ABSTRACT

The present research work was carried out to investigate the anatomical, antioxidant and phycochemical studies on Chlorophycota and Rhodophycota seaweeds of Karachi coast. Total eight seaweeds were collected from Karachi Coast belonging to two phyla. Benthic marine algae were collected from Paradise Point, Buleji, Hawks Bay and Manora of Karachi coastal area during the months of November 2011 to April 2014. In phylum Chlorophycota two classes Ulvophyceae and Siphonocladophyceae showed three orders Ulvales, Bryopsidales and Codiales with four species *Ulva fasciata* Delile, *U. intestinalis* Linnaeus, *Halimeda macroloba* Decaisne, *Codium flabellatum* (Silva) Nizamuddin placed in their respective orders. While in Rhodophycota four genera having four species belonging to a single class i.e. Ceramophyceae with three orders; Gigartinales, Cryptonemales, Rhodomeniales having four species, *Agardhiella robusta* (Greville) Børgesen, *Halymenia porphyraeformis* (Børgesen) Parkinson, *Botriocladia laptopoda* (J. Agardh) Kylin and *Coelarthrum muelleri* (Sonder) Børgesen. Physico chemical properties of the surface seawater were investigated. Present findings revealed that the diversity of seaweeds was strongly associated with salinity and pH regimes. Because when the environmental conditions were moderate as in April, collection of maximum seaweeds was employed.

For anatomical studies parts of thalli were cut into thin sections by free hand section cutting techniques. These sections after staining were examined under microscopes. It was observed that *Ulva fasciata* possesses undulate frond with smooth texture, having frill like margin with short hollow stipe. Two identical rows of cells were present, *Ulva intestinalis* had several elongated, spirally coiled blades with spiky margins. A double row of extended cells was observed. *Halimeda macroloba* is composed of segments variable in shape, usually trilobate, twisted and discoid. Cortex with 3-5 layers of dichotomously branched siphons become coalescent after decalcification. *Codium flabellatum* showed long central cells with utricles. *Agardhiella robusta* a red, cylindrical alga with uneven divisions on the entire sides showing irregularly polychotomous branching with large polygonal cells. *Halymenia porphyraeformis* showed

medullary cells loosely arranged in the gelatinous matrix characterized by stellate cells. *Botriocladia laptopoda* bearing dichotomous branching with small rounded gland cells and elongated central cells. *Coelarthrum muelleri* having dichotomous or trichotomous branches, with hard basal part and empty segments.

In order to investigate the antioxidant and fatty acids, the crude methanol extract by maceration techniques was prepared and subjected to fractionation with *n*-hexane, petroleum ether, chloroform, methanol and water for antioxidant. The antioxidant activity was evaluated by four in-vitro assays viz; DPPH radical scavenging activity, total antioxidant activity by phosphomolybdenum method, ferric reducing antioxidant power (FRAP) assay and determination of total phenolic contents. The significant IC_{50} values (concentration of sample required to scavenge 50% free radical) was observed in the methanol fraction of *Agardhiella robusta* (IC_{50} 25.81± 0.65) as compared to that of BHT (standard antioxidant) which was 12.52.±0.89. The methanol extract showed highest total antioxidant activity assessed by phosphomolybdenum assay in red seaweed *Halymenia porphyraeformis* (1.012± 0.02) followed by the *n*-hexane extract of *Agardhiella robusta* (0.947± 0.05). A maximum amount of FRAP was observed in *Agardhiella robusta* (16.1± 0.63) TEμM/ml in methanol extract. Majority of the highest FRAP values were observed in methanol extracts except *Codium flabellatum*, where petroleum ether extract showed maximum FRAP. Total phenolic contents noticed in methanol extract of *Agardhiella robusta* (1632±0.12) GAEmg/ml and they were found in greater amount in red seaweeds ranging from 1632±0.12 GAEmg/ml to 946±3.46 GAEmg/ml than in green 733±1.72 GAEmg/ml to 580±2.88 GAEmg/ml.

For phycochemical studies the methanol extracts of the seaweeds obtained by maceration technique, evaporated in vacuum rotary evaporator in the Phycology Laboratory of GCU Lahore, Pakistan. Fractions were eluted initially in *n*-hexane and then polarity was gradually increased by using the chloroform, ethyl acetate or other polar solvents. Among eight species total 40 fatty acids (FAs) including 13 saturated and 27 unsaturated fatty acids were identified from column chromatography fractions with the help of GC-MS. The unsaturated fatty acids comprised of 11 monounsaturated, 8 diunsaturated and 8 triunsaturated fatty acids. It is clearly indicated from the results that there is a greater diversity

among unsaturated fatty acids than saturated fatty acids. There was lowest Rel. %age of (C19:0) stearic acid (0.6%) and the highest Rel. %age was recorded in case of (C16:0) palmitic acid (47.34%) among the saturated FAs, lowest Rel. %age of (C29:1) nonacosanoate (0.8%) and the highest Rel.%age was recorded for (C17:1) heptadecylenic acid (15.76%) among the monounsaturated FAs, lowest rel.%age of (C24:2) tricosadienoic acid (1.52%) and the highest Rel. %age was shown by (C24:2) tricosadienoic acid (11.52%) among the diunsaturated FAs, lowest Rel. %age of (C17:3) heptadecatrienoate (0.4%) and the highest Rel. %age was shown by (C18:3) octadecatrienoate (13.56%) among the triunsaturated FAs.

Myristic acid (C14:0), pentadecylic (C15:0), palmitic (C16:0), margeric acid (C17:0), stearic acid (C19:0), nonadecylate (C21:0) were found in more than 4 species out of 8 seaweeds, were followed by pentadecylenic (C15:1) and pentadecatrienoic (C15:3) acids, which could be detected in 5 species. Several acids such as C8:1, C13:0, C15:4, C16:2, C17:3, C18:2, C20:4, C21:5, C23:0, C23:6, C24:5, C26:0, C27:0, C31:0, C32:0 and C33:0 were the least common FAs, as they were found only in any one of the investigated species.

Overall *Ulva fasciata* showed the highest (C16:0) methyl palmitic acid Rel. %age (47.34%) in saturated fatty acids while the lowest Rel. %age was displayed by (C13:3) heptatrienoic acid (0.26%) in *Halimeda macroloba* by unsaturated fatty acid. The present research also useful for the isolation of particular phenolic compounds and fatty acids which can yield high value products.