Natural Product Research: Formerly Natural Product Letters

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gnpl20

Seed oils from non-conventional sources in north-east India: potential feedstock for production of biodiesel

Priyanka Barua\textsuperscript{a}, Kajal Dutta\textsuperscript{a}, Sanjay Basumatary\textsuperscript{a}, Dinesh C. Deka\textsuperscript{b} & Dibakar C. Deka\textsuperscript{a}

\textsuperscript{a} Department of Chemistry, Gauhati University, Guwahati 781014, Assam, India
\textsuperscript{b} Department of Botany, Birjhora Mahavidyalaya, Bongaigaon 783380, Assam, India

Published online: 31 Jan 2014.

To cite this article: Priyanka Barua, Kajal Dutta, Sanjay Basumatary, Dinesh C. Deka & Dibakar C. Deka (2014) Seed oils from non-conventional sources in north-east India: potential feedstock for production of biodiesel, Natural Product Research: Formerly Natural Product Letters, 28:8, 577-580, DOI: 10.1080/14786419.2014.881361

To link to this article: http://dx.doi.org/10.1080/14786419.2014.881361

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the “Content”) contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms &
SHORT COMMUNICATION

Seed oils from non-conventional sources in north-east India: potential feedstock for production of biodiesel

Priyanka Barua, Kajal Dutta, Sanjay Basumatary, Dinesh C. Deka and Dibakar C. Deka*

Department of Chemistry, Gauhati University, Guwahati 781014, Assam, India; Department of Botany, Birjhora Mahavidyalaya, Bongaigaon 783380, Assam, India

(Received 26 October 2013; final version received 6 January 2014)

A total of nine oilseeds with more than 15 wt% oil have been investigated for evaluating them as feedstock for biodiesel industries. Fatty acid profiles of all the nine oil samples have been determined by GC–MS analysis. The saponification numbers, gross heats of combustion of the oils and those of corresponding fatty acid methyl esters (FAMEs) as well as cetane indices of the FAMEs have been calculated empirically. Iodine values have been determined experimentally. These values have been used for predicting the quality of the corresponding biodiesels. If prepared from these oils, biodiesels are likely to meet the major specification of biodiesel standards of the USA, Germany and European Standard Organisation. Seed oil from Cucumis sativus is found rich in linoleic acid which is considered an essential fatty acid of biological significance.

Keywords: oilseeds; biodiesel; saponification number; iodine value; cetane index; north-east India

1. Introduction

In the search for alternative, biodegradable, carbon-neutral, non-toxic and renewable fuels to sustain with continuing developments, biodiesel has emerged globally, with considerable potential to replace conventional sources of energy such as petroleum-derived fuels, coal and natural gas which are fast depleting, and at the current usage rate will soon be exhausted (Ma & Hanna 1999; Srivastav & Prasad 2000; Karmee & Chadha 2005; Ramadhar et al. 2005). Due to the use of edible vegetable oil as major feedstock, biodiesel suffers from one of its major disadvantages, viz. high cost. Alternative feedstock needs to be explored to make production of biodiesel cost-effective (Srivastav & Prasad 2000; Zhang et al. 2003). Use of vegetable oils from non-conventional sources such as wild and non-edible fruits as feedstock may be the answer. Such oils will have no competition from the edible oils, and this will help in stabilisation of market price for feedstock.

North-east of India (90°E to 97°E and 22°N to 29°N) is considered a biodiversity hotspot, and here in this region one can find a wide variety of plant species, many of which produce oilseeds but not used for human consumption. Many such plants are fast vanishing because people are not interested in their preservation as they do not grow with a price-tag. Use of such non-conventional and non-edible feedstock from wild plants will ensure preservation of many plant species which are on the verge of extinction. Such visionary action may help to prevent global warming and related fallouts. Some of the plants already investigated and reported from this region are Nahor (Mesua ferrea) (De & Bhattacharyya 1999), Karanja (Pongamia pinnata)
2. Results and discussion

2.1. Oil contents of plant seeds

Both oil content and quality of oil are important parameters for screening oilseeds as potential and economically viable source of oils. On this background, a total of 54 oilseeds were screened, and 9 of them listed in Table S1 were taken up for further investigation. These nine oilseeds are rich in oil ranging from about 18 wt% to about 48 wt% (after purification).

*Citrus maxima* Merr., locally called ‘Robab tenga’ in Assamese, is an important source of non-conventional oil with the highest oil content (48%). The plant bears edible fruits spherical in shape (14–20 cm in diameter, weighing 0.75–2.0 kg) with a good number of small seeds inside. Fruits are popular but are yet to be commercially exploited. Commercial exploitation of the fruits would yield large quantities of seeds which can be used for the production of oil.

Another economically viable feedstock for biodiesel which may be considered for further research is *Anisomeles indica* (‘Thoiding angouba’ in local language) from Manipur. It is a wild plant (herbaceous shrub) of about 1.5 m height with one-seeded nutlets that are ovoid, 1.8 mm in diameter and glossy black when ripe. With oil content as high as 41.8% and all the physico-chemical property parameters in the prescribed range, this plant also attracts attention as a feedstock for biodiesel.

2.2. Transesterification of seed oils with methanol to fatty acid methyl esters

All the nine seed oil samples were transesterified to the corresponding fatty acid methyl esters (FAMEs) using a catalyst derived from *Musa balbisiana* Colla (a variety of banana plant) (Deka & Talukdar 2007; Deka & Basumatary 2011) at ambient temperature of 30–35°C in less than 4 h with yields 90–96 wt% (Table S2).

2.3. Composition of the FAME mixtures derived from the seed oils

Gas chromatography (GC) of the FAMEs and the mass spectrometric analysis of the individual GC peak reveal that major fatty acids present as their methyl esters are palmitic acid (C16:0), oleic acid (C18:1), stearic acid (C18:0) and linoleic acid (C18:2) (Table S3). The percentage of methyl palmitate is the highest in the FAME from *Luffa acutangula* (61.6%) and the lowest (9.6%) in the FAME from *A. indica*. Palmitoleic acid (C16:1) is observed only in one sample (*Jatropha curcas*), that too in very low concentration. Oleic acid is found in moderate quantities in all the seed oils, highest (70.5%) in *A. indica* and lowest (14.2%) in *L. acutangula*. Linoleic acid, the shortest chained ω-6 fatty acid, which is considered as an essential fatty acid of immense biological significance (Lands 2005; Hibbeln et al. 2006; Harris et al. 2009), is observed in high percentage in FAMEs derived from *Cucumis sativus* (65.5 wt%) seed oil. This seed oil deserves further attention from nutritionists. Arachidic (eicosanoic) acid (C20:0) is observed in three samples in low concentration (Table S3). Behenic (docosanoic) acid (C22:0) is observed in only one sample (*Parkia timoriana*), but its unsaturated derivatives are absent in all the samples.

2.4. Iodine values of the oil samples

Iodine value (IV) is a measure of the degree of unsaturation in an oil sample, and it ranges from 35.6 to 115.2 g I₂/100 g oil for the nine samples studied (Table S4). *L. acutangula* seed oil...
with IV 35.6 (lowest) is dominated by saturated C16:0 acid (61.6%) while *A. indica* with IV 115.2 (highest) is dominated by unsaturated 18:1 fatty acid (70.5%). Unsaturation to limited extent is desirable in biodiesel feedstock to meet the requirements for cold weather conditions (Ramos et al. 2009). Unsaturation reduces cloud point, pour point and cold filter plugging point to make biodiesel suitable for cold weather conditions. However, a very high IV is not desirable. A high IV denotes the presence of higher number of double bonds, which in turn reduces the cetane number and shelf life by reacting with atmospheric oxygen. The biodiesel standards of Germany (DIN 51606) and European Organisation (EN 14214) have set the maximum permissible limit of IV as 120 and 115, respectively. Out of the nine seed oil samples reported here only, one sample (*A. indica* seed oil, IV 115.2) is slightly above the limit of the standard of the European Organisation (EN 14214), but well within the German (DIN 51606) permissible limit. Thus all the nine samples are qualified to be good feedstock for biodiesel industries.

### 2.5. Calculated saponification number, cetane index and gross heats of combustion

The saponification number (SN) value gives an idea about the number of ester equivalents per unit mass of the oil or biodiesel. Higher SN value of a glyceride indicates the dominance of shorter chain fatty acids or vice versa. The SN values of the nine samples listed in Table S4 range from 190.6 to 199.7 mg KOH/g oil with *A. indica* having the lowest (190.6 mg KOH/g oil) and *L. acutangula* having the highest SN value (199.7 mg KOH/g oil). The biodiesels obtained from soybean, sunflower, palm, canola and *J. curcas* oils have SNs 201, 200, 207, 182 and 202 mg KOH/g, respectively (Winayanuwattikun et al. 2008; Leung et al. 2010). All the nine seed oil FAMEs have SN values which are comparable to these values.

Cetane index (CI) is an important parameter to judge ignition quality of biodiesel fuels. Calculated CIs for biodiesels corresponding to all the nine oil samples are shown in Table S4. Biodiesel standards of the USA (ASTM D6751), Germany (DIN V 51606) and the European Organisation (EN 14214) are 47, 49 and 51, respectively, as the minimum requirement. Thus all the nine seed oils have CI values well above the minimum prescribed norms set by all the three standards.

The gross heats of combustion (HG), or the energy released when a compound undergoes complete combustion with oxygen under standard conditions, is an important parameter in deciding the suitability of an oil or the corresponding FAME mixture for use in diesel engines. GH of the oils under investigation and the corresponding FAMEs are shown in Table S4. It should be noted that the HG values of oils and the corresponding values for the FAME mixture are practically the same, and this is expected because atomic composition on the conversion of oil to FAME mixture virtually remains unchanged both qualitatively and quantitatively. All the nine samples reported here have HG values of about 36–39 MJkg⁻¹.

### 3. Conclusions

A total of nine seed oils were investigated for suitability as feedstock in biodiesel industries. All the samples were converted to FAME in 90% or more yields using a heterogeneous base catalyst. Almost all the oils contain palmitic, linoleic, oleic and stearic acids in varying compositions. Apart from these major fatty acids, arachidic acid, behenic acid, eicosenoic acid and palmitoleic acid are also observed as minor constituents in a few samples. IVs of the samples were determined experimentally, while SNs, GH and CIs of the FAME mixtures were estimated empirically. Based on these data, all of the nine samples are considered as prospective candidates for feedstock in biodiesel industries. Biodiesel prepared from these seed oils is expected to meet the biodiesel standards in the USA, Germany and the European Organisations.
Supplementary material

Experimental details relating to this article are available online, alongside Tables S1–S4.

Acknowledgements

This work was funded by the Department of Biotechnology (DBT), Government of India. One of the authors (PB) thanks the DBT for a Junior Research Fellowship.

References


