RESEARCH PAPER | Botany | Volume : 5 | Issue : 8 | August 2015 | ISSN - 2249-555X

# Seeds of *Salicornia brachiata* as a source of edible oil

KEYWORDS: Salicornia brachiata, seeds, edible oil


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**ABSTRACT** *Salicornia brachiata is a salt tolerant halophyte occurs in mangrove habitats of the Godavari estuary. Seeds of the Salicornia brachiata were collected from estuarine regions of the Godavari deltaic regions, processedand analyzed to determine their potential to be used as source of edible oil. Two solvents were employed for extraction of oil and the quantity of oil varied from 24.5 to 26.5 ml/100gm of seeds.A total of 12 amino acids and 10 fatty acids were identified in the oil sample of S. brachiata seeds. The predominant fatty acids in this halophyte seed oil werepalmitic, stearic and oleic acids and no fatty acid exceeding 20 carbons was detected. The oil was rich (> 40 %) in polyunsaturated fatty acids, particularly oleic and linoleic acid, which has medical significance and, more specifically, the oil contained a small amount of C18:3 linolenic-ω3, which may result in better oil stability than commercial oils.Absence of fatty acids with more than C20 carbon chain make this oil a probable candidate for biofuel research. Interestingly the oil also contained amino acids especially isoleucine, alanine and glycine. No undesirable acid compounds were found in S. brachiata seed oil.*

**s1. Introduction**

*Salicornia brachiata* is an annual leafless with articulated and succulent herb occur in the mangrove habitats of the tropical regions of the world. Species of *Salicaornia* is a new seed oil crop for irrigation with salt water (Glenn et al. 1991; costa, 2006; zerai et al , 2010).Good quality oil was extracted from a salt tolerant species *Suadea moquinii* (Weber et al, 2001). Seeds of *S. bigelovii* contain 26-33% of fatty acids (Glenn et al., 1998, Anwar et al., 2003) exceeding levels of traditional oil seeds such as cotton (15-24%) and soybean (17-21%) The average seed production varies from 2.0 to 2.7 tonnes / hectare/year (Clark, 1994). Several investigations have emphasized the importance of halophyte oil as a source of poly unsaturated fatty acids (Glenn et al., 1998, Ruana et al., 2008). Plants popularly known as Sea asparagus are cooked and eaten as vegetable or pickled. It is also a good fodder for cattle, sheep and goat. Plant material is also used as raw material in paper and board factories. Its seeds yield high quality edible oil which is rich in poly unsaturated fatty acids similar to safflower oil. Commercial cultivation of this population will generate the employment opportunities to the coastal inhabitants, besides most of the wastelands can be converted into productive soils. (Narasimha Rao and Reddi , 2013) studied the distribution and density of *Salicornia brachiata* in the mangrove habitats of the Godavari estuary. In the present investigation an attempt was made on the extraction of oil from the seeds of the *Salicornia brachiata* and examines the composition and its suitability as edible oils.

**2. Material and methods**

Populations of *Salicornia brachiata* were raised in the estuarine regions of Chollangi near Kakinada. Harvesting carried out, when color of the plant populations turn into yellow. Seeds were collected, cleaned and separated using 0.7mm sieves. The seeds were washed thoroughly to remove other unwanted materials and then dried at 50˚C for 24 h. Dried seeds were weighed and ground. The powdered seeds were neatly packed and stored at −20˚ C for seven days. The oil was extracted from the powdered seeds through the solvent extraction method using hexane and petroleum ether. About 100 g powdered seed immersed in above said solvent and was agitated gently in a conical flask for 24 h. The residue was allowed to settle and supernatant was decanted and heated to 40˚C until solvent was completely evaporated. The final weight of the solid material left after evaporation was noted.

**2.1 Fatty acid profiles**

**2.1.1 Methanolysis of oil sample:**

A standard protocol involving saponification followed by $BF_3$ catalyzed methylation of fatty acids was done on the oil sample. An oil sample in a screw-capped glass tube (16.5 × 105 mm) was hydrolyzed with 1 ml of 1 M KOH in 70% ethanol at 90°C for 1 h. The reaction mixture was acidified with 0.2 ml of 6 M HCl, and then 1 ml of water was added. FFAs released were extracted with 1 ml of hexane. After evaporation of the hexane in vacuo, the FFAs were methylated with 1 ml of 14% BF 3 in methanol at 37°C for 20 min. Water was added to the solution, and then FAMEs were extracted with 1 ml of hexane.

Fatty acid methyl esters were analyzed by using GC-MS 2010 AF PLUS (Shimadzu, Kyoto, Japan) fitted with a Supelco wax-10 fused-silica capillary column (Supelco, Bellefonte, PA) (60 m ×0.32 mm i.d.). The column temperature was kept at 150°C for 2 min, then raised to 220°C at a rate of 3°C/min and held for 15 min. Identification of individual fatty acids was done by an automatic comparison of the mass spectral fragmentation with that of NIST database supplied with the system. HPLC analysis was done on Agilent 1100 HPLC system with a PDA detector and an Eclipse Plus C-18 column.

**3. Results and Discussion**

Oil extracted from the seeds of *Salicornia brachiata* varied in the yield using different solvents. Maximum oil yield (26.5 ml.) was reported when the powered seeds were extracted with petroleum ether and 24.5 ml. oil was obtained when treated with the solvent hexane (Table.1). Results of the present study agrees with the investigations of ( Eganathan et.al.,2006).

Volume : 5 | Issue : 8 | August 2015 | ISSN - 2249-555X

**Table 1. Extraction of oil from seeds of *Salicornia brachiata* using two different solvents**

| S .No | Seed quantity **(grams)** | Oil Extraction **(ml)** | |
|---|---|---|---|
| | | Petroleum ether | Hexane |
| 1 | 100 | 24.5 ±0.42 | 21.5 ± 0.34 |
| 2 | 100 | 23.0 ± 0.36 | 22.0 ± 0.26 |
| 3 | 100 | 25.5 ± 0.29 | 23.5 ±0.31 |
| 4 | 100 | 25.0 ± 0.39 | 22.5 ±0.41 |
| 5 | 100 | 26.5 ± 0.42 | 24.5 ± 0.37 |

**Table 2. HPLC analysis of the seed oil**

| S.No | Amino acids | **Conc** **(Pmol** /µL) |
|---|---|---|
| 1 | Phosphoserine | 8.085 |
| 2 | Aspartic acid | 3.008 |
| 3 | Glutamic acid | 0.693 |
| 4 | Serine | 24.522 |
| 5 | Glycine | 31.391 |
| 6 | Alanine | 91.507 |
| 7 | Anserine | 5.274 |
| 8 | Valine | 4.384 |
| 9 | Methionine | 1.601 |
| 10 | Isoleucine | 157.289 |
| 11 | Phenylalanine | 4.795 |
| 12 | Lysine | 6.264 |

HPLC analysis on the seeds of the *Salicornia brachiata* reveals that the presence of 12 amino acids including isoleucine, alanine and methionine (Table.2). The GC-MS results clearly showed the presence of 10 fatty acids, out of which four major fatty acids viz., palmitic acid methyl ester (27.726%), oleic acid methyl ester (22.225%), stearic acid methyl ester (23.017) and linoleic acid methyl ester (18.946) as shown in the table.2

**Table 3: GC-MS FAME analysis of the oil sample**

| Fatty acid methyl ester | m/z | carbons | % |
|---|---|---|---|
| (Z)-9-Hexadecenoic acid, methyl ester | 55 | C16 | 0.789 |
| Palmitic acid methyl ester | 74 | C16 | 27.726 |
| Oleic acid methyl ester (Z, Z) | 67 | C18 | 22.225 |
| Stearic acid methyl ester | 74 | C18 | 23.017 |
| Linoleic acid methyl ester (Z, Z) | 67 | C18 | 18.946 |
| Docos-13-enoic acid (Z) | 55 | C20 | 1.727 |
| Arachidic acid methyl ester | 74 | C20 | 3.462 |
| Ricinoleic acid | 83 | C18 | 0.388 |
| 11-eicosenoic acid methyl ester (gondoic acid) | 55 | C20 | 1.724 |

The oil was rich (> 40 %) in polyunsaturated fatty acids, particularly oleic and linoleic acid, which has medical significance and, more specifically, the oil contained a small amount of C18:3 linolenic-ω3, which may result in better oil stability than commercial oils (El-Mallah et al. 1994). For instance, soya bean oil contains up to 6.8% of linolenic-ω3, and it is less stable due to fast oxidation. The sum of saturated palmitic and stearic acids (24.8%) in *S. ambigua* seed oil represents a major quantitative difference in comparison to commercial oils, such as canola and olive oil with low saturated acids, Similar high concentrations of palmitic acid (21.8-29.4%) were found in seeds of salt flat and coastal dune halophytes (*Arthrocnemum macrostachyum*, *Haloxylon stocksii*, *Alhagi maurorum*, *Cressa cretica* and *Halopyrum mucronatum*) from Asia (Weber et al., 2007). Ricinoleic acid, a major constituent of castor oil, is also present in the oil extracted from *S. brachiata*. Absence of fatty acids with more than C20 carbon chain make this oil a probable candidate for biofuel research.

*S. brachiata* can be cultivated in estuarine and salt-water irrigated regions of the tropical and subtropical habitats of the world. Seed oil of this species showed the composition similar to the edible oils. No undesirable fatty acid component was found in *S.brachiata* seed oil and it could be recommended for bio fuel production also.

**ACKNOWLEDGEMENT**

Grateful thanks are due to the Department of Science & Technology, Technology Bhavan, New Delhi for the Financial assistance Under the Project "Distribution, cultivation and Conservation of *Salicornia brachiata*: a potential halophyte for bio-fuels". Sanction order No. WTI/ WARW/13/2011 (G) dated 14-11-2011.

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