Blue-green microalgae-based exopolymers as an efficient bioflocculant for microplastics debris

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INTRODUCTION

Microplastics (MPs) pollution is the major environmental concern of the 21st century due to the increasing global plastic production and excessive consumption. New sustainable strategies are required to remove these plastic debris from wastewater using natural biological materials through clean approaches [1]. Cyanobacterial-based exopolymers (EPS) have attractive physical-chemical properties that can be applied as bioflocculants, bio emulsifying and biosorbents [2]. These properties make EPSs a promising flocculant as alternative to synthetic resources. *Gloecapsa* sp. exhibited different types of EPS *(i)* cell-bound or capsular polysaccharides (CPS) and *(ii)* released polysaccharides (RPS). In the current study, different extraction and purification methods were applied for CPS and RPS of *Gloecapsa* sp.. They were characterized in terms of morphological and structural properties. The bioflocculant activity was also evaluated from the supernatant and *Gloecapsa* cultures and compared with the bioflocculant activity of commercial products.

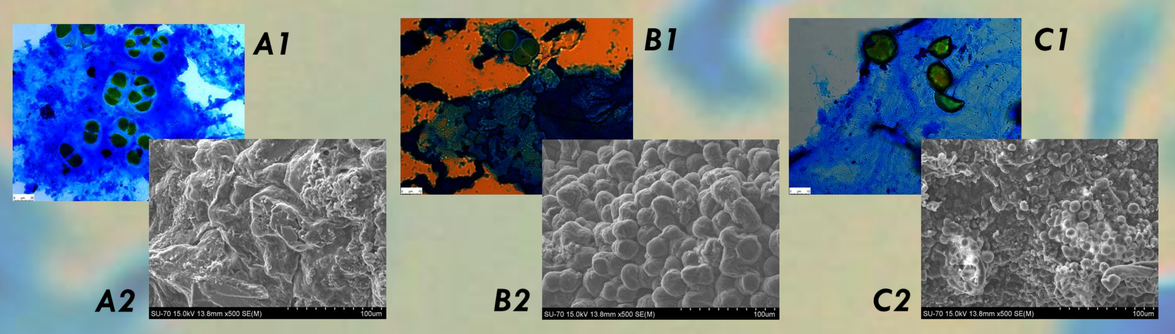

Figure 1. Bright field (A1,B1,C1 – stained with Alcian Blue) and SEM micrographs (A2,B2,C2) of *Gloecapsa* sp. cells of each extraction steps.

Table 1. Bioflocculation activity of *Gloecapsa* sp. (culture and supernatant) exopolymers under different concentrations of cations at 30, 60 and 120 min.

	Microplastics		
	Flocculating activity (%)		
	30 min	60 min	120 min
1% $CaCl_2$			
Supernatant	6.341 ± 0.427	1.289 ± 0.243	7.361 ± 0.584
Culture medium	8.967± 0.128	1.289 ± 0.243	4.507 ± 0.175
1% $FeCl_3.7H_2O$			
Supernatant	0.230 ± 0.046	9.844 ± 1.337	13.286 ± 2.269
Culture medium	5.421± 0.875	9.889 ± 0.171	15.124 ± 3.300
0.25% $FeCl_3.7H_2O$			
Supernatant	31.050 ± 0.676	32.965 ± 1.558	30.212 ±2.407
Culture medium	27.548 ± 0.225	29.459 ± 1.417	27.234 ± 0.601

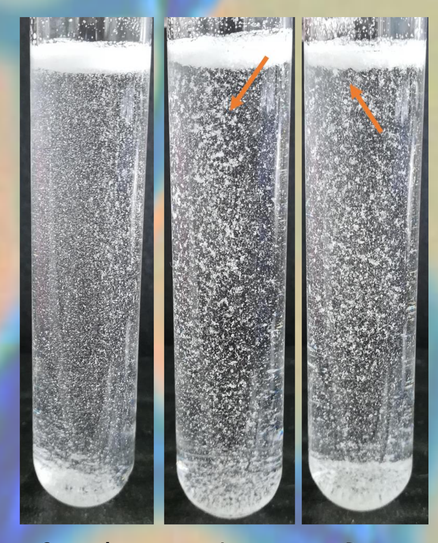

Figure 2. Bio flocculation activity of supernatant *Gloecapsa* sp. (A) and *Gloecapsa* sp. culture (B).

METHODS

30 ± 1 °C, 14:10 h (L/D)
40 µmol photons m^{-2} s^{-1}

Biomass – CPS

Centrifugation

Supernantant – RPS

Ultrafiltration Mw > 5 kDa

Precipitation Mw > 12-14 kDa

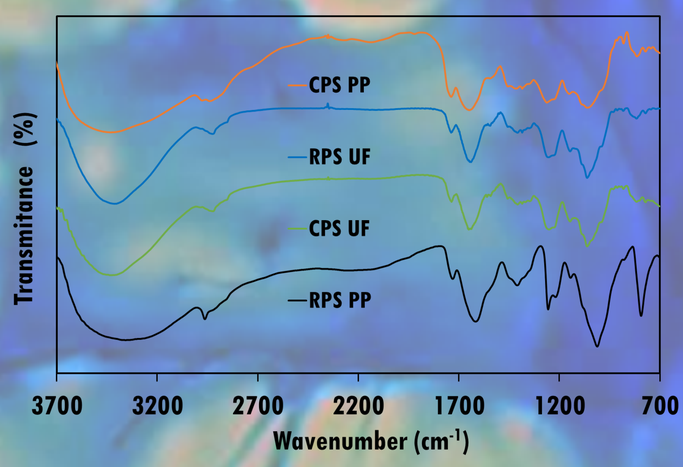

Figure 3. FTIR spectra of *Gloecapsa* sp. CPS and RPS.

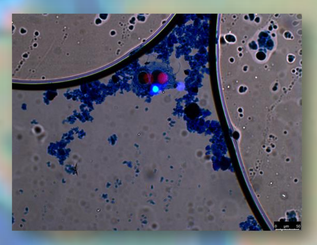

Figure 4. Agglomeration of MPs on *Gloecapsa* culture (x400). EPS were stained with Alcian Blue.

Structural and morphological characterization

Flocculation activity:
* pH 7.5, [MPs] and [kaolin] = 2 g L^{-1}
* Stirring 300 rpm, 60 min, OD = 550 nm

RESULTS

- CPS was removed successfully through reflux extraction;
- EPS showed a polysaccharide and anionic nature;
- CPS yield of 0.273 g L^{-1} and RPS yield of 0.236 g L^{-1} were obtained.
- A bioflocculating activity of 33% was achieved for *Gloecapsa* culture to remove microplastics of contaminated water.

CONCLUSIONS

The results indicate that *Gloecapsa* sp. was a good producer of EPS. The predominant *Gloecapsa* EPS's polysaccharide and anionic nature confers attractive and promising flocculant properties suitable to be applied in wastewater treatment, contributing for a sustainable and clean environment.

REFERENCES

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