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# WEIGHT LOSS AND CHANGES IN ORGANIC, INORGANIC AND CHLOROPHYLL CONTENTS IN THREE SPECIES OF SEAWEEDS DURING DECOMPOSITION

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**Abstract**

Seaweed species constitute an important component in the mangrove ecosystem in Pakistan and contribute to the primary production and food web. Decomposition rate of these most common species of seaweed viz., *Enteromorpha intestinalis, E. clathrata* and *Ulva reticulata* occurring in mangrove environment were estimated in the laboratory using nylon mesh bag. Each seaweed species was decomposed separately in nylon net bag (1 $mm^2$ mesh) and were placed in well aerated seawater tanks. Triplicate sample bags of each seaweed species were retrieved after 2, 5, 7, 14, and 30 days and treated for further analysis. Seaweeds decompose at significantly higher rate compared to mangroves. Time required for 50% weight loss ($t_{50}$) was 2, 6 and 5 days for *E. intestinalis, E. clathrata* and *U. reticulata*, respectively. *E. intestinalis* appeared to decompose faster than the other two species. Concentration of total chlorophyll was initially high and decreases during decomposition with a concomitant increase in Phaeopigment (degraded form of chlorophyll). Two-way analysis of variance showed that concentration of total chlorophyll and weight loss depends on incubation period and each species had significantly different ($p<0.001$) decomposition rates.

## Introduction

Seaweeds constitute an important component of marine living resource, growing in the shallow waters where suitable substrate is available. The brown (Phaeophycota), red (Rhodophycota) and green (chlorophycota) seaweeds are classified on the basis of major pigments they contain. Seaweeds are a good source of a number of products and are rich in agar agar, gelatin, protein, iodine, bromine and vitamins etc., (Rao & Tipins, 1964). They are also used as food, fodder and manure in various part of the world (Chapman & Chapman, 1980; Blanchard *et al*., 2000; Malea & Haritonidis, 2001; Lamare & Wing, 2001; Zodape, 2001). Biochemical composition and its seasonal variation have been reported from Pakistan (Qasim, 1980).

Due to the warm climate and nutrient supplementation through upwelling, Pakistan coast is rich in algal diversity and biomass. A number of green, red and brown seaweeds have been recorded from the coast of Pakistan (Anand, 1940; Shameel & Tanaka, 1992; Tanaka & Shameel, 1992; Hameed *et al*., 2000) where they occur in high abundance (Shameel & Nizamuddin, 1972; Saifullah, 1973; Saifullah & Nizamuddin, 1977; Shameel, 1987; Qari & Qasim, 1988; Shameel, 2001).

Seaweed detritus also play a significant role in the marine ecosystem (Paine & Vadas, 1969; Mann, 1972), particularly in the shallow coastal areas it appears to be the main energy source for benthos (Jefferies, 1972; Hay, 1992). Seaweeds in the aquatic environment go through various mode of degradation (Harrison, 1977); soluble organic compounds are leached rapidly in the initial phase of decay followed by slow decomposition of more resistant chemical materials (Granado & Cabellero, 1996). Decomposition is a complex process and appeared to be regulated by multitude of organisms including bacteria, fungi, insects and many invertebrate (Suberkropp & klung, 1976; Vasantha *et al*., 1988), physico-chemical properties of the material and environmental factors (Howard & Howard, 1979).

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The present study employs three species of seaweeds such as, *Ulva reticulata*, *Enteromorpha intestinalis* and *Enteromorpha clathrata,* which commonly grow in sheltered areas, for example, they are known to form thick mats over a considerable zone in mangrove swamps (Anand, 1940; Saifullah & Nizamuddin 1977). Mangrove detrital system has been studied in Pakistan (Siddiqui & Qasim, 1990; 1994), but little attention has been given on the decomposition of seaweeds which is growing abundantly in these swamps. The present study was therefore undertaken on the decomposition rates of three mat-forming seaweed species to establish the importance of seaweed decomposition in the mangrove ecosystem. Changes in biochemical parameters such as, inorganic and organic matter and pigment composition are also reported.

## Materials and Methods

The decomposition of seaweeds was studied in the laboratory using nylon mesh bags. Three species including *E. intestinalis*, *E. clathrata* and *U. reticulata* were collected from Sandspit backwaters in November, 2000 and brought to the laboratory in polythene bags, sorted and washed. Known amount (50 g) of blot-dried sample of each species was placed separately in nylon bags (40X60 cm) of 1 $mm^2$ mesh. Sets of fifteen bags for each species were incubated in a series of well aerated tanks containing 5 liters of seawater. Triplicate samples of each species were taken prior to incubation and treated as initial (0 hr) samples. A set of three bags for each species was recovered after 2, 5, 7, 14 and 30 days. Material from each bag was gently removed, blot dried and weighed. Water content (Strickland & Parson, 1972), organic and inorganic contents (Horwitz, 1975) were determined gravimetrically. Photosynthetic pigments, such as, chlorophyll (Chlorophyll *a*, Chlorophyll *b* and total Chlorophyll) and phaeopigments were also determined in the decaying material using the modified methods of Strickland & Parson (1972). Two-way analysis of variance (ANOVA) was used to evaluate differences in the rate of weight loss and total chlorophyll among three species of seaweeds.

## Results

All three species of seaweeds decomposed rapidly where *E. intestinalis* appears to have highest decomposition rate compared to the other two species (Fig. 1). Only a small amount of seaweed eg., 12.3% (*E. intestinalis*), 16.9% (*U. reticulata*) and 18.2% (*E. clathrata*) was left after an incubation period of 30 days. Time required for the loss of 50% of the initial weight ($t_{50}$) was 2, 5 and 6 days for *E. intestinalis, U. reticulata* and *E. clathrata*, respectively (Table 1). The rate of decomposition of the three seaweeds was 2.90 mg/d (*E. clathrata*), 2.73 mg/d (*U. reticulata*) and 2.72 gm/d (*E. intestinalis*). Two-way ANOVA showed significant differences in the decomposition rate (weight loss) of all three species ($p<0.001$).

Water content was high in all three species with *E. clathrata* having highest value (74 g %), followed by *U. reticulata* and *E. intestinalis*. The percent water content decrease with time during incubation (Fig. 1). Similarly organic and inorganic matter varied during decomposition. Value of organic matter in all three species viz., *E. clathrata* (9.4%), *U. reticulata* (91.7%) and *E. intestinalis* (88.7%) were generally high initially, which reduced to 33-38% at the end of 30 days incubation. On the average, 55% of organic matter was released in 30 days. Rapid increases in inorganic content during decomposition were observed up to 62-67% in 30 days (Fig. 2).

**Table 1. Value of $R^2$ and $t_{50}$ (time required for 50 % decomposition) of three species of seaweeds *E. intestinalis, E. clathrata* and *U. reticulate*.**

| Seaweed species | Value of $R^2$ | $t_{50}$ (days) |
|---|---|---|
| *Enteromorpha intestinalis* | 0.90 | 2 |
| *Enteromorpha clathrata* | 0.89 | 6 |
| *Ulva reticulate* | 0.97 | 5 |

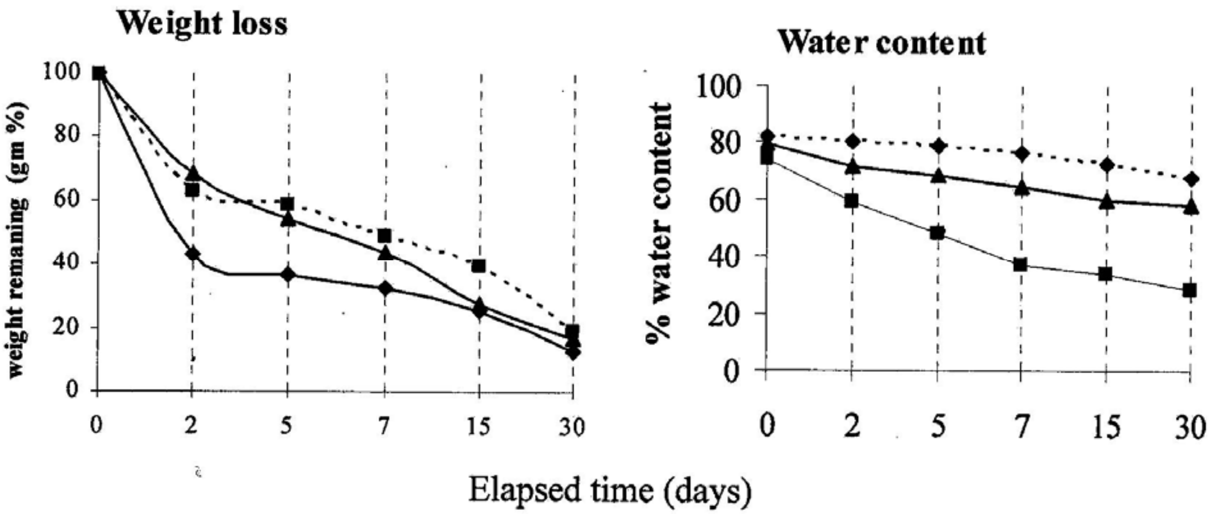


Fig. 1. Percent (%) weight remaining and water content during decomposition of three species of seaweeds (*E. intestinalis* (-♦-), *E. clathrata* (-■-) and *U. reticulata* (-▲-)).

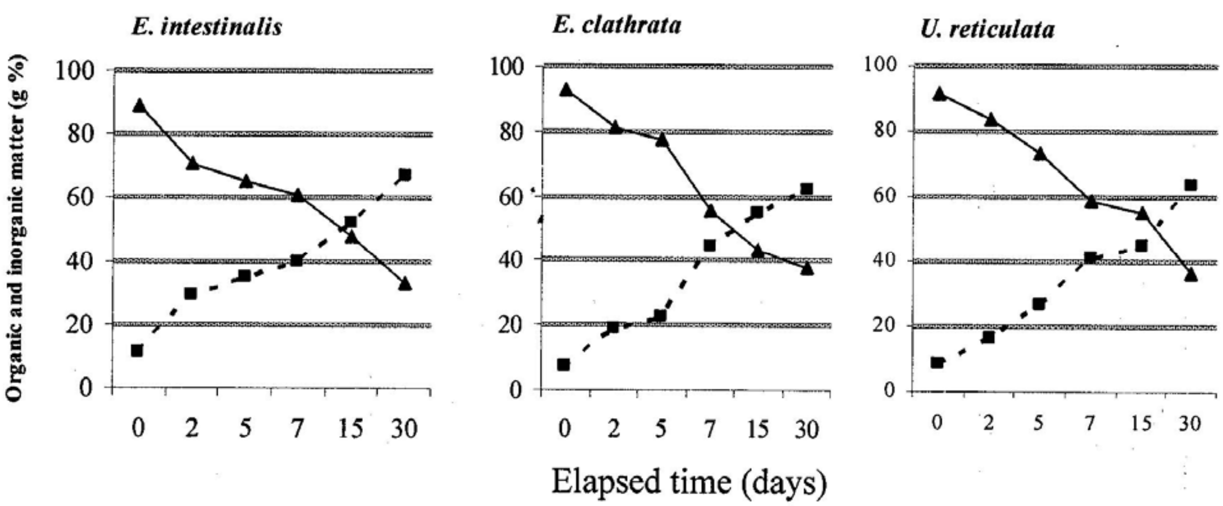


Fig. 2. Percent (%) organic and inorganic matter in decomposing seaweeds, organic matter (-▲-) inorganic matter (-■-).

Chlorophyll *a* is the primary photosynthetic pigment in seaweeds. The value of chlorophyll *a* in *U. reticulata* was 0.9 mg/g as compared to *E. intestinalis* (0.8 mg/g) and *E. clathrata* (0.7 mg/g). Similarly, *U. reticulata* had higher chlorophyll *b* value (0.7 mg/g) followed by values in *E. intestinalis* (0.4 mg/g) and *E. clathrata* (03 mg/g). Both chlorophyll *a* and *b* contents and total chlorophyll vary significantly ($p<0.001$) among species and decreases with time during decomposition (Figs. 3 & 4). Phaeopigments are degraded product of chlorophyll, which increases during decomposition, for example, from 0.2 mg/g to 0.9 mg/g in *U. reticulata,* from 0.1 to 0.9 mg/g in *E. intestinalis* and from 0.2 mg/g to 0.8 mg/g in *E. clathrata* in 30 days (Fig. 3).

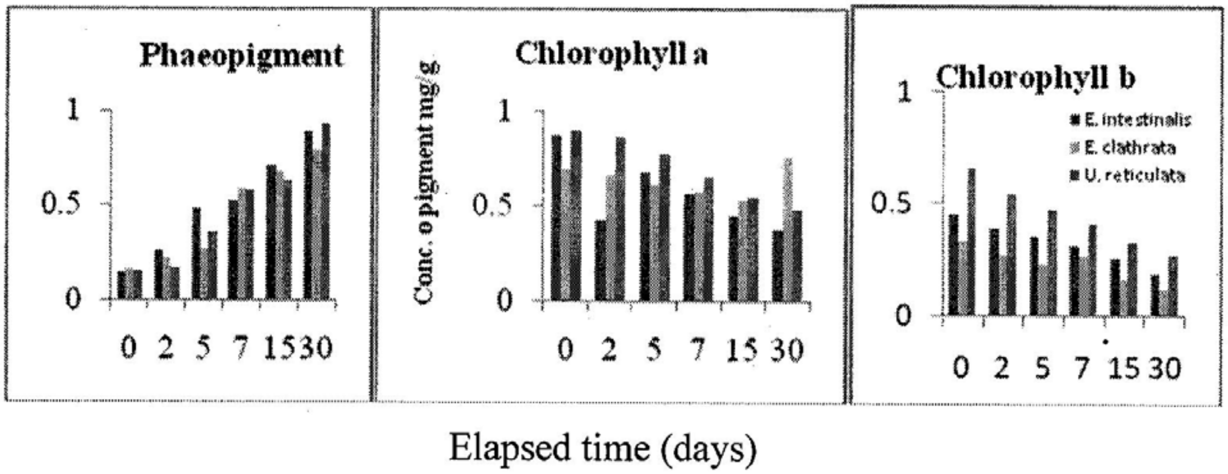


Fig. 3. Changes in concentration of detrital pigments in three seaweed species viz., *E. intestinalis, E. clathrata* and *U. reticulata* during decomposition.

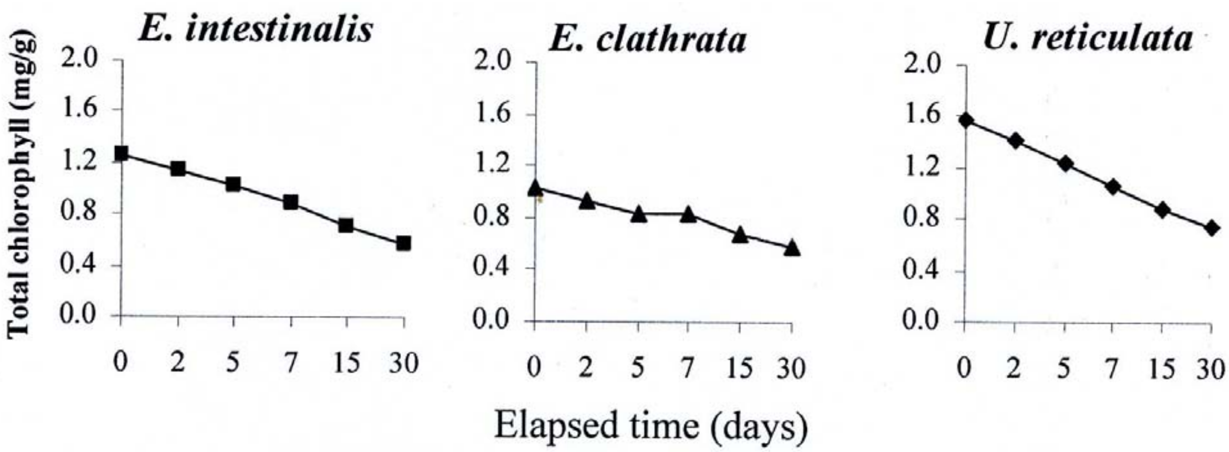


Fig. 4. Concentration of total chlorophyll in decomposing seaweeds viz., *E. intestinalis, E. clathrata* and *U. reticulate*.

## Discussion

Mat forming seaweeds covered a wide spread area of mud flats adjacent to mangrove forest in the Sandspit backwaters and in the Indus delta and form a few millimeter thick layer on sediment surface. Presence of algal mats may be attributed to the high nutrient loading through industrial and domestic sewage being drained in these areas (Khan & Saleem, 1988; Rizvi *et al*., 1988).

This study shows that algae decompose at a very high rate ($t_{50}$ = 2 to 6 days) almost eight fold faster compared to highly vascular mangrove litter ($t_{50}$ 16 to 48 days) (Siddiqui & Qasim, 1988). The high rates of seaweed reminerilization leave less material to deposit as peat. It may be due to the fact that seaweeds lack structural polysaccharide that are part of chemical structure of vascular plant (Josselyn & Mathieson, 1980; Williams, 1984) and take longer time to decompose. In addition, soft and delicate structure of seaweeds render them as easily consumable food by a number of organisms that participate in the decomposition of plant material, such as mollusks, crabs, copepods, polycheate worms, nematodes, protozoans, fungi and bacteria (Suberkropp & Klung, 1976; Howard & Howard, 1979; Mouzouras, 1989; Christoffersen *et al*., 2002). Also the fine algal strands provide more surface area for colonization of bacteria and fungi, which are the main decomposers of plant material (Suberkropp & Klung, 1976; Zhuang *et al*., 2000) and hence help in their faster decomposition.

Organic and inorganic contents observed in the present study remain well within the range reported earlier for different seaweeds from Karachi coast (Qasim, 1980). Leaching of organic matter at a higher rate in the initial stage of decomposition causes increases in the inorganic content. A similar increase in inorganic matter has been observed previously in decomposing mangrove detritus (Hoq *et al*., 2002; Meziane & Tsuchiya, 2002). Decrease in total chlorophyll content with increase in the phaeopigments, the degradation product of chlorophyll, suggested that chlorophyll in addition to leaching out, has been degraded into phaeopigments during decomposition of algae. Given the high rate of seaweed decomposition and that it covers a considerable area in coastal mud flats, a continuous and high rate of release of particulate and dissolved nutrients in water are expected and hence seaweeds appear to play a significance role in nutrient cycling and food web in mangrove ecosystem.

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