

# Estimation of Microalgae Biodiesel Quality Based on Fatty Acid Compositions



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## ABSTRACT:

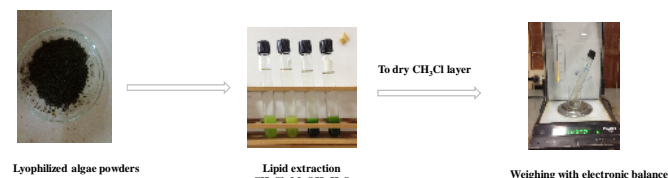
Microalgae are feedstocks for second generation fuel that can be used as a renewable source of biodiesel with the potential to displace petroleum fuel. They produce oils with high lipid content, fast growing rates and capable of growing in saline waters. Six species of microalgae, *Nannochloropsis sp.*, *Chlorella sp.*, *Dunaliella sp.*, *Isochrysis galbana.*, *Tetraselmis sp.* and *Chaetoseros sp.* from marine were investigated in our work. The fatty acid compositions obtained from transesterification method were determined by gas chromatography with flame ionization detector (GC-FID). The chromatogram showed palmitic acid (C16:0), oleic acid (C18:1) and linoleic acid (C18:2) were the major acids in all species. In addition, fatty acid compositions were used to predict the quality of fatty acid methyl ester or biodiesel by empirical determination. Three values; saponification number (SN), iodine value (IV) and cetane number (CN) were obtained from determination. The result showed SN and IV were varied from 161.03 to 192.60 and 43.51 to 63.95 respectively. The CN value of every species were higher than 51 that limited for ignition property of fuel. In addition, fatty acid compositions obtained from methylation with boron trifluoride were compared the estimation CN value with transesterification method. Thus in this research, fatty acid composition suggested that our six species of microalgae can generate biodiesel with high quality.

## OBJECTIVE:

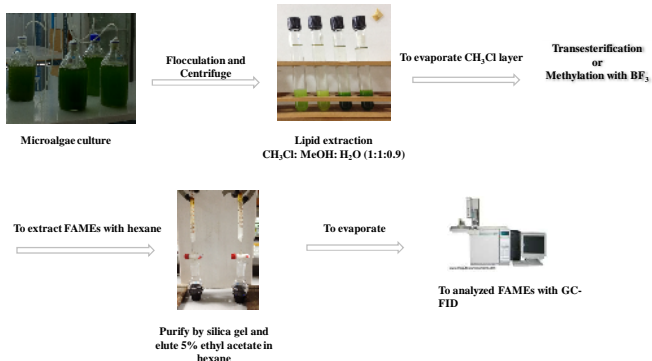
To screen 6 microalgae species by investigated lipid content and fatty acid profile that used for estimating the biodiesel properties. The iodine value (IV), saponification number (SN) and cetane number (CN) were predicted from FAMES composition by gas chromatography (GC).

## METHOD:

### Lipid content



### Fatty acid composition



### Estimation of biodiesel properties

$$SN = \frac{(560 \times A_1)}{MW_i} \quad (1)$$

$$IV = \frac{(254 \times D \times A_2)}{MW_i} \quad (2)$$

$$CN = 46.3 + \frac{5458}{SN} - 0.225 \times IV \quad (3)$$

A<sub>1</sub> is the percentage, D is the number of double bond and MW<sub>i</sub> is the molecular mass of fatty acid

## CONCLUSIONS:

In this study different two method, transesterification with sodium methoxide and BF<sub>3</sub> method were applied for converting lipid to fatty acid methyl ester. It was observed that transesterification method present the best result on fatty acid acid compositions. The result showed high amount of most identify fatty acid and less amount of unidentify fatty acid. While BF<sub>3</sub> method showed less amount of identify fatty acid and high amount of unidentify fatty acid. Both results indicate that transesterification method is better than BF<sub>3</sub> method in fatty acid composition analysis for wet microalgae sample.

The microalgae biodiesel qualities estimated on SN, IV and CN value have desirable value within the requirement of EN standard. In addition, *Chlorella sp.* is selected as raw material for our further study in biodiesel production process.

## RESULT:

Table 1 Fatty acid profile of six microalgae from transesterification and methylation with BF<sub>3</sub>

Fatty acid (%)	Microalgae species					
	<i>Nannochloropsis</i>	<i>Chlorella</i>	<i>Isochrysis galbana</i>	<i>Tetraselmis</i>	<i>Dunaliella</i>	<i>Chaetoseros</i>
C12:0	0.00, (0.00)*	0.00, (0.00)	0.00, (0.00)	0.00, (0.00)	0.00, (0.00)	0.00, (0.00)
C14:0	0.00, (3.59)	1.05, (1.24)	1.19, (23.25)	1.20, (5.50)	1.08, (1.50)	0.79, (17.55)
C14:1	1.44, (0.00)	0.27, (0.00)	0.45, (0.00)	0.24, (0.00)	0.32, (0.00)	0.48, (0.00)
C16:0	29.59, (4.10)	36.53, (1.91)	44.63, (2.86)	48.19, (1.80)	39.16, (3.11)	28.79, (27.74)
C16:1	0.00, (0.00)	0.48, (0.00)	0.55, (0.00)	0.48, (0.00)	0.69, (0.00)	0.75, (0.00)
C18:0	0.00, (0.00)	0.00, (11.47)	0.00, (0.00)	0.00, (0.00)	0.00, (0.00)	0.00, (0.00)
C18:1	38.22, (27.64)	41.82, (5.92)	37.20, (35.96)	34.25, (32.58)	36.06, (11.82)	45.40, (15.31)
C18:2n6c	2.85, (0.00)	10.85, (25.8)	8.47, (4.13)	8.70, (0.00)	10.42, (0.00)	10.11, (0.00)
C18:2n6t	7.02, (11.49)	0.00, (0.00)	0.00, (0.00)	0.00, (12.49)	0.00, (13.45)	0.00, (2.48)
C18:3n6	0.00, (0.00)	0.00, (0.00)	0.00, (0.00)	0.00, (0.00)	0.00, (1.15)	0.00, (0.00)
C18:3n3	1.21, (8.71)	0.82, (11.78)	0.06, (1.24)	0.26, (5.85)	0.49, (23.29)	0.00, (5.18)
C20:0	0.00, (0.00)	0.00, (0.00)	0.16, (0.00)	0.26, (0.00)	0.06, (0.00)	0.25, (0.00)
C20:1n9	0.90, (0.00)	0.25, (0.00)	0.17, (0.00)	0.23, (0.00)	0.17, (0.00)	0.75, (0.00)
C20:2	1.12, (0.00)	0.40, (0.00)	0.37, (0.00)	0.02, (0.00)	0.29, (0.00)	1.08, (0.00)
C20:3n6	0.00, (0.00)	0.00, (0.00)	0.00, (0.00)	0.00, (0.00)	0.00, (0.00)	0.00, (0.00)
C20:3n3	1.62, (0.00)	0.00, (0.00)	0.09, (0.00)	0.26, (0.00)	0.29, (0.00)	0.00, (0.00)
C20:4	0.00, (0.00)	0.00, (0.00)	0.00, (0.00)	0.00, (0.00)	0.00, (1.45)	0.00, (0.00)
C20:5	0.41, (0.00)	0.00, (0.00)	0.00, (0.00)	0.22, (0.00)	0.15, (0.00)	0.00, (4.27)
C22:0	0.00, (0.00)	0.00, (0.00)	0.19, (0.00)	0.77, (0.00)	0.00, (0.00)	1.54, (0.00)
C22:1n9	0.53, (0.00)	0.23, (0.00)	0.00, (0.45)	0.00, (0.00)	0.07, (0.00)	0.00, (0.00)
C24:0	0.00, (0.00)	0.00, (0.00)	0.00, (0.00)	0.28, (0.00)	0.00, (0.00)	0.00, (0.00)
C22:6	0.00, (0.00)	0.00, (0.00)	0.00, (1.08)	0.03, (0.00)	0.47, (0.00)	0.00, (0.00)
Unidentify	15.09, (43.49)	7.30, (42.60)	6.47, (31.04)	4.64, (41.78)	10.28, (41.92)	10.06, (25.26)

\*(%) Amount of fatty acid (%) from methylation with BF<sub>3</sub>

Table 2 Percentage of lipid content and estimated parameter of microalgae biodiesel obtained from transesterification method and methylation with BF<sub>3</sub>

Name	Lipid content (% dry wt.)	SN		IV		CN	
		Trans. <sup>1</sup>	BF <sub>3</sub> <sup>2</sup>	Trans.	BF <sub>3</sub>	Trans.	BF <sub>3</sub>
<i>Nannochloropsis sp.</i>	5.85 ± 0.44	166.19	109.64	60.69	66.19	65.53	81.19
<i>Chlorella sp.</i>	16.46 ± 1.51	182.37	109.76	58.13	79.01	63.16	78.25
<i>Dunaliella sp.</i>	11.24 ± 1.13	177.02	112.20	54.54	101.60	64.87	72.09
<i>Isochrysis galbana</i>	7.45 ± 0.52	185.49	140.06	48.08	45.77	64.91	74.99
<i>Chaetoseros sp.</i>	5.12 ± 0.55	175.10	153.90	59.32	48.03	64.15	70.96
<i>Tetraselmis sp.</i>	9.47 ± 0.38	189.85	112.92	47.35	64.70	64.40	80.07

<sup>1</sup> Transesterification method and <sup>2</sup> Boron trifluoride method

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