EC NUTRITION
Commentary

Superoxide Dismutase as a New Entrant into the Vitagene Family in Animals/Poultry

Peter F Surai[1-7]*

[1]Vitagene and Health Research Centre, Bristol, UK

[2]Department of Hygiene and Poultry Sciences, Moscow State Academy of Veterinary Medicine and Biotechnology Named After K.I. Skryabin, Moscow, Russia

[3]Department of Microbiology and Biochemistry, Faculty of Veterinary Medicine, Trakia University, Stara Zagora, Bulgaria

[4]Department of Animal Nutrition, Faculty of Agricultural and Environmental Sciences, Szent Istvan University, Hungary

[5]Saint-Petersburg State Academy of Veterinary Medicine, St. Petersburg, Russia

[6]Sumy National agrarian University, Sumy, Ukraine

[7]Odessa National Academy of Food Technologies, Odessa, Ukraine

***Corresponding Author**: Peter F Surai, Vitagene and Health Research Centre, Bristol, UK.

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It is well known that poultry production is associated with a range of various stresses, including technological, environmental, nutritional and internal stresses [1]. In fact, in commercial poultry production it is practically impossible to avoid stresses and they are responsible for decreased productive and reproductive performances of growing birds and breeders. Importantly, on the molecular level, most of commercially relevant stresses in poultry production are associated with overproduction of reactive oxygen and nitrogen species (RONS) and oxidative stress [2]. Therefore, an antioxidant defence network developed during evolution is believed to be responsible for maintenance of the redox balance in the cells/tissues providing optimal conditions for cell signaling and effective adaptation to stress challenges [2].

Among many different antioxidant mechanisms operating in animals/poultry, vitagenes recently has become a center of attention [1]. The term "vitagene" was first introduced in 1998 by Rattan [3], indicating "Our survival and the physical quality of life depends upon an efficient functioning of various maintenance and repair processes. This complex network of the so-called longevity assurance processes is composed of several genes, which may be called vitagenes". Later the vitagene concept has been further developed/adapted in relation to medical sciences by Calabrese and colleagues [4,5] and the term "vitagenes" includes a group of genes responsible for cellular homeostasis maintenance under stress conditions. Therefore, the vitagene family is suggested to include: HSP70, HO-1, thioredoxin system, glutathione system and sirtuins. The products of the aforementioned vitagenes are believed to be involved in the detection of stress and creation of a protective stress response and effective adaptation to diverse forms of stress and cell injuries. The vitagene concept is already found its wide acceptance in the medical sciences in relation to free radical-related diseases and recently it has been successfully applied to poultry and animal production and it was suggested superoxide dismutase (SOD) to be included into the vitagene family [1,2,6,7]. Indeed, there are several important points suggesting that SOD plays an important role is stress adaptation as an integral part of the vitagene family.

At present, three distinct isoforms of SOD (Cu, Mn-SOD, Mn-SOD and EC-SOD) have been identified in mammals and birds and their genomic structure, cDNA, and proteins have been described. The biosynthesis of SODs, in most biological systems is shown to be well controlled. For example, exposure to various stresses, including increased pO_2, increased intracellular fluxes of O_2^-, metal ions perturbation, environmental oxidants have been shown to influence the rate of SOD synthesis and activity in both prokaryotic and eukaryotic organisms [7].

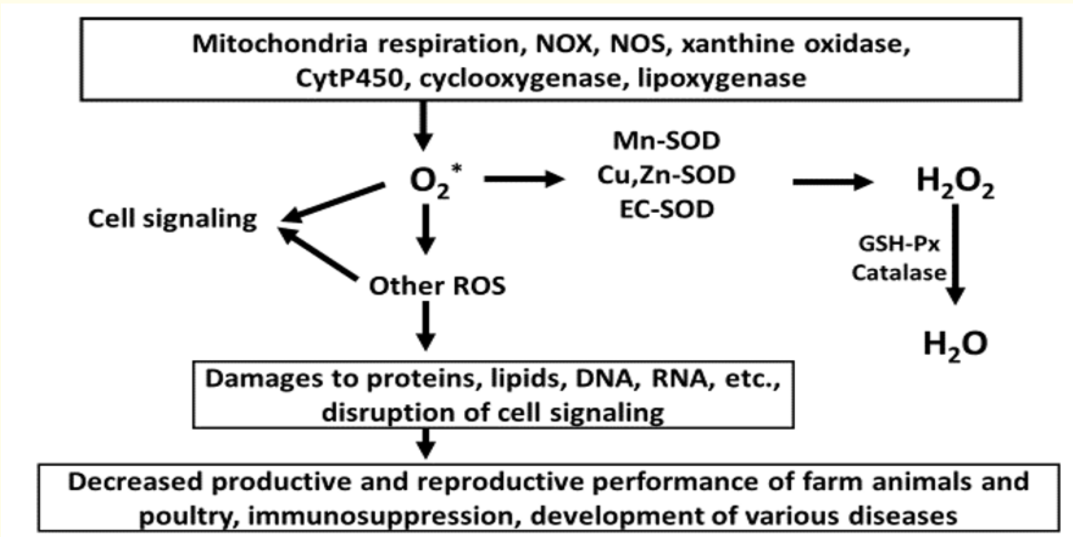

Figure 1: *Protective roles of SOD in animal/poultry physiology (Adapted from [2,7]).*

Taking into account recent advances in understanding SOD functions in biological systems (Figure 1) it is reasonable to include SOD into the vitagene family. First of all, SOD is the main antioxidant enzyme of the first level of antioxidant defence responsible for the detoxification of the superoxide radical, the main radical produced in biological system [2,7]. Secondly, in biological systems SOD is the major source of H_2O_2, an important molecule involved in effective redox signaling and participating in stress adaptation [8]. Thirdly, SOD is located in mitochondria matrix (Mn-SOD), cytosol, intermembrane space of mitochondria, nucleus (Cu, Zn-SOD), extracellular matrix and circulation (EC-SOD), been an effective antioxidant defence mechanism for all important cellular parts/organelles [2,7]. Fourthly, being inducible enzymes (MnSOD and EC-SOD) and affected by various post-translational modifications, including nitration, phosphorylation, glutathiolation and glycation (Cu, Zn-SOD), acetylation (Mn-SOD) and glycosylation (EC-SOD), SOD can effectively respond to changing environment [2,7]. Finally, a range of transcriptional factors, including Nrf2, NF-κB, AP-1, FOXO, p53 and others have been indicated to regulate the constitutive or inducible expression levels of all three SODs. Furthermore, in addition to transcriptional control, epigenetic regulation and posttranscriptional modifications are shown to be responsible for a regulation of the SOD functional activity [7]. This provides very sophisticated mechanisms of stress signaling. In fact, via these mechanisms SOD can interact with other members of the vitagene family. For example, sirtuins can affect SOD acetylation and increase/decrease its activity. On the other hand, directly or indirectly SOD can affect redox homeostasis in the cell/tissue, and this could affect expression of other vitagenes, including HO-1, sirtuins, etc [1].

In conclusion, the vitagene concept of fighting stresses and stress adaptation has been successfully developed and applied to medical sciences and poultry/animal sciences. Therefore, inclusion into the vitagene family of SOD is considered as an important step in strengthening the concept. There is a range of nutrients, including carnitine, silymarin, taurine, etc. [9,10], which can upregulate vitagenes and help stress adaptation. Indeed, nutritional modulation of vitagenes warrants further investigations.

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