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Properties and characterization of biodiesel from selected microalgae strains

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Abstract

The demand for alternative fuels has increased in the past several years[1]. Biofuels are gaining importance as significant substitutes for the depleting fossil fuels. The fact that biofuels are renewable fuels with very low emissions of CO2 in the lifecycle offers them a competitive advantage[2]. However, the first produced biodiesel derived from edible oil seed crops (first generation feedstocks), lurking a serious risk of disturbing the overall worldwide balance of food reserves and safety. The second generation feedstocks for biodiesel production obtained from non-edible oil seed crops, waste cooking oil, animal fats, etc., but these feedstocks are not sufficient to cover the present energy needs. Recent focus is on microalgae as the third generation feedstock[3].

Microalgae do not compete for land, but they can grow in salty (sea), brackish (lagoons) and fresh (lakes) water. Moreover, microalgae have high photosynthetic efficiency using solar energy, water and carbon dioxide to produce higher quantities of biomass than other feedstocks. In the present research work, two indigenous fresh water (ChlorF1, ChlorF2) and two marine (ChlorM1, ChlorM2) Chlorophyte strains have been cultivated successfully under laboratory conditions using commercial fertilizer (Nutrileaf 30-10-10, initial concentration=70 g/m^3) as nutrient source. The produced biodiesel from the microalgae biomass achieved a range of 2.2 - 10.6% total lipid content and an unsaturated FAME content between 48 mol% and 59 mol%. The iodine value, the cetane number, the cold filter plugging point (CFPP) and the oxidative stability of the ultimate biodiesels were determined, based on the compositions of the four (4) microalgae strains and compared with the specifications in the EU and US standards, EN 14214 and ASTM D6751 respectively.

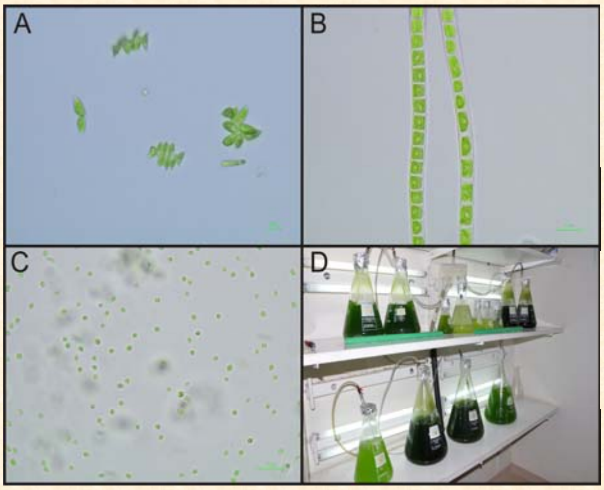

Fig. 1. **Chlorophyte strains cultivated under laboratory conditions using commercial fertilizer (Nutrileaf 30-10-10, initial concentration=70 g/m^3) as nutrient source: A, B) indigenous fresh water stains, C) a marine water strain of Chlorella, D) growth of strains under laboratory conditions.**

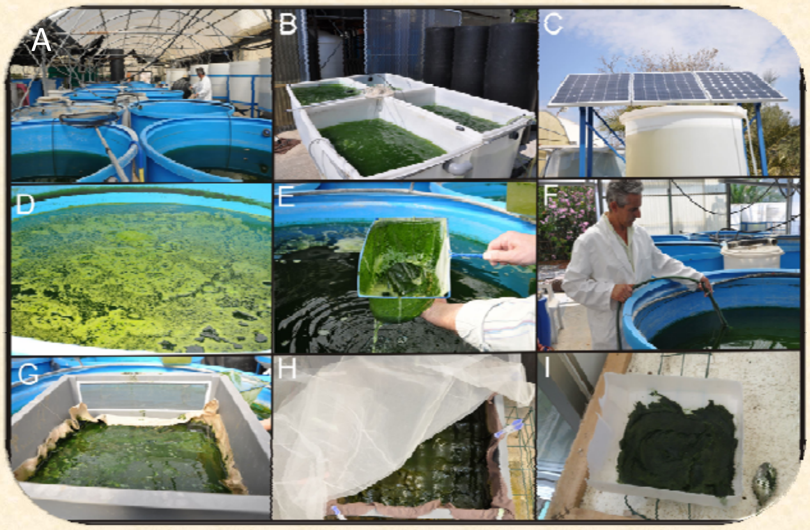

Fig. 2. **Mass cultivation (A-D) and harvesting (E-I) facilities of indigenous fresh water Chlorophyte strains in a greenhouse of Fisheries Research Institute, Greece.**

Table 1. **Composition of biodiesel from four (4) microalgae strains.**

	Biodiesel composition (wt.%)			
FAME	ChlorF1	ChlorF2	ChlorM1	ChlorM2
C12:0	1.85	1.25	2.17	2.70
C16:0	38.62	22.32	26.33	23.38
C16:1	10.43	4.05	3.75	3.32
C17:0	2.49	4.70	1.97	9.38
C18:0	5.22	8.15	11.49	8.59
C18:1	16.33	5.72	4.02	3.61
C18:2	11.89	14.75	14.87	24.92
C18:3	12.57	36.69	35.40	24.11
C22:0	0.59	2.38	0.00	0.00

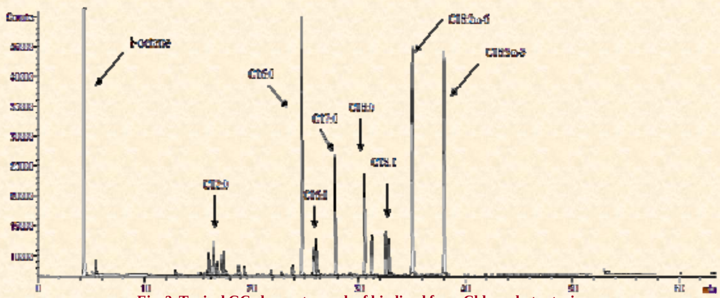

Fig. 3. **Typical GC chromatograph of biodiesel from Chlorophyte strains.**

Table 2. **Predicted biodiesel properties comparing with the corresponding properties of biodiesel from known vegetable oils, from other algae strain and with the specifications in the EU and US standards.**

Property	Units	ASTM D6751	EN 14214	ChlorF1	ChlorF2	ChlorM1	ChlorM2	Coelastrum [4]	Soybean [5]	Sunflower [5]	Palm [5]
Iodine Value	g I_2 / 100 g biodiesel	-	max. 120	77	130	125	112	88	128	132	57
Cetane Number	-	min. 47	min. 51	56	45	46	49	57	49	50	61
CFPP	^{o} C	-	-*	7	15	10	4	-5	-5	-3	10
Oxidative Stability	h; 110 ^{o} C	min. 3	min. 6	7	5	5	5	4	1	1	4

** Country specific CFPP (Greece) according to ELOT EN 14214: +5 ^{o} C / -5 ^{o} C*

Conclusions

- Gas chromatographic analysis data revealed that microalgal biodiesel obtained from Chlorophyte algae strains biomass were composed of fatty acid methyl esters.
- The ultimate predicted fuel properties of algal biodiesel show that biodiesel from Chlorophyte algae was significantly comparable in quality with other biodiesels.

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