Potential of Macroalgae for the removal of Aluminum ion and organic pollutants from Natural Waters

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ABSTRACT

Previous studies showed that the immobilized algae gracilaria and sargassum absorbs a percentage of the emergent semi-volatile pollutants found in the Puerto Nuevo River. Epidemiological studies suggest that a relationship exists between Aluminum (Al) and Alzheimer disease (AD) involving relative risks for population exposed to Al concentrations in drinking water higher that 0.1mg/L. This research is based on the 'New Mortality Statistics' of 2008 in Puerto Rico. Three towns with a higher incidence of deaths and three towns with the lowest incidence of deaths related to Alzheimer were chosen and the rivers or reservoirs that supply water to the same. To carry out this research the algae gracilaria and sargassum were used; these are not laboratory algae. Then it was proceeded to the identification of the aluminum in water samples and the immobilization of the algae with silica, for later to precede with the absorption of the aluminum, both as the aluminum substance and the river water samples. Finally the detection of aluminum in the samples was realized by a colorimetric method EDTA Complexometric. The immobilized algae, glacilaria and sargassum, absorbed 67 and 64 % of the aluminum present in the model solutions. Glacilaria spp. packing was more effective removing the aluminum present in the solutions. According to our previous and current research results we can conclude that macroalgae packing are a green and cheap alternative to remove simultaneously organic pollutants and Aluminium from water samples.

INTRODUCTION

- Aluminum is the most abundant metal on the planet. It is mostly found combined with other elements. Although we are in contact with it everyday, it can be very toxic when exposed to certain amounts.

- Epidemiological studies suggest that a relationship exists between Aluminum (Al) and Alzheimer disease (AD) involving relative risks for population exposed to Al concentrations in drinking water higher that 0.1mg/L.

- Because marine environments are normally scarce in these metals, some marine algae especially have developed efficient mechanisms to gather these heavy metals from the environment and take them up.

- Algae have different type of uses when it comes to the term of immobilization; one way to immobilize algae is with silica. A great way to use immobilized algae is by absorbing liquid pollutants. (Hameed & Hammouda, 2007). In recent studies we demonstrated that immobilized algae were effective alternative to remove organic pollutants from water.

  ✓ Can the immobilized algae, *Glacilaria* spp. and *Sargassum* spp. , simultaneously remove the organic pollutants and the aluminum present in water samples?

Carraizo Resrvoir
Río Grande de Loíza
Pitahaya River
Maunabo River

ATLANTIC OCEAN

CARIBBEAN SEA

METHODOLOGY

ALUMINUM

Sample Preparation for Al testing
- Water samples were collected and acidified
- 1 L was filtrated
- And pre concentrated to 100 mL

Macroalgae SPE capacity to remove Al
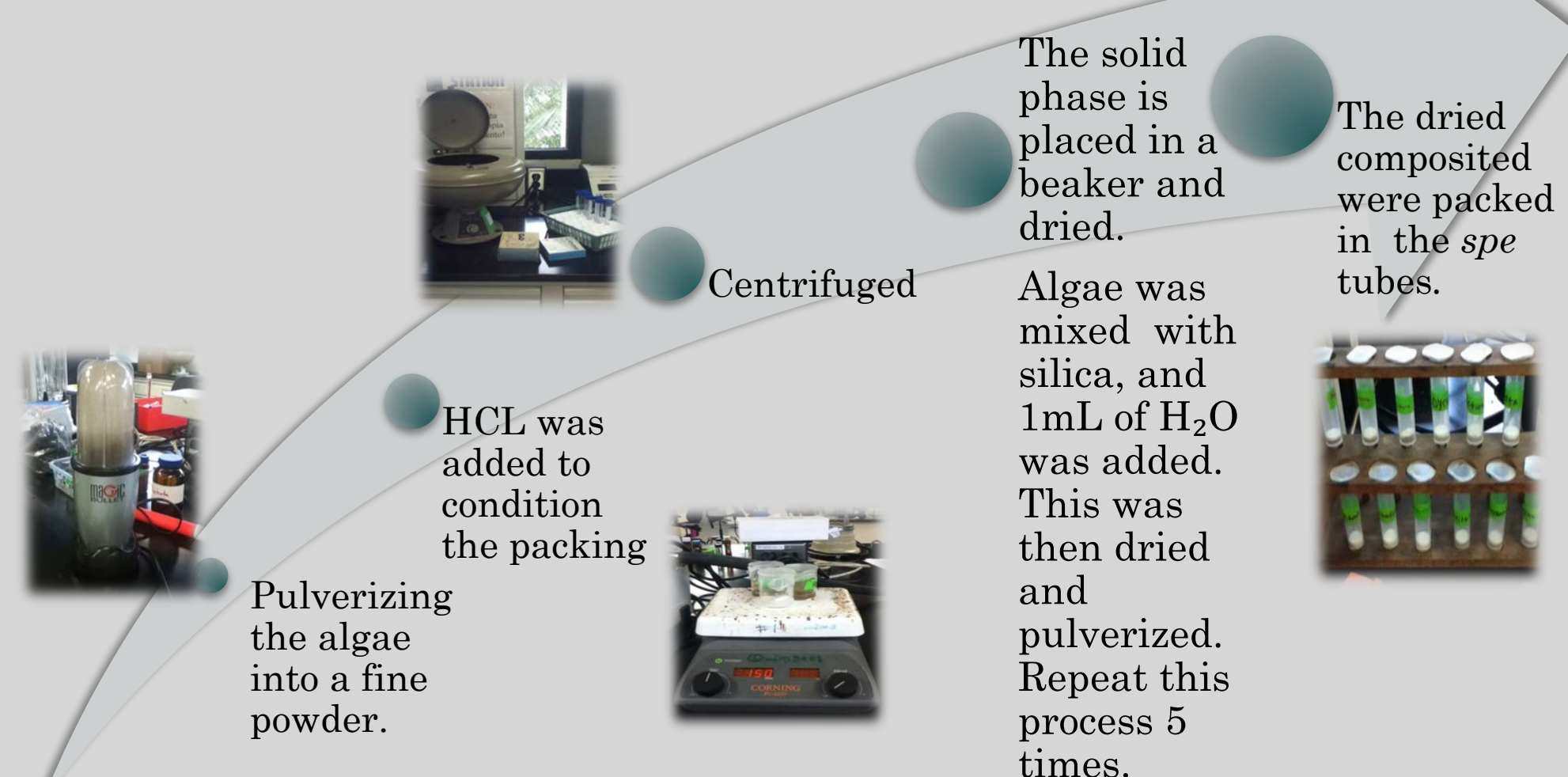- HCl was used to Conditioning the algae-SPE tubes
- An Aluminum standard solution of 5ppm was used to determine the algae-spe potential to remove Al from water samples

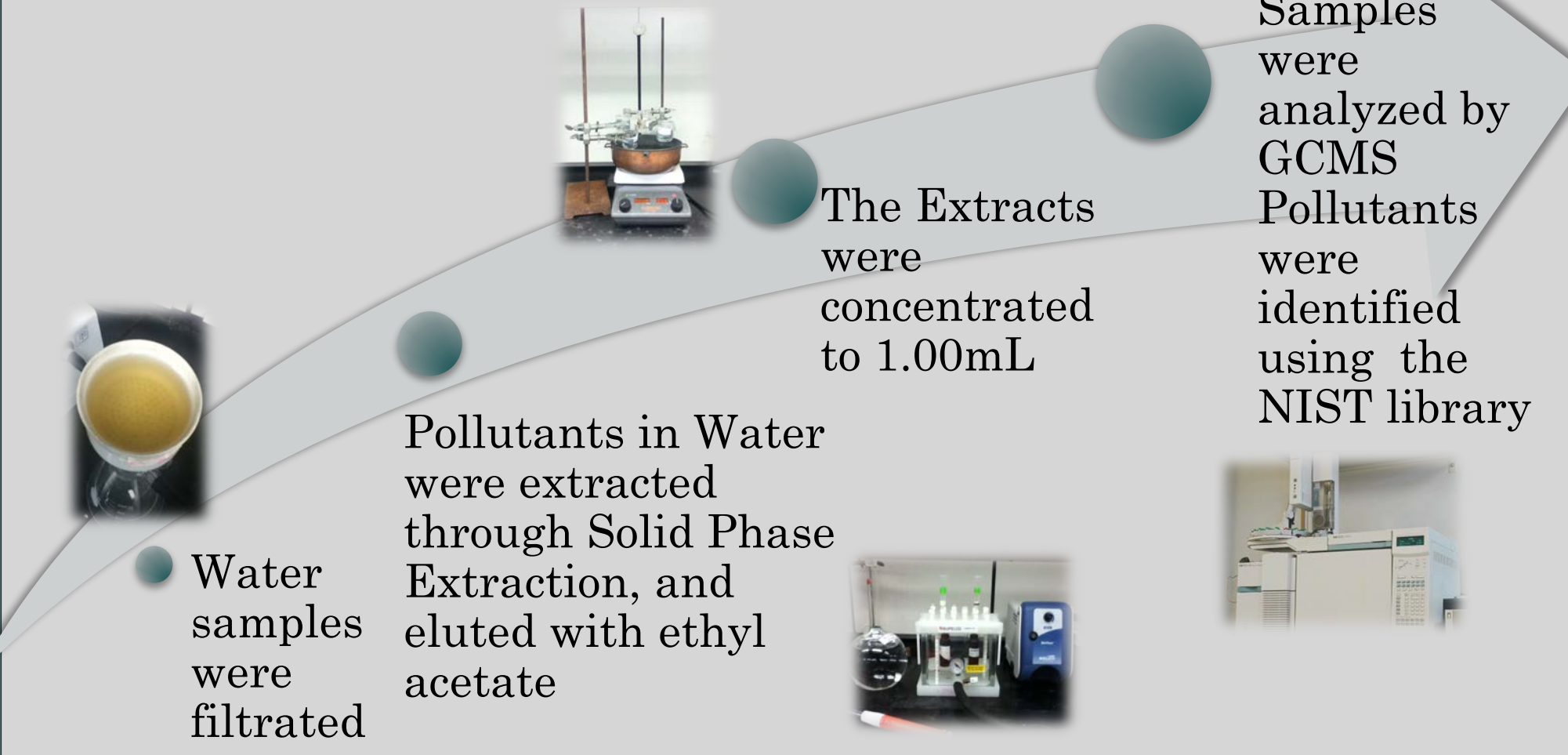**Detection of Aluminum by colorimetric method EDTA Complexometric**
- A calibration curve was made with an aluminum solutions in the range of 0.1 to 5ppm.
- Solutions were made for each sample
- Samples were measured in the Ultraviolet Spectrometer (UV)

Preparation of Macro algae Filters

Pulverizing the algae into a fine powder.

HCL was added to condition the packing

Centrifuged

The solid phase is placed in a beaker and dried.

Algae was mixed with silica, and 1mL of H₂O was added. This was then dried and pulverized. Repeat this process 5 times.

The dried composited were packed in the spe tubes.

GC MS Analysis of Water Samples – for organic pollutants

Water samples were filtrated

Pollutants in Water were extracted through Solid Phase Extraction, and eluted with ethyl acetate

The Extracts were concentrated to 1.00mL

Samples were analyzed by GCMS Pollutants were identified using the NIST library

RESULTS

Calibration Curve for the Determination of Al in Water Samples

$y = 0.4543x - 0.0884$
$R^2 = 0.9987$
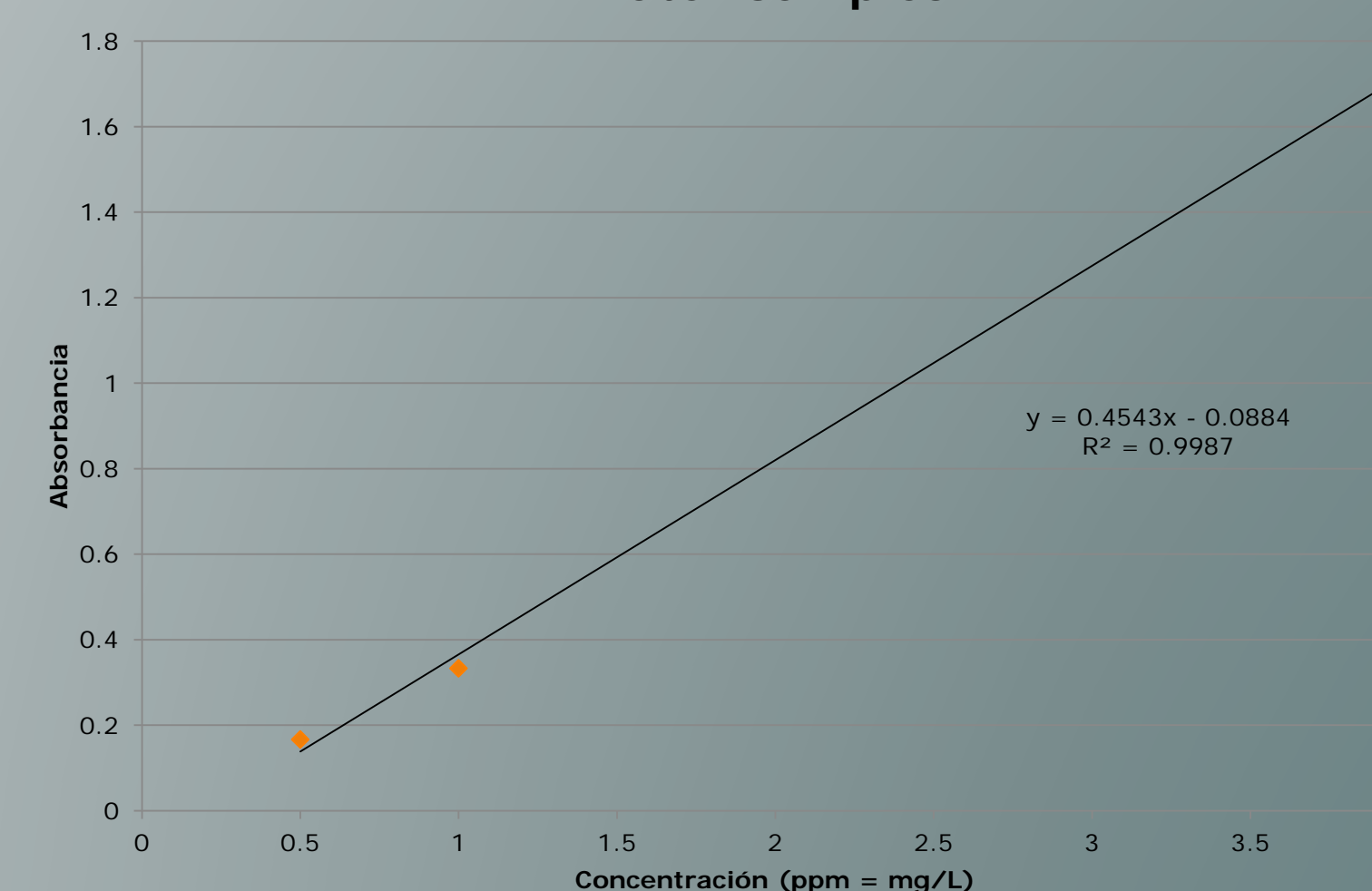
Macro-Alage SPE Al Retention Capacity

Algae	Absorbance (±0.0001)	Al Absorbed (mg/L)	Residual Al Concentration (ppm = mg/L)	Absorption Capacity (µg Al/ g dry algae)
Glacilaria	0.6667	3.34	1.66	33
Sargassum	0.7333	3.20	1.80	32

Aluminum Concentration in Water Samples

Sites	Absorbance (±0.0001)	Concentration (ppm = mg/L)
Río Grande de Loiza	0.2667	0.078
Carraizo	0.3000	0.085
Pitahaya	0.2667	0.078
Maunabo	0.2667	0.078
Blanco	0.4000	0.175

GCMS analysis of Semi volatile Organic Pollutants

Río Grande de Loiza

Compound	Ret Time	Area
Ethylbenzene	5.112	4069201
Phenol, 2,6-bis(1,1-dimethylethyl)	23.5	11289762
Hexadecane	24.665	5836195
Benzenesulfonamide, N-ethyl-2-meth	25.655	10062722
Benzene, 1,1'-(1,3-propanediyl)bis	25.709	7275590
Benzenesulfonamide, N-ethyl-4-meth	27.061	6039624
Octadecane	29.054	13382462
Eicosane	33.043	10202440
Heneicosane	34.908	2678904
Eicosane	36.698	12088449
Tetracosane	40.06	19721882
Eicosane	41.644	10560399

Embalse Carraizo

Compound	ret time	area
Ethylbenze	5.109	3339778
Bicyclo	5.776	5.1E+02
Dodecanoic acid, methyl ester	22.849	8507281
Phenol, 2,6-bis(1,1-dimethylethyl)	23.449	7115722
Hexadecane	24.663	4857844
Benzenesulfonamide, N-ethyl-2-meth	25.632	3905628
Benzene, 1,1'-(1,3 propanediyl)bis	25.71	6141001
Propenic acid ,oxybis(methyl-2)	26.745	2604885
Benzene, 1,1'-(1,2-cyclobutanediyl)	27.768	6058721
Octadecane	29.053	1.1E+03
Eeiicosane	33.045	6333523
Eicosane	36.698	4233377

- The organic compounds from the sites are:
  - Ethylbenzene occurs from the use of consumer products, gasoline, pesticides, solvents, carpet glues, varnishes, paints, and tobacco smoke.
  - Phenol is used primarily in the production of nylon and other synthetic fibers.
  - Hexadecane is from diesel.

ACKNOWLEDGEMENT

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CONCLUSIONS

- The immobilized algae, glacilaria and sargassum, absorbed 67 and 64 % of the aluminum present in the model solutions.
- Glacilaria spp. packing was more effective removing the aluminum present in the solutions.
- According to our previous and current research results we can conclude that macroalgae packing are a green and cheap alternative to remove simultaneously organic pollutants and Aluminium from water samples.