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COMPARATIVE COMPOSITION OF FATTY ACIDS OF *CODIUM DECORTICATUM* AND C. *FLABELLATUM* (BRYOPSIDOPHYCEAE)

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ABSTRACT

Fatty acid composition of two peen seaweeds *Codium* decorticatum f. monstrosum (Montague) Nizamuddin and *C. flabellatum* Silva Nizamuddin, found in Karachi coastal waters, has been reported. Altogether 15 saturated and 22 unsaturated fatty acids including 13 monoenoic, 4 dienoic and 5 trienoic acids were identified as methyl esters by gas chromatography-mass spectrometry. They include one saturated hydroxy and three substituted unsaturated fatty acids. The 2,3-dimethmy propane, 3,8-dimethyl-2,7-nonadienoic, 7-ethyl-3-methyl-2, 6-undecadienoic, 3,7,11-trimethyl-2, 6, 10-dodmtdenoic, nonacosanoic and nonionic acids are being reported for the first time from any species of *Codium* as well as any seaweed of Pakistan. Both the seaweed exhibited specific differences in their fatty acid composition.

Introduction

Lipids are chemically heterogenous group of substances having in common the property of insolubility in water, but solubility in nonpolar solvents such as chloroform, hydrocarbons or alcohols (Guff and Harwood, 1991). They occur throughout the living world in microorganisms, animals and plants including algae. Seaweeds are an extremely diverse group of organisms and the[i]r lipid composition and metabolism are exceptionally varied (Harwood and Jones, 1989). Marine algae in general contain a bewildering array of major fatty acids.

Codium Stackhouse is a group of spongy green seaweeds, which may be cylindrical or flattened or irregularly shaped and branched or thalloid. They grow abundantly, being attached firmly to the mid and lower littoral rocks at Karachi (Anand, 1940; Salim, 1965) and the adjacent coastal areas of Lasbela (Shameel, 1987; Shameel *et al*, 1989). Although total fat, glycerides and phospholipids (Qasim, 1986) and detailed fatty acid composition of C. iyengari*i* (Shameel, 1990; Aliya *et al.*, 1991) have been investigated, but no such study has been carried out on the fatty acids of other species of *Codium* from Karachi coast. In this paper an attempt has been made to present a detailed comparative fatty acid composition of *Codium* decorticatum (Woodward) Howe f. monstrosum (Montague) Nizamuddin and *C. flabellatum* Silva et Nizamuddin.

Materials and Methods

Healthy and clean thalli of *Codium decorticatum* and *C. flabellatum* were collected both as drift material as well as epilithon from the littoral rocks of Manora, Buleji and Nathiagali areas near Karachi during November 1989 and January 1991. The seaweeds were thoroughly washed with tap water to remove sand particles, animal castings, epiphytes and epizoons and later on, dried in shade. The dried thalli of *C. decorticatum* (530 g) and *C. flabellatum* (1100 g) were chopped into small pieces and soaked in ethanol (EtOH) for about one month at room temperature. The ethanolic extract so obtained was evaporated under vacuum, which yielded dark green thick residue (35 g of *C. decorticatum* and 33 g of *C. flabellatum*).

The ethanolic extracts were partitioned with ethyl acetate (EtOAc) and water, the partitioning was repeated 3 times. The EtOAc extract was evaporated under reduced pressure and yielded thick greenish residue (26 g of *C. decorticatum* and 19 g of *C. flabellatum*). The EtOAc layers were loaded on silica gel columns (70 -230 mesh) and fractions were eluted first with hexane and then by enhanced polarity using increased the quantity of chloroform. In the case of *C. decorticatum* fraction A was eluted with pure hexane, fraction B with hexane: chloroform (98:02), fraction C with hexane: chloroform (75:25) and fraction D with hexane: chloroform (6535). In *C flabellatum* fraction A was eluted with hexane: chloroform (98:02), fraction B with hexane: chloroform (85:15), fraction C with hexane: chloroform (80:20) and fraction D with hexane:chloroform (75:25). All these fractions were thick and oily.

The fractions A-D of both the species were esterified with diazomethane. The methylated fatty acid fractions were analysed first by gas liquid chromatography (GLC) and finally by gas chromatography-mass spectrometry (GC-MS). The procedure of esterification and the details of GLC and GC-MS techniques were the same as described previously (Aliya *et al*, 1991).

Results and Discussion

The analysis of the fatty add methyl esters of *Codium decorticatum* f. *monstrosum* and *C flabellatum* through GC-MS indicated the presence of 37 different fatty acids. The identity of fatty acids was confirmed by matching the mass spectra of the unknown compounds with those of the NBS mass spectra library (Helles and Milne, 1978). The positions of the double bonds could not be ascertained in some of the unsaturated fatty acids. The significant ions in the mass spectra of their methyl esters are given below:

***n*-Heptanoate:** GC-MS, m/z 144 (M^+, $C_8H_{16}O_2$, 15%), 129 (M^+-15, 52%), 113 (M^+-31, 7%), 101 (M^+-43, 68%), 87 (26%), 73 (31%), 59 (37%), 55 (100%).

2,3-Dimethoxy-propanoate: 148 (M^+, $C_6H_{12}O_4$, 5%), 135 (M^+-13, 11%), 116 (M^+ -32, 12%), 91 (M^+ -57, 15%), 77(22%), 63 (13%), 55 (100%).

n-Octanoate: 158 (M^+, $C_9H_{18}O_2$, 33%), 143 (M^+-15, 85%), 127 (M^+-31, 8%), 115 (M^+ -43, 38%), 101 (75%), 87 (82%), 73 (59%), 55 (100%).

***n*-Nonanoate**: 172 (M^+, $C_{10}H_{20}O_2$, 11%), 157 (M^+-15, 37%), 129 (M^+-43, 8%), 111 (27%), 97 01%), 83 (37%), 69 (28%), 55 (100%).

9-Decenoate: 184 (M^+, $C_{11}H_{20}O_2$, 21%), 152 (M^+ -32, 2%), 127 (M^+ -57, 11%), 113 (12%), 99 (15%), 85 (75%), 71(100%).

Undecenoate: 194 (M^+, $C_{12}H_{18}O_2$, 65%), 162 (M^+-32, 4%), 155 (3%), 141 (7%),127 (3%),113 (2%), 99 (4%), 85 (14%), 71(17%).

3,8-Dimethyl-2,7-nonadienoate: 196 (M^+, $C_{12}H_{20}O_2$, 5%), 139 (M^+-57, 2%), 125 (6%), 111 (8%), 97 (11%), 83 (12%), 71 (100%).

10-Undecenoate: 198 (M^+, $C_{12}H_{22}O_2$, 35%), 166 (M^+-32, 2%), 141 (M^+-57, 17%), 127 (16%), 113 (15%), 99 (20%), 85 (80%), 71(100%).

9-Dodecenoate: 212 (M^+, $C_{13}H_{24}O_2$, 98%), 155 (M^+-57, 40%), 141 (42%), 127 (50%), 113 (62%), 99 (97%), 85 (98%), 71(100%).

Tridecatrienoate: 222 (M^+, $C_{14}H_{22}O_2$, 5%), 190 (M^+-32, 3%), 177 (29%), 149 (98%), 121(6%), 93 (10%), 65 (15%).

Tridecenoate: 226 (M^+, $C_{14}H_{26}O_2$, 5%), 194 (M^+ -32, 10%), 169 (M^+ -57, 12%), 155 (7%), 141(20%),127 (12%), 113 (22%), 99 (23%), 85 (70%), 71(100%).

7-Ethyl3-methyl-2,6-undecadienoate: 238 (M^+, $C_{15}H_{26}O_2$, 49%), 181 (M^+-57, 5%),167 (3%), 153 (5%),139 (6%),125 (22%), 111(43%), 97 (84%), 83 (100%).

9-Tetradecenoate: 240 (M^+, $C_{15}H_{28}O_2$, 18%), 183 (M^+ -57, 10%), 169 (11%), 155 (10%), 141 (9%), 127 (10%), 113 (12%), 99 (18%), 85 (73%), 71(100%).

3,7,11-Trimethyl-2,6,10-dodecatrienoate: 250 (M^+, $C_{16}H_{26}O_2$, 17%), 193 (M^+-47, 3%), 179 (4%), 165 (5%), 151 (3%), 137 (5%), 123 (8%), 109 (15%), 95 (13%), 81 (7%), 67 (20%), 58 (100%).

Pentadecenoate: 254 (M^+, $C_{16}H_{30}O_2$, 3%), 197 (M^+-57, 3%), 127(2%), 113(3%), 99(3%), 85(10%), 71(100%).

n-Pentadecanoate: 256 (M^+, $C_{17}H_{34}O_2$, 17%), 213 (M^+-43,11%), 199 (4%), 185 (6%), 171 (6%), 157 (8%), 143 (5%), 129 (23%), 115 (12%), 101 (8%), 87 (15%), 73

(100%).

Hexadecadienoate: 266 (M^+, $C_{17}H_{30}O_2$, 18%), 209 (M^+-57, 3%), 168 (6%), 153 (5%), 139 (7%), 125 (21%), 111 (45%), 97 (82%), 83 (100%).

***n*-Huxadecanoate**: 270 (M^+, $C_{17}H_{34}O_2$, 60%) 239 (M^+-31. 22%), 227 (M^+-43, 45%), 213 (70%), 199 (25%), 185 (20%), 171 (25%), 157 (84%), 143 (70%), 129 (30%), 115 (38%), 101 (100%).

Heptadecatrienoate: 278 (M^+, $C_{18}H_{30}O_2$, 35%), 204 (M^+-74, 3%), 190 (3%), 176 (6%), 162 (15%), 148 (10%), 135 (23%), 121 (45%), 107 (42%), 93 (54%), 79 (100%).

Heptadecenoate: 282 (M^+, $C_{18}H_{34}O_2$, 17%), 208 (M^+-74, 3%), 169 (2%), 141 (4%), 127 (7%), 113 (4%), 99 (98%), 85 (14%), 71 (100%).

***n*-Heptadecnoate**: 284 (M^+, $C_{18}H_{36}O_2$, 55%), 241 (M^+-43, 30%), 213 (10%), 199 (12%), 157 (24%), 143 (14%), 129 (9%), 115 (10%), 101 (44%), 88 (100%).

Octadecadienoate: 294 (M^+, $C_{19}H_{34}O_2$, 4%), 237 (M^+-57, 5%), 223 (12%) 209 (5%), 195 (7%), 181 (8%), 167 (4%), 153 (8%), 139 (7%), 125 (20%), 111 (29%), 97 (50%), 83 (62%), 71(100%).

9-Octadecenoate: 296 (M^+, $C_{19}H_{36}O_2$, 57%), 264 (M^+_- 32, 5%) 222 (M^+-74, 7%), 208 (6%), 194 (5%), 180 (62%), 166 (4%), 152 (8%), 138 (20%), 124 (62%), 110 (22%), 96 (45%), 82 (81%), 71 (100%).

***n*-Octadecanoate**: 298 (M^+, $C_{19}H_{38}O_2$, 18%), 255 (M^+-43, 7%), 241(6%), 227 (4%), 213 (7%), 199 (5%), 171(5%), 157 (22%), 143 (10%), 101 (60%), 88 (100%).

Nonadecenoate: 310 (M^+, $C_{20}H_{38}O_2$ 4%) 253 (M^+-57, 4%), 223 (2%), 225 (3%), 211 (4%), 183 (3%), 169 (2%), 155 (4%), 141 (6%), 127 (3%), 113 (7%), 99 (8%), 85 (27%), 71 (100%).

***n*-Nonadecanoate**: 312 (M^+, $C_{20}H_{40}O_2$, 5%), 281 (M^+-31, 22%), 269 (M^+-434%), 255 (3%), 197 (6%), 183 (8%), 169 (6%), 155 (7%), 141 (11%), 127 (14%), 113 (17%), 99 (17%), 85 (58%), 71 (100%).

9-Eicoseooate: 324 (M^+, $C_{21}H_{40}O_2$, 20%), 267 (M^+-57, 2%), 225 (2%), 141 (2%), 127 (6%),111 (7%), 97 (11%), 83 (10%), 69 (12%), 58 (100%).

***n*-Eicosanoate**: 326 (M^+, $C_{21}H_{42}O_2$, 7%), 283 (M^+-43, 3%), 227 (2%), 213 (5%), 185 (5%), 157 (7%), 149 (3%), 143 (6%), 129(4%), 73 (100%).

Heneicosenoate: 338 (M^+-$C_{22}H_{42}O_2$, 16%), 281 (M^+ -57, 2%), 253 (4%), 239 (2%), 211 (3%), 183 (2%), 155 (2%), 141 (3%), 127 (4%), 113 (4%), 99 (5%), 85 (17%), 71 (39%), 57 (100%).

***n*-Henekosanoate**: 340 (M^+, $C_{22}H_{44}O_2$, 32%), 309 (M^+-31, 7%), 297 (M^+-43, 11%), 283 (2%), 267 (3%), 241 (6%), 227 (2%), 199 (7%), 171 (3%), 157 (4%), 143 (12%), 129 (2%), 115 (3%), 101 (7%), 87 (22%),72 (3%), 55 (100%).

11-Docosenoate: 352 (M^+, $C_{21}H_{44}O_2$, 17%), 295 (M^+-57, 4%), 253 (2%), 239 (3%), 127 (2%), 113 (4%), 99 (2%), 85 (12%), 71 (35%), 59 (100%).

***n*-Docosanoate**: 354 (M^+, $C_{23}H_{46}O_2$, 30%), 323 (M^+-31, 6%), 311 (M^+ -43, 8%), 297 (2%), 269 (2%), 255 (4%), 199 (3%), 185 (3%), 171 (2%), 157 (3%), 143 (7%), 129 (2%), 115 (3%), 101 (3%), 87 (22%),73 (4%), 57 (100%).

Tricosenoate: 366 (M^+, $C_{24}H_{46}O_2$, 5%), 334 (M^+-32, 3%), 292 (M^+-74, 6%), 278 (2%), 264 (3%), 250 (3%), 236 (4%), 222 (5%), 208 (62%), 194 (8%), 180 (44%), 166 (6%), 1.52 (25%), 138 (5%), 124 (5%), 110 (15%), 96 (20%), 82 (12%), 74 (100%).

***n*-Tricosanoate**: 368 (M^+ , $C_{24}H_{48}O_2$, 75%), 337 (M^+ -31, 11%), 325 (M^+ -43, 19%), 311 (5%), 297 (2%), 283 (6%), 269 (7%), 241 (3%), 213 (3%), 199 (12%), 185 (5%), 171 (3%),157 (2%), 143 (23%), 129 (10%), 115 (3%), 101 (7%), 87 (67%), 74 (100%).

***n*-Tetracosanoate**: 382 (M^+, $C_{25}H_{50}O_2$, 72%), 351 (M^+ -31, 10%), 339 (M^+ -43, 16%), 311 (3%), 297 (5%), 283 (5%), 255 (2%), 241 (4%), 227 (2%), 213 (2%), 199 (7%), 185 (6%), 171 (3%), 157 (6%), 143 (25%), 129 (12%), 115 (8%), 101 (7%), 87 (75%), 74 (100%).

Nonaacosatrienoate: 446 (M^+, $C_{30}H_{54}O_2$, 5%), 372 (M^+-74, 2%), 303 (2%), 275 (4%), 247 (5%), 219 (3%), 207 (2%), 191 (10%), 163 (9%), 149 (18%), 135 (22%), 107 (47%), 90 (57%), 79 (100%).

***n*-Nonacosanoate**: 452 (M^+, $C_{30}H_{60}O_2$, 5%), 421 (M^+ -31, 2%), 351 (6%), 337 (2%), 295 (4%), 267 (4%), 239 (2%), 225 (4%), 197 (2%), 183 (2%), 169 (4%), 155 (4%), 141 (7%), 127 (7%), 113 (2%), 99 (14%), 85 (54%), 71 (83%), 57 (100%).

Altogether 15 saturated and 22 unsaturated fatty acids have been identified from both the species. The relative retention time (RRT) and relative percentage of occurrence of their methyl esters are given in Table 1. Majority of the fractions showed a relatively high level of unsaturated fatty acids than the saturated ones. It is contrary to what has commonly been observed in other green seaweeds of Karachi (Qasim, 1986; Shamed, 1990; Shameel and Khan, 1991). However, one fraction of C. iyengarii also exhibited a high level of unsaturated acids (Aliya *et al,* 1991). Nonadecylic acid was present in C decortiatum and arachidic acid in *C flabellatum* in largest quantity among all the fatty acids detected, saturated as well as unsaturated. It is quite unusual, as palmitic acid occurs in largest amount not only in other species of Codium but in various green, brown and red seaweeds of Karachi (Qasim, 1986; Shameel, 1990). Palmitate is invariably the major fatty acid of marine algae with myristate often being found in appreciable quantities (Joyard and Douce, 1987). It appears that various species of Codium differ in their fatty acid composition.

The detection of propanoic and nonacosanoic acids in *C. decorticatum* and *C flabellatum* is very interesting. It is the first report of occurrence of saturated fatty acids with a low and high molecular weight respectively. Usually the saturated fatty acids of Karachi seaweeds range between C_8 and C_{22} (Shameel, 1990). In *C iyengarii* certain fatty acids lower than Cs and higher than C_{22} have recently been detected (Aliya *et al*, 1991). But this study further enhances the range of saturated fatty acids found in Karachi seaweeds. Although acids from C_2 to over Cap have been reported but the most common lie in the range of C_{12}-C_{22} (Harwood, 1988). The presence of 2,3-dimethoxy-propanoic acid is the first report of occurrence of a saturated hydroxy acid in any marine alga of Karachi. *Codium iyengarii* contained malonic acid, a dicarboxylic acid in appreciable amount (Aliya *et al*, 1991), but no such add could be detected in *C. decorticatum* and *C. flabellatum*. It reveals specific differences in the lipid metabolism of Codium.

The study of 22 unsaturated fatty acids revealed the presence of 13 monoenoic, 4 dienoic and 5 trienoic acids. It is quite interesting that no di- ortrienoic acid was detected in *C. dwarkense*, *C. fragile* and *C. iyengarii* (Khotimchonko and Svetoshev, 1983; Aliya *et al.*, 1991). However, they are present in other green seaweeds (Shameel and Khan, 1991). The di- and trienoic acids also include three substituted acids i.e. 3,8-dimethyl-2, 7-nonadienoic, 7-ethyl-3-methyl-2,6-undecadienoic and 3,7 ,1l-trimethyl-2,6,10-dodecatrienoic acids. These are the first detected substituted unsaturated fatty acids from a Karachi seaweed. Codium iyengarii contained two different aliphatic triple bonded or ethynoic acids in sufficient quantity (Aliya *et al.*, 1991), but such acids could not be detected in the present species. The detection of nonacosatrienoic acid in the latter is the first report, as no unsaturated fatty acid higher than C_{24} was known so far from Karachi seaweeds (Aliya *et al.,* 1991). This further enhances the range of unsaturated acids.

Table 1

Fatty acids of *Codium decorticatum* and *C. flabellatum* analysed as methyl esters (MW = molecular weight, RRT = relative retention time).

Systematic name (common name)	Molecular formula (MW)	Relative percentage *C. decorticatum* (RRT)	Relative percentage *C. flabellatum* (RRT)
Fraction A			
n-Nonanoate (Nonylate)	$C_{10}H_{20}O_2$ (172)	-	19.19 (3.25)
9-Decenoate (Caproleate)	$C_{11}H_{20}O_2$ (184)	2.90 (1.70)	-
10-Undecenoate (Undecylenate)	$C_{12}H_{22}O_2$ (198)	7.30 (2.19)	-
9-Dodecenoate (Lauroleate)	$C_{13}H_{24}O_2$ (212)	3.30 (2.61)	-
Tridecatrienoate	$C_{14}H_{22}O_2$ (222)	5.80 (3.09)	-
7-Ethyl-3-methyl-2, 6-undecadienoate	$C_{15}H_{26}O_2$ (238)	5.01 (3.36)	-
9-Tetradecenoate (Myristoleate)	$C_{15}H_{28}O_2$ (240)	20.80% (3.52)	-
Pentadecenoate	$C_{16}H_{30}O_2$ (254)	7.09 (3.88)	-
n-Pentadecanoate (Pentadecylate)	$C_{16}H_{32}O_2$ (256)	6.05 (4.04)	-
Hexadecadienoate	$C_{17}H_{30}O_2$ (266)	6.68 (4.19)	-
n-Hexadecanoate (Palmitate)	$C_{17}H_{34}O_2$ (270)	-	23.23 (5.28)

Systematic name (common name)	Molecular formula (MW)	Relative percentage *C. decorticatum* (RRT)	*C. flabellatum* (RRT)
Heptadecatrienoate	$C_{18}H_{30}O_2$ (278)	6.26 (4.21)	-
Heptadecenoate (Heptadecylenate)	$C_{18}H_{34}O_2$ (282)	9.18 (4.55)	-
n-Heptadecanoate (Margarate)	$C_{18}H_{36}O_2$ (284)	-	22.20 (5.65)
9-Octadecenoate (Oleate)	$C_{19}H_{36}O_2$ (296)	7.90 (4.63)	-
n-Octadecanoate (Stearate)	$C_{19}H_{38}O_2$ (298)	11.40 (5.31)	-
n-Eicosanoate (Arachidate)	$C_{21}H_{42}O_2$ (326)	-	35.30 (8.14)
Fraction B			
n-Heptanoate (Heptylate)	$C_8H_{16}O_2$ (144)	-	9.35 (1.00)
n-Octanoate (Caprylate)	$C_9H_{18}O_2$ (158)	-	5.60 (1.19)
n-Nonanoate (Nonylate)	$C_{10}H_{20}O_2$ (172)	-	12.80 (1.45)
Undecatrienoate	$C_{12}H_{18}O_2$ (194)	3.90 (1.82)	-
Tridecenoate (Decylacrylate)	$C_{14}H_{26}O_2$ (226)	4.50 (2.58)	-
3,7,11-Trimethyl-2,6,10-dodecatrienoate	$C_{16}H_{26}O_2$ (250)	-	5.24 (1.77)

Systematic name (common name)	Molecular formula (MW)	Relative percentage *C. decorticatum* (RRT)	*C. flabellatum* (RRT)
Pentadecenoate	$C_{16}H_{30}O_2$ (254)	-	10.28 (2.32)
n-Pentadecanoate (Pentadecylate)	$C_{16}H_{32}O_2$ (256)	10.70 (3.37)	-
n-Hexadecanoate (Palmitate)	$C_{17}H_{34}O_2$ (270)	12.60 (3.50)	6.73 (2.35)
Heptadecatrienoate	$C_{18}H_{30}O_2$ (278)	28.10 (3.64)	17.50 (2.45)
n-Heptadecanoate (Margarate)	$C_{18}H_{36}O_2$ (284)	-	7.48 (2.48)
9-Octadecenoate (Oleate)	$C_{19}H_{36}O_2$ (296)	15.28 (4.91)	6.62 (2.65)
9-Eicosenoate (Gadoleate)	$C_{21}H_{40}O_2$ (324)	-	6.84 (3.60)
Heneicosenoate	$C_{22}H_{42}O_2$ (338)	-	5.60 (3.43)
n-Docosanoate (Behenate)	$C_{23}H_{46}O_2$ (354)	15.40 (5.60)	5.80 (3.77)
n-Tetracosanoate (Lignocerate)	$C_{25}H_{50}O_2$ (382)	9.01 (6.88)	-
Fraction C			
2,3-Dimethoxy-propanoate (Propionate)	$C_6H_{12}O_4$ (148)	3.44 (0.97)	12.50 (1.06)

Systematic name (common name)	Molecular formula (MW)	Relative percentage *C. decorticatum* (RRT)	*C. flabellatum* (RRT)
9-Tetradecenoate (Myristoleate)	$C_{15}H_{28}O_2$ (240)	-	4.60 (2.78)
3,7,11-Trimethyl-2,6,10-dodecatri-enoate	$C_{16}H_{26}O_2$ (250)	15.90 (2.90)	-
n-Hexadecanoate (Palmitate)	$C_{17}H_{34}O_2$ (270)	-	7.36 (3.39)
n-Heptadecanoate (Margarate)	$C_{18}H_{36}O_2$ (284)	-	7.36 (3.58)
Octadecadienoate	$C_{19}H_{34}O_2$ (294)	9.40 (3.66)	-
9-Octadecenoate (Oleate)	$C_{19}H_{36}O_2$ (296)	12.93 (3.95)	8.28 (3.94)
Nonadecenoate (Nonadecylenate)	$C_{20}H_{38}O_2$ (310)	-	4.90 (4.19)
n-Nonadecanoate (Nonadecylate)	$C_{20}H_{40}O_2$ (312)	43.10 (3.98)	-
9-Eicosenoate (Gadoleate)	$C_{21}H_{40}O_2$ (324)	8.60 (4.07)	9.50 (4.96)
n-Heneicosanoate	$C_{22}H_{44}O_2$ (340)	-	9.50 (5.01)
11-Docosenoate (Cetoleate)	$C_{23}H_{44}O_2$ (352)	-	11.04 (5.44)
n-Docosanoate (Behenate)	$C_{23}H_{46}O_2$ (354)	6.46 (4.66)	13.80 (6.02)
n-Tricosanoate	$C_{24}H_{48}O_2$ (368)	-	11.04 (6.27)

Systematic name (common name)	Molecular formula (MW)	Relative percentage *C. decorticatum* (RRT)	*C. flabellatum* (RRT)
Fraction D			
3,8-Dimethyl-2,7-nonadienoate	$C_{12}H_{20}O_2$ (196)	-	17.80 (0.99)
Tridecatrienoate	$C_{14}H_{22}O_2$ (222)	2.00 (0.98)	-
Pentadecenoate	$C_{16}H_{30}O_2$ (254)	3.20 (1.30)	-
n-Pentadecanoate (Pentadecylate)	$C_{16}H_{32}O_2$ (256)	20.00 (1.42)	-
n-Hexadecanoate (Palmitate)	$C_{17}H_{34}O_2$ (270)	-	10.25 (1.06)
Heptadecatrienoate	$C_{18}H_{30}O_2$ (278)	12.40 (1.45)	14.10 (1.08)
Heptadecenoate (Heptadecylenate)	$C_{18}H_{34}O_2$ (282)	6.60 (1.47)	10.25 (1.13)
n-Heptadecanoate (Margarate)	$C_{18}H_{36}O_2$ (284)	6.40 (1.51)	29.48 (1.27)
n-Nonadecanoate (Nonadecylate)	$C_{20}H_{40}O_2$ (312)	4.40 (1.61)	-
9-Eicosenoate (Gadoleate)	$C_{21}H_{40}O_2$ (324)	9.00 (1.63)	-
n-Docosanoate (Behenate)	$C_{23}H_{46}O_2$ (354)	6.00 (1.66)	-
Tricosenoate	$C_{24}H_{46}O_2$ (366)	10.40 (1.72)	-
Nonacosatrienoate	$C_{30}H_{54}O_2$ (446)	14.00 (1.95)	18.01 (1.29)
n-Nonacosanoate	$C_{30}H_{60}O_2$ (452)	5.40 (2.10)	-

Lipids of both the species were partitioned with different compositions of solvents. Therefore, the comparison of relative amounts of saturated and unsaturated fatty acids of both the species is not appropriate. However, *Codium decorticatum* differed remarkably in its fatty acid composition than *C. flabellatum.* Although fractions B and C of *C. flabellatum* exhibited greater variety of fatty acids than those of *C. decorticatum,* the fractions A and D of the latter species showed more than twice acids than those of the former one (Table 1). When the results of all the four fractions of each species are combined *C. decorticatum* contained much more variety of fatty acids than *C. flabellatum*. The unsaturated fatty acid found in largest quantity in *C. decorticatum* was heptadecatrienoic acid and that in *C. flabellatum* was nonacosatrienoic acid. It is unusual, as oleic acid normally occurs in largest amount among green seaweeds of Karachi (Shamed and Khan, 1991). Generally in marine algae, Cis fatty acids are less important, with oleic being the major monoenoic acid component (Harwood *et al*, 1989). One common theme for all marine algae, with the exception of chlorophyta including Codium, is that C_{20} polyenoic acids are the major constituents (Stymne *et al.*, 1987). The substituted unsaturated fatty acid, 7-ethyl-3-methyl-2, 6- undecadienoic acid, was found in *C. decorticatum* and could not be detected in *C. flabellatum* and other species (Aliya *et al*, 1991), while 3, 8-dimethyl-2, 7-nonadienoic acid was present in *C. flabellatum* but absent in *C. decorticatum*. Similarly several fatty acids were found only in one species, indicating specific differences among investigated seaweeds.

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