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Research Article

SONNERATIA ALBA J. SMITH: A VITAL SOURCE OF GAMMA LINOLENIC ACID (GLA)

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ABSTRACT

Fresh leaves and stem of the mangrove *Sonneratia alba* J. Smith were analyzed in an attempt to evaluate their potential contribution of fatty acid composition. Fatty acids play a crucial role in growth & development of the body. Essential fatty acids (EFAs) belong to family omega-3 & omega-6 needed in sufficient quantity in our body for proper functioning. From these EFAs, one of the most important fatty acid is Gamma Linolenic Acid (GLA), which occurs in higher percentage (25%) in evening prime rose as well as borage oil. But in the present investigation, GLA percentage in leaves of *S. alba* is 36.20% while in stem it is 11% along with other important fatty acids. The results show that GLA percentage in this mangrove species is very much significant with no trans-fatty acids. Therefore, it can be used as an alternative source of GLA.

Key words: Mangrove, Sonneratia alba, FAs, EFAs, GLA, trans fatty acids

INTRODUCTION

Mangrove is the term used for a group of plants that adapted for survival in sheltered saline habitats along the coasts of tropics & subtropics. In chemistry, especially biochemistry, a fatty acid is a carboxylic acid with a long unbranched aliphatic chain, which is either saturated or unsaturated. Most naturally occurring fatty acids have a chain of an even number of carbon atoms, from 4 to 28. Fatty acids are the building blocks of fat in the body & in food. They are a source of energy and constituents of cellular membranes as well. Fatty acids are the constituents of all plant cells, where they function as membrane components, storage products, metabolites, and as a source of energy [1]. They are also important nutrient substances and metabolites in living organisms [2]. However, fewer data are available for the fatty acids of mangroves & sediments in mangrove swamps [3, 4, and 5]

There are two families of essential fatty acids (EFAs), the omega-6 & omega-3 series. The omega-3 fatty acids were first discovered in the early 1970's when Danish physicians observed that Greenland Eskimos had an exceptionally low incidence of heart disease and arthritis despite the fact that they consumed a diet high in fat. These early studies established fish as a rich source of n-3 fatty acids. These EFAs cannot manufacture by the body in sufficient quantity & therefore must be obtained from food. Fatty acids that have double bonds are known as unsaturated while the fatty acids without double bonds are known as saturated. Monounsaturated (MUFA) if only one double bond is present and polyunsaturated fatty acids (PUFA) if they have two or more double bonds generally separated by a single methylene group. Fatty acids play an important role in many functions of the skin [6]. Polyunsaturated fatty acids especially Gamma linolenic acid(GLA)- needed for maintenance of hormonal balance & healthy skin structure, Arachidonic acid(AA)-found in membrane &helps with the transmission of messages in the central nervous system, Docosahexaenoic acid(DHA)- needed for brain and eye health & Eicosapentanoic acid(EPA)-maintaining healthy & supple joints, circulation and heart health represents importance of EFAs. The deficiency of these EFAs causes skin eruptions, loss of hair, liver degeneration, susceptibility to infections, poor wound healing, male sterility, arthritis, growth retardation and circulatory problems [7]. Among all these EFAs, one of the most important fatty acid is GLA.

GLA was first isolated from the seed oil of evening prime rose (*Oenothera biennis* L.). GLA is omega-6 polyunsaturated fatty acid & used as a dietary supplement. Some clinical research suggested that, GLA may be useful for the diabetic neuropathy, rheumatoid arthritis, allergies, breast cancer, eczema, high blood pressure, menopausal systems, mastalgia, osteoporosis, premenstrual syndrome, dietary source etc. [8]. There are several different types of omega-6 fatty acids. Most omega-6 fatty acids in the diet come from vegetable oils in the form of linoleic acid (LA). The body converts linoleic acid to GLA and then to arachidonic acid (AA). There is some preliminary evidence that, GLA may help reduce high blood pressure, either alone or in combination with the omega-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), found in fish oil. More recent research has established that EPA and DHA play a crucial role in the prevention of atherosclerosis, heart attack, depression and cancer[9,10]. In addition, omega-3 consumption reduced the inflammation caused by rheumatoid arthritis [11].

The present work is carried out on fatty acids from leaves and stem of *Sonneratia alba*. The present piece of work suggests a mangrove species *Sonneratia alba* as a rich source of essential fatty acids (EFAs) in general and GLA in particular.

Abbreviations: GLA, Gamma Linolenic Acid; AA, Arachidonic Acid; DHA, Docosahexaenoic Acid; EPA, Eicosapentaenoic Acid

MATERIAL AND METHOD

Extraction of fatty acids

Leaves and stem of naturally grown mangrove *Sonneratia alba* were collected from west coast of Maharashtra. Fresh leaves and stem were washed and blotted to dry. Then the samples were then subjected to extraction in methanol by using Soxhlet Apparatus. To analyze fatty acids from the oil fractions by gas chromatography technique, the oil was subjected to transesterification to obtain the fatty acid methyl esters. The fatty acid methyl ester fraction was eluted with petroleum ether: diethyl ether= 50:50 (v/v), the fractions were redissolved in hexane and subjected to GC analysis.

GC-FID analysis

Fatty acid methyl esters were analyzed by GC-FID. A SHIMADZU GC-17-A- gas chromatograph with flame ionization detector (FID) was used. Fatty acid methyl esters were separated on CHROMOPACK WCOT 25mX 0.25 mm ID, 0.2 µm film thickness capillary column using temperature programme from 15^{0}C/5 min, 4^{0}C / min until 235^{0}C and 50 min at 235^{0}C with the following conditions: Injector temperature 260^{0}C, FID temperature 260^{0}C and carrier gas-Helium. The identification of fatty acids was done by comparison with the methyl esters of standard fatty acids.

RESULTS AND DISCUSSION

In the previous reports, lauric acid was present in much lower amounts in the fresh leaves of some mangroves such as *A. marina, R. stylosa, R. apiculata, R. mucronata, Ceriops tagal, B. sexangula, B. gymnorhiza, A. ilicifolius, X. granatum and S. caseolaris* [12]

Rich source of GLA is evening prime rose and borage oil, which represents highest percentage 25-28%. But present investigation shows that, GLA found in the leaves as well as stem of *Sonneratia alba* are 36.20% & 11% respectively with no trans-fat. These amounts show higher than the evening prime rose & borage seed oil since this source may be used as significant source of GLA.The leaf & stem sample of *Sonneratia alba* shows highest percentage of saturated as well as polyunsaturated fatty acids with little monounsaturated fatty acids composition (Table 1 & 2). In leaf sample of *S. alba* saturated fatty acids, Tricosanoic acid (C23:0), Caprylic acid (C8:0) and Heneicosanoic acid (C21:0) are found in much more amount than others, while in stem Tridecanoic acid (C13:0), Myristic acid (C14:0) and Tricosanoic acid (C23:0) are found in large amounts (Figure 1 & 2). The result shows common saturated fatty acid in both leaf as well as stem is Tricosanoic acid (C23:0) with same quantity (25.40%). The presence of monounsaturated fatty acids are very least in both except Myristoleic acid (C14:1) and Cis-11-Eicosenoic acid (C20:1) present very neglible amount in leaf and stem respectively. But most important polyunsaturated fatty acids from family omega-3 and omega-6 are present in higher percentage in both leaf and stem of *S. alba*. Leaf sample shows one of the most EFA, which is must require by our body is GLA.

Table 1: Fatty acids of leaves of *Sonneratia alba* J. Smith.

Sr. No.	Fatty Acid	Percentage (%)
Saturated fatty acids		
1	Caproic acid (C6:0)	2.40
2	Caprylic acid (C8:0)	10.10
3	Myristic acid (C14:0)	2.30
4	Pentadecanoic acid (C15:0)	1.30
5	Arachidic acid (C20:0)	2.80
6	Heneicosanoic acid (C21:0)	6.60
7	Behenic acid (C22:0)	1.80
8	Tricosanoic acid (C23:0)	25.40
Total saturated Fatty Acids: 52.70%		
Monounsaturated fatty acids		
1	Myristoleic acid (C14:1)	3.40
Monounsaturated Fatty Acids: 3.40%		
Polyunsaturated fatty acids		
1	Gamma-Linolenic acid(C18:2n6c)	36.20
2	Linolenic acid (C18:2n6c)	1.80
3	Cis-11,14-Eicosadienoic acid (C20:2)	2.80
4	Cis-4,7,10,13,16,19-Docosahexaenoic acid (C22:6n3)	3.10
Total Polyunsaturated fatty Acids: 43.90%		

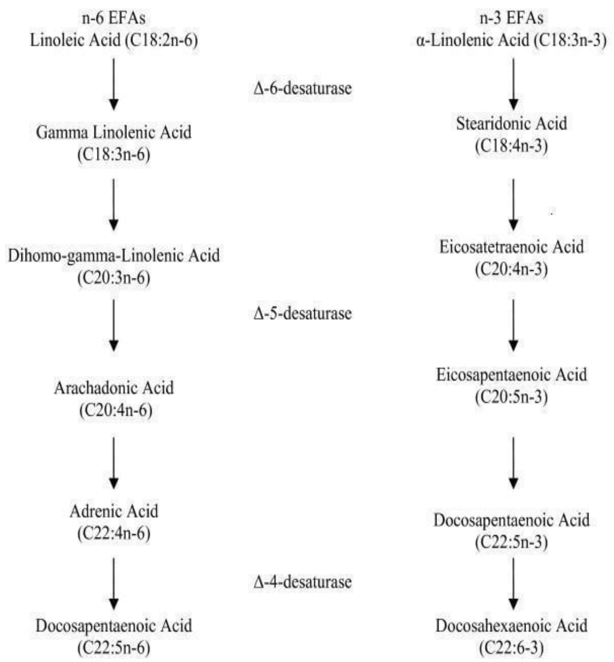

Fig 1: Linlenic acid GLA metabolism and elongation.

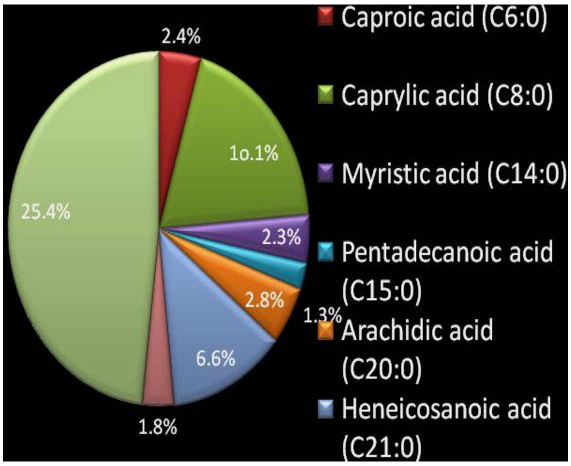

Figure 2: Leaf sample of S. alba:Saturated fatty acids

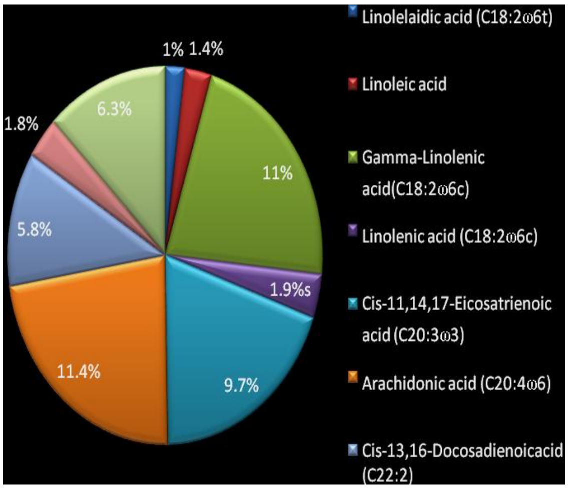

Fig 3: Leaf sample of *S. alba*:Polyunsaturated fatty acids.

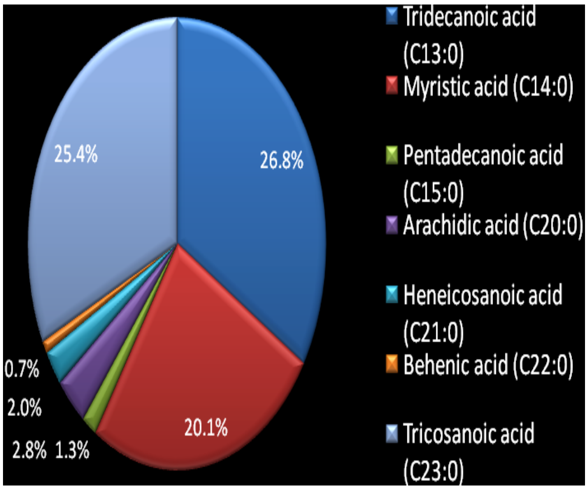

Figure-4: Stem sample of *S. alba*:Saturated fatty acids.

Table 2: Fatty acids of stem of *Sonneratia alba* J. Smith

Sr. No.	Fatty Acid	Percentage (%)
Saturated fatty acids		
1	Tridecanoic acid (C13:0)	26.80
2	Myristic acid (C14:0)	20.10
3	Pentadecanoic acid (C15:0)	1.30
4	Arachidic acid (C20:0)	2.80
5	Heneicosanoic acid (C21:0)	2.00
6	Behenic acid (C22:0)	0.70
7	Tricosanoic acid (C23:0)	25.40
Total saturated Fatty Acids: 49.60%		
Monounsaturated fatty acids		
1	Cis-11-Eicosenoic acid (C20:1)	0.20
Total Monounsaturated Fatty Acids: 0.20%		
Polyunsaturated fatty acids		
1	Linolelaidic acid (C18:2n6t)	1.00
2	Linoleic acid	1.40
3	Gamma-Linolenic acid(C18:2n6c)	11.00
4	Linolenic acid (C18:2n6c)	1.90
5	Cis-11,14,17-Eicosatrienoic acid (C20:3n3)	9.70
6	Arachidonic acid (C20:4n6)	11.40
7	Cis-13,16-Docosadienoicacid (C22:2)	5.80
8	Cis-5,8,11,14,17-Eicosapentaenoic acid (C22: 5n3)	1.80
9	Cis-4,7,10,13,16,19-Docosahexaenoic acid (C22:6n3)	6.30
Total Polyunsaturated fatty Acids: 50.30%		

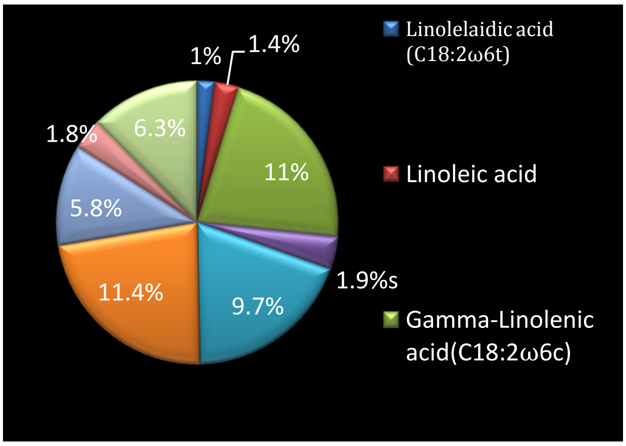

Figure 5: Stem sample of *Sonneratia alba*: Polyunsaturated fatty acids (Total PUSFAs=50.30%)

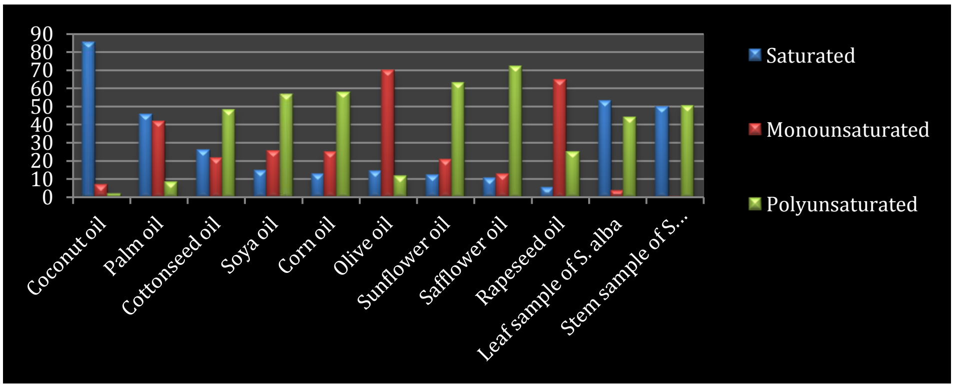

Figure 6: Comparision of *Sonneratia alba* leaf & stem sample with standard oils fatty acids.

Table-3: standard Fatty Acids in Dietary Fats in comparison with *Sonneratia alba:*

Sr. No.	Name of Sample	Saturated (%)	Monounsaturated (%)	Polyunsaturated (%)	Trans fat (%)
1	Coconut oil	85.2	6.6	1.7	0
2	Palm oil	45.3	41.6	8.3	0
3	Cottonseed oil	25.5	21.3	48.1	0
4	Soya oil	14.5	25.2	56.5	0
5	Corn oil	12.7	24.7	57.8	0
6	Olive oil	14	69.7	11.2	0
7	Sunflower oil	11.9	20.2	63.0	0
8	Safflower oil	10.2	12.6	72.1	0
9	Rapeseed oil	5.3	64.3	24.8	0
10	Leaf sample of *S. alba*	52.70	3.40	43.90	0
11	Stem sample of *S. alba*	49.60	0.20	50.30	0

The highest percentage of GLA extracted from seed oil of evening prime rose and borage oil which is 25-28%. This information relates with our data then the percentage of GLA is higher in leaf sample of *S. alba* which is 36.20% and in stem it is 11%. Not only the GLA but other EFAs are also present in much amounts namely linolenic acid, Cis-4,7,10,13,16,19-docosahexaenoic acid (DHA), arachidonic acid and cis-5,8,11,14,17-eicosapentaenoic acid (EPA) [Figure3&4]. Omega-3 fatty acids, such as docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) are important for enzymatic pathways required to metabolize long-chain polyunsaturated fatty acids (PUFAs). These EFAs are needed in proper amounts for various body functioning and presence of these EFAs in mangrove represents medicinal value of the coastal bioresources.

Omega-3 (n/ω-3) and omega-6 (n/ω-6) fatty acids are two separate distinct families, yet they are synthesized by some of the same enzymes; specifically, delta-5-desaturase and delta-6-desaturase. Excess of one family of FAs can interfere with the metabolism of the other, reducing its incorporation into tissue lipids and altering their overall biological effects (Figure-5).

The total saturated fatty acids in both leaf as well as stem of *S. alba* represents higher value 52.70% and 49.60% respectively in comparison with palm oil, cottonseed oil, soya oil, corn oil, olive oil, sunflower oil, safflower oil and rapeseed oil. Polyunsaturated fatty acids are also present in much more amount than coconut oil, palm oil, cottonseed oil, olive oil and rapeseed oil [13].

In comparison with fatty acids in dietary fats samples from both leaf and stem shows zero trans-fat. Trans fats are actually unsaturated fats, but they can raise total and LDL (bad) cholesterol levels while also lowering HDL (good) cholesterol levels. There is no trans fat indicating that the source is edible like other oils (Table-3 & Figure-6).

The role of fatty acids in our body has a specific function in appropriate amount. EFAs mainly GLA is the most essential for growth and development. Apart from GLA, many of the EFAs perform their role in proper enzymatic pathways to carry out important physiological metabolism. Linoleic acid, linolenic acid, and arachidonic acid are known as vitamin F, which is necessary for growth and protection of the skin. In summary our results suggests that percentage of GLA found in mangrove *Sonneratia alba* provides an alternative source of EFAs. So, the present investigation justifies the use of mangrove species in traditional medicine and specifically *Sonneratia alba* as a coastal bioresource.

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