Subject area: __*ORG*__ Registration #: _____

Emerging biological applications of Reactive Chalcogen Species (RCS)

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Keywords: *Reactive Sulfur Species, Reactive Selenium Species, cellular thiolstat, oxidative stress*

Highlights

Natural as well as synthetic chalcogen-based compounds interact with the proteins of the cellular thiolstat and modulate the redox state of the cell fairly activity and selectively.
Nanotechnology provides an interesting key to to unlock the biological activity of elemental chalcogens.

Abstract

Chalcogen-based natural and synthetic organic compounds have recently attracted the attention of scientists due to their widespread applications in the fields of medicine and agriculture. These compounds modulate the intracellular redox state rather effectively, by several different mechanisms rapidly and with an increased degree of selectivity. The most dominating mechanisms include the reversible modification of cysteine residues of the proteins, especially those belonging to the cellular thiolstat, production of Reactive Oxygen Species and depletion of cellular GSH levels. These chalcogen-based redox modulating agents have, therefore, great potential to serve as effective and at the same time selective cytotoxic agent.[1,2]
Natural sulfur based (pro)oxidants such as allicin and polysulfanes demonstrate great antimicrobial activity against a broad spectrum of microorganisms.[1] Several of these natural products are, therefore, currently employed as green phytoprotectants. Moreover, polysulfanes have also been reported to target various cancer cells fairly selectively.[2, 3] Similarly, several organo-selenium and organo-tellurium compounds have demonstrated great cytotoxic activity against a wide range of cancer cells. Interestingly, these compounds target the cancer cells selectively and induce apoptosis without harming the normal cells.[4]
Another interesting approach involves the interaction of nanotechnology with elemental chalcogens. Nanoparticles of elemental sulfur, selenium and tellurium have proven to be active against a broad spectrum of microorganisms.[5] Nanoparticles could be generated physically by mechanical grinding, chemically by the redox reactions of selenite and biologically by employing certain bacteria or yeasts such as *Staphylococcus carnosus* or *Saccharomyces cerevisiae*.[6]
The widespread applications of chalcogen-based redox modulating agents in the fields of medicine and agriculture provide a promising areas of research and a stimulating topic for interdisciplinary projects ranging from nanotechnology and synthetic chemistry to pharmacy, medicine and agricultural sciences.

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