

## Aspects Relating of the Oxidative Stress to Living Organisms

Monica Butnariu<sup>1\*</sup> and Ionel Samfira<sup>2</sup>

<sup>1</sup>Discipline of Chemistry and Vegetal Biochemistry, Banat's University of Agricultural Sciences and Veterinary Medicine from Timisoara, Romania

<sup>2</sup>Discipline of Grassland and Fodder plants culture, Banat's University of Agricultural Sciences and Veterinary Medicine from Timisoara, Romania

Free radicals (pro-oxidants) are compounds belonging to the radical groups; they are active biochemically and biologically, and they destroy cell membranes, nuclei, and cytoplasm, producing and maintaining an intense oxidative stress. This is a consequence of the presence of one or several free electrons on the last layer of an atom in the molecule. Free radicals are oxygenated electron-deficit anions that do not make up salts, acids, or bases, but keep this reactive (free) form [1].

Oxygen electronic structure explains why the element, though a free diradical (two unpaired electrons) have low reactivity. Oxygen is essential for aerobic bodies' life, but, in concentrations that are too high, it can turn toxic. Molecular oxygen in fundamental state is inert, and its partial reduction results in active oxygen species—the most dangerous free radicals [2]. This group of compounds is called Reactive Oxygen Species (ROS). ROS is a term including not only oxygen radicals (O and H), but also oxygen non-radical derivatives, including hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), hypochlorous acid (HOCl), and ozone (O<sub>3</sub>) [3]. Even if ROS are not true free radicals, these species are molecule reactive [4].

Under physiological conditions, ROS are produced in small amounts in the cells [5].

The interaction between these species and lipid membranes, nucleic acids, proteins and enzymes or other small molecules, leads inevitably to cell lesions (Figure 1).

These cell lesions are one of the factors leading to ageing and degenerative diseases at cell level, there are several types of reactive species.

The variety of free radicals in nature resulted from different processes (ultraviolet radiations, gamma radiations, action of specific particles, etc.) makes their classification difficult [6,7].

From the point of view of the nature of the element containing free electrons, free radicals can be: superoxide, peroxide, hydroxide, nitric oxide, nitrite, nitrate, alkoxy (Table 1).

Cell production of ROS roots in enzymatic and non-enzymatic sources.

Electron transfer from proteins or enzymatic systems can lead to ROS as a result of electron transfer reactions. This "unintentional" generation of ROS in mitochondria represents 1–2% of the total O<sub>2</sub> consumed in reducing conditions. Body oxygen content represents 65% and inhaled air oxygen content is 21%. Cells generate aerobic energy, reducing O<sub>2</sub> to water.

Oxygen can be used in catabolic and anabolic processes, allowing larger amounts of energy than possible in its absence [8].

Oxygen has a particular electronic structure in its fundamental state, with two non-participating electrons on the last layer, each of which is localised on an orbital n\* (Figure 2).

These two electrons have the same quantum number of spin; thus, if O<sub>2</sub> tries to oxidate a compound by accepting two electrons, they need to have a parallel spin number to occupy the free spaces in the orbitals n\*

(in an orbital, two electrons have anti-parallel spins +1/2 and -1/2) [9].

This particularity asks for a restriction of oxidations, determining higher or lower reactivity, depending on the nature of the electron donor (Table 2).

All oxidations in nature are based on these two pathways, even if the forms may seem varied.

Peroxides and superoxides are anions that have oxidative action (peroxides, alkoxy, nitrosamines, acrolein) derive from H<sub>2</sub>O<sub>2</sub> and from other sources/processes, like the anions resulted from the degradation (rancidisation, proteolytic degradation, etc.) of lipid-rich foods (lipid peroxides, lipid alkoxy) or from food processing (frying, refreezing, etc.).

Hypochlorous acid behaves like free radicals (but they do not belong to this class).

Other sources of free radicals are nitrosamines and unsaturated aldehydes (acrolein), very active and destructive because of their action on cell membranes [10].

Evolutively, nature has selected and included in the composition of the organisms, reactions generating free radicals with multiple roles: functional, intracellular communication, or destructive, cytotoxic. If, at molecular level, the main target of the free radicals is the free or protein groups SH, at cellular level, the major goal is cell membranes.

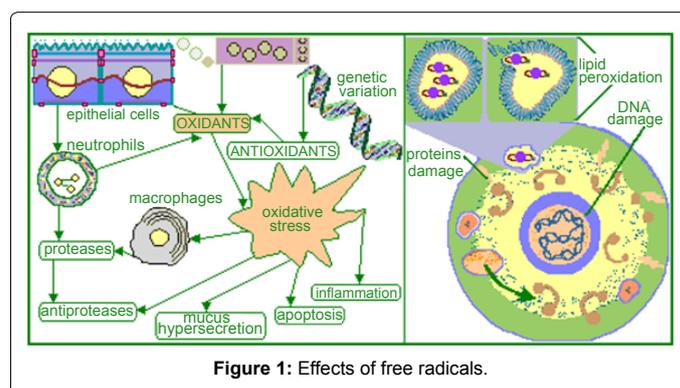


Figure 1: Effects of free radicals.

\*Corresponding author: Monica Butnariu, Discipline of Chemistry and Vegetal Biochemistry, Banat's University of Agricultural Sciences and Veterinary Medicine from Timisoara, 300645, Calea Aradului 119, Timis, Romania, Tel: +40-0-256-277-464; E-mail: [monicabutnariu@yahoo.com](mailto:monicabutnariu@yahoo.com), [monica\\_butnariu@usab-tm.ro](mailto:monica_butnariu@usab-tm.ro)

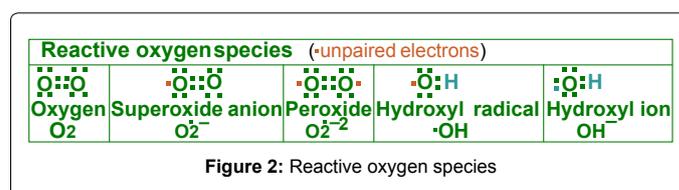
Received July 20, 2013; Accepted July 22, 2013; Published July 22, 2013

Citation: Butnariu M, Samfira I (2013) Aspects Relating of the Oxidative Stress to Living Organisms. J Biodivers Endanger Species 1: e106. doi:10.4172/2332-2543.1000e106

Copyright: © 2013 Butnariu M. et al, This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Species/Common Name	Systematic Name/Alternative and Comments
CO/carbon monoxide	carbon monoxide/Oxidomethanediyl (CH <sub>3</sub> <sup>•</sup> )
CO <sub>2</sub> /carbon dioxide	carbon dioxide/dioxidomethane
CO <sub>2</sub> <sup>-•</sup> /carbon dioxide radical anion	dioxidocarbonate (•1-)/oxidooxomethyl radical
CO <sub>3</sub> <sup>-•</sup> /carbonate radical	trioxidocarbonate (•1-)
H•/hydrogen atom	monohydrogen (•)
H <sub>2</sub> O/water	dihydrogen monoxide/oxidane
H <sub>2</sub> O <sub>2</sub> /hydrogen peroxide	dihydrodioxide/dioxidane
H <sub>3</sub> C•	methyl radical
HNO <sub>2</sub>	nitrous acid
HNO <sub>3</sub>	nitric acid
HO•/hydroxyl radical	hydridooxygen/oxidanyl
HO <sub>2</sub> <sup>-•</sup> /hydridodioxigen (1-)	dioxidanide, hydrogendioxide (1-)/hydrogenperoxide (1-)
HO <sub>2</sub> <sup>•</sup> /hydroperoxyl, but is obsolete	Hydridodioxigen (•) dioxidanyl/hydrodioxyl, perhydroxyl
HO <sub>3</sub> <sup>•</sup> /hydrogen trioxide radical	hydridotrioxigen (•)/trioxidanyl
HOCO•	hydroxidooxidocarbon (•)
HOCO <sub>2</sub>	hydroxidodioxidocarbon (•)
HOCl/hypochlorous acid	hydrogenoxidochlorate
HOBr/hypobromous acid	hydrogenoxidobromate
HOI/hypoiodous acid	hydrogenoxidoidate
HOSCN/hypothiocyanous acid	hydrogenoxidothiocyanate
HON <sub>2</sub> <sup>•</sup>	hydroxidonitrogen(2•) (triplet)/hydrogen oxidonitrate(2•)
HOOCO/ (hydridodioxido)	oxidocarbon(•)
HOONO/peroxynitrous acid	hydrogenoxidoperoxidonitrate/nitrosodioxidane
(NO) <sub>2</sub> <sup>••</sup>	bis (oxidonitrate) (n - n) (•1-)
N <sub>2</sub> O/nitrous oxide	dinitrogen monoxide
N <sub>2</sub> O•	oxidodinitrate (•1-)
N <sub>2</sub> O <sub>3</sub>	dinitrogen trioxide
N <sub>3</sub> <sup>•</sup> /azidyl radical	trinitrogen (2n - n)(•)
NO•/nitric oxide, but is obsolete	oxidonitrogen (•)/oxoazanyl, nitrogen monoxide
NO <sup>-</sup> (2•)/nitroxyl	oxidonitrate (2•1-) (triplet)
NO <sub>2</sub> <sup>-•</sup> /nitrite	dioxidonitrate (1-)
NO <sub>2</sub> <sup>•</sup> /nitrogen dioxide	dioxidonitrogen
NO <sub>2</sub> <sup>2•</sup>	dioxidonitrate(•2-)
NO <sub>3</sub> <sup>-•</sup> /nitrate	trioxidonitrate (-)
NO <sub>3</sub> <sup>•</sup> /nitrogen trioxide	trioxidonitrogen (•)/nitrosoxidanyl
NO <sub>3</sub> <sup>2•</sup>	trioxidonitrate (•2-)
O <sup>-•</sup> /radical anion of HO•	oxide (•1-)/oxidanidyl
O <sub>2</sub> <sup>-•</sup> /superoxide	dioxide (•1-)/dioxidanidyl
O <sub>2</sub> <sup>••</sup> /	dioxygen (•1+)
O <sub>2</sub> <sup>2•</sup> /oxygen, usually O written O <sub>2</sub>	dioxygen (triplet)/dioxidanediyl
O <sub>3</sub> /ozone	trioxygen
O <sub>3</sub> <sup>-•</sup> /ozonide	trioxide (•1-)/trioxidanidyl
OCl•/hypochlorite	oxidochlorate (1-)
OBr•/hypobromite	oxidobromate (1-)
OI•/hypoiodite	oxidoidate (1-)
OSCN•/hypothiocyanate	oxidothiocyanate (1-)
OCOO <sup>-•</sup>	(dioxido) oxidocarbonate (•1-)
ONOO <sup>-•</sup> /peroxynitrite	oxidoperoxidonitrate (1-)/nitrosodioxidanide
ONOOH/peroxynitrous acid	hydrogen-oxidoperoxinitrate/nitrosodioxidane
ONOO•	(dioxido)oxidonitrogen (•)/nitrosodioxidanyl

**Table 1:** Formulae and IUPAC Recommended Names of Simple Compounds Containing C, H, and O in Free Radical Biology



No.	Species/Abbreviation	Name
	Asc; AscH <sup>-</sup> ; Asc <sup>-•</sup>	ascorbate, general; ascorbate monoanion; ascorbate radical
	CAT	catalase
	HRP	peroxidase
	GPx	glutathione peroxidase
	GR	glutathione disulfide reductase; often referred to as glutathione reductase
	Grx	glutaredoxin
	GSH	glutathione, not reduced glutathione (a misnomer)
	GST	glutathione S transferase
	LDL	low density lipoprotein
	OH <sup>-</sup>	hydroxide anion, not to be confused with HO•
	PUFA	polyunsaturated fatty acid
	RO•	alkoxyl radical; not alkoxy
	ROO•	alkyl dioxygen (•), alkylidoxyl, alkylperoxyl radical; not peroxy
	SOD	superoxide dismutase

\*These are commonly used abbreviations. Others appear in the literature.

**Table 2:** Common Abbreviations.

## References

- Veda S, Patel K, Srinivasan K (2008) Influence of food acidulants and antioxidant spices on the bioaccessibility of beta-carotene from selected vegetables. J Agr Food Chem 56: 8714-8719.
- Cynshi O, Tamura K, Niki E (2010) Design, synthesis, and action of antiatherogenic antioxidants. Method Mol Biol 610: 91-107.
- Takabe W, Li R, Ai L, Yu F, Berliner JA, et al. (2010) Oxidized Low-Density Lipoprotein -Activated c-Jun NH<sub>2</sub>-Terminal Kinase Regulates Manganese Superoxide Dismutase Ubiquitination: Implication for Mitochondrial Redox Status and Apoptosis. Arterioscl Throm Vas 30: 436-441.
- Dadali VA, Tutel'ian VA, Dadali luV, Kravchenko LV (2010) Carotenoids. Bioavailability, biotransformation, antioxidant properties. Vop pitaniia 79: 4-18.
- Surapaneni KM, Venkataramana G (2007) Status of lipid peroxidation, glutathione, ascorbic acid, vitamin E and antioxidant enzymes in patients with osteoarthritis. Indian Journal of Med Sci 61: 9-14.
- Kanamoto T, Rimayanti UHO, Kiuchi Y (2011) Platelet -derived growth factor receptor alpha is associated with oxidative stress -induced retinal cell death. Curr Eye Res 36: 336-40.
- Pattillo CB, Pardue S, Shen X, Fang K, Langston W, et al. (2010) ICAM -1 cytoplasmic tail regulates endothelial glutathione synthesis through a NOX<sub>4</sub>/PI<sub>3</sub>-kinase -dependent pathway. Free Radical Bio Med 49: 1119-1128.
- Jacobs AC, Resendiz MJ, Greenberg MM (2011) Product and mechanistic analysis of the reactivity of a C6 -pyrimidine radical in RNA. J Am Chem Soc 133: 5152-5159.
- Pickrell AM, Fukui H, Moraes CT (2009) The role of cytochrome c oxidase deficiency in ROS and amyloid plaque formation. J Bioenerg Biomembr 41: 453-456.
- Rizzo AM, Berselli P, Zava S, Montorfano G, Negroni M, et al. (2011) Endogenous Antioxidants and Radical Scavengers. Adv Exp Med Biol 698: 52-67.

**Citation:** Butnariu M, Samfira I (2013) Aspects Relating of the Oxidative Stress to Living Organisms. J Biodivers Endanger Species 1: e106. doi:10.4172/2332-2543.1000e106