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Effect of Selenium and Vitamin E on cryopreservation of semen and reproductive performance of animals (a review)

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Abstract
Livestock is a major sector nowadays converting into an industry. Buffalo is one of the major constituents of the animal sector and is liked mostly due to its milk and meat in the Asian countries. Use of artificial insemination technique has improved meat and milk quality in this animal. Artificial insemination is one of best and quick technique to improve reproductive efficiency. However, the major problem with this reproductive technique is a reduction in the quality of semen during freezing and thawing. The production of reactive oxygen species during the process of cryopreservation hampers the motility of spermatozoa. The reactive oxygen species decreases cellular viability by initiation of lipid per oxidation of bio-membranes. To minimize this damage, antioxidants are used as cryoprotectants against the lipid per oxidation of bio-membranes. There are many antioxidants used to counteract the problems occurring during cryopreservation. In this review the beneficial effects of Selenium and Vitamin E as antioxidants on cryopreservation of semen are considered to be monitored.

Keywords: Vitamin E and Selenium, semen and reproductive performance.

1. Introduction
Livestock is a chief sector in Pakistan. According to the economic survey of Pakistan (2012-2013) it contributes about 11.9% in GDP of Pakistan. It is considered as the backbone in relation to the source of income in rural areas. This sector comprises about 55.4% of the agriculture sector. According to the economic survey of Pakistan (2012-2013) the total population of buffaloes in Pakistan this year is 33.7 Million and there is no considerable improvement in livestock sector in the year. There are many factors which hinder the production of buffalos. Among them major is the less success in the artificial insemination for this animal. Artificial insemination is used to improve the genetic constitution of the livestock. Quick genetic progression in mammals requires amplification of artificial insemination [1]. Use of artificial insemination with cryopreservation of semen is inadequate in buffalo due to the deprived feasibility of buffalo bull spermatozoa as compared to cattle bull spermatozoa [2]. This is thought to be due to the elevated amount of phospholipid and unsaturated fatty acid production in mammalian spermatozoa which makes it best accessible to lipid peroxidation [3]. Defense to spermatozoa in counteracting lipid peroxidation in seminal plasma is supervised through its constituents having antioxidants naturally [4]. But when the semen sample is subjected to cooling during the process of cryopreservation there is a proliferation in reactive oxygen species in semen progressing to spermatozoa damage [5]. These species are produced due to injurious effects of oxygen by the formation and action of a lot of chemical compounds and are known as reactive oxygen species having potential to donate oxygen to other substances. It is thought that antioxidants are responsible for opposition of spermatozoa against oxidative stress [6]. And prevent the needless free radicals manufacture [7]. The antioxidants can be defined as any constituents that postponed or prevent oxidative damage to cellular molecule [8].
Vitamins and minerals perform vital part in the growth and reproductive health of animals. Selenium (Se) is a necessary trace nutrient for growth and development of humans and animals. Insufficiency of Selenium has been associated with reproductive complications and decreased sperm quality of rats, mice, chickens, pigs, sheep and cattle [9]. It has been reported that adding Se in diet improves reproductive performance of mice, sheep and cattle [10].

Selenium (Se) is found in the earth's crust in association with metals and in traces in water. It constitutes a necessary part of glutathione peroxidase an enzyme responsible for protecting cell internal structures from free radicals and is thus considered an excellent antioxidant for cellular membrane lipids [11]. It is reported that Glutathione peroxidase activity is found in the semen of several species like ram, dog, human, goat, chicken and bovine bulls [12]. Vitamin E is also an important antioxidant in preventing cellular damages caused due to lipid peroxidation. Vitamin E and Selenium are necessary nutrients that are important ingredients of the antioxidant system, to be responsible for defense of tissues and cells. Selenium, a constituent of enzyme Glutathione, along with vitamin E assists as a biological antioxidant and maintains cellular consistency [6].

2. Selenium as an antioxidant

Selenium serves as an essential antioxidant in animal reproduction [13, 14, 15, 16]. Its effects of antioxidants can be mediated through its roles as part of antioxidant enzymes (GSH-Px) in body [17]. Many selenoproteins participate and regulate the physiological functions including antioxidants and stability of cell membranes. The significance of Selenium is pronounced from the fact that supplementation of selenium proves the better storage along the less release of lipids from the sperm cell during long time storage [18].

The cryopreservation of semen has both physical and chemical stress to sperm membranes [19, 20] along oxidative stress [21] resulting in the disturbances of the physiological activities of sperms. Many studies have reported the effects of antioxidants on semen extenders during the cryopreservation [22, 23] and significant correlation between the level of selenium in seminal plasma and sperm integrity [24, 25]. The level of 2 µg /mL of selenium can improve the quality of fresh and frozen semen in buffalo bull [26] and in mice, human, ram, bovine and other species [27, 28, 29]. The reduction in the oxidative stress due to use of this antioxidant in extending media for cryopreservation of spermatozoa has useful effects in boar. The feeding of boar with selenium improves the reproductive efficiency and ejaculate of semen along the less oxidative stress [30]. The abnormal sperm mitochondria results in the selenium deficient diet in semen of goat [31]. The effect of Selenium and Vitamin E on motility, viability, Acrosomal Reaction and accumulation of ammonia in the culture medium during different incubation periods in porcine sperm was investigated. It was concluded that seleno L-methionine, seleno L-methionine and Vitamin E played an important role in reducing the accumulation of ammonia and subsequently in increasing the rate of acrosomal reaction and the utilization of glucose in spermatozoa [32].

From the above reviews it is clearly highlighted that selenium administered to animals, given in the feed or supplemented to the semen *in vitro* has beneficial as well as protective effects.

3. Valuable effects of Vitamin E as an antioxidant

Numerous studies have reported useful effects of the antioxidant effect of Vitamin E on sperm parameters. The results confirm the protective and beneficial effects of vitamin E on semen quality and support their use in male infertility treatment [33]. Sperms are prone to oxidative damage because they produce reactive oxygen species (ROS), have a high polyunsaturated fat content and a reduced capacity to repair DNA damage [5]. Vitamin E and beta-carotene are proven to have antioxidant properties that help to oppose the destructive effects of excess (ROS) [34]. Vitamin E is one of the main membrane protecting against reactive oxygen species (ROS) and lipid peroxidation (LPO) [35]. Antioxidants are the main defense factors against oxidative stress provoked by free radicals [36]. Vitamin E is thought to be the principal constituent of the antioxidant system of the spermatozoa and is one of the major membrane protecting against (ROS) and (LPO) attack [37]. In the semen of rams, addition of antioxidants such as vitamin C and E to semen preservation media improved longevity and quality of cooled sperms [38]. A study in albino male mice intended to assess the effects of L-arginine, vitamin E and their combinations on sperm quality showed that mice treated with vitamin E considerably decreased sperms defective head when compared with control groups [39]. Vitamin E in fact scavenges free radicals and reacts with them, producing stable ROOH groups. It has been suggested that vitamin E provides biological stability to the spermatozoal plasma membrane [40]. The dietary increase in the Vitamin E content of semen was found to result in a significant reduction in the susceptibility of the semen to lipid peroxidation [41, 42]. Aminipour *et al*. (2013)[43] studied the various levels of vitamin E added in Tris extender on semen characteristics of Ghezel rams before and after cryopreservation. The vitamin E had significant effect on viability, motility, progressive motility and normal of spermatozoa in before and after cryopreservation. Addition of α-tocopherol at the rate of 0.4 µg/100 ml in extender was the perfect dose to maintain plasma membrane integrity of frozen semen of bucks [44]. The vitamin E added to chicken semen extender during *in vitro* storage of semen has beneficial effects on sperm motility, viability rates and lower morphological defects due to reduction of (ROS) [45].

4. Combined valuable effects of selenium and vitamin E as antioxidants

Selenium and vitamin E are being used together and these have tremendous effect when used in combine form. These have complementary role in protection of cell against lipid per oxidation and free radicals and consequently on the reproductive health of animals. This is due to the fact that Selenium enhances the requirement for vitamin E and is vital in individuals using selenium deficient diet [46]. This cooperative effect of these antioxidants makes them essential for each other. Many workers used these antioxidants in combine form either in feed or by supplementation through parental route. Baladi ewes were fed with selenium and vitamin E to enhance metabolic and reproductive performance. They reported with increase onset of estrus, fertility, pregnancy and lambing rates, number of births, weight at weaning, twining and mortality rate [47]. The addition of selenium and vitamin E on the pregnant ewes especially on the productive characteristics of ewes and their lambs had increased plasma total protein and globulin level. Hematology of born lambs were higher with red blood cells, packed cell volume, hemoglobin and mean corpuscular hemoglobin ratio. The use of these antioxidants at late pregnancy and early gestation has a protective effect on the mother and young ones [48]. The effect of dietary selenium and vitamin E on 3 year old White Koluda gander's response to semen collection and ejaculate proved that supplemental dietary selenium and vitamin E improved both the response to manual semen collection and semen quality [49]. To detect reproductive performance of rabbit does were fed diets supplemented vitamin E and selenium yeast under heat stress. Higher kidding rate, litter size, average weight of kits at birth, reproductive index, and reduced gestation period length with

dietary supplementation were reported [50]. Supplementation of vitamin E and Selenium in late gestation improved production and reproductive efficiency of buffaloes and their young ones. Colostrum production, Milk production, conception rate and estrus rate and calf body weight were also enhanced [51, 52].

The deficiency of selenium is commonly present in ruminants [53]. The levels of vitamins and minerals in animal body play an important role in the growth and reproductive efficiency of animals [54]. The supplementation of selenium helps in the growth of body and reproductive performance of lambs [55] and reduction of free radicals [56]. Feeding of dietary Selenium and vitamin E improved, sperm motility and concentration of spermatozoa, reduction of abnormalities, mmaturation of spermatozoa and higher ATP concentration in the semen of boars [57] and spermatogenesis with participation in the synthesis of antioxidant enzymes [58, 59, 60]. The level of selenium and vitamin E contribute the protection of seminiferous tubules and synthesis of testosterone in the male reproductive system [61].

5. Conclusion and Implications

Use of vitamin E and selenium individually and in combine form are favorable for the decrease in the lipid per oxidation and free radical production by which cells are at peak danger to acceleration of metabolism and ultimate cellular death. During the process of freezing and thawing lot of spermatozoa are damaged and metabolic activities are thought to be responsible for that. By the use of selenium and vitamin E individually and in combine form can improve the preservation capability of semen due to their great effect on decreasing the reactive oxygen species production. By the light of these reviews these antioxidants should be used in combined form in semen extenders to sustain good quality of semen and to promote the artificial insemination in order to enhance production of livestock which is a big need of the time to compete the abrupt increasing population with every day increasing nutrition requirement of the world.

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