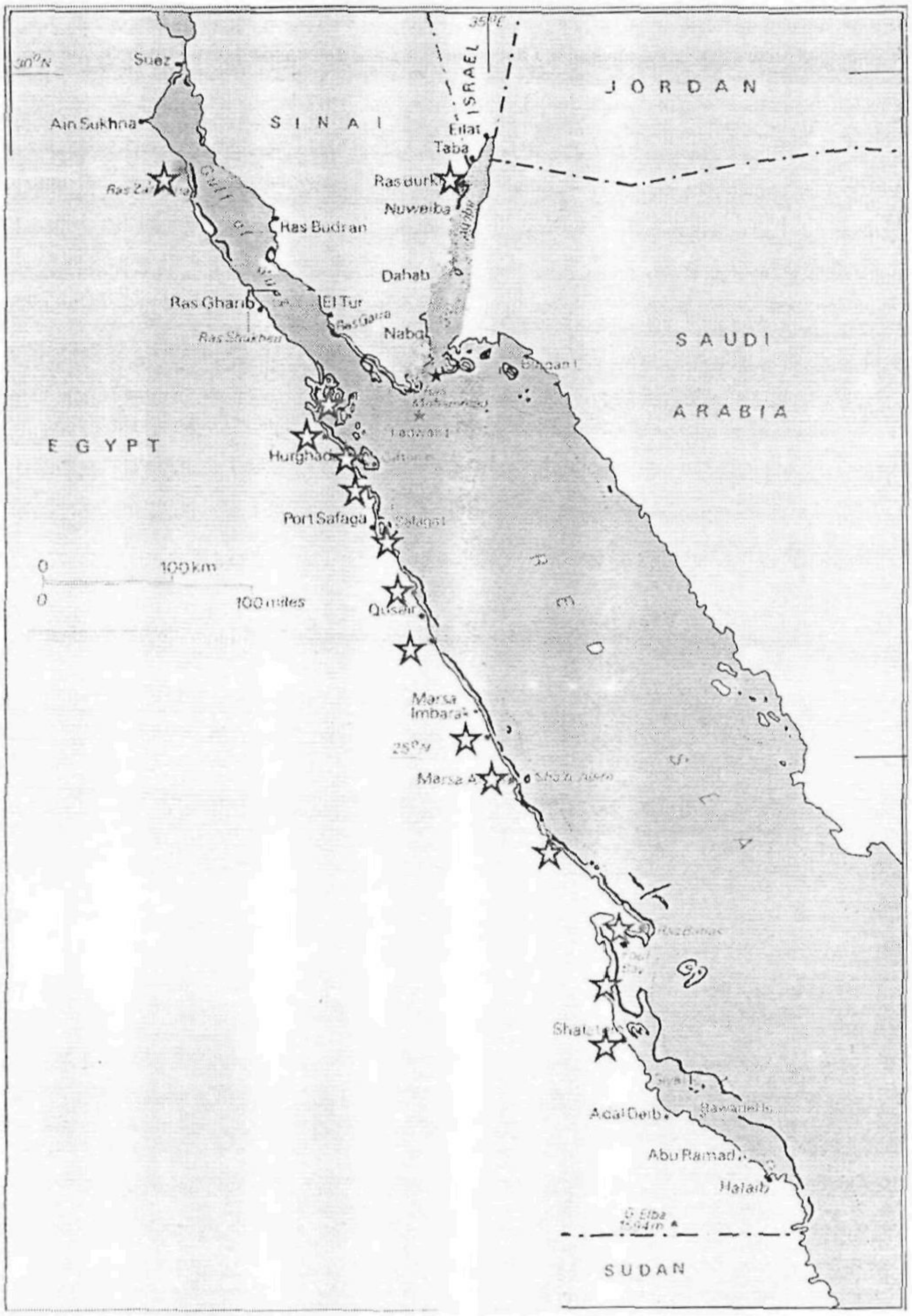


Fig. (1). Map showing the location of the investigated sites at the Red Sea.

**Table (1):** Concentrations of chlorophyll *a*, chlorophyll *b*, β-carotene and total pigment contents in the investigated seagrass species at the different sites (mg $100^{-g}$).

| Site | Species | Chlorophyll *a* | Chlorophyll *b* | β-carotene | Total pigment |
|---|---|---|---|---|---|
| Shalatin | *T. hemprichii* | 2.482 | 3.905 | 0.0005 | 6.388 |
| El Homairaa | *H. stipulacea* | 4.241 | 5.273 | 0.0010 | 9.514 |
| Ras Banas | *T. ciliatum* | 2.984 | 3.764 | 0.0005 | 6.749 |
| Branees | *H. uninervis* | 7.709 | 10.918 | 0.0006 | 18.627 |
| Abu Ghuson | *T. hemprichii* | 8.494 | 5.677 | 0.0001 | 14.172 |
| Marsa Allam | *H. uninervis* | 3.575 | 4.116 | 0.0005 | 7.691 |
| Marsa Asalay (Um Kewig) | *H. stipulacea* | 9.381 | 6.402 | 0.0003 | 15.784 |
| Sharm El Bahari | *H. stipulacea* | 5.028 | 5.815 | 0.0002 | 10.843 |
| El Hamrawen | *H. stipulacea* | 7.311 | 5.412 | 0.0002 | 12.723 |
| Gasous | *H. stipulacea* | 6.271 | 4.744 | 0.0002 | 11.015 |
| Ras Abu Somah | *H. stipulacea* | 1.081 | 1.968 | 0.0001 | 3.049 |
| | *H. uninervis* | 3.189 | 4.915 | 0.0001 | 8.105 |
| Abu Galawa | *H. ovalis* | 2.123 | 2.197 | 0.0002 | 4.321 |
| | *H. stipulacea* | 4.443 | 3.139 | 0.0001 | 7.582 |
| Marine Station (NIOF) | *H. stipulacea* | 4.995 | 6.090 | 0.0023 | 11.088 |
| | *T. ciliatum* | 2.759 | 3.409 | 0.0002 | 6.168 |
| Abu Shaar | *H. stipulacea* | 6.629 | 5.006 | 0.0004 | 11.636 |
| | *H. uninervis* | 2.682 | 2.824 | 0.0002 | 5.506 |
| El Kafrawy Project | *H. stipulacea* | 12.158 | 8.621 | 0.0006 | 20.780 |
| Ras Burkha | *H. stipulacea* | 4.608 | 4.217 | 0.0003 | 8.825 |
| | *T. ciliatum* | 4.243 | 4.220 | 0.0004 | 8.464 |

Table (2): Concentrations of iodine contents in the investigated seagrass species at the different sites ( g $100^{-g}$ ).

| Site | Species | Iodine |
|---|---|---|
| Shalatin | *T. hemprichii* | 0.029 |
| El Homairaa | *H. stipulacea* | 0.038 |
| Ras Banas | *T. ciliatum* | 0.035 |
| Branees | *H. uninervis* | 0.029 |
| Abu Ghuson port | *T. hemprichii* | 0.028 |
| Marsa Allam | *H. uninervis* | 0.033 |
| Marsa Asalay (Um Kewig) | *H. stipulacea* | 0.036 |
| Sharm El Bahari (Mangrove) | *H. stipulacea* | 0.033 |
| El Hamrawen | *H. stipulacea* | 0.035 |
| Gasous | *H. stipulacea* | 0.033 |
| Ras Abu Somah | *H. stipulacea* | 0.031 |
| | *H. uninervis* | 0.037 |
| Abu Galawa | *H. ovalis* | 0.031 |
| | *H. stipulacea* | 0.034 |
| Marine Station (NIOF) | *H. stipulacea* | 0.033 |
| | *T. ciliatum* | 0.022 |
| Abu Shaar | *H. stipulacea* | 0.021 |
| | *H. uninervis* | 0.033 |
| El Kafrawy Project | *H. stipulacea* | 0.024 |
| Ras Burkha | *H. stipulacea* | 0.027 |
| | *T. ciliatum* | 0.026 |

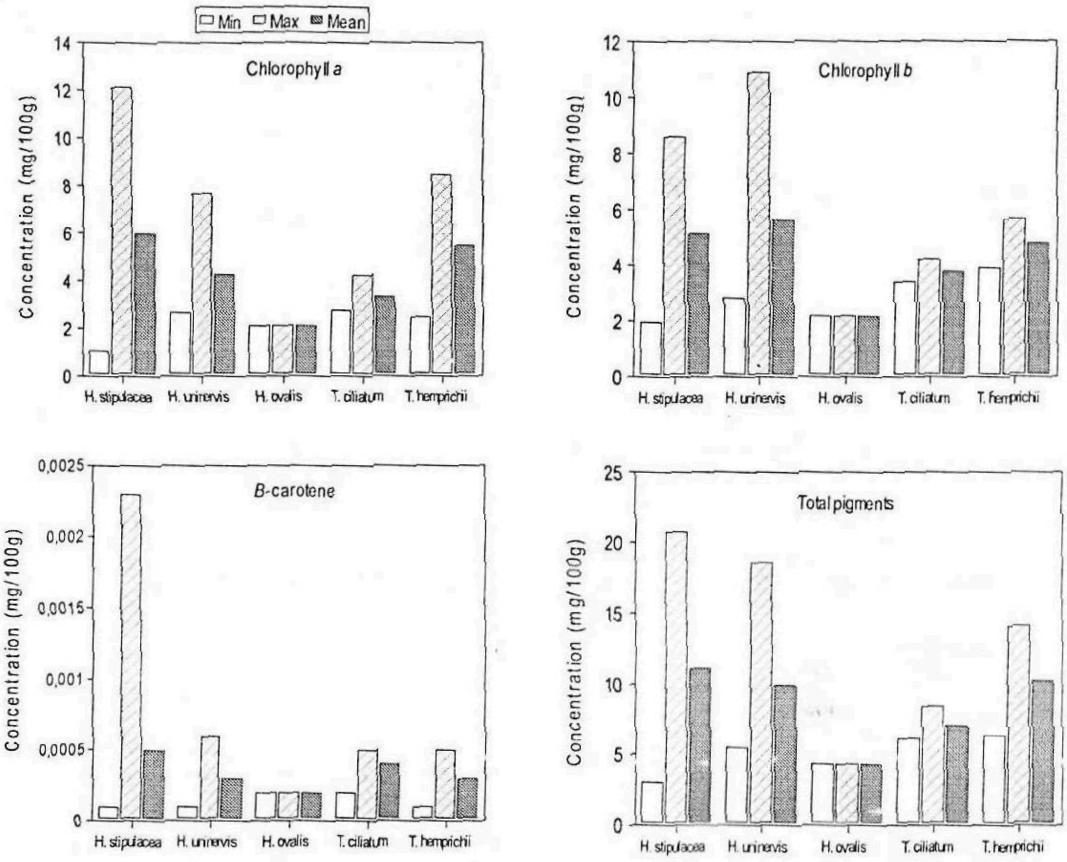


Fig. (2) Minimum, maximum and mean concentrations of chlorophyll *a*, *b*, *B*-carotene and total pigments in the different seagrasses species.

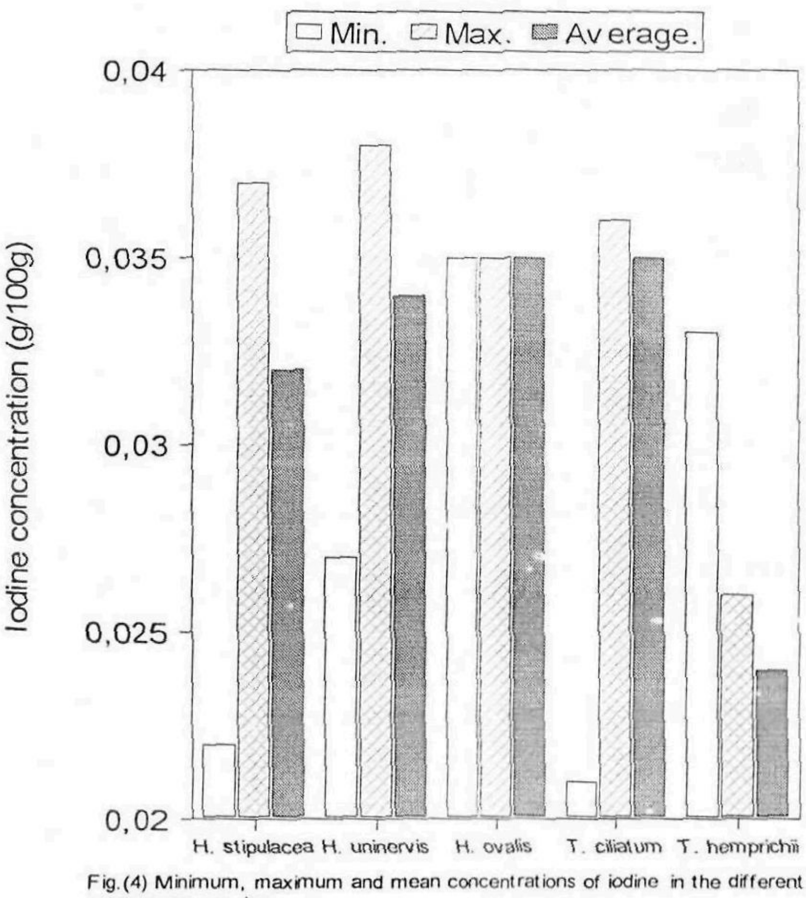


Fig. (4) Minimum, maximum and mean concentrations of iodine in the different seagrasses species.