ANTIOXIDANTS IN ANIMAL PRODUCTION AND REPRODUCTION-A REVIEW

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ABSTRACT
Antioxidant is known to be a vital feed additive which helps to combat oxidative stress in living organism. The challenges of increasing cost of animal production and reduced demand for animal products due to reduced income and loss of job among citizens as a result of post covid-19 effect could make farmers to play down on its importance as feed additives. This review further expatiate its various classification and significance in animal production (enhanced performance, health and welfare) through feed supplementation and reproductive efficiency in male and female animals.
Keywords: antioxidants, animal production, animal reproduction, covid-19, feed additive

INTRODUCTION
The global impact of post-covid 19 on animal production is somewhat disturbing. Increase in cost of production coupled with low income rate which has grossly affected the demand for animal products despite the increasing population among other factors could cause a farmer to ignore some basic fundamentals that enhance effective animal production and reproduction. Among such fundamentals are the benefits of antioxidants as examined in this review.
Antioxidants are broadly defined as any substance that delays, prevents or removes oxidative damage to target molecules (Halliwell, 2007). They are the agents, which break the oxidative chain reaction, thereby, reducing the oxidative stress (Kumar and Mahmood, 2001).
Imbalance between oxidants and antioxidants at the cellular or individual level causes oxidative stress (Lykkesfeldt and Svendsen, 2007), which leads to damages and disruption of normal metabolism and physiology (Trevisan et al., 2001). Ultimately leading to loss of cell function or necrosis, if not controlled (Chauhan et al., 2014).
In general, antioxidants are compounds and reactions which dispose, scavenge, and suppress the formation of reactive oxygen species (ROS), or oppose their actions (Bansal and Bilaspuri, 2011).

ANTIOXIDANT ACTIVITIES IN LIVESTOCK
Living animals develop precise antioxidant defense mechanisms to combat ROS and reactive nitrogen specie (RNS) while growing (Surai, 2002). These antioxidants are diverse and responsible for the protection of cells from the actions of free radicals. The antioxidant system as highlighted by Fotina et al., (2013) are as follows:

1. Natural fat-soluble antioxidants (vitamins A, E, carotenoids, ubiquinones, etc.)
2. Water-soluble antioxidants (ascorbic acid, uric acid, taurine, etc.)
3. Antioxidant enzymes: glutathione peroxidase (GSH-Px), catalase (CAT) and superoxide dismutase (SOD).
4. Thiol redox system consisting of the glutathione system (glutathione/glutathione reductase/glutaredoxin/glutathione peroxidase and a thioredoxin system (thioredoxin/thioredoxin peroxidase/thioredoxin reductase).

Antioxidative mechanisms in biological systems according to (SIES, 1985) can broadly be classified into two:

1. Non-enzymatic such as Vitamin E, Vitamin C, B-Carotene, Glutathion, Flavine, Organic acids, Plasma proteins and technically produced antioxidants.
2. Enzymatic which include superoxiddismutases (CuZn-, Mn-Enzymes), GSH-Peroxidase (containing selenium and free of selenium, GSH-transferases), Catalases, Auxiliary enzyme (NADPH-quinon oxidoreductase), Conjugating enzymes (UDP-glucoronyl-transferase).

The protective antioxidant compounds are reportedly situated in organelles, subcellular compartments or the extracellular space aiding optimum cellular protection. Antioxidant system of the body is responsible for prevention of damaging effects of free radicals in stress conditions. Hence, dietary supplementation of antioxidant compounds is a means of advancing broiler (Fotina et al., 2013) and by extension, animal production efficiency.

Antioxidants as feed additive

The addition of antioxidants as nutritional supplements in animal diets is a common practice to improve animal performance, health, and welfare. For meat animals, natural antioxidants added to feed do not only improve the oxidative stability and organoleptic properties of meat but they also can enhance the nutritional value and the health benefit of meat products (Kasapidou et al., 2012).

α-Tocopherol is the most traditional feed additive up to about 500 mg/kg feed supplementation levels. Reports from González-Calvo et al., (2015) showed that the fresh color of meat on retail display was maintained for beef, lamb and poultry respectively. This protective effect is exerted via the delayed oxidation of oxymyoglobin and the inhibition of polyunsaturated fatty acids (PUFAs oxidation). The goal of the livestock producer is to produce nutritionally balanced or enhanced meat that contains appropriate amounts of n-3 PUFAs (from α- linolenic acid) versus n-6 PUFAs formed from linoleic acid (18:2) (Williams, 2000).

Aromatic herbs and essential oils are known for their antioxidant potency which is mainly attributed to phenolic compounds in the oil or in other phytochemical fractions. Some non-phenolic substances also exhibit antioxidant activity, for example, caryophyllene, careen, and terpinene (Franz et al., 2010). Such substances contribute to the protection of feed lipids from oxidative damage (Delles et al., 2014). In chicken, oregano added in doses of 50–100 mg/kg to the broiler diet exerted an antioxidant effect in the muscle tissue (Youdim and Deans, 2000).

Significance of trace elements

Trace elements are cofactors of enzymes like superoxide dismutase (SOD) (Antonyuk et al., 2009), glutathione reductase, glutathione peroxidase, thioredoxin reductase (Huang et al., 2012), ceruloplasmin (Hussein and Staufenbiel, 2012) and catalase (Markesbery et al., 2001). These enzymes are important to maintain the immunity of animals (Gressley, 2009). They act as antioxidants (NRC, 2001) and prevent oxidative stress by neutralizing oxidants produced under different stresses like environmental or production stress or stress related to infections or diseases (Gressley, 2009). Being components of the anti-oxidant system (Spears, 1995), trace elements prevent oxidative stress. Copper is the essential element in two enzymes that are important for immune competence; copper/zinc-superoxide dismutase (SOD) and ceruloplasmin (Hussein and Staufenbiel, 2012). Iron is an essential component of catalase, peroxidase and cytochrome oxidase (NRC, 2001). These play important roles in oxidative stress (Antonyuk et al., 2009). Selenium is an essential part of a family of enzymes called glutathione peroxidases (GSH-Px) and thioredoxin reductases (Huang et al., 2012) which are important for neutralizing free radicals or oxidants. Zinc and manganese, in addition to copper, are also integral parts of SOD (Tomlinson et al., 2004, Markesbery et al., 2001). All these neutralize free radicals like peroxides, super oxides or hydroxyl ions (Yatoo et al., 2013).

Antioxidants and female animal reproduction

To evaluate reproduction status of female animals, many factors must be considered, such as estrous cycle, ovarian functions and ovulation, embryo development, pregnancy and fetal development. The estrous cycle involves many histological, physiological, morphological, and biochemical changes within the ovary (Zhong, 2013).

Any imbalance between oxidants and antioxidants in these changes leads to dysfunctions of the ovary and irregular estrous cycle (Gupta et al., 2011). Ovulation oxidative stress is an underlying reason of irregular estrous cycle (Martins et al., 2011), polycystic ovary syndrome (Wong et al., 2010), endometritis (Bedaiwy et al., 2002; Lambrinoudaki et al., 2009), infertility (Fleischer et al., 2001), pregnancy failure (Hansen. 2002; Harvey et al., 2002), and embryo development. Increased antioxidant status of the reproductive tract may improve competence of oocyte or embryo development (Cerri et al., 2009), pregnancy and fetal development (Volpato et al., 2008).

Antioxidants and male animal reproduction

To evaluate reproduction status of male animals, many factors must be considered, such as spermatogenesis, semen functions, sperm quality, and fertility. Spermatogenesis depends on intratesticular and extratesticular hormonal regulatory processes and functions of the intertubular microvasculature (Holstein et al., 2003). Semen parameters such as sperm count and concentration, viability, mobility, and morphology are indicators to evaluate semen functions (Rodriguez-Martinez, 2006). Infertility is not only a major public health problem in humans, but also the case in animals due to extensive feeding system and application of synthetic feed additives.

Oxidative stress is a main underlying cause which can interfere with spermatogenesis, reduce sperm quality and production, and even cause infertility (Boonsorn et al., 2010). Because elevated ROS generation causes damage to the spermatozona DNA, results in increased apoptosis of cells, and therefore, leads to a low fertility rate (Kaur and Bansal, 2003). The application of exogenous plant derived antioxidant is likely to improve health status of male animals (Nantia et al., 2009).

CONCLUSION

The role of antioxidant supplementation cannot be overemphasized and must not be compromised by farmers whose focus is centered on efficient animal production. Its benefits are evident in the stability of animal performance, health and welfare during production, reproduction and quality of animal products.

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