Mangroves acquire a range of features which make them uniquely adaptable to their stressful environment, they are halophytic or salt tolerant, have aerial roots for gathering oxygen and seeds that geminate on the tree. Mangroves like other plants depend on the photosynthetic reduction of carbon dioxide to form carbohydrates and other organic constituents necessary for growth and maintenance. They are known to synthesise more polyphenols and tannins in response to salinity and organic acid metabolism which vary with different species (Basak et al., 1996). These salt-tolerant plants have evolved mechanisms to cope with the harmful environmental conditions that include salt and desiccation. Mangroves have enormous economic and ecological value. Extracts from mangroves and mangrove-dependent species have proven activity against human, animal and plant pathogens. Mangroves may be further developed as sources of high-value commercial products and fishery resources and as sites for a burgeoning ecotourism industry. They protect and stabilise coastlines, enrich coastal waters, yield commercial forest products and support coastal fisheries. Mangrove forests are among the world’s most productive ecosystems, producing organic carbon well in excess of the ecosystem requirements and
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contributing significantly to the global carbon cycle. Mangroves create typical ecological environments that host rich assemblages of species.

In order to assess the contribution of mangroves towards the environment and their importance as sources for potential chemicals for future use, chemotaxonomy is of much relevance compared with the classical taxonomy based on morphological features. In chemotaxonomy, environment has a specific role. It is linked with environmental compositions as well as the metabolic character of the plants. So, environmental conditions are important. In order to understand the relative importance of biochemical processes and the relevance of chemotaxonomy, it is necessary to characterise and quantify chemical constituents in the plant materials. The Rhizophoraceae family of true mangrove plants is the most populated and contains widely distributed species. There is a gap of information towards the chemistry of Rhizophoraceae mangroves from Kerala for their use in various applications including extraction of bioactive metabolites and as biomarkers.

The main objective of the study was to identify the major factors contributing to the chemotaxonomy of Rhizophoraceae mangroves and to identify the potent species for the extraction of bioactive metabolites. The leaves and bark of five mangrove plants of family Rhizophoraceae; Bruguiera cylindrica and Bruguiera gymnorrhiza belonging to the genus Bruguiera; Kandelia candel of the genus Kandelia; Rhizophora mucronata and Rhizophora apiculata of the genus Rhizophora are considered for this study. The basic chemical characterisation of the mangroves have been carried out by determining the elemental, isotopic, mineral and biochemical composition of the leaves and bark. The presence of food flavonoids and
their relevance towards chemotaxonomy has been investigated. The use of n-alkanes and fatty acids in chemotaxonomic studies and biomarker studies has been validated by their quantitative and qualitative analysis.

*K.candel* was found to exhibit highest carbon content among the five *Rhizophoraceae* mangroves under investigation. The macronutrient elements, H,N, P and S are more concentrated in the leaves and less in the bark of mangroves while C is more concentrated in their bark. No specific trends were observed according to genera. The carbon isotope composition of leaves of the *Rhizophoraceae* mangrove under the present investigation matches well with the all ready established values of δ¹³C for C3 plants. The plant components of *K. candel* were enriched in ¹³C relative to other *Rhizophoraceae* mangroves by 1 to 2.5‰. The most depleted δ¹³C was found in *B. gymnorrizha*. The present nitrogen stable isotope results fall within the range of plants that obtain inorganic nitrogen directly from seawater. The lower C/N in the leaves suggests that the leaves have high nutrient quality compared to bark and significantly higher nutritional quality was observed in *B. cylindrica* leaves than the other mangrove plants in this study.

All plants, except *B. gymnorrizha* are found to accumulate sodium in their leaves than in the bark. The genus *Rhizophora* as well as *Kandelia* exhibited higher potassium content than the *Bruguiera* plants. The salt exclusion mechanism is efficiently operative in *K. candel* followed by *Rhizophora* species. Plants of the genus *Bruguiera* were found to be the least salt excluding mangroves among the *Rhizophoraceae* plants under investigation. *R. apiculata* leaves were found to be the richest in magnesium.
content while the iron rich mangrove plant was found to be *B. gymnorrhiza*. All the mangrove plant parts investigated contained manganese within the recommended level for plants. Zinc and copper content was found to be highest in *K. candel*. Pb in this study was found to be below the recommended levels. In this research study, it was found that the leaves and bark of the mangrove plant *R. mucronata* is free from cadmium.

The present study gives an idea that, except for *Bruguiera* mangroves, the major portion of the total carbohydrates are in the form of low molecular weight carbohydrates. Being high in sugars, proteins and lipids, *K. candel* was found to be species with high calorific value. The leaves of *K. candel*, the bark of *R. apiculata*, the leaves and bark of *R. mucronata* can be used as sources of antioxidant materials. Using PCA, the major processes differentiating the mangroves plants are identified as the transport of photosynthetic products in leaves and accumulation as well as storage of minerals and nutrients. The leaves of the two *Bruguiera* plants exhibited distinct chemical character with respect to the minerals and biochemical parameters, *B. cylindrica* being more similar to the genus, *Rhizophora*. The study also reveals the intermediate chemical character of *K. candel* and the distinct behaviour of *B. gymnorrhiza*.

The observed levels of flavonoid contents confirm the importance of these mangrove plants as excellent sources of plant antioxidants. The quantitative and qualitative estimation of the five bioactive food flavonoids-myricetin, quercetin, kaempferol, luteolin and apigenin- in *Rhizophoraceae* mangroves is done for the first time. The total flavonoids are found to be more concentrated in the leaves than in the bark. Quercetin was found to be
the ubiquitous flavonoid and found to be present in high concentration in all the mangroves of this study. *B. gymnorrhiza* can be a very good source of myricetin.

The presence of luteolin in *B. cylindrica* alone as well as the variations in different flavonols and flavones in these plants can be helpful for providing chemotaxonomic relationships between different genera of this family. Comparing the flavonoid composition of the five species reveals greater similarity of *R. mucronata* with *B. gymnorrhiza*. The presence of all the flavonoids in their leaves can be regarded as a specific taxonomic character of the plants, *R. mucronata* and *B. gymnorrhiza*. From this study it is found that all the mangroves of the family *Rhizophoraceae* can be regarded as primitive in flavonoid patterns. *R. mucronata* contains the flavonoid, procyanide Type B which is isolated for the first time from this plant.

The leaves and barks contribute differently towards the chemical classification of the five mangrove plants; *B. cylindrica*, *B. gymnorrhiza*, *K. candel*, *R. apiculata* and *R. mucronata* on the basis of their alkane composition. The study identifies C\textsubscript{31} as the most abundant n-alkane in the *Rhizophoraceae* mangroves with an exception of *R. mucronata* which showed high abundance for C\textsubscript{29}. The n-alkane profiles of the mangrove plant leaves and bark were characteristic by a high proportion of low molecular weight components. The higher proportions of C\textsubscript{17} and C\textsubscript{22} detected in the mangroves suggest the need to adopt or develop methods and proxies in which the quantity and distribution of n-alkanes of the dominant mangrove species of neighbouring mangrove area while using it as a
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Biomarker. Alkane compositions link the two genera, Bruguiera and Rhizophora closer with K. candel showing an intermediate character between the them. Rhizophoraceae mangroves, especially R. mucronata can be used as a potential source for the production of wax for food use. The results of PCA support the limitations of alkanes towards its use in chemotaxonomic as well as biomarker studies.

Linoleic acid is the most abundant fatty acid found in the Rhizophoraceae mangroves from Kochi, southwest coast of India. The study confirms the use of the PUFAs, cis-18:2ω6 and 18:3ω3 as biomarker for mangrove plants. The lower or nil concentration in the mangroves plants use of long chain fatty acids limit their use as biomarkers for mangrove plants. B. cylindrica is chemically distinct from other mangrove plants by the presence of fatty acids 20:5ω3 and 20:3ω6 whereas the absence of fatty acid 18: 1ω9trans in B. gymnorrizha alone makes it distinct. Similarities exist between the genera Kandelia and Rhizophora with respect to the presence of FA 22:0 and absence of FA 22:1ω9. The variation of fatty acid profiles depends upon geographical location and this variation is not the same in all plants except for the most dominant fatty acid. Also, these variations cannot be related to classical taxonomic variations. From the study it was found that the leaves and barks contribute differently to the fatty acid composition of the plants, thereby to the surrounding sediment environment. The variation in the foliar nutrient levels with respect to fatty content can be used to study the food preferences in the mangrove dependent organisms. These mangrove plants can be used as a source of essential fatty acids of manifold benefits.
The quantity and quality of the beneficial and toxic components in the mangrove extracts are helpful in evaluating their use in ethanopharmaceutical practices thereby opening new corridors for novel drug development. The chemical parameters of mangrove leaves and bark can assist in an effective application of taxonomic approach towards their use in various economic and ecological services.

Combining the observations of the chemical components-resemblance of C3 plants by the $\delta^{13}$C values, terrestrial character by fatty acids and intermediate character between terrestrial and aquatic by alkanes-the mangroves can be classified only as modified vascular plants with properties of both terrestrial and aquatic plants. When the beneficial characters are considered chemotaxonomy is more relevant than morphological classification and the former depends on environment settings. So, chemotaxonomy should be defined on environment setting while morphological classification does not have any relation with environment setting. This study provides a significant evidence for this hypothesis. Species diversity is not the same as diversity in chemicals. Plants of same genera show different chemical characters. It can be concluded that alkane profiles cannot end up in specific classification except to define the general character of the plants whereas flavonoids and fatty acids can be used as chemotaxonomic markers for Rhizophoraceae mangroves form Kochi.