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Effect of adding inorganic selenium to the diet of Osimi ewes on wool characteristics

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Abstract

The experiment was conducted to assess the physico-mechanical properties of Ossimi ewe wool when supplemented with selenium (Se) during the wool growth phase. Forty indigenous dry Ossimi ewes, weighing 45–50 kg and aged three to four years, were randomly allocated into four groups with similar average body weights. The first, second, and third treated groups received supplementation of 20, 30, and 40 mg of inorganic selenium (Se) per kg of dry matter per head per day, while the control group was only given the basic diet. The results demonstrated significant enhancements in certain physical attributes, including increased staple length (STL) and fiber diameter (FD), decreased contaminants, and higher clean wool weight. Staple strength and elongation percentage increased in all treated groups. Furthermore, all treated groups exhibited a notable rise in blood plasma selenium levels. In summary, selenium supplementation enhanced certain wool characteristics in Egyptian sheep.

Keywords: selenium, wool, Ossimi ewes.

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1. Introduction

The significance of maintaining a sufficient supply of microelements, such as selenium, lies in their participation in a variety of biological processes and their structural, catalytic, and regulatory functions within the organism. These microelements significantly impact the overall health and well-being of the organism (Underwood and Suttle, 1999). Working in conjunction with vitamin E, selenium plays a critical role in the body's antioxidant defense system. It is a component of glutathione peroxidase (GSH-Px), which helps protect against oxidative stress by counteracting harmful free radicals. Selenium also contributes to the function of the immune system, aiding the body's defense against pathogens and promoting optimal immune responses (McKenzie *et al*., 1998). Furthermore, selenium plays a crucial role in the proper functioning of the thyroid gland and the metabolism of thyroid hormones. It is involved in the synthesis, activation, and regulation of thyroid hormones, which are vital for various physiological processes, such as growth, development, and metabolism (Ruz *et al*., 1995). In addition to its roles in antioxidant and immune function, selenium is also essential for reproduction. Optimal levels of selenium are required for optimal reproductive performance in both males and females. Research has linked selenium deficiency to reproductive disorders and reduced fertility in animals (Birringer *et al*., 2002). This study aimed to explore how various levels of inorganic selenium affect wool production and quality in Ossimi ewes. By analyzing the influence of selenium supplementation on these aspects, the researchers sought to understand the potential advantages of selenium in enhancing wool characteristics in the ewes under study.

2. Materials and methods

The study utilized 40 Ossimi ewes to investigate the impact of feeding them inorganic selenium on the growth of their wool. The trial spanned from July 1st, 2022, to January 1st, 2023, encompassing six months of wool growth. The ewes were divided into four groups of ten, each with similar average body weights. The Control Group received the basal diet without any additives. Group (1) was given the basal diet along with 20 mg of selenium (Se) per kilogram of dry matter (DM) per head each day. Group (2) received the basal diet plus 30 mg Se per kg DM per head per day, while Group (3) was given the basal diet plus 40 mg Se per kg DM per head per day. The animals' diet consisted of a concentrate feed mixture comprising 22% undecorated cotton seed cake, 20% molasses, 44% wheat bran, 10% yellow corn, 2.5% ground limestone, and 1.5% common salt. The nutritional regimens followed the guidelines of the NRC (1988), which were tailored to the average body weight and adjusted for the physiological stage. The ewes had to drink water, and have clover hay, and rice straw *ad-libitum* throughout the experimental period. Wool samples were taken from the ewes on January 1st, 2023, which marked the conclusion of the trial period. Samples

of wool measuring 10 × 10 cm (100 cm^2) were collected from a tattooed region on the right mid-side position. At the start of each phase, the tattooed regions were shaved down to the skin. Blood samples were obtained during the shoring process to determine the level in the blood of glutathione peroxidase (GPX). Ten sheep from each group were used to collect ten milliliters of blood. The blood sample was drawn by jugular venipuncture using 18-gauge needles and 10-milliliter heparin-filled vacutainers. After being drawn, the blood samples were frozen, centrifuged, and kept for further examination. The physical characteristics of the wool included the weight of clean wool samples, the fiber diameter, and the staple length. The weight of clean wool was determined after any leftover grease was removed from scoured samples using ethyl ether as a solvent in a Soxhlet apparatus. The method used to find the proportion of clean wool was clean scoured yield percentage = (Weight of scoured and dried sample/Weight of greasy sample). The percentage of contaminants (C) was calculated using the following formula: (weight of grease sample - weight of clean sample) / weight of grease sample × 100. Twenty randomly chosen staples from each sample were measured for length using a centigrade ruler; measurements were taken to the closest 0.25 cm. The standard error and mean staple length were calculated for each treatment. The fiber diameter was measured in microns using a Carl-Zeiss micro-imaging G and bh instrument with lenses and Image Analyzer software (Zen, 2012, Blue edition). To measure staple strength and elongation, the Agrtiest Staple Breaker was employed (Caffin, 1980). Staple strength was measured by applying force to break the staple and dividing the result by the thickness of the staple (measured in Newton per kilotex, or N/Ktex). To ascertain the effect of selenium supplementation on the quality and characteristics of the wool produced by the Ossimi ewes, ten randomly selected staples from each sample were tested using a device that measured staple strength. The mechanical and physical properties of the wool were assessed. To compare means, a multiple-range test created by Duncan (1955) was employed.

3. Results and Discussion

Table (1) indicates that there was a difference observed between the groups in terms of clean wool weights. The group supplemented with 40 mg of selenium exhibited the highest clean wool weight at 71.44%, followed by the group supplemented with 30 mg of selenium at 66.32%. On the other hand, the group supplemented with 20 mg of selenium showed lower clean wool weights at 65.19%, and the control group had the lowest clean wool weight at 60.47%. Additionally, the levels of wool contaminants were found to be significantly increased in the control group and the group supplemented with 20 mg of selenium compared to the other treated groups. The wool contaminants

were measured at 20.56, 35.68, 34.81, and 39.53 for the groups supplemented with 40 mg, 30 mg, and 20 mg of selenium, and the control group, respectively. The growth rate of wool is influenced by factors such as temperature, light, and light intensity. According to Lindner and Ferguson (1956) and Thwaites (1972), these factors play a role in regulating wool growth. El-sherbiny *et al*. (1978) also reported that in Egyptian coarse wool sheep, temperature was the primary factor affecting the wool growth rhythm, rather than light.

Table (1): Means ± standard errors of clean weights of wool samples and percentage of contaminants in four groups of ewes.

Variables	Experimental groups			
	Control group	20 mg Se supplemented	30 mg Se supplemented	40 mg Se supplemented
C.W.S (%)	60.47	65.19	66.32	71.44
C%	39.53	34.81	35.68	28.56

C.W.S = clean weights of wool samples, C % = percentage of contaminants.

The results presented in Table (2) indicate that there was a significant difference ($P<0.05$) observed between the groups in terms of staple length when selenium was added to the sheep's diet. The staple lengths were measured at 5.14 ± 0.64 cm, 5.28 ± 0.44 cm, 5.86 ± 0.34 cm, and 6.35 ± 0.78 cm for the control ewes, 20, 30 and 40 mg selenium supplemented groups, respectively. This suggests that the addition of selenium to the diet led to an increase in staple length. Furthermore, the addition of selenium to the sheep's diet was found to significantly increase fiber diameter (FD) ($P<0.05$). For the control group, 20, 30, and 40 mg selenium supplemented groups, the FD values were 30.47 ± 0.45 µm, 34.99 ± 0.39 µm, 38.32 ± 0.54 µm, and 43.74 ± 0.48 µm, respectively. This suggests that selenium, specifically, had an impact on FD through its potential effect on protein metabolism. Selenium plays a crucial role in protein and nucleic acid metabolism in farm animals, as mentioned by Amata (2013). Wool is primarily composed of protein, and therefore the addition of selenium, particularly chromium, to the diet can impact protein metabolism, leading to improvements in staple length and fiber diameter. This is particularly important for producers of fine wool as higher FD can result in price penalties. It is worth noting that the increase in staple length between the treated and untreated groups due to the supplementation of organic selenium was found to be insignificant in this study. This contrasts with the findings of Saudi (2018), They found that adding varying amounts of selenoprotein to Rahmani ewes' diets significantly increased staple length ($P<0.01$). Additionally, a comparison of fine, medium, and strong wool strains in Australian Merino sheep showed an association between increased staple length and increased clean fleece weight (Williams, 2000). Selenium is essential

for the activity of glutathione peroxidase (GPX), an enzyme that breaks down hydrogen peroxide and lipid peroxides. It is also involved in controlling free radicals in immune cells and thyrocytes, supporting normal immune activity (Corvilain *et al*., 1993; Larsen, 1993). Dietary deficiencies of selenium can decrease the levels of immunoglobulins (Ig) G and Ig M in plasma (Larsen, 1993).

Table (2): Means ± standard errors of staple length and fiber diameter in the experimental groups.

Variables	Experimental groups			
	Control group	20 mg Se supplemented	30 mg Se supplemented	40 mg Se supplemented
STL (cm)	5.14 ± 0.64[a]	5.28 ± 0.44[a]	5.86 ± 0.34[a]	6.35± 0.78[a]
FD (µm)	30.47 ± 0.45[b]	34.99 ± 0.39[a]	38.32 ± 0.54[a]	43.74 ± 0.48[a]

[a,b] Means within the same rows with different superscripts are significantly different (P<0.05). STL = staple length, FD= fiber diameter

Table (3) demonstrates that the addition of selenium to the ewes' diet had a significant effect (P<0.05) on several wool fiber characteristics. The staple strength (SST) was significantly increased in the treated groups compared to the control group. The SST measurements were 38.12 ± 0.98 N/Ktex, 41.74 ± 0.74 N/Ktex, 49.35 ± 1.45 N/Ktex, and 54.12 ± 1.35 N/Ktex for the control group, 20, 30 and 40 mg selenium supplemented groups, respectively. The strength of wool fibers is influenced by nutrient supply, which can affect fiber diameter and intrinsic strength, as mentioned by Reis *et al*. (1992). The characteristics of fiber diameter have been shown to have an impact on staple strength, as reported by Hansford and Kennedy (1988), Denney (1990), and Peterson (1997). Additionally, the elongation percentage (ELO) of wool fibers was significantly increased in the supplemented ewes compared to the control ewes due to the addition of selenium. The ELO measurements were 32.42 ± 0.87%, 36.47 ± 1.45%, 39.89 ± 0.89%, and 46.18 ± 1.14% for the control group, 20, 30 and 40 mg selenium-treated ewes, respectively. Furthermore, Helal (2005) reported that the elongation of wool staples tends to increase with the increase in wool protein content. This implies that the effect of selenium on wool protein content may be responsible for the rise in elongation percentage seen in the treated groups.

Table (3): Means ± standard errors of staple strength and elongation percentage during the experimental groups.

Variables	Experimental groups			
	Control group	20 mg Se supplemented	30 mg Se supplemented	40 mg Se supplemented
SST (N/Ktex)	38.12 ± 0.98b	41.74 ±0.74 a	49.35 ± 1.45a	54.12 ± 1.35a
ELO %	32.42 ± 0.87b	36.47 ± 1.45a	39.89 ± 0.89a	46.18 ± 1.14a

[a,b] Means within the same columns with different superscripts are significantly different (P<0.05). SST= staple strength, ELO %= elongation percentage.

According to Table (4), there were significant variations ($p<0.05$) in the glutathione peroxidase activity (GPX) levels in the ewes' blood plasma between the various treatments. In comparison to the control group, the 40 mg selenium-supplemented sheep showed the highest GPX activity, followed by the 30 mg and 20 mg selenium-treated ewes, respectively. The GPX level was 3.41 ± 0.540 µU/ml in the control group and 7.36 ± 0.60 µU/ml and 8.48 ± 0.67 µU/ml in the ewes supplemented with 20 and 30 mg of selenium, respectively. The sheep treated with 40 mg of selenium had the highest GPX level, measuring 10.89 ± 0.51 µU/ml. Glutathione peroxidase (GPX) is an enzyme present in plasma that plays a crucial role in the defense against oxidative stress. It contributes to the reduction of hydrogen peroxide and lipid peroxides, thereby protecting animal tissues from oxidative damage (Halliwell and Chirico, 1993). GPX activity is commonly used as an indicator of oxidative stress, reflecting the equilibrium between the antioxidant defense mechanisms and the generation of reactive oxygen species (ROS) (Tüzün *et al*., 2002).

Table (4): Means ± standard errors of glutathione peroxidase enzyme level of activity during the experimental groups.

Variables	Experimental groups			
	Control group	20 mg Se supplemented	30 mg Se supplemented	40 mg Se supplemented
GPx activity (µU/ml)	3.41 ± 0.540^{c}	7.36 ± 0.60^{b}	8.48 ± 0.67^{b}	10.89 ± 0.51^{a}

^{a,b,c} Means within the same rows with different superscripts are significantly different ($P<0.05$). GPX= glutathione peroxidase enzyme level of activity.

Protecting the cell membrane from oxidative damage brought on by free radicals is the role of GPX in cellular oxidation-reduction reactions (Flohe *et al*., 1973). By catalyzing the reduction of peroxides, GPX contributes to the oxidative defense system of animal tissues. GSH (glutathione) is an essential component for GPX activity. It acts as a reservoir of cysteine and is involved in various cellular processes. It is possible to enhance the animals' general health and wool production by selecting both GSH concentrations and wool growth rates (Liu and Eady, 2005). These findings suggest that the supplementation of selenium in the ewes' diet led to an increase in GPX activity in the blood plasma, indicating enhanced antioxidant defense and potential reduction in oxidative stress.

3. Conclusion

Selenium supplementation demonstrates a noteworthy influence on various wool properties of Egyptian sheep. The reduction of wool impurities by selenium results in improved wool production qualities, particularly in clean wool weight. Selenium's substantial effects on fiber diameter (FD) and staple length (STL) lead to enhancements in all

mechanical properties, subsequently improving specific staple strength (SST) and elongation at break (ELO %). Furthermore, compared to the control group, the selenium levels in the blood plasma were higher. One potential approach to enhance the mechanical and physical characteristics of Egyptian wool is through the incorporation of selenium into the diet at levels of 20, 30, and 40 milligrams per kilogram.

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