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Recent Trends in Biotechnology and Chemical Engineering

Comparison of Biodiesel Production from Macro and Micro Algae

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Abstract: The world is entering into a new era in a few years but the most required fuel sources are depleting at a rate which that we cannot control. The increase use of the fossil fuels are also effecting the environment by the emission of CO_2 gases in the atmosphere, which are resulting in increase in global temperature. Thus a new fuel source which has less CO_2 emission and is economically feasible is required. The production of bio-diesel from algae is one such promising method. The bio-diesel is having less CO_2 and NO_x emissions. As the algae are grown in CO_2 rich environment it helps us to reuse the CO_2 in the air. In this paper the transesterification of micro and macro algae and their yield and the property of the bio-diesel produced are compared. The comparison was made between the *Oedigonium* species which is a macro algae and the *Nanochloropsis* species which is a microalgae.
Keywords: Biodiesel, Microalgae, Macro algae, transesterification, *Oedigonium sp, Nanochloropsis sp.*

Introduction:

The usage of fuels have considerably increased due to technological development and the increase in the usage of vehicles[1]. The usage of fossil fuels have increased the carbon emission and have caused global warming, furthermore they are depleting at rate faster than anyone can imagine. Thus a new fuel source is required to sustain growth and development. Bio-fuels are one such source which seems to be promising solution for the future[2]. They are derived from plants and microorganisms. The so called biodiesel is obtained by transesterification of triglyceride oil with monohydric alcohols. This biodiesel have been extracted from canola and soybean, palm, sunflower oil and algal oil are proved to be a good substitute for diesel fuel[3,]. Biodiesel is non-toxic and can be considered as renewable source of energy[4]. The usage of fossil fuels have increased the CO_2 level in the atmosphere along with NO_x gases. By the usage of biofuels the carbon emission and NO_x gas emission can be reduced[8].

The microalgae and macro algae grow in CO_2 rich environment and convert the CO_2 into lipids and biomass. The lipid produced is transesterified to give bio-diesel[5]. Furthermore the biomass obtained can also be burned as fuel. Some algae biomass can be used as feedstock[6]. The algae produce large amount of biodiesel compared to other methods and hence they seem to be the only way to produce enough automotive fuel to replace the current gasoline usage[7]. The microalgae produce more biodiesel than the macro algae and this paper compares the biodiesel production of the *Oedigonium* species which is a macro algae and the *Nanochloropsis* species which is a microalgae.

Materials and Methods

The simple direct transesterification method was used to compare the biodiesel yield of the algae

Sample Collection

Two petri dish samples of algae (*Oedigonium* and *Nanochloropsis*) were from Phycology laboratory, Institute of Biological Science, Faculty of Science, University of Malaya, Kuala Lumpur, Malaysia.

Oil extraction

Both the algae were ground with ball mill as to reduce their size. The ground algae samples are dried in an oven for 25 min to remove the moisture content. Hexane and ether solution were mixed with the dried algae samples. For settling the mixture is kept for 24 hours.

Evaporation

The mixture was evaporated in vaccum to evaporate the hexane and the ether. The oil will remain after the evaporation of hexane and ether. The process is done in a rotary evaporator.

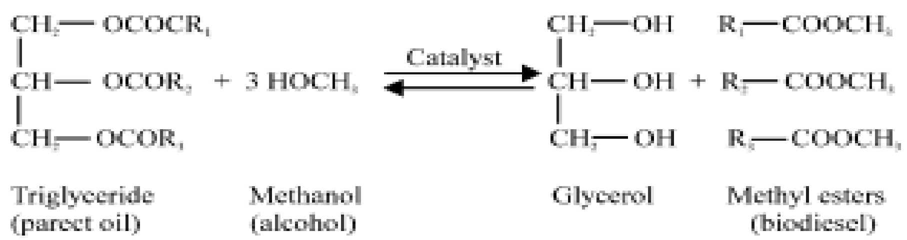
Mixing of catalyst and methanol

24 mL of methanol was mixed with 0.25g of NaOH and stirred properly for 30 min.

Biodiesel production

The algal oil was mixed with the catalyst and methanol mixture in a conical flask and the reaction mixture were heated in hot water bath at 90^{o}C for 40 minutes. The reaction takes as shown in (Figure- 1)

Figure 1: Transesterification reaction



Transesterification

The transesterification process takes place. The solution in the conical flask is shaken for 3 hrs by an electric shaker.

Settling

After the shaking process the biodiesel was kept undisturbed to settle into two layers of biodiesel and sediments.

Separation of biodiesel

The biodiesel obtained was separated by the process of sedimentation in flask separator carefully.

Washing

Biodiesel was washed by 5% water until it was become clean.

Drying

A drier was used to dry the biodiesel obtained and was fan dried for 14 hours.

Storage

Biodiesel production was measured by using measuring jar, pH was measured and stored for analysis.

Results and Discussion

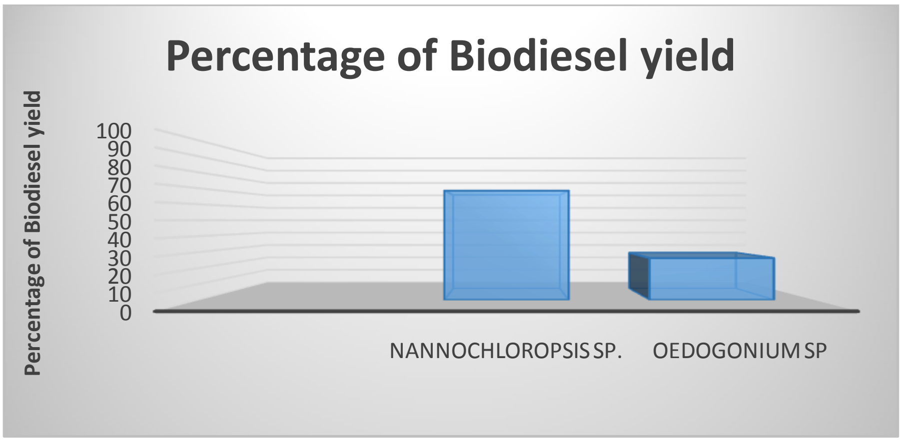
Results

There are various methods available for the production of biodiesel but the best method is the direct transesterification of the most effective one. This study was based on the direct transesterified results of both the algae. The results of biodiesel production by direct transesterification were obtained for 1.5gm Dry weight of the algae gravimetrically. The gravimetrical biodiesel yield for *Oedigonium sp* was 0.398gm and for *Nanochloropsis sp* was 1.028gm. However the gravimetric biodiesel yield for other crops and algae were also compared with these two algae (Table- 1) & (Figure- 2)

Table 1: Biodiesel Yield from various source

Crops/Algae	Gravimetric Biodiesel yield (g/1.5g dw)	Percentage of Biodiesel yield
Castor	0.501	33.4
Jatropha	0.933	62.2
Coconut	0.862	57.4
Dunaliella salina	1.0	66.6
Spirogyra sp	0.333	22.2
Nannochloropsis sp.	1.028	68.5
Oedigonium sp	0.398	26.3

Figure 2: Percentage of Biodiesel yield from the two species.

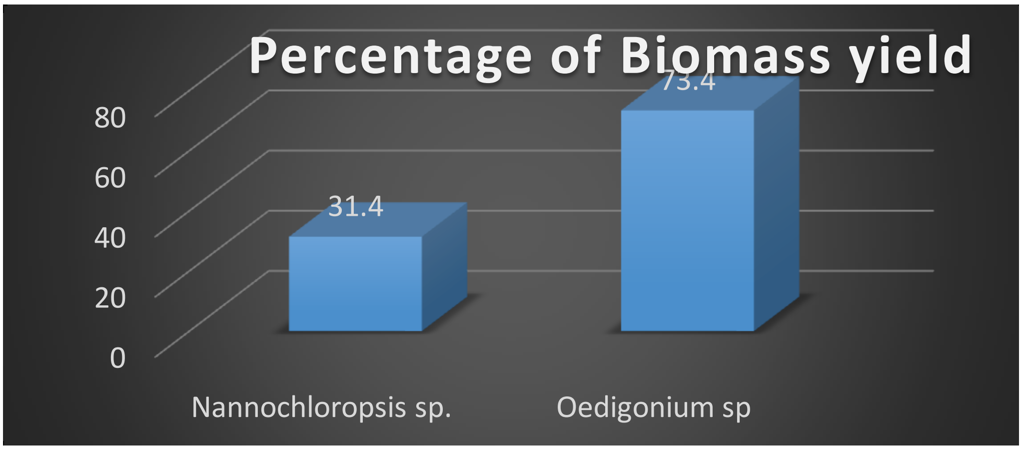


From the above table it can be seen that the microalgae species give the maximum biodiesel yield compared to other crops and macro algae. The *Nanochloropsis* species gives a biodiesel yield of 68.5% and the *Odeogonium* species gives yield of only 26.3%. By comparing these results it can be said that the microalgae are more suitable for the production of biodiesel than that of the macro algae species. The biomass yield was also compared and the following results were obtained. For nanochloropsis sp the yield was 0.472 gm and for oedigonium sp it was 1.102 gm which is discussed in (Table- 2**)**

Table 2: Comparison of biomass production from micro and macro algae

Crops/Algae	**Biomass yield (g/1.5g dw)**	**Percentage of Biomass yield**
Nannochloropsis sp.	0.472	31.4
Oedigonium sp.	1.102	73.4

Figure 3: Percentage of biomass yield from the two species.



From (Figure- 3) it can be seen that the microalgae yield less biomass compared to the macro algae. Hence for the production of biomass the macro algae are more suitable than the micro algae.

Discussions:

The biodiesel production is a viable solution for the future but the selection of the source seems to be the bigger problem. There are many source like *Jatropha*, Coconut, and Castor etc. But the lipid content is the source of the biodiesel yielded and hence comparing lipid content the algae contain more lipid content than any other plants and oil seeds. The production of biodiesel is possible from both micro and macro algae but in comparing both due to high lipid content the microalgae yields more biodiesel than that of the macro algae. Comparing the yield of microalgae with other with other sources like *Jatropha* it has more yield. Since the microalgae generally grow much faster than other plants and require much less area for cultivation they can be cultivated in large amounts and can be used to produce biodiesel economically. Production of biodiesel from algae will help in the reduction of the CO_2 and NO_x gases in the atmosphere since the algae grow on CO_2 environment hence the production of biodiesel from algae is both economical and environmentally safe. In algae since microalgae contains more lipid content it is best suitable for the production of biodiesel comparative to the macro algae. Hence from the comparison made in this paper it can be said that the *Nanochloropsis* species is better than the *Oedigonium* species for the biodiesel production. On the contrary for production of biomass the macro algae yield is more than that of the micro algae and hence the macro algae are better for the production of biomass. Biomass can also be further converted into source of energy by direct burning or converting them to biofuels[9-12].

Conclusion:

The biodiesel production from algae is an economical process since the algae are cheap and easier to grow. Hence the algae seem to be a viable source for the production of biodiesel. By the above comparison we can say that the production of biodiesel from the microalgae seems to gives better results than the macro algae. Currently many researches are going on to find better method for the extraction of the oil and many new equipment are being designed for this purpose to scale up this process to large scale. Hence further research is required for this field regarding the biomass yield from the micro and macro algae.

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