Hydrocarbons from Pond Scum

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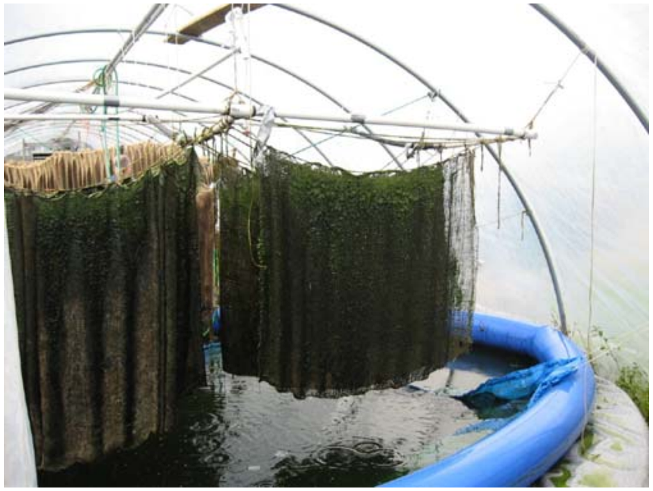
Hydrocarbons from Pond Scum



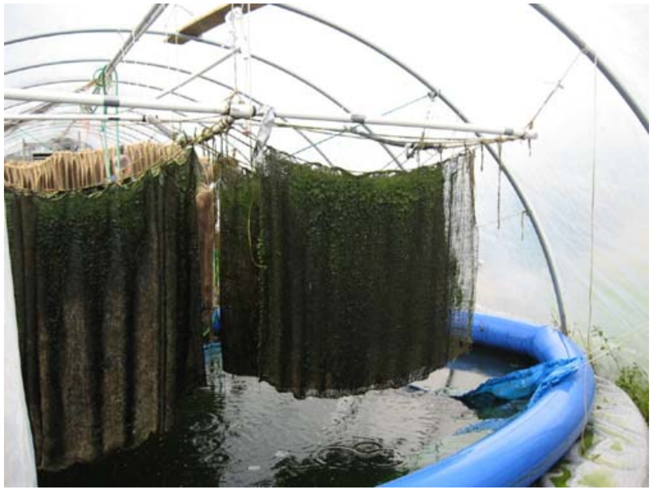
Renewegy has developed a proprietary "aeroponic algalculture" technique.

Eliminates many of the problems encountered in conventional aquaculture systems.

Some Advantages of Algae as a Source of Biofuels

- *Does not displace croplands used to produce food.*
- *Characterized by rapid growth and homogeneity.*
- *Readily lends itself to industrial scale processing.*
- *Algal cells are not bound together and offer little resistance to enzyme activity along the surface of each cell – easier to process to make ethanol.*
- *No lignin*
- *Many algae have a high content of oils and free fatty acids.*

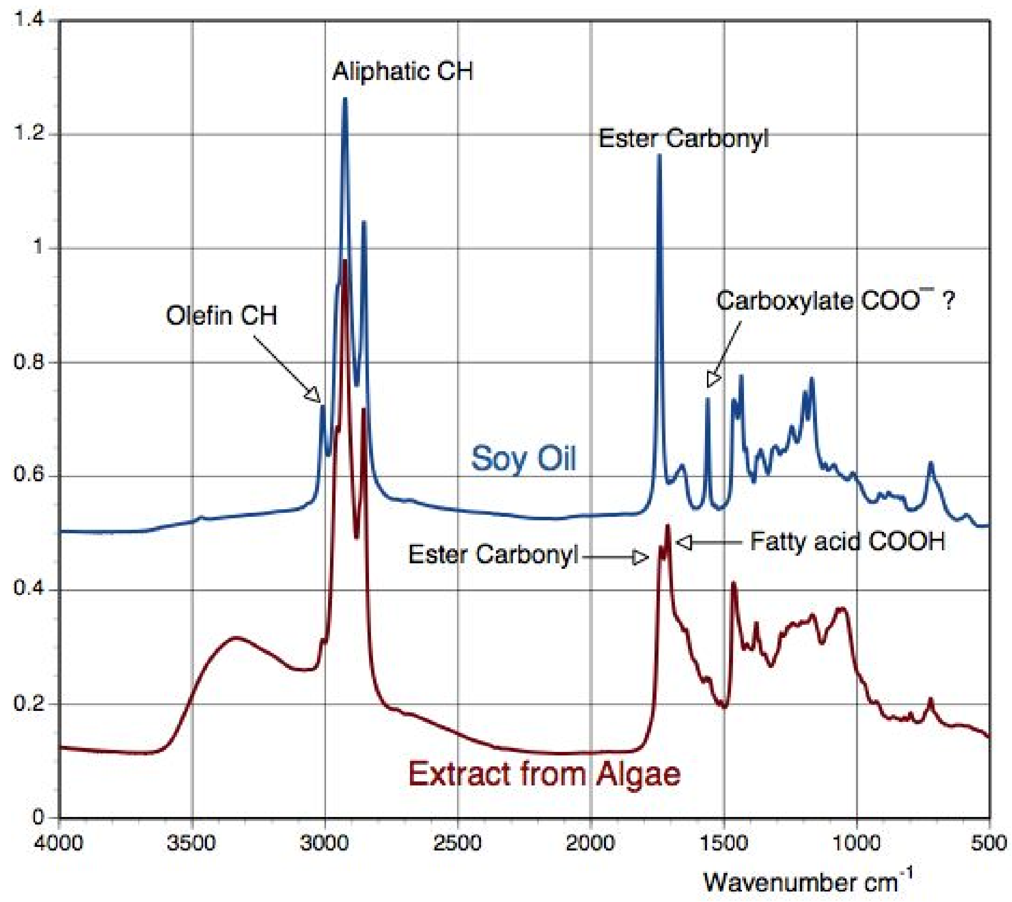
Hydrocarbons from Pond Scum



Yield

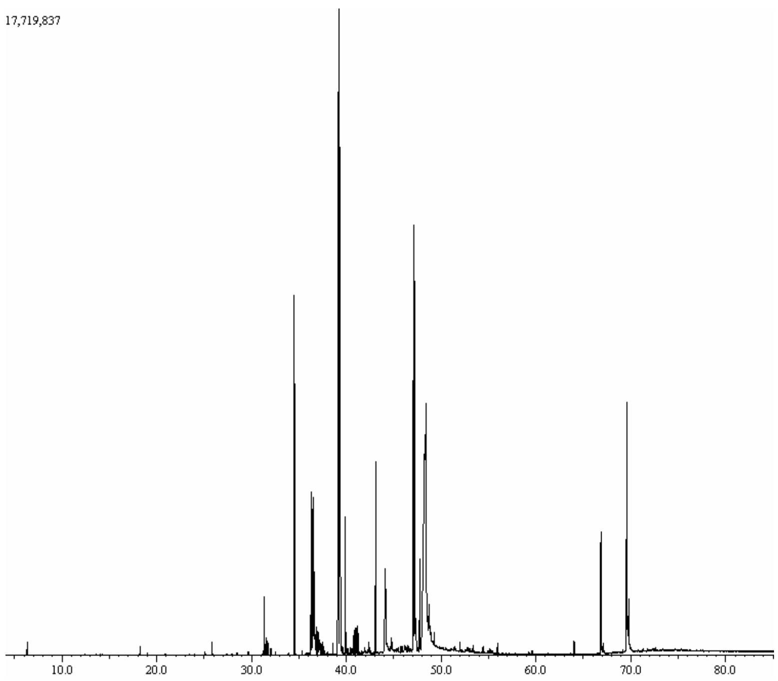
Methanol extraction	*18.9 %*
Ethanol extraction	*15.3%*

Nature of Extract



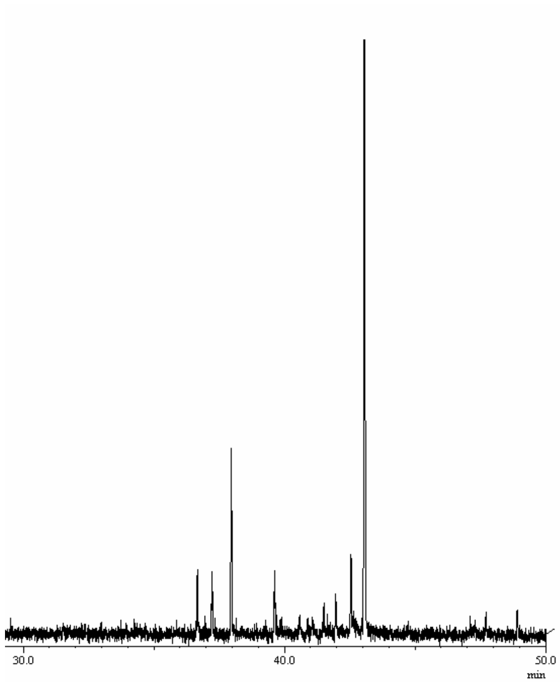
Nature of Extract

GC/MS – Soy Oil



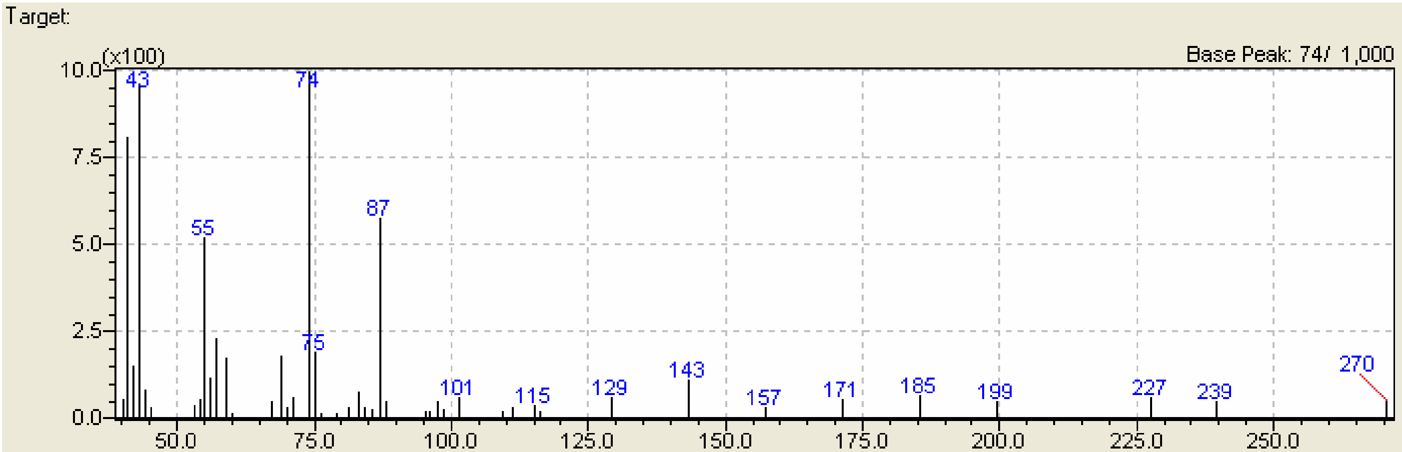
Retention time (min)

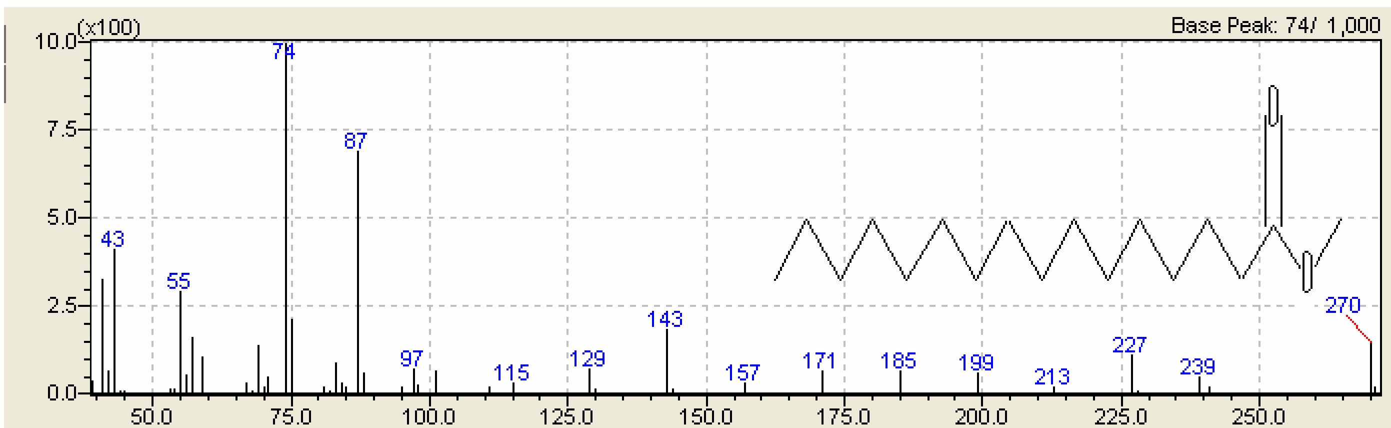
GC/MS – Algae Extract



Retention time (min)

Nature of Extract





270 : Hexadecanoic acid, methyl ester $$ Palmitic acid, methyl ester $$ n-Hexadecanoic acid methyl ester $$ Metholene 2216 $$ Methyl hexadecan

Kolbe Electrolysis

Faraday originally observed (in 1834) that hydrocarbons are formed upon electrolysis of acetate solutions, but it was H. Kolbe who performed the first detailed investigations of the reactions of carboxylic acids at an anode some fifteen years later.

$$RCOO^- + R'COO^- \rightarrow R\bullet + R'\bullet + 2CO_2 + 2e^-$$

$$R\bullet + R'\bullet \rightarrow R - R'$$

DIESEL FUEL BY KOLBE ELECTROLYSIS OF POTASSIUM OF SALTS OF COCONUT FATTY ACIDS AND ACETIC ACID

FLORENTINO C. SUMERA[1] and SALMA SADAIN[2]

ABSTRACT

Kolbe electrolysis of potassium salts of coconut fatty acids and acetic acid using platinum electrodes, produced a clear liquid product (58% theoretical yield) with very good diesel-fuel properties. Analysis of the liquid product showed that it contained 83% straight chain hydrocarbons, shown by gas chromatography to be composed of 0.5% decane ($C_{10}H_{22}$), *34.6% dodecane* ($C_{12}H_{26}$), *22.5% tetradecane* ($C_{14}H_{30}$), *14.2% hexadecane* ($C_{16}H_{34}$), *17.0% octadecane* ($C_{18}H_{38}$), *2.1% eicosane* ($C_{20}H_{42}$), *6.5% docosane* ($C_{22}H_{46}$), *and 3.0% tetracosane* ($C_{24}H_{30}$).

The physico-chemical properties of the product revealed its potential as a better diesel substitute than currently known coconut oil derivatives.

INTRODUCTION

The uncertainty of the prices and supply of crude oil and the fact that fossil fuel is non renewable make any petroleum-dependent country look for alternative sources of fuel. One such alternative is to use available vegetable oils for diesel engines. Preliminary studies on the use of vegetable oils, such as coconut oil to substitute diesel fuel however, described them to be good only for short term engine use (Arida, 1984). Prolonged use even if the vegetable oil were mixed with diesel fuel, caused several problems, one of which was extensive clogging of fuel lines, that eventually prevented the engine to operate. All these problems stem from the highly viscosity, low volatility and polymerization tendency of vegetable oil. One suggested way to avoid these problems was to modify the structure of the vegetable oil and improve its physico-chemical properties to meet the specification of current diesel engines.

One such modification is made by transforming the vegetable oil into fatty esters (Arida, 1984; Banzon, 1980; Ong et al., 1984). The transformation is done through transesterification of the vegetable oil with ethanol or methanol in the presence of an acid or base catalyst. It was reported that the properties of the fatty ester derivatives meet the requirements of current diesel engines and are therefore better substitute than the original vegetable oil.

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Table II. Gas chromatographic Data of Fraction 1

Peak Number	Retention Time	Normalized Area (%)	Corresponding Standard Hydrocarbon*
1	14.8	0.53	Decane ($C_{10}H_{22}$)
2	17.1	34.63	Dodecane ($C_{12}H_{25}$)
3	21.4	22.45	Tetradecane ($C_{14}H_{30}$)
4	25.0	14.23	Hexadecane ($C_{16}H_{34}$)
5	28.5	17.04	Octadecane ($C_{18}H_{38}$)
6	31.25	2.05	Eicosane ($C_{20}H_{42}$)
7	34.5	6.54	Docosane ($C_{22}H_{46}$)
8	38.6	3.04	Tetracosane ($C_{24}H_{50}$)

*Determined by spiking

Gas chromatography of the more polar portion of the product (Figure 5) on Chromosorb W containing 5% diethylene glycol succinate showed that this second column fraction contain six different esters with ethyl laurate as the major component (Table III).

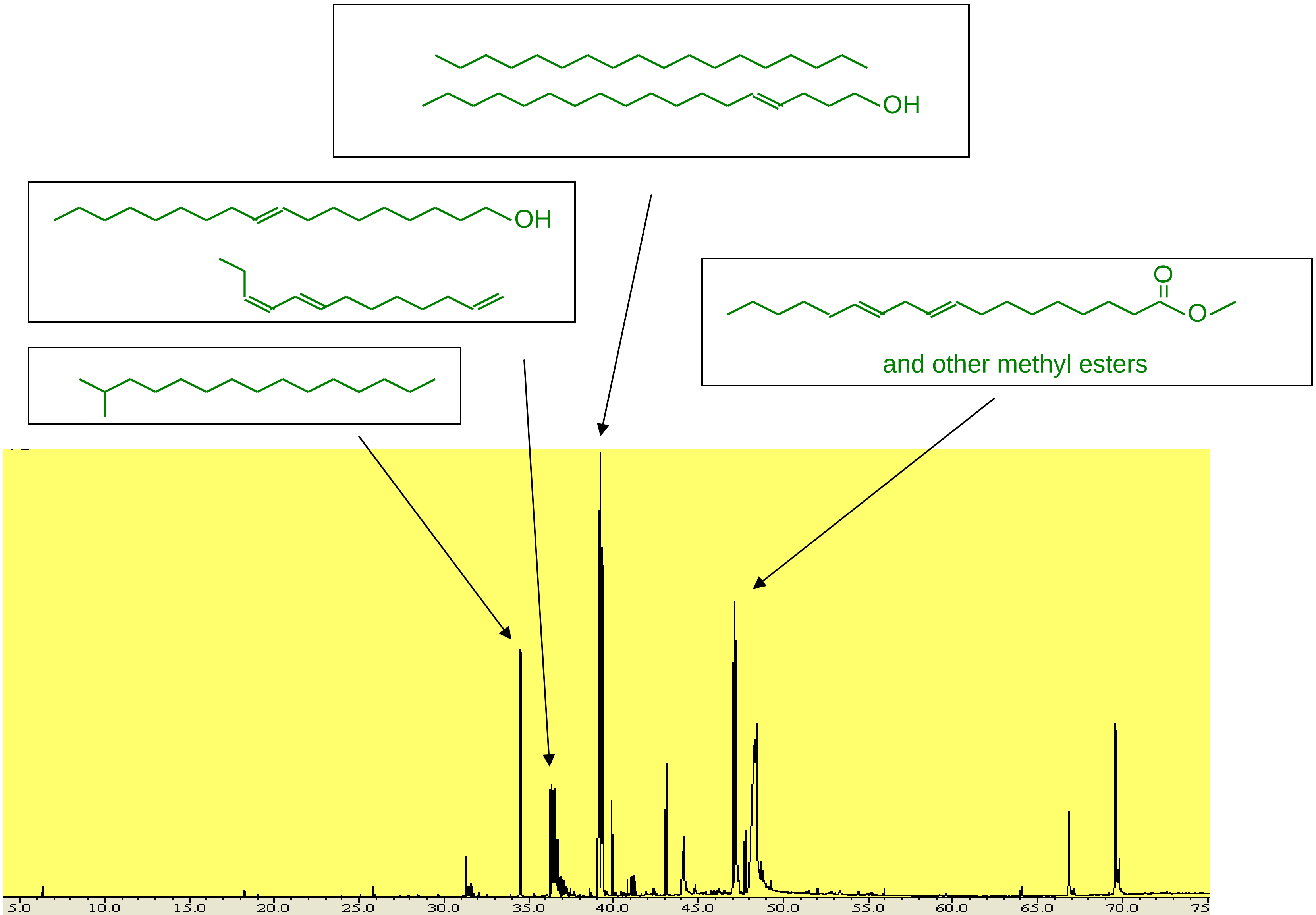
Table III. Gas Chromatographic Data of Fraction 2

Peak Number	Retention Time (min.)	Normalized Area (%)	Corresponding Ethyl Ester
1	12.2	4.5	Ethyl Caprate $CH_3\,(CH_2)_8\,COOC_2H_5$
2	14.6	66.5	Ethyl Laurate $CH_3\,(CH_2)_{10}\,COOC_2H_5$
3	17.2	14.5	Ethyl Myristate $CH_3\,(CH_2)_{12}\,COOC_2H_5$
4	20.2	8.5	Ethyl Palmitate $CH_3\,(CH_2)_{14}\,COOC_2H_5$
5	22.6	6.0	Ethyl Stearate $CH_3\,(CH_2)_{16}\,COOC_2H_5$

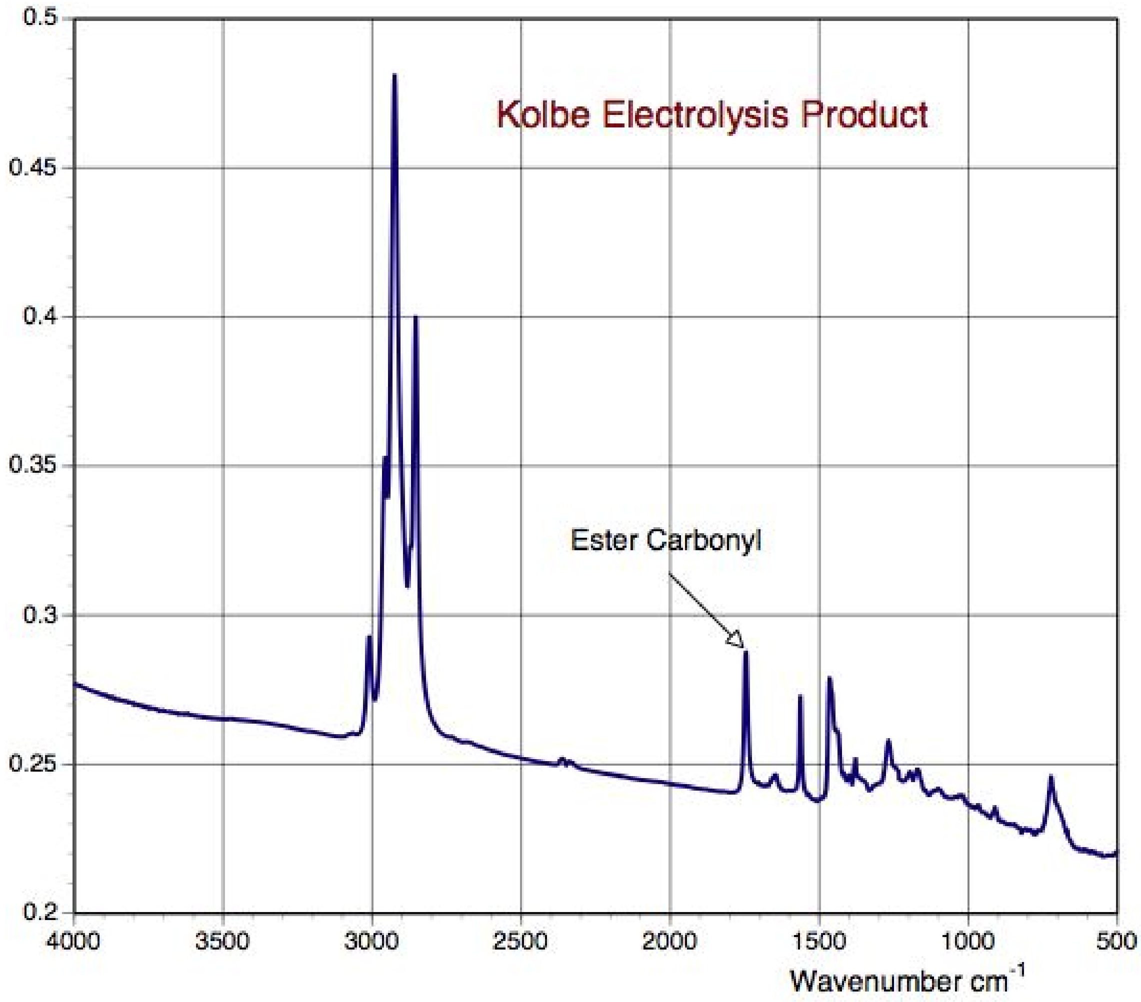
Kolbe Electrolysis

- *Reaction vessel: 250ml three neck and two 2.5x2.5 cm platinum electrodes.*
- *Methanol solution of saponified oil and acetic acid*
- *The electrolysis solution was magnetically stirred and the flask placed in a water bath to keep the temperature below 45˚C.*
- *Electrolysis was started with a 3 amp current flow and stopped when the current dropped to less than 1 amp.*

Kolbe Electrolysis – Soy Oil



Kolbe Electrolysis – Algae Extract



Conclusions Based on Preliminary Work

The "aeroponic algalculture" technique appears to be a useful way to mass produce algae for biofuel applications.

Kolbe Electrolysis has some promise as a technique for processing algal and other oils into biofuels