

Aerobic granules synthesized with EPS and degrading strain *Rhodococcus* sp. FP1 for industrial wastewater treatment



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PORTO



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Background

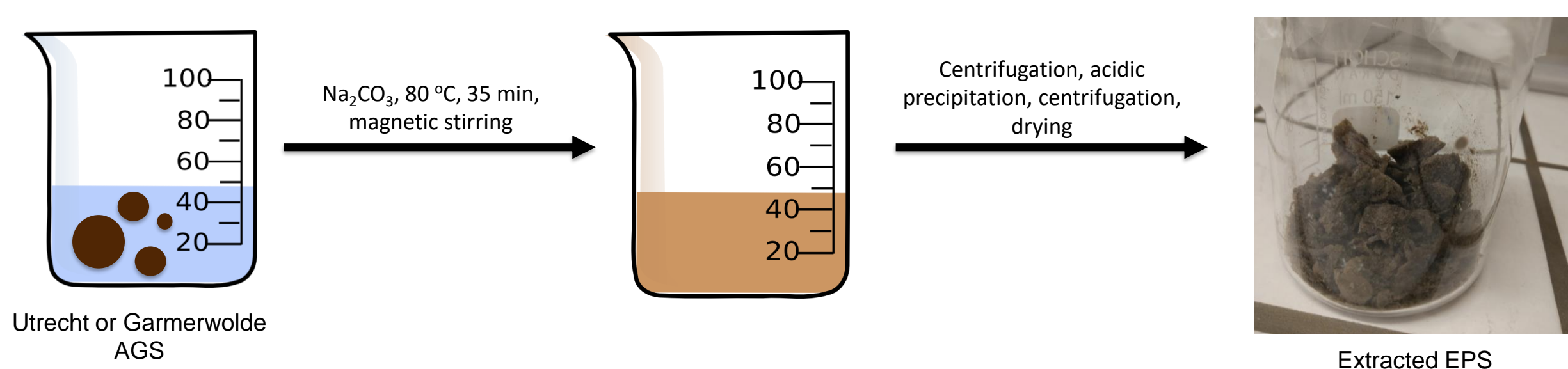
Aerobic granular sludge-sequencing batch reactors (AGS-SBR) have been introduced as a promising and innovative wastewater treatment system economically outcompeting the conventional activated sludge system. AGS is considered a special case of suspended biofilms, composed of self-immobilized microorganisms that form spherical sludge aggregates. Microorganisms are embedded in a self-produced extracellular polymeric substances matrix thus avoiding the need of any carrier ^{1,2}. Many synthetic organic chemicals or metabolites are being released directly into the environment after wastewater treatment processes, which are not conceived to remove them from the effluents ³.

In spite of the AGS tolerance to toxicity, the indigenous microbial communities in biotreatment processes may not be effective in removing recalcitrant pollutants. Bioaugmentation strategies, which consists of adding specific microorganisms to the system can be a solution to overcome the difficulty to eliminate certain compounds in wastewaters. However, it is still not a well-established strategy and deserves attention to become a promising alternative ^{4,5}.

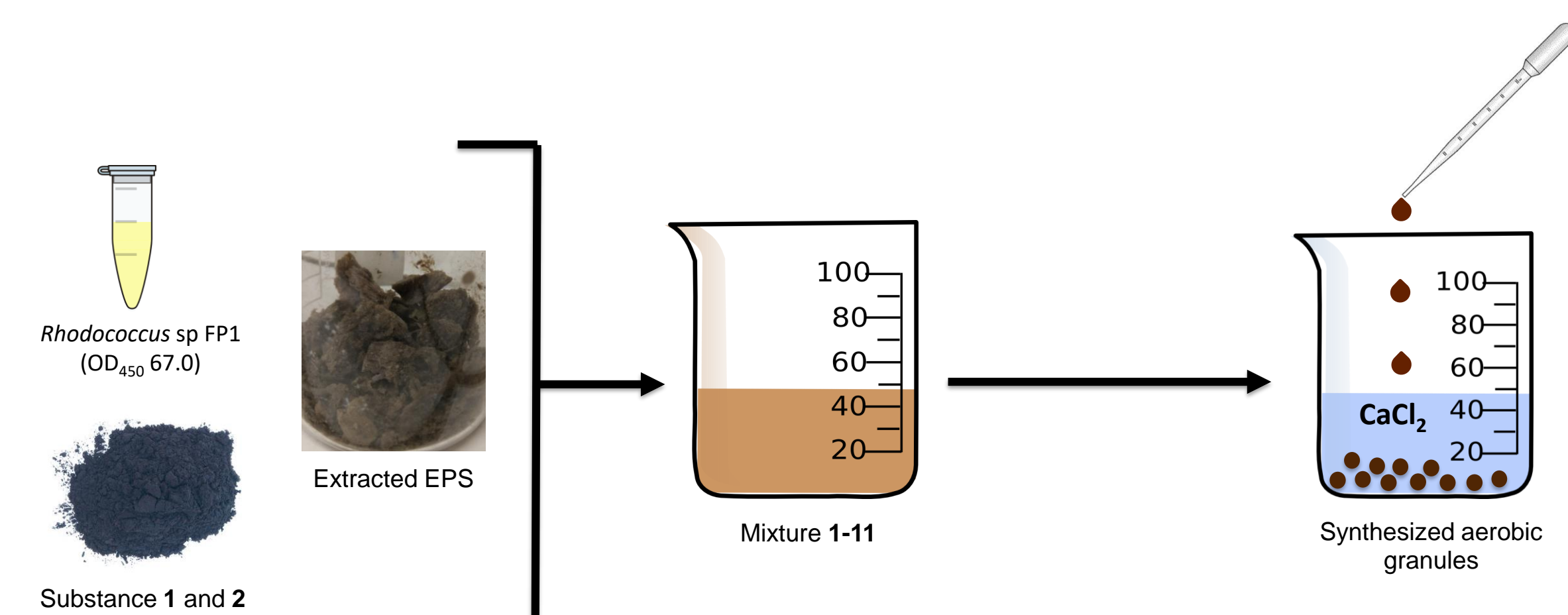
This work aimed to synthesize strong aerobic granules using EPS (extracted from AGS) and a specialized bacterial strain capable of degrading 2-fluorophenol, with the aid of specific substances to increase the cross-linking potential of EPS.

Material and methods

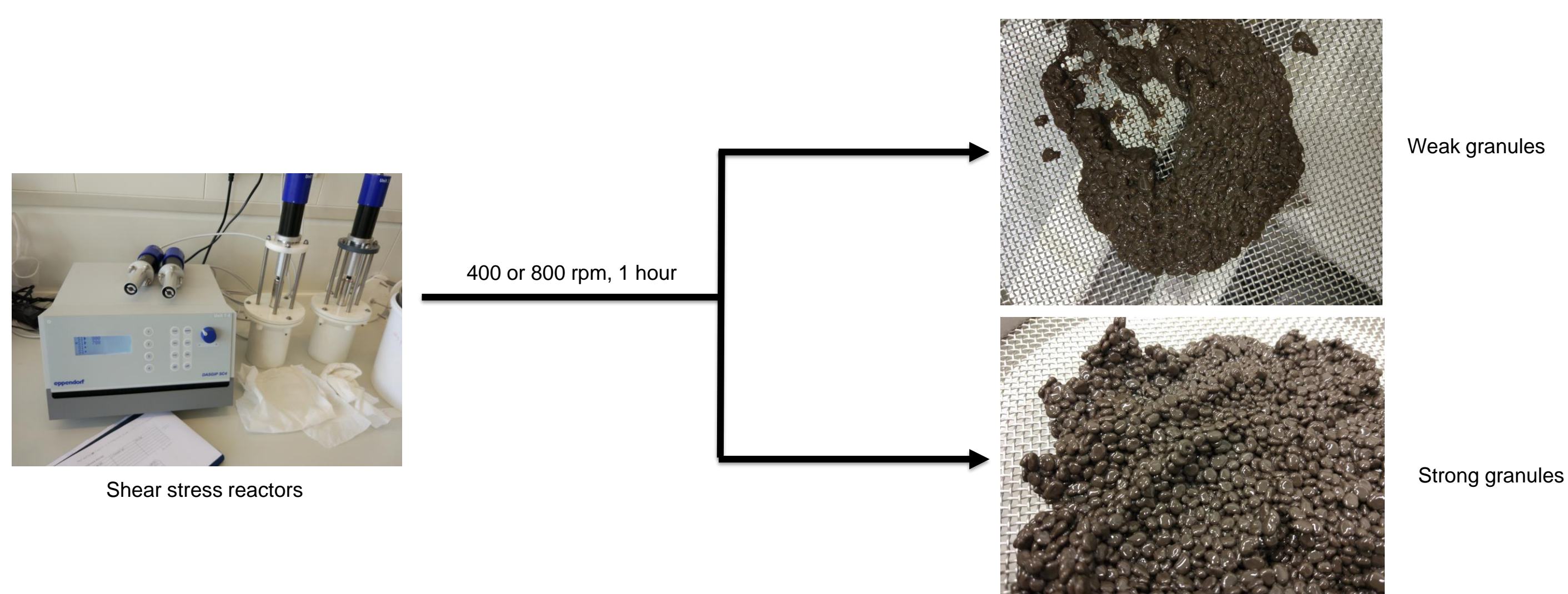
EPS extraction from aerobic granules ⁶



Synthesis of granules with extracted EPS, bacterial suspension and substance 1 or 2



Shear stress test



Results

K (s⁻¹) values represent the parameter that is used to evaluate the granules strength. The lower the K value, the stronger are the granules. Granules from the Utrecht Nereda[®] wastewater treatment plant showed a K value for 400 rpm test of $5.2 \times 10^{-8} \text{ s}^{-1}$ and a K value for 800 rpm of $6.3 \times 10^{-6} \text{ s}^{-1}$.

Table 1 - Composition (EPS, substances 1 and 2 percentage), and granules source for EPS extraction of each mixture that was used to produce the beads, and respective K value for the shear stress test at 400 or 800 rpm.

Mixture no.	EPS % in the mixture (% w/v)	Substance 1 (% w/v)	Substance 2 (% w/v)	Bacteria (% v/v)	Granules source for EPS extraction	Shear stress (rpm)	K (s ⁻¹) (± SD) ^a
1	100 (10 % w/v)	-	-	10	Utrecht	400	6.5×10^{-5} (±1.5×10 ⁻⁵)
2	90 (10 % w/v)	10 (12% w/v)	-	10	Utrecht	400	6.9×10^{-5} (±1.3×10 ⁻⁵)
3	85 (10% w/v)	15 (12% w/v)	-	10	Utrecht	400	7.7×10^{-5} (±1.2×10 ⁻⁵)
4	100 (15% w/v)	-	-	20	Utrecht	800	1.2×10^{-4} (±4.3×10 ⁻⁵)
5	-	-	100 (3% w/v)	20	-	800	5.6×10^{-6} (±6.2×10 ⁻⁷)
6	94 (11% w/v)	-	6 (0.68% w/v)	10	Garmerwolde	800	3.7×10^{-6} (±1.3×10⁻⁷)
7	-	-	100 (0.68% w/v)	10	-	800	1.5×10^{-5} (±1.4×10 ⁻⁶)
8	97 (12% w/v)	-	3 (0.3% w/v)	10	Garmerwolde	800	1.4×10^{-4} (±3.4×10 ⁻⁶)
9	95(11% w/v)	-	5 (0.63% w/v)	10	Garmerwolde	800	3.2×10^{-5} (±4.5×10 ⁻⁷)
10	94 (14.5 %w/v)	-	6 (1% w/v)	10	Garmerwolde	800	1.5×10^{-4} (±5.8×10 ⁻⁶)
11	96 (19% w/v)	-	4 (0.68% w/v)	10	Garmerwolde	800	1.9×10^{-4} (±7.7×10 ⁻⁶)

^a K values are presented as an average of two measurements.

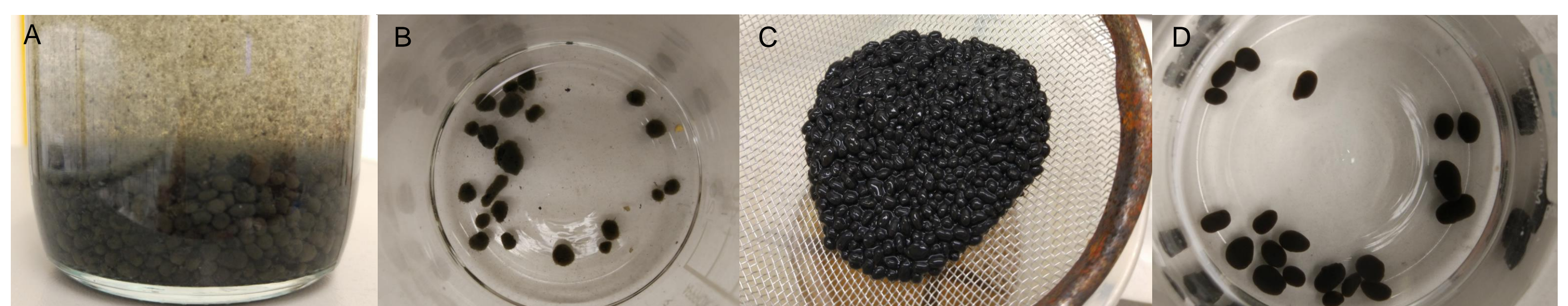


Figure 1 – Aerobic granules from a full-scale Nereda[®] wastewater treatment plant (A and B) and aerobic granules synthesized with EPS and degrading strain *Rhodococcus* sp. FP1 (C and D).

Conclusions

- ✓ Substance 1 was not efficient in improving the strength of the granules, due to concentration or inability to promote the crosslinking of EPS;
- ✓ Granules from mixture 6 were the most similar in terms of strength to the Utrecht granules.
- ✓ The source of EPS affected the strength of the granules, even with conditions similar to mixture 6
- ✓ Control beads from mixture 7 showed to be weaker than the ones from mixture 6, reinforcing that EPS was a key component to increase the strength of the produced granules.
- ✓ EPS composition and concentration are important to produce strong granules that can be further used in bioaugmentation.

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