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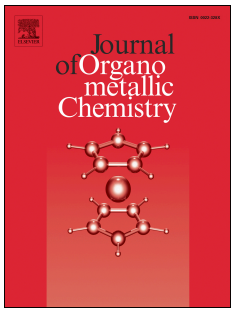

Assessing Ge-132 as an antioxidant in organic and water-containing media

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Assessing Ge-132 as an antioxidant in organic and water-containing media

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Abstract. The antioxidant activity of Ge-132 (2-carboxyethylgermanium sesquioxide, $[(O_{0.5})_3GeCH_2CH_2COOH]_n$), a widely used organic germanium dietary supplement, was assessed by cyclic voltammetry and through its interaction with a stable radical 2,2,-diphenyl-1-picrylhydrazyl (DPPH) monitored by UV-Vis and EPR spectroscopy in water, CH_3CN, DMF, MeOH, and their mixtures with water. The results obtained by these methods are coherent in that Ge-132 can manifest its antioxidant activity only in the absence of water because the latter hydrolyses its Ge-O-Ge fragment responsible for quenching free radicals. Thus, contrary to a common use of Ge-132 as a water-soluble agent, it can act as an antioxidant solely in a lipid environment, which is important for understanding the mechanism of its biological activity.

Keywords: antioxidants, germanium sesquioxides, Ge-132, cyclic voltammetry, DPPH, UV spectroscopy, EPR, HRMS.

Introduction

Controlling the level of free radicals involved in aerobic metabolism in living organisms [1] is important for handling oxidative stress and pathophysiology of several diseases [2] and supposedly for aging-related issues [3]. Their level is normally regulated by enzymes (superoxide dismutase etc), non-enzymatic antioxidants such as glutathione, vitamins A, C, E [2, 4, 5] and exogenous antioxidants [6] which form two groups, hydrophilic (hydrosoluble) and hydrophobic (liposoluble) [1, 6, 7], depending on the media in which they are more efficiently blocking free radicals. Low toxicity of Ge sesquioxides [8], and particularly the efforts of Asai Germanium Company worked out the advent of 2-carboxyethylgermanium sesquioxide (Ge-132) reported to have – besides immunomodulating [9-11], anti-inflammatory, anti-virus, hepato and radioprotector activity ([12] and refs therein) – antioxidant properties [9, 13-18]. Although this germanium preparation is being intensively studied [19-21] and even commercialized, its antioxidant mechanism is far from being established. For its understanding, two aspects of chemistry of Ge-132 seem of prime importance: (*i*) 2D polymer and a monomer triol forms exist in hydrolysis equilibrium (Scheme 1) [16] and (*ii*) interaction of Ge-132 with free radicals supposedly involves a Ge-O-Ge link [22,23], absent in the monomer (Scheme 2). In the light of this, one can expect the antioxidant activity of Ge-132 to depend strongly on the presence of water in its environment.

To the best of our knowledge, this issue has never been addressed. This aspect is especially intriguing since Ge-132 is primarily known as water-soluble germanium supplement [9, 11].