Simulated solar radiation under continuous flow mode as a way to rapidly decrease the input of antibiotics into the aquatic environment

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Antibiotics are amongst the most used drugs, undeniably playing a critical role in health and life expectancy. However, they also pose a potential threat due to the induction of antimicrobial resistance. This fact requires an urgent multisectoral action including to achieve the United Nations Sustainable Development Goals (SDGs). Their presence in the environment, due to the discharge of effluents of different origins, is of great concern and photodegradation appears as an alternative and sustainable process for their removal. This is the basis of the REM-AQUA Project – Photosensitized degradation as a remediation process for the removal of pharmaceuticals from aquaculture effluents (PTDC/ASP-PES/29021/2017). Regarding an industrial application of the photodegradation under solar radiation, it is important that the process runs continuously. Flow photochemistry in a microreactor has many advantages in comparison to batch systems, like large surface area-to-volume ratio, uniform irradiation and rapid photon transfer.

Therefore, the assessment of the photodegradation of an antibiotic (sulfamethoxazole, SMX) was performed, using simulated solar irradiation in continuous flow mode (Fig. 1a). Obtained results showed that, compared with batch operation, the irradiation time needed to reach SMX half-life time was sharply decreased from 7.54 h to 1.5 h. Moreover, the interrelation between SMX removal, mineralization and antibacterial activity was evaluated. Although mineralization was slower than SMX removal, bacterial activity increased after SMX photodegradation. Such an increase was also verified in environmental waters. Thus, this study has proven that photodegradation is an efficient and sustainable process for both the remediation of waters contaminated with antibiotics and minimization of bacterial resistance.

Next steps of the REM-AQUA Project rely on the use of a small-scale reactor for the photodegradation of antibiotics by using natural sunlight (Fig. 1b).

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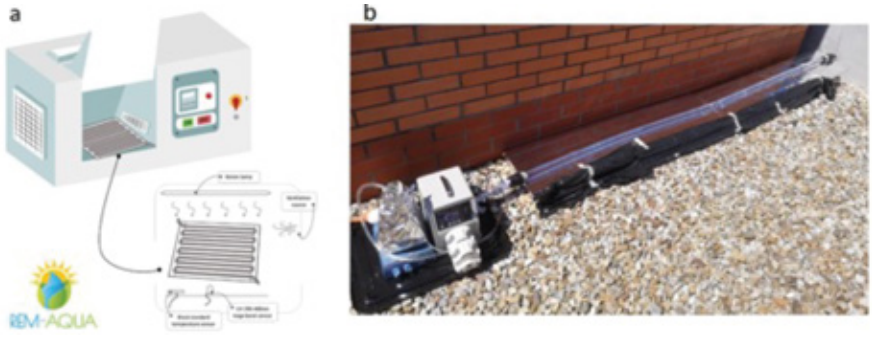

FIGURE 1
Experiments within REM-AQUA Project: (a) Scheme of the apparatus used to study SMX photodegradation in continuous flow mode under simulated solar radiation; (b) Small-scale reactor for photodegradation under natural sunlight.