Dietary inorganic chromium improved wool traits of Ossimi ewes.

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ABSTRACT

Limited information is available about the impact of dietary inorganic chromium (Cr) on wool characteristic of Ossimi sheep. This study was performed to determine the effect of adding dietary Cr to the of Ossimi ewes during the wool growth phase. A total of 40 ewes were divided into four groups at similar live-body weights. The first, second and third groups received the basal diet with 0.2, 0.3 and 0.6 g Cr $kg.d.head^{-1}$. The results indicated a significant positive impact on distinct physical characteristics in treatments of 0.2, 0.3, and 0.6 mg/Kg DM. Notably, improvements were observed in fiber diameter and staple length. Furthermore, an increase in the yield of clean wool and a concurrent reduction in contaminants were evident. Staple strength and elongation percentage was increased in all treated groups. The level of Cr in the blood plasma was significantly higher in all treated groups compared to the control group. In conclusion, dietary Cr improved most wool characteristics of Egyptian Ossimi sheep.

Keywords: Chromium, wool traits, Ossimi ewes.

INTRODUCTION

Ossimi sheep possess distinguishable wool characteristics compared to other sheep breeds. For instance, the fine quality of Ossimi wool is renowned for its softness and fineness. Studies have shown that Ossimi wool fibers have a smaller diameter compared to some other sheep breeds, making it desirable for various textile applications (El-Nouty et al., 2006). The same authors indicated that the staple length of Ossimi wool exhibits a moderate length, making it suitable for spinning and weaving processes. Ossimi wool falls within a specific range, contributing to its usability in textile production. Additionally, Ossimi wool comes in a variety of natural colors, ranging from white to various shades of brown and black. This natural color diversity adds to the aesthetic appeal of Ossimi wool products and provides options for dyeing. Furthermore, the crimping pattern of Ossimi wool fibers is distinct, providing elasticity and resilience to the wool. The crimp frequency and amplitude of Ossimi wool contribute to its ability to retain shape and provide warmth (Shaker et al., 2015). In addition, Ossimi wool is resistant to felting, a quality that makes it durable and long-lasting. The structural characteristics of Ossimi wool fibers contribute to their ability to resist felting and abrasion (Shaker et al., 2015).

The quantity and quality of fiber produced by wool-producing animals are markedly influenced by nutrition. Both the length growth and diameter of the fiber respond to changes in nutrient supply. The major limitation to wool growth is the amount and composition of amino acids available to wool follicles.

Chromium (Cr) is a crucial micronutrient essential for sheep, and the need significantly increases when animals are exposed to different stresses (Anderson 1987; NRC 2007). This nutrient affects the level of the insulin hormone, which, in turn, affects the metabolism process of nutrients (Mertz 1993). Chromium is needed in the synthesis of protein (Mertz 1993). Therefore, Cr affects the growth and productivity of animals (Jacques and Steward 1999). For instance, Arvizu et al. (2011) indicated that organic Cr could affect the performance, carcass characteristics, and other meat quality parameters in Suffolk × Dorper (SD) and Rambouillet grazing lambs. While the effects of in-organic Cr on the wool characteristics of the Egyptian Ossimi breed are not well identified.

Therefore, this study aims to evaluate the effects of various Cr levels on the quantitative and qualitative characteristics of wool produced by Ossimi ewes.

MATERIAL AND METHODS

Animals and management

The herein experiment was conducted on a group of 40 Ossimi ewes. The ewes were 3-4 years old, dry (non-lactating), and weighed between 45 and 50 kg. In order to guarantee that each of the four equal groups of ten ewes had a nearly identical mean live body weight, the ewes were split at random. During the experiment, the animals were fed a maintenance and production diet based on their average body weight, following the guidelines outlined in the National Research Council (NRC, 1988). The NRC provides comprehensive recommendations for animal nutrition, including dietary requirements for different species and production stages.

The concentrate feed mixture given to the ewes in this experiment consisted of 22% undecorated cotton seed cake, 20% molasses, 44% wheat bran, 10% yellow corn, 2.5% ground limestone, and 1.5% common salt.

In addition to the concentrate feed mixture, the ewes had free access to water throughout the entire experimental period. The sheep were also provided with clover hay and rice straw, that were represented sources of roughage or fiber in their feed.

The experimental design

The trial started on January 1st and ended on July 1st, 2022, with a duration of six months. The animals were randomly divided into four groups including a control group (received a basal diet without any supplementary additives) and other dietary Cr treatments in a dose of 0.2, 0.3, or 0.6 g kg. DM. h/d. At the end of the experimental period, wool samples were shorn from the ewes on July 1st, 2022. The wool samples were taken from a tattooed area measuring 10×10 cm (100 cm^2) on the right mid-side of the ewes. The tattooed areas were shorn to the skin at the beginning of each period.

Blood samples were also collected at the same time as the wool samples. Ten milliliters of blood were collected from ten ewes in each group to assess the chromium element (μg/L) in their blood plasma. The blood samples were collected via jugular venipuncture using 18-gauge needles and heparin vacutainers. After collection, the blood samples were centrifuged, frozen, and kept for analysis. The Cr content in the plasma was analyzed using flame atomic absorption spectrophotometry with a Perkin Elmer 3110 instrument.

Physical measurements of the wool samples included the weight of clean wool, staple length, and fiber diameter. The weight of clean wool was determined after removing residual grease from scoured samples using an ethyl ether solvent in a Soxhlet apparatus. The clean wool percentage was calculated based on the yield of the 100 cm2 samples. The contaminants percentage (C%) was calculated according to the following formula:

$$C\% = \frac{\text{Weight of the greasy sample} - \text{weight of the clean sample}}{\text{weight of the greasy sample}} \times 100$$

Measurements of wool characteristics

Staple length was measured by selecting 20 random staples from each sample, using a centigrade ruler. The measurements were rounded to the nearest 0.25 cm. The mean staple length and standard error were then calculated for each treatment group. This analysis provides information on the average length of wool staples in each group and the variability around those means.

Fiber diameter was measured in microns using Image analyzer software (Zen, 2012, Blue edition) and a Carl-Zeiss micro-imaging device with lenses 10/0.847. This measurement allows for an assessment of the thickness of individual wool fibers in each sample.

Staple strength and elongation were measured using the Artiest Staple Breaker (Caffin, 1980). Staple strength was determined by applying force to a staple until it broke and measuring the required force in Newton. This force was then divided by the thickness of the staple in millimeters to obtain the staple strength in Newton per kilotex (N/Ktex). The staple breaker was used to assess the resistance of the wool staples to breakage. For each measured parameter, a specific number of random staples (10 for staple strength) were selected from each sample, and the appropriate measurements were obtained. This allows for an estimation of the average staple strength and elongation in each treatment group.

Statistical analysis

The data collected underwent analysis using the general linear model (GLM) in the SPSS program, specifically the statistical product and service solutions version from 1999. One-way analysis of variance (ANOVA) was used in the current study using Tukey post-hoc test. The percentage of C% was estimated using Arcsine test. Data was presented as mean ± standard error of the mean (SEM) using the significant level of 0.05.

RESULTS AND DISCUSSION

Data of the wool cleaning characteristics are depicted in Table 1. The higher levels of clean weights of wool samples (CWS) were observed in the treated groups in a Cr dose dependent manner compared to the control group (p

≤0.05). On the other hand, the higher wool contaminant percentages (C%) were observed in the control and 0.2 mg Cr groups, compared to 0.3 and 0.6 mg Cr treated groups ($p \leq 0.05$). These results indicated that the dietary Cr relatively improved the wool cleaning characteristics in a dose dependent manner. Nonetheless, the availability of nutrients to wool follicles during the process of fiber growth might affect some characteristics related to wool quality, such as fiber strength, staple length, and diameter (Russel, 2002).

Data presented in Table 2 depicts the wool external quality in the experimental groups. All Cr treated groups had slightly higher values of the staple length (STL) in a dose dependent manner compared to the control group ($p>0.05$). Also, the higher values of fibre diameter (FD) were observed in all treated groups in a dose dependent manner compared to the control group ($p<0.05$). These results indicated that dietary Cr could improve the wool external quality characteristics. Chromium has a key role in protein and nucleic acid metabolism in farm animals (Amata, 2013). Basically, wool is formed of protein (Gitero et al., 2023), which is affected by the addition of chromium to the diet though its effect on the protein metabolism (Gu et al., 2020). In this context, the increase of STL and FD could be explained by the light of chromium effect on protein metabolism (Shi, et al., 2024), resulting in the enhancement of both STL and FD. Since higher FD results in price penalties, this is crucial for producers of fine wool. A recent report by Hernández-García et al. (2024) indicates that dietary Cr improves the performance of lambs and increases serum metabolites in lambs including T_3, T_4, TSH, and glucose levels. With increasing such serum metabolites, wool yield and its characteristics can be improved.

Data presented in Table 3 depicts the wool internal quality in the experimental groups. The higher values of staple strength and elongation percentage were observed in all treated groups in a dose dependent manner compared to the control group ($p<0.05$). These results reflect that the dietary Cr could improve the wool internal quality characteristics.

The food supply has a significant impact on the strength of wool fibers through variations in intrinsic strength and impacts on fiber diameter (Reis, 1992). McGregor et al., (2016) also found that dietary organic minerals increase wool quality. Additionally, Gheetas (2023) indicated that dietary inorganic selenium improves staple strength and the elongation characteristic of wool.

Data presented in Table 4 depicts the plasma Cr concentration among different the experimental groups. The higher Cr concentrations were observed in all treated groups in a dose dependent manner compared to the control group ($p<0.05$). These results reflect that the dietary Cr could be reflected in the blood plasma.

Organic sources of chromium were found to be highly bioavailable in the blood of animals (Yenice et al., 2015). Lalhriatpuii et al., (2024) indicated that dietary organic and inorganic forms of Cr increase plasma Cr level in Black Bengal goats.

CONCLUSION

Supplementing the diet of Egyptian sheep with chromium seems to have a great effect on all wool characteristics. Chromium improved the wool production traits especially clean wool weight which happened through its reduction of wool contaminants. All mechanical properties significantly affected through the effect of chromium on FD and STL and this lead to an improvement in SST and ELO (%). The level of chromium in the blood plasma was greater than control group. Addition of chromium to the diet at 0.2 ,0.3 and 0.6 mg \ Kg ration could be used as a way to improve some physical and mechanical properties of the Egyptian wool.

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Table 1: The wool cleaning characteristics in of the experimental ewes.

Variables	Experimental groups				SEM	*p*-value
	Control	0.2 mg Cr	0.3 mg Cr	0.6 mg Cr		
C.W.S. (g)	19.35^{c}	20.32^{b}	24.92^{a}	26.67^{a}	0.57	0.008
C (%)	35.15^{a}	34.84 ^{a}	30.25 ^{b}	30.12 ^{b}		0.042

Note: CWS: clean weights of wool samples. C%: contaminants percentage. SEM: standard error of the mean. Means within a row with different superscripts are significantly different (p ≤ 0.05).

Table 2: Wool external quality indication of the experimental ewes.

Variables	Experimental groups				SEM	*p*-value
	Control	0.2 mg Cr	0.3 mg Cr	0.6 mg Cr		
STL (cm)	5.67 ^{a}	6.00 ^{a}	6.46 ^{a}	6.72^{a}	0.18	0.06
FD (µm)	32.20^{b}	36.21 ^{a}	39.74 ^{a}	41.83 ^{a}	0.64	0.042

Note: STL: staple length. FD: fibre diameter. SEM: Means within a row with different superscripts are significantly different (p ≤ 0.05).

Table 3: Wool internal quality indication of the experimental ewes.

Variables	Experimental groups				SEM	*p*-value
	Control	0.2 mg Cr	0.3 mg Cr	0.6 mg Cr		
SST (N/Ktex)	40.74[b]	44.49 [a]	47.81 [a]	50.12 [a]	1.41	0.032
ELO %	27.12 [b]	31.03 [a]	34.19 [a]	38.78 [a]	1.42	0.029

Note: SST: staple strength. ELO %: elongation percentage. SEM: Means within a row with different superscripts are significantly different ($p \leq 0.05$).

Table 4: plasma chromium concentration in different the experimental groups.

Item	Experimental groups				SEM	*p*-value
Variables	Control group	0.2 mg Cr	0.3 mg Cr	0.6 mg Cr		
Chromium (µg/L)	17.51[c]	22.42 [b]	25.74 [b]	29.36[a]	0.52	0.003

Note: SEM: Means within a row with different superscripts are significantly different ($p \leq 0.05$).

الكروم الغذائي الغير عضوى في العلائق يحسن من صفات الصوف للنعاج الأوسيمي

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الملخص العربي:

تتوفر معلومات محدودة حول تأثير الكروم الغير عضوي الغذائي (Cr) على خصائص الصوف لأغنام الأوسيمي. أجريت هذه الدراسة لتحديد تأثير إضافة الكروم الغذائي إلى صوف النعاج الأوسيمي أثناء مرحلة نمو الصوف. تم تقسيم عدد 40 نعجة إلى أربع مجموعات بأوزان جسم حية مماثلة. تلقت المجموعات الأولى والثانية والثالثة النظام الغذائي الأساسي بـ 0.2 و 0.3 و 0.6 جم كروم/ كجم. رأس-1. أشارت النتائج إلى وجود تأثير إيجابي كبير على الخصائص الفيزيائية المميزة في معاملات 0.2 و 0.3 و 0.6 مجم كروم / كجم مادة جافة. ومن الجدير بالذكر أنه تم ملاحظة تحسن في قطر الألياف وطول الخصلة. علاوة على ذلك، كان هناك زيادة في إنتاج الصوف النظيف وانخفاض في نسبة الشوائب. كما لوحظ أيضا زيادة في متانة الخصلات ونسبة الاستطالة في جميع المجموعات المعاملة. كان مستوى الكروم في بلازما الدم أعلى بشكل ملحوظ في جميع المجموعات المعاملة مقارنة بمجموعة الكنترول. ختاماً ،إضافة الكروم في العليقة أدى إلى تحسين معظم خصائص الصوف لأغنام الأوسيمي المصرية.

الكلمات الاسترشادية: الكروم , صفات الصوف , نعاج الأوسيمي