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Review on the impact of anti-oxidant status of Vitamin E and Selenium on meat quality parameters in livestock

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Abstract
Selenium (Se) and Vitamin E have been proven as antioxidants in biological fluids and body systems, since decades and are in constant use in commercial industry. It is because of their independent bio-mechanism in quenching free radicals generated out of cellular metabolism, resulting in cellular maintenance and biological rhythm. Seeing the importance, the National Research Council has been recommending dietary levels of Se and Vitamin-E for various categories and species of livestock in regular interval *viz.* 0.3 ppm selenium and 100 mg of vitamin E per day for kids (NRC, 2007) [25]. Subsequent upon the inclusion in the feedlot ration, its impact on carcass trait and meat quality parameters is of paramount importance. The present review focused the effect of dietary Se and Vitamin E on carcass parameters in livestock species.

Keywords: Anti-oxidant, biological fluids and body systems, Selenium (Se) and Vitamin E

Introduction
With an atomic number 34 having atomic mass of 78.96, Selenium has been recognized for several decades as an essential trace mineral required by all animals (Phillips *et al.*, 1989) [27]. Preliminary work for its nutritional essentiality, selenium arose from the work of Patterson *et al.* (1957) [26] in chicks. Selenium plays an important role in numerous body functions such as antioxidant defense, immune system, reproduction, and thyroid hormone metabolism (Surai, 2002) [34]. Several diseases in cattle are caused by deficiency of Se. Such conditions include nutritional muscular dystrophy (white muscle disease), retained fetal membranes, increased susceptibility to mastitis, infertility, abortion, premature birth, weak or dead calves, cystic ovaries, metritis, delayed conception and poor fertility (Spears *et al.*, 1986) [33]. Selenium is also a component of enzyme type I deiodinase (IDI), which is required for the conversion of thyroxine into more active tri-iodothyronine (Beckett *et al.*, 1987) [1]. Selenium has also been shown to improve immune responses in animals (Reddy *et al.*, 1987a) [29]. Vitamin E is the generic name for a series of fat soluble compounds called tocopherols and tocotrienols (NRC, 2001) [24]. Vitamin E (tocopherol) was discovered by Evans and Bishop in 1922[9], as an important fat soluble antioxidant vitamin. Vitamin E naturally occurs in feedstuffs as alpha tocopherol, and is the most biologically active form of vitamin E as well (NRC, 2001) [24]. Selenium and vitamin E have a complex relationship with each other. Both Se and vitamin E exert similar antioxidant effects in cells, but via independent biochemical pathways and in different locations (McDowell, 1989) [19]. Vitamin E and Se are two important components of the antioxidant defense system of living tissues (Gerloff, 1992) [12]. Vitamin E has the ability to quench free radicals capable of initiating and propagating lipid oxidation, where as Se-containing antioxidant enzyme, glutathione peroxidase (GSH-Px), catalyzes the decomposition of lipid hydroperoxides into less reactive products (Faustman *et al.*, 1989) [10]. A diet deficient in vitamin E may increase the amount of Se needed to prevent certain abnormalities, such as nutritional muscular dystrophy (Miller *et al.*, 1988) [21]. Though, a lot of work has been done in different species and for various biological samples on antioxidants status of these two, but very scanty work has been reported in meat quality traits, given selenium and vitamin E in the diet. Present review work focused on the targeted effect of dietary Se and Vitamin E on carcass traits in livestock species.

Effect of vitamin E and selenium supplementation on carcass characteristics

Selenium is needed not only for healthy and productive animals but also for the production of meat, milk and other products (Surai, 2002) [34]. Studies revealed by researchers varied for the use of Se and Vitamin E on carcass characteristics. The inclusion of vitamin E in the ratio of pigs (Corino *et al.*, 1999) [3] and selenium in the feed of broilers (Edens, 1996) [8] have been shown to improve their meat quality. Vitamin E supplementation enhanced the colour, lipid stability and reduced drip loss in beef by stabilizing the integrity of the cell (Mitsumoto *et al.*, 1997) [22]. Furthermore, the inclusion of vitamin E in the ratio of beef cattle has been shown to extend the keeping quality of beef (Faustman *et al.*, 1989) [10]. Contrary to it, Dufrasne *et al.* (2000) [7] did not observe any significant difference in carcass characteristics of the bulls fed with 1000 mg vitamin E/ bull/d in comparison to the control group. Similar findings by Yang *et al.* (2002) [39] showed that carcass weight of the animal did not differ by supplementing 2500 IU vitamin E to pasture and grain fed cattle. Guo *et al.* (2006) [13] observed that supplementation of vitamin E @ 40 IU to 200 IU/kg BW for 63 days in finishing pigs had no effect on carcass characteristics like dressing % and back fat thickness. Study in the sheep species by Salman and yildiz (2009) [30] revealed no change in carcass weight of lambs fed with 300 ppm organic selenium for 84 days. Likewise in buffalo bulls, Dass *et al.* (2008) [4] did not find any effect of vitamin E supplementation (300-600IU//d/animal) on carcass characteristics (slaughter weight, height, carcass length, carcass weight, loin eye area, empty body weight, dressing %, head yield, hide yield). Dominguez-vara *et al.* (2009) [6] observed that supplementation of 0.3 ppm Se as selenium yeast to lambs had no effect on their carcass characteristics like slaughter weight, carcass weight and loin eye area. In turkeys (Milkulski *et al.*, 2009) [20] and chicken (Heindi *et al.*, 2010) [14] similar findings have been reported after supplementing 0.3 ppm Se in their respective ration for a certain period.

On the various organ weights and its quality, inclusion of either or both antioxidants in the ration, did not affect profoundly as reported by various scientists. Lawler *et al.* (2004) [17] noted that feeding a naturally high selenium diet to beef steers had no effect on kidney, liver and spleen weight. Similarly, Salman and yildiz (2009) [30] observed no change in weight of visceral organs like heart, lungs, liver, spleen, kidney of lambs fed with 300 ppm organic selenium fed for 84 days. Houben *et al.* (2000) [15] did not find any significant effect on meat moisture percent of beef bulls supplemented with vitamin E (2025 IU /animal/ day) for 136 days. Similarly, Yang *et al.* (2002) [39] showed non-significant difference for lipid concentration in muscles of steers given vitamin E in comparison to non-supplemented steers. A similar study by Dass *et al.* (2011) [5] proved no change in moisture, CP, lipid concentration in muscles of buffaloes supplemented with 300 and 600 IU of vitamin E. In pigs, Bobcek *et al.* (2004) [2] observed no change in CP content of muscle after supplementing with 0.3 ppm organic selenium for 97 days as similar observation reported by Dominguez-vara *et al.*, 2009[6] in lambs, Skrivanova *et al.* (2007) [32] in calves and Zhan *et al.* (2007) [41] in finishing pigs. Contrary to the findings above, Milkulski *et al.* (2009) [20] observed a significant increase in the crude fat content of muscle after supplementation with 0.3 ppm Seas selenium yeast in turkeys for 112 days. Besides, Zavodnik *et al.* (2011) [40] observed 1.97% increase in DM content of pork obtained from pigs fed with concentrate mixture containing 250 g selenium yeast per ton for 178 days.

Effect of vitamin E and/or selenium supplementation on physicochemical properties of meat

Diet has a profound effect on the abdominal, subcutaneous and intramuscular fat deposition, on flavour, texture, meat juiciness and on meat tenderness or toughness. Effects of dietary antioxidants have been reviewed on certain parameters to ascertain their impact on physicochemical properties of meat. Walsh *et al.* (1993) [38] observed decreased thiobarbituric acid reactive substances (TBARS) concentration in muscles of 7 months old crossbred calves supplemented with sodium selenite @ 0.438 ppm for 50 weeks. Dietary vitamin E supplementation (2000 mg α-tocopheryl acetate/ kg feed) for approximately 50 days in beef cattle prior to their slaughter improved the colour in fresh beef than un supplemented beef (Lynch *et al.*, 1999) [18]. Lynch *et al.* (1999) [18] reported higher ($P<0.01$) pH values of meat from the vitamin E(2000 IU/ animal/day) supplemented bulls. Yang *et al.* (2002) [39] observed non significant difference in TBARS value of the meat obtained from steers fed with 2500 IU of alpha-tocopheryl acetate/d. Vitamin E supplementation (45 mg vitamin E per lamb per day for 75 days) in the diet of Morkaraman male lambs significantly reduced lipid oxidation and tended to maintain meat redness (Muhlis *et al.*, 2003) [23]. Bobcek *et al.* (2004) [2] observed decreased TBARS concentration in muscles of pigs supplemented with 0.3 ppm organic selenium for 97 days. Contrary to the above, Guo *et al.* (2006) [13] observed that supplementation of vitamin E @ 40 IU to 200 IU/kg for 63 days in the diet of finishing pigs had no effect on pH and color stability of meat as like Zhan *et al.* (2007) [41] in finishing pigs. In the same line, Svedaite *et al.* (2009) [35] observed that feeding a diet containing 0.1 ppm Se and 20 IU of vitamin-E to pigs for 4 months had no effect on meat pH tenderness and color intensity similar to Vignola *et al.* (2009) [37] in lambs. An improved physio chemical value was noticed by Zavodnik *et al.* (2011) [40] with 32% reduction in TBARS concentration and 0.92% increase in water holding capacity of pork when pigs fed with concentrate mixture containing 250 g selenium yeast per ton for 178 days. Dass *et al.* (2011) [5] observed significant differences in flavor, tenderness and juiciness in Longissimus dorsi muscle of buffaloes supplemented with 300 IU of vitamin E/d. Contrary, Gaber *et al.* (1996) [11] did not find any effect of vitamin E supplementation on juiceness, flavor and overall acceptability of meat of dairy steer.

On mineral content in meat, Taylor (2005) [36] and Qin *et al.* (2007) [28] in lambs reported increased Se concentration in various organs and muscles of lambs fed with 2.9 ppm and 0.1 ppm of organic selenium respectively. Zhan *et al.* (2007) [41] observed increased Se content in blood serum, muscle, liver and kidney of pigs supplemented with 0.3ppm organic selenium for 40 days. Similar to the above findings, Juniper *et al.* (2009a) [16] in lambs and Shi *et al.* (2011) in goats observed higher Se concentration in organs and skeletal muscle by inclusion of 0.3 ppm Se in the animal ration. Zavodnik *et al.* (2011) [40] observed 27.8% increase in selenium concentration in muscle of pigs fed with concentrate mixture containing 250 g selenium yeast per ton for 178 days as compared to control.

Conclusion

Vitamin E and selenium are an integral part of the antioxidant system present in all cells and their deficiency causes muscle degeneration and suppression of immunity in young ones. Supplementing with vitamin E and Selenium resulted in improved growth and enhanced immune responses are well documented. Though the present review on the effect of Vitamin E and Se on meat quality varies across documented reports, in many ways specifies in improving the meat quality, enhancing the colour, lipid stability, reduced drip loss and improving the keeping quality of meat.

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