News approaches for a circular economy: how haloarchaea can contribute to environmental pollution

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Climate change has critically accelerated the formation of so-called extreme environments, ecosystems that present a series of characteristics that make life a survival phenomenon. The diversity of organisms in these environments is very limited, and the few organisms that manage to survive must acquire complex adaptations to these environmental adversities.

The so-called haloarchaea are halophilic micro-organisms that have managed to acquire a multitude of adaptations to high salt concentration (accumulation of compatible solutes), high solar radiation (production of pigments) or lack of nutrients (production of bioplastics). These adaptations lead to the production of certain biomolecules that, in addition to guaranteeing their survival, can be applied in a multitude of fields such as the biotechnological, biomedical and pharmaceutical industries. In this presentation we will take a journey through the different biomolecules of interest, focusing on the production of carotenoid pigments and the so-called polyhydroxyalkanoates.

The main function of carotenoid pigments is to eliminate reactive oxygen species that are generated by high solar radiation and cause severe cell damage. Haloarchaea are capable of producing a characteristic pigment called bacteriorruberin, which has a greater antioxidant capacity due to the presence of a greater number of carbons than the rest of the carotenoids. This high antioxidant capacity has been studied in the biomedical industry as a treatment for various neurodegenerative diseases and as antitumour agents.

In situations of excess carbon source in the environment, certain species of haloarchaea are capable of producing polyhydroxyalkanoates as a reserve source when there is a shortage of nutrients in the environment. These biopolymers are used as bioplastics due to their high biodegradability and biocompatibility. In addition, the production of bioplastics in these microorganisms has a number of advantages that can be compared to current petroleum-based plastics. The main monomers produced are polyhydroxybutyrate (PHB) and polyhydroxyvalerate (PHV), which in combination can give rise to plastics with different degrees of stiffness. These bioplastics have proven to be of great use in the food industry as

food packaging, as well as healthcare materials in the biomedical industry. Efforts are currently focused on improving the production efficiency of these bioplastics and their extraction method, in order to avoid the use of environmentally harmful organic solvents.

Finally, these haloarchaea have the capacity to tolerate and metabolise a multitude of toxic compounds, in a bioremediation process that makes it possible to obtain these biomolecules of interest. Species such as *Haloferax mediterranei* have been used to bioremediate different chemical compounds in order to eliminate them from the environment and generate carotenoid pigments and bioplastics to contribute to a circular economy. Therefore, the use of this type of haloarchaea represents a great revolution that can contribute to a certain extent to improving the environment.