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Microalgae culture for biodiesel production using agricultural residues as culture medium

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INTRODUCTION: In rural areas, due to poor management of agricultural waste, high pollution problems are generated which cause eutrophication and contamination of aquifers. An alternative to this problem can be the bioremediation of these effluents using microalgae cultures. Microalgae are autotrophic microorganisms that occupy the first link in the food chain, and in recent years there has been an increase in research on their uses and applications due to the large amount of bioproducts and benefits we can obtain from them. Bioremediation work with microalgae can help improve the quality of effluents and generate a lipid-rich biomass for the production of biofuels. In this work we use cultures of the microalgae *Scenedesmus dimorphus* and *Neochloris oleoabundans*, to bioremediate effluents from the agricultural industry and we analyze the algal biomass to determine if it is optimal for the production of biofuels.

Figure 1.

Material and Methods. Aqueous extracts were prepared from lamb, rabbit and chicken manure (Figure1) and leached from the worm compost, these were irradiated with UV light for 48 hours. Microalgae strains were obtained from the Laboratory of Applied Phycology of UAM Iztapalapa and were scaled up to 16L biorectors (Figure 2). Cell growth was determined by counting in a Neubauer chamber, and pigment, protein, carbohydrate and lipid analyses were performed. Oil extraction was performed with a Soxhlet using hexane as a solvent, during 16 hours at reflux (Figure 3). For the alkaline transesterification, methanol was used together with potassium hydroxide as catalyst and oil in order to separate glycerin from triglycerides and obtain methyl esters. After this, caloric index tests were performed on a Parr Model 6400 calorimeter to determine its potential with respect to diesel. The profile of fatty acids was made by gas chromatography.

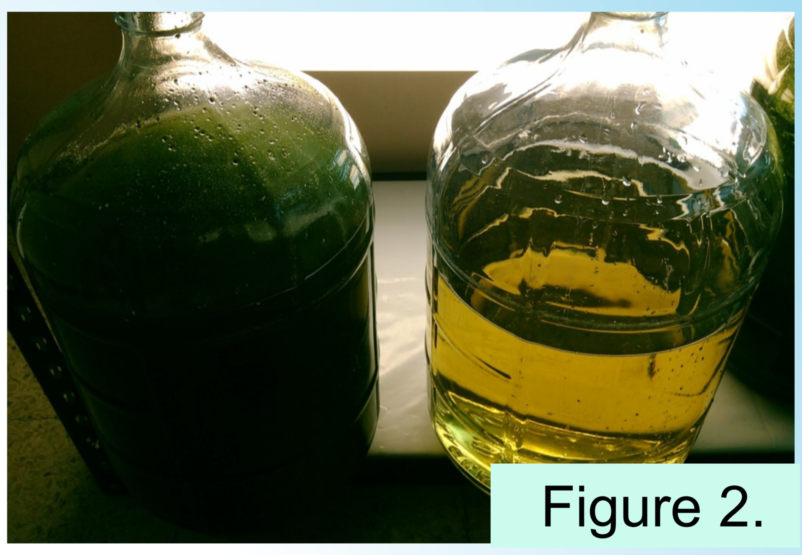

Figure 2.

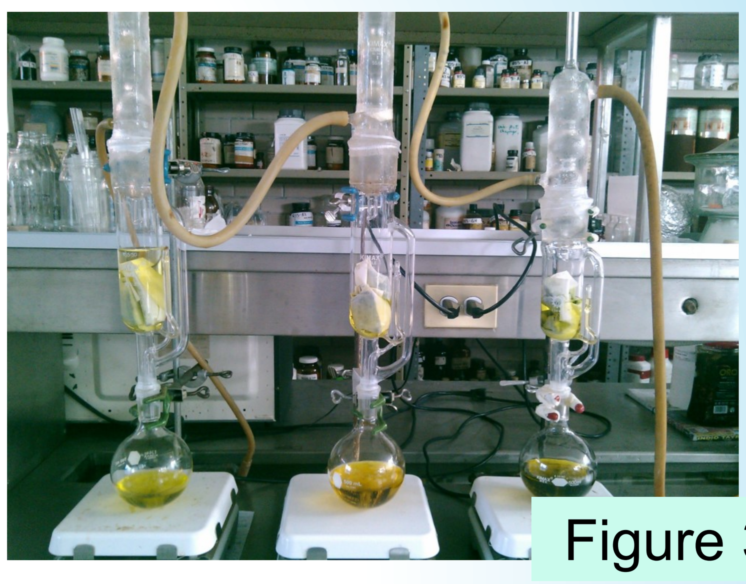

Figure 3

Results and Discussion: The microalgae grew well in the different types of organic leachates, achieving ammonia removal levels of up to 99% in the case of rabbit waste and 95 % in the case of lamb waste. The algal biomass harvested from the bioremediation processes gave interesting results in terms of fatty acid composition, which indicates the potential for biodiesel production from it. In the European Union standard EN 14214, it is indicated that the fatty acids with the highest content should be those with long chains and a high degree of saturation such as: Palmitoleic, Oleic and Myristic. In *Scenedesmus* and *Neochloris* we can see a profile of optimal oils for the production of biodiesel. The predominant fatty acids are polyunsaturated and a good amount of monounsaturated fatty acids (Tables 1, 2).

Table 1. Fatty acid profile of the Scenedesmus dimorphus

Acid	Content %	Acid	Content %	Acid	Content %
Palmitic	11,203	Palmitic	10,906	Palmitic	9,151
Stearic	4,7	Stearic	4,808	Stearic	3,8424
Oleic	22,586	Oleic	23,132	Oleic	35,406
Linoleum	50,623	Linoleum	40,064	Linoleico	40,566
Linolenic	6,484	Linolenic	6.782		
		Arachidico	0,356	Arachidico	0,475
Behenico	0,335	Behenico	0,493	Behenico	0,445
Total	95,931	Total	86,541	Total	89,8854
Saturated	16,238	Saturated	16,563	Saturated	13,9134
Monounsaturated	22,586	Monounsaturated	23,132	Monounsaturated	35,406
Polyunsaturated	57,107	Polyunsaturated	46,846	Polyunsaturated	40,566

Table 2. Fatty acid profile of the Neochloris oleoabundans

Acid	Content %	Acid	Content %	Acid	Content %
Palmitic	9,077	Palmitic	11,592	Palmitic	9,359
		Palmitoleico	0,139		
Stearic	3,774	Stearic	4,462	Stearic	3,817
Oleic	33,579	Oleic	23,407	Oleic	34,436
Linoleum	41,502	Linoleum	49,025	Linoleum	40,566
Linolenic	6,735	Linolenic	6,709	Linolenic	6,544
Arachidico	0,418	Arachidico	0,32	Arachidico	0,459
Behenico	0,382	Behenico	0,417	Behenico	0,417
Total	95,467	Total	96,071	Total	95,598
Saturated	13,651	Saturated	16,791	Saturated	14,052
Monounsaturated	33,579	Monounsaturated	23,546	Monounsaturated	34,436
Polyunsaturated	48,237	Polyunsaturated	55,734	Polyunsaturated	47,11

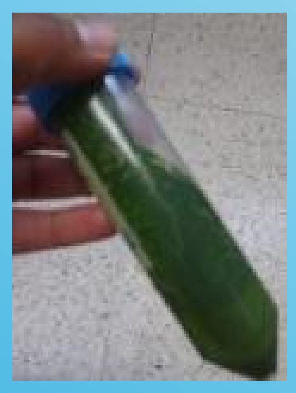

Table 3. Oil and biodiesel production yields of the two microalgae in the different culture media

Microalgae	Culture media	Weight of biomass	Oil performance	% Oil performance	Performance of biodiesel (g)	% Performance of biodiesel
S. dimorphus	Bayfoland forte	12,4	3,3	26,5	1,9	15,7
S. dimorphus	Lamb waste	10,4	2,9	27,8	1,2	12,,4
S. dimorphus	Rabbit waste	18,4	4,7	25,7	1,8	9,8
N. oleoabundans	Bayfoland forte	14,7	5,2	37,8	2,9	20
N. oleoabundans	Lamb waste	22,5	8,5	37,9	5,6	25,1
N. oleoabundans	Rabbit waste	9,6	4,5	47	3,5	36,4

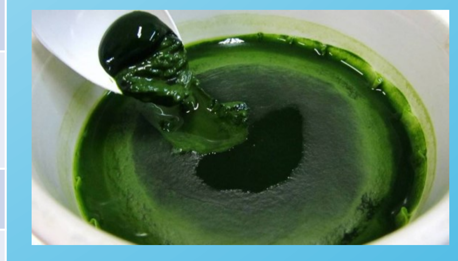

Table 4. Combustion Entalpy. Comparison between petrodiesel and biodiesel resulting from this investigation

Microalgae	Culture media	Calorific Index KJ/g	Comparison with diesel %
S. dimorphus	Bayfoland forte	38,97	93,05
S. dimorphus	Lamb waste	38,09	90,95
S. dimorphus	Rabbit waste	38,37	91,62
N. oleoabundans	Bayfoland forte	36,79	87,85
N. oleoabundans	Lamb waste	38,92	92,93
N. oleoabundans	Rabbit waste	39,09	93,34
	Diesel	41,88	100

Conclusions: The results of the combustion enthalpy between petrodiesel and biodiesel resulting from this research are promising, and comparing the results in oil and biodiesel performances that we obtained in this work makes us think about microalgae as an ecologically sustainable feedstock. The culture media used turned out to be efficient for the production of algal biomass, so we plan to continue working with these effluents now on a pilot plant scale, since a double benefit is achieved: the treatment of organic leachates and the generation of an algal biomass with potential for the production of biodiesel. .