Available online at http://bjas.bajas.edu.iq
https://doi.org/10.37077/25200860.2025.38.sp.6
College of Agriculture, University of Basrah

Basrah Journal of Agricultural Sciences

ISSN 1814 – 5868 Basrah J. Agric. Sci., 38(Special Issue), 72-83,2025 E-ISSN: 2520-0860

Relationship Between Growth and Development of Sheep Wool and Goat Hair with Their Mineral Components and Some Biochemical Parameters in the Blood

Manal A .Ahmed*, Aliaa J. Shabeeb & Waleed Y. Kassim

Department of Animal Production, College of Agriculture, University of Basrah, Iraq.

***Corresponding author email: M.A.A:** Manal.ahmed@uobasrah.edu.iq, **A.J.S.:** aliaa.shabeeb@uobasrah.edu.iq, **W.Y.K.:** waleed.yosif@uobasrah.edu.iq

Received 30th September 2024; Accepted 12th January 2025; Available online 24th August 2025

Abstract: This study aimed to determine the relationship between the growth of wool in sheep and hair in goats and their content of minerals, and some biochemical blood parameters. Twelve animals, six months old and about 20.85 kg body weight including, Arabi lambs and six local goats. Wool and hair characteristics, as well as the concentration of Zn and Cu in the shoulder and hip region, were measured. The results revealed an increase in Zn content in the wool and hair at the third month of the experiment, and the increase was proportional to both shoulder and hip areas. In sheep, a significant correlation was recorded between the weight of clean wool and the length of the staple in the shoulder region. In the hip region, there was a significant correlation between the weight of the crude and clean wool. While in goats, a significant correlation was recorded in the shoulder region between the weight of the crude hair and the length of the staple. Also, a highly significant correlation was recorded in the hip region between the weight of the crude hair and the weight of the clean fleece. Highly significant correlations between cholesterol concentration and both of fiber length in the shoulder and crude, clean wool weight in hip areas. In goats, a significant correlation was recorded in the shoulder and hip region between glucose concentration and clean hair weight. Therefore, it can be concluded that there are significant correlations between the wool and hair production and some biochemical blood parameters.

Keywords: Blood parameters, Copper , Hair, Wool , Zinc**.**

Introduction

Arabi sheep are distinguished by their production of long and hard wool, which makes them good in the textile industry (Taherpour *et al*., 2012).Wool and hair parameters of the local sheep and goats are affected by several factors, including the age, weight, season, and feed content of amino acids and vitamins (AL- Jassim *et al.,* 2006; Kassim *et al.,* 2019; Kassim & Al-Helou, 2024),and minerals. In particular, copper and zinc are important in maintaining the properties and production of wool. (Anna *et al*., 2019;Erika *et al*.,2020). . In the early sixties of the last century, the mineral analysis in the hair was utilized for the first time to evaluate the mineral status in humans as an indicator for trace elements in 1990 (Bencze, 1990; Dombovári & Papp, 1998; Chyla & Zyrnicki, 2000). The hair could be used to estimate trace and major elements, toxic elements, and even drug residues over long

periods (Wichert *et al*., 2002; Dunnett & Lees, 2003). It also represents a good and easy source of tissue samples that can be obtained in simple, non-surgical, or painful ways. Additionally, samples can be prepared and stored at room temperature for long periods without any change in their composition, which reflects consequently on the results (Dunnett & Lees, 2003; Gratacos-Cubarsi *et al*., 2006; Kempson & Lombi, 2011). In addition, the concentration of mineral elements in the hair is almost equal to their concentration in the body, whether the body is in a state of physiological balance or a pathological state, compared to the blood, which showed variability in element content depending on the diet and animal health state (Miroshnikov *et al*., 2017).Gabryszuk *et al*.,(2001) reported that wool analysis exhibited significant differences in the concentration of mineral elements between breeds of ewes Booroola and Polish Merino, while no significant differences appeared when the analysis was performed using blood plasma between the two dynasties. Also, the elements accumulate in the hair regularly and selectively compared to some other tissues of the body, which is considered a good indicator of hair and wool quality (McDowell, 1992). As some researchers have demonstrated the existence of significant correlations between wool production and its properties with hormones, enzymes, and certain blood parameters like glucose, cholesterol, and total protein, the method of estimating blood biochemical parameters is also helpful for predicting wool and hair growth, production, and physical properties through selection to improve wool and hair production traits of Arabian sheep and goats. (Al-Helou,2005; Nabeel *et al*.,2012;Hafetd *et al* .,2021). Thus, the current study aimed to evaluate the effect of mineral elements content and biochemical blood parameters on the quality and quantity of sheep wool and goats' hair in shoulder and hip area.

Materials & Methods

The study was carried out in the animal field / College of Agriculture /University of Basrah from 1/11/2022 to 31/1/2023. Twelve animals, six months old, about 20.85 kg body weight including, six Arabi lambs and six local Iraqi black goats. Animals were fed at rate of 3% of body weight. The feed contains 350g bran wheat and 150g barley in addition to green plants and grasses. All animals in the field were supplied with clean water and salt mixture blocks.

Physical wool parameters

Wool and hair samples were taken from the shoulder and hip areas (10cm2) monthly of the animals by sharp scissors at the level of the skin surface, and stored in plastic bags. By a sensitive balance, the weight of wool and hair crude was recorded and washed with clean water to remove the dirt and dust. Wool and hair samples were dried at room temperature for five days and weighed again. Three random patterns were taken from each sample and placed on a piece of white paper to measure the distance between the two ends of each pattern and to record the fiber length. Then the same samples were taped with tape to record the length of the staples (Kassim & Al-Helou, 2024).

Minerals elements concentration

Mineral content of wool and hair was performed by digestion of 0.5 g of each using glass tubes and covered with a glass bubble ,1.5 ml of nitric acid and 1.5 ml of pure perchloric acid were added to the tubes, mixed well, subsequently, incubated for 12-16 hours.

The tubes were placed on a hot plate at 70°C until the solution became clear, then diluted to the required volume (Standard Method). Finally, by using the atomic absorption device GBC FQuip Ment (Scientific SensAA), the concentration of minerals (Zn and Cu) was determined in the samples (Estefan *et al*., 2013).

Biochemical blood parameters

Ten mL of blood was collected from the jugular vein monthly from every animal by tubes containing a clotting agent (gel). Tubes were centrifuged at 5000 rpm for 15 minutes to separate the serum; the serum was frozen at -20°C for further tests. The concentration of glucose, cholesterol, and triglycerides was determined by a chemical kit from Biolabo, France.

Experiment design and statistical analysis A completely randomised design was used for the experiment (CRD). SPSS software was used to analyse the data (2019). The two-way ANOVA analysis of variance was used to compare the means at the 0.05 probability level. The findings are shown as (mean±Sd). By calculating the rank correlation coefficient (rs), the title (Sperman's Coefficient of Rank Correlation) between the estimates of the attributes analysed using the procedure of rank was established. Using the formula, he supplied (Steel & Torrie, 1980). $rs = 1\ (6\sum di^2\ /\ [n(n^2-1)]$ Since: di = The differences between the ranks of any two characteristics of each animal. n= Number of ranks. It can be calculated the significance of the rank correlation coefficient according to the following equation: $t = rs\sqrt{(\mathrm{n}-2)/\ (1-r^2s)}$

Results & Discussion

It is clear from Table (1), there are significant (P<0.05) differences in the weight of crude wool in the shoulder and the hip regions during the second (December) and third months (January), while the weight of clean wool was increased significantly (P<0.05) during the third month (January) in the shoulder region and second (December) and third (January) months in the hip regions. The result is consistent with the results of Behrem & Gȍl (2022) in Merino crossbreds and with Fernandez *et al*., (2020) in Merino sheep, who reported a significant improvement in wool during October and November compared with September. This improvement during the second (December) and third months (January) could be attributed to the increase in both the quantity and quality of pastures, which positively affected the feed intake and ultimately led to a higher wool yield. A significant (P<0.05) increase in the weight of wool in the shoulder region was observed compared with the hip region, which may be due to the low rate of primary and secondary wool follicles in the rear areas of the body in sheep (Kazmi *et al*., 2017). The length of the staple and fiber was improved (P<0.05) in the shoulder and hip regions during the second and third months of the experiment, which is consistent with Al-Hellou (2005) in Arabi lamb. Al-Hellou (2005) explained his result by the fact that the increase in age improves the efficiency of food conversion and the efficiency of wool follicles, which consequently leads to an increase in the length of the staple. On the other hand, the increase in the fiber length can be attributed to a highly significant relationship between the length of the fiber and the length of the staple, as the length of the staple constitutes 70-90% of the length of the fiber (Al-Dabbagh & Abbo, 2014). Increasing wool fiber length has a positive effect on increasing on wool weight because the fibers form almost 41.4% of the wool weight in sheep (Liu *et al*., 1994).

Table (1): The wool characteristics of sheep during the months of the experiment (Mean ± SE).

Parameters	Shoulder region				Hip region			
	First month	Second month	Third month	Mean	First month	Second month	Third month	Mean
Crude weight wool (g)	1.21b ± 0.07	2.21 a ± 1.31	2.38 a ± 1.04	1.93 A ±1.04	1.22 c ± 0.51	1.76 b ± 0.59	2.57 a ± 0.74	1.85 B ± 0.81
Clean weight wool (g)	1.15 b ± 0.90	1.16 b ± 0.66	1.81 a ± 0.53	1.37 ± 0.73	0.91 c ± 0.69	1.31 b ± 0.35	1.88 a ± 0.45	1.36 ± 0.63
Staple length (cm)	3.35 b ± 0.85	5.30 a ± 0.97	5.80 a ± 1.09	4.81 ± 3.40	3.65 c ± 1.08	5.25 b ± 1.17	5.80 a ± 1.03	4.9 ± 1.38
Fiber length (cm)	4.40 c ± 1.08	9.60 b ± 3.71	10.20 a ± 3.23	8.06 ± 3.24	6.05 c ± 3.20	8.20 b ± 2.48	9.50 a ± 2.64	7.91 ± 2.97

abc Different small letters within rows refer to a significant difference (P<0.05) between months in sheep.

AB Different capital letters within rows refer to a significant difference (P<0.05) between shoulder and hip region in Sheep

Table (2) shows that there was a significant (P<0.05) increase in crude hair weight in the shoulder region during the third month, while a significant (P<0.05) increase appeared in the weight of crude and clean hair in the hip region during the second and third months. This increase in hair weight with age could be attributed to the fact that the surface area of the body increases as animal growth was proceeded, which has positive effect on the increase in the weight of the fleece (Al–Kouzai *et al.,* 1999). Likewise, there was a significant (P<0.05) superiority for the hip region in the weight of crude and clean hair compared with the shoulder region. AL- Jassim *et al.*,(2006), attributed similar finding to the existence of a significant correlation between the weight of the fleece of in the hip region and the body weight of local goats.

Table (2): The hair characteristics of goats during the months of the experiment (Mean ± SE).

Parameters	Shoulder region				Hip region			
	First month	Second month	Third month	Mean	First month	Second month	Third month	Mean
Crude weight Hair (g)	0.68 b ± 0.15	0.94 b ± 0.57	1.43 a ± 0.95	1.01 B ± 0.68	1.20 b ± 0.36	1.27 a ± 0.69	1.30 a ± 0.49	1.25 A ± 0.49
Clean weight Hair (g)	0.56 ± 0.33	0.59 ± 0.17	0.71 ± 0.59	0.62 B± 0.38	0.76 b ± 0.70	1.09a ± 0.76	1.17 a ± 0.50	1.00 A ± 0.64
Staple length (cm)	6.60 c ± 1.78	7.15 b ± 1.69	8.25 a ± 2.42	7.33 A ± 1.97	6.20 b ± 1.09	6.37b ± 3.65	6.90 a ± 1.63	6.49 B ± 2.24
Fiber length (cm)	7. 70 b ± 0.48	8.50 a ± 1.69	8.50 a ± 2.42	8.23 ± 1.64	7.24 b ± 2.84	8.65a ± 2.10	8.70 a ± 2.38	8.19 ± 2.38

abc Different small letters within rows refer to a significant difference (P<0.05) between months in goat.

AB Different capital letters within rows refer to a significant difference (P<0.05) between shoulder and hip region in goat

There was a significant difference (P<0.05) in the length of the staple and the fiber in the shoulder region during the second and third months, while in the hip region, there was a significant (P<0.05) superiority in the length of the staple during the third month, and the length of the fibers was significantly superior during the second and third months. This result clarifies the remarkable effect of age on the length of the staple. This finding agrees with that of AL-Jassim *et al*., (2006) in local goats but is not consistent with Selçuk (2018).

Table (3) shows there is a significant (P<0.05) increase in Zn content of wool in the shoulder and hip regions in sheep during the second and third months; the mean was within the values reported by Sedat *et al.*, (2022) in Merino Sheep (9.80-383.60 mg kg $^{-1}$for the shoulder and hip regions, respectively). While it was less than the values obtained by Kołłacz *et al.*, (1999) (140.21-224.73 mg. kg $^{-1}$ for the shoulder and hip regions, respectively) in Polish Merino sheep. Also, less than the result of Patkowska-Sokola *et al.*, (2009) in Awassi sheep (73.62 - 88.80 mg. kg $^{-1}$ for the shoulder and hip regions, respectively). Results revealed a significant (P< 0.05) increase in the level of zinc in the hair of the shoulder and hip regions of goats during the second and third months of the experiment. These values were lower than those found by Pavlata *et al.,* (2011) in goats (97.9 mg kg $^{-1}$).The remarkable increase in the Zn content of hair within the December and January months may due to improve the quality of fodder provided from refreshed pastures during the winter season , it is known that the concentration of mineral elements in wool or hair depends widely on the quality of the feed (Ramirez-Perez *et al*., 2000:Erika *et al*.,2020). The existence of positive correlations between the length and thickness of the fibers, their tensile strength, and their Zn content was confirmed by Anna *et al*., (2019). As the concentration of Zn was increased by one mg, the diameter of the fibers was decreased, and the quality of the wool was improved (Sedat *et al*., 2022). From Table 3, a significant (P<0.05) superiority was observed in the concentration of Zn in goats in the shoulder and hip regions compared with sheep. Since both types of animals were under the same nutritional, environmental, and management conditions, the reason for this superiority of goats may be due to a difference in metabolism between animals with similar nutrition (Erika *et al*.,2015).The concentration of Cu in wool was not significantly differed between the shoulder and hip regions during all months (Table 3), and it was within the values of Kołłacz *et al*., (1999) (4.33 -7.23 mg. kg $^{-1}$ for the shoulder and hip regions, respectively) in Polish Merino sheep. However, the result obtained in a current study was less than the values of Patkowska-Sokola *et al.* (2009) in Awassi sheep. The copper concentration was 5.30 -10.30 mg. kg $^{-1}$ for the shoulder and the hip regions, respectively. Sedat *et al.*, (2022) in Merino sheep (9.80-383.60 mg kg $^{-1}$for the shoulder and the hip regions, respectively). On the other hand, no significant differences were found in Cu concentration between the shoulder and hip regions of goats. The average values of Cu level in sheep and goats were higher than 2.5 mg. kg $^{-1}$ which indicates that the decrease in Cu level was for a short period and has no effect on the wool production. It was within the values (4.14) mg kg $^{-1}$ which indicates adequate dietary processing of Cu (Suttle & McMurray, 1983). The copper deficiency often occurs in tropical areas such as Basrah, which suffer from a nutritional problem represented by a significant Cu deficiency due to the low Cu concentration in animal food or

increase in other elements with high concentrations that are hostile to Cu, such as S, and Fe (Sousa *et al.,* 2012). Increasing the level of copper by one unit in wool leads to an increae in wool elasticity by 0.29 percent (Sedat *et al.,*2022). The Cu content in wool and hair of animals was affected by several factors such as type of feed, animal physiological condition, lactation (Wnuk, *et al.,* 2003).

Table (3): The concentration of Zn and Cu in sheep wool and goat hair (Mean ± SE).

Metal elements	Type of animal			
Zn mg.kg^{-1}	Sheep		Goat	
	shoulder	Hip	shoulder	Hip
First month	20.6 c ±2.60	27.2 c ±3.27	25.4 c ±6.87	32.4 c ±5.02
Second month	22.4 b ±3.50	28.8 b ±2.38	35.2 b ±5.11	38.2 b ±5.71
Third month	25.2 a ±3.03	30.2 a ±6.09	40.2 a ±5.44	45.2 a ±3.11
Mean	22.73 B ±3.45 5	28.73 B ±4.11	33.6 A ±8.36	38.6 A ±6.97
Cu mg.kg^{-1}				
First month	3.01±1.03	4.22±0.74	4.04±0.40	3.07± 0.72
Second month	3.03±0.51	4.03±0.60	4.17±1.09	4.33±0.45
Third month	3.03±0.67	4.01±0.43	4.30±0.84	3.61±0.74
Mean	3.02±0.71	4.08±0.57	4.17±0.77	3.67±0.80

abc Different small letters within columns refer to a significant difference (P<0.05) between months in the same animal.
AB Different capital letters within rows refer to a significant difference (P<0.05) between sheep and goat

Table 4 illustrates that there is no significant difference in the glucose concentration during the months of the experiment in sheep and goats, however, the means were significantly (P<0.05) higher in goats than in sheep. Regarding the cholesterol concentration in sheep and goats, there was a significant (P<0.05) increase during the second and third months, the result agreed with the result of Al-Hellou (2005) in lambs. The reason May be related to the biochemical characteristics of blood that are affected by the animal's breed, sex, type, environmental changes, and performance metabolism (Cruz *et al.,* 2017).

Table (4): The concentration of glucose, cholesterol, and triglycerides in the serum of sheep and goats during the months of the experiment (Mean ± SE).

Animal / parameters	Sheep				Goat			
	first month	second month	third month	Mean	first month	second month	third month	Mean
Glucose mg/100 ml	46.02 ± 5.13	46.70 ± 9.32	51.46 ± 5.45	48.06 B ± 6.86	56.53 ± 7.89	54.60 ± 7.56	59.21 ± 7.35	56.78 A ± 7.31
Cholesterol mg/100 ml	69.86 c ± 11.87	85.10 b ± 3.76	101.89 a ± 9.90	85.61 ± 15.99	65.74 c ± 15.12	85.36 b ± 3.95	97.91 a ± 4.56	83.00 ± 16.23
Triglycerides mg/100 ml	42.09 ± 11.36	37.28 ± 3.28	40.74 ± 4.88	40.03 ± 7.15	36.12 ± 3.80	36.55 ± 3.04	40.35 ± 3.31	37.67 ± 3.71

abc Different small letters within rows refer to a significant difference (P<0.05) between the months for the same animal.
AB Different capital letters within rows refer to a significant difference (P<0.05) between sheep and goats.

It is clear from Table (5) that there were significant (P<0.05) correlation coefficients between clean wool weight and staple length in the shoulder region of sheep, and between crude weight wool and the weight of clean wool. These results are consistent with those obtained by Taha (2011) and Al-Dabbagh & Abbo (2014) in Awassi ewes. Results showed that, there was a significant (P<0.05) correlation between crude weight wool and the length of the staple, which is consistent with the results of Ahtash *et al.* (2021) in Barbary sheep and Behrem & Gὺl (2022) in Merino sheep, and Gὺl & Dikme (2023) in Malya sheep.

Table (5): Correlation coefficient between wool characteristics and the level of minerals in the shoulder and hip regions of Arabi sheep

parameters	Level of Cu	Level of Zn	Staple length	Fiber length	Clean weight wool
			Shoulder region		
Crude weight wool	0.049	0.356	0.080	0.146	0.343
Clean weight wool	0.103	0.321	0.864*	0.362	-
Fiber length	0.009	0.003	0.077	-	
Staple length	0.219	0.379	-		
Level of Zn	0.052	-			
			Hip region		
Crude weight wool	0.119	0.375	0.704*	0.385	0.810*
Clean weight wool	0.091	-0.137	0.495	0.175	-
Fiber length	-.0189	0.107	0.073	-	
Staple length	-.0304	0.370	-		
Level of Zn	0.024	-			

*Correlation is significant at the 0.05 level. **Correlation is significant at the 0.01 level

Table (6) shows a significant (P<0.05) correlation in goats between the clean weight hair and the length of the staple in the shoulder region, also, a highly significant correlation (P<0.01) was observed in the hip region between the weight of the crude hair and the weight of the clean hair. There was a significant correlation (P<0.05) between the weight of the clean hair and the fiber length. These results are consistent with Bahattin *et al.* (2017) in goats.

Table (6): Correlation coefficient between hair characteristics and the level of minerals in the shoulder and hip regions of local black goats.

parameters	Level of Cu	Level of Zn	Staple length	Fiber length	Clean weight hair
			Shoulder region		
Crude weight hair	0.164	0.143	0.766*	0.034	0.362
Clean weight hair	0.185	0.118	0.227	0.013	-
Fiber length	0.214	0.133	0.028	-	
Staple length	0.278	0.051	-		
Level of Zn	0.174	-			
			Hip region		
Crude weight hair	0.102	0.293	0.446	0.037	0.668**
Clean weight hair	0.304	0.224	0.490	0.576*	-
Fiber length	0.191	-0.123	0.327	-	
Staple length	-0.345	-.005	-		
Level of Zn	0.344	-			

*Correlation is significant at the 0.05 level. **Correlation is significant at the 0.01 level

It appears from Table (7), that there was a highly significant correlation (P < 0.01) in sheep between cholesterol concentration and the length of the fiber in the shoulder area as well. A highly significant (P<0.01) is also existed between cholesterol concentration crude wool weight and clean wool weight. These results are consistent with the results of Al-Hellou (2005) in the Arabi lambs .The results of the current study showed that there was a negative significant (P<0.05) correlation between the concentration of triglycerides and the weight of clean wool in the hip area.

Table (7): Correlation coefficient between wool characteristics and the level of some biochemical parameters in the hip and shoulder regions of Arabi sheep

Parameters	Glucose	Cholesterol	Triglyceride	Glucose	Cholesterol	Triglyceride
	Hip region			Shoulder region		
Crude weight wool	0.091	0.666**	-0.036	-0.021	0.512	-0.25
Clean weight wool	0.301	0.832**	-0.558*	-0.271	0.263	-0.475
Fiber length	0.365	0.462	0.153	0.387	0.763**	0.107
Staple length	0.191	0.638	0.082	-0.092	0.193	-0.102
Triglyceride	-0.012	-0.273	-	-	-	-
Cholesterol	0.352	-				

*Correlation is significant at the 0.05 level. **Correlation is significant at- the 0.01 level.

Table 8 shows that in goats, there was a highly significant correlation (P < 0.01) between glucose concentration and clean hair weight in the shoulder, while the correlation was significant (P< 0.05) between glucose concentration and clean hair weight in the shoulder and hip area.

Table (8): Correlation coefficient between hair characteristics and level of some biochemical parameters in the hip and shoulder regions of black local goats

Parameters	Glucose	Cholesterol	Triglyceride	Glucose	Cholesterol	Triglyceride
	Hip region			Shoulder region		
Crude weight hair	0.349	0.153	-0.242	0.381	0.437	0.238
Clean weight hair	0.544*	0.223	-0.209	0.673**	0.275	0.459
Fiber length	0.465	0.189	-0.081	0.159	0.156	-0.302
Staple length	0.074	0.135	-0.1	0.333	0.477	0.463
Triglyceride	0.34	0.621*	-	-	-	-
Cholesterol	0.245					

*Correlation is significant at the 0.05 level. **Correlation is significant at the 0.01 level

Conclusion

According to the results obtained in this study, it can be concluded that the age of the animal had a positive effect on the production of wool or hair in sheep and goats, respectively. The area where the wool or hair sample was taken from the animal had a clear effect, the wool in the shoulder area of sheep was characterized by faster and denser growth compared to the

hip area. On the contrary, the hip area was superior in hair growth compared with the shoulder area in goats. Also, an increase in the wool and hair growth was shown as animal age was proceeded the wool content of zinc, was not affected by the sampling area. In general, this element is more abundant in goat hair than in sheep wool. No correlations were found between zinc and copper concentrations and wool or hair production, so the concentration of these elements cannot be relied upon to improve the quality and quantity of wool and hair, at least in this study. While significant correlations have been observed for some biochemical blood traits such as cholesterol in sheep and glucose in local black goats, through these correlations' wool or hair production and their characteristics can be predicted and thus genetically improved.

Acknowledgments

The authors would like to thank the staff of Animal Farm, Agriculture College, University of Basrah for their assistance in completing this study.

Contributions of authors

M.A.A.; Fieldwork, collected the wool data, determined wool and hair parameters, writing the paper.

A.J.S.; Field work, collected the wool data, determined wool and hair parameters, evaluated the paper.

W.Y.K. Field work, blood samples collection, determining biochemical blood parameters, suggestion of a title of the paper, designing and planning the experiments, evaluation of the paper

ORCID

M.A.A., https://orcid.org/0000-0002-8314-6675.

A.J.S., https://orcid.org/0000-0002-9282-6867

W.Y.K., https://orcid.org/0000-0002-1319-2713

Conflicts of interest

The authors have no conflict of interest.

Ethical approval

In this study all ethical guidelines by national and international institutions related to Animal breeding we as applied

References

Ahtash. A., Aiad A. & Fathi, A. (2021). Estimation of Some Genetic Parameters of the Growth and Wool Characteristics of The Libyan Barbary Sheep. *Sebha University Jouranal of Pure and Applied Sciences*, *20* (1). https://doi.org/10.51984/jopas.v20i1.1231

Al-Dabbagh, S.F., &Abbo, N.Y. (2014).A comparison of phenotypic performance of wool physical properties in Awassi ewes. *Iraqi Journal of Veterinary Sciences*,*28* (1), 49-54.
https://www.vetmedmosul.com/article_89341.html

Al-Hellou. M. F. .(2005) The Use of Blood Traits and Biochemical Parameters As Growth Indicators and Study of Sexual Puberty and Wool Traits of Arabi Lambs. Ph. D. Thesis. Coll. Agric. Univ. Basrah.*(In Arabic).p 150*

AL-Jassim,A.F.,Kasim., W,Y., & AL-Ghalibi, H,A.J. (2006) .Effect of season, ,age and bodyweight on some blood and hairs characteristic of black local Iraqi goat. *Basrah Journal of Agricultural Sciences,19(2)*1-11.*(InArabic).*

Al – Kouzai , A.L., Abdul- Lattif, F.H., & Taher , K.N.(1999).Effect of age and sex on flecce weight of Angora goats in Iraq . *Al. Qadisiya Journal, 1:*4-9.

Anna, W., Stefania, K., Bozena, P., Robert ,B., Paulina, C., &Katarzyna, C.(2019).The influence of zinc-methionine bioplex supplementation to pregnant and lactating sheep on selected wool parameters. *Archives Animal Breeding, 62,* 99–105, https://doi.org/10.5194/aab-62-99-2019

Bahattin, C., Orhan, Y., & Elvan, O. (2017).Physical-chemical composition of milk and fiber quality in hair goats and the phenotypic correlations between milk composition and fiber traits. *Pakistan Veterinary Journal, 37*(1), 35-38.

Behrem, S., & Gől ,Sabri .(2022).Effects of age and body region on wool characteristics of Merino sheep crossbreds in Turkey . *Turkish Journal of Veterinary & Animal Sciences, 46*, 235-247. https://journals.tubitak.gov.tr/veterinary/vol46/iss2/8/

Bencze, K. (1990). What contribution can be made to biological monitoring by hair analysis? *Fresenius' Journal of Analytical Chemistry, 338*(1),58–61. https://doi.org/10.1007/BF00322786

Chyla, M.A., &Zyrnicki, W. (2000). Determination of metal concentrations in animal hair by the ICP method – comparison of various washing procedures. *Biological Trace Element Research, 75*, 187-194.

Dombovári, J., & Papp, L. (1998).Comparison of Sample Preparation Methods for Elemental Analysis

Dunnett, M. & Lees, P. (2003). Trace element, toxin and drug elimination in hair with. particular reference to the horse. *Research in Veterinary Science, 75*(2), 89-101. https://doi.org/10.1016/S0034-5288(03)00074-2

Erika, S., Katai, F., Komlósi, L., & Szabó, Cs. (2015). Effect breed and sampling place on the mineral content of cattle hair. *Poljoprivreda/Agriculture*, *21*, Supplement 1, 59-62 http://doi.org/10.18047/poljo.21.1.sup.13

Erika, S., János, K., István, K., János, O., & Csaba, S. (2020). Newly grown. wool mineral content response to dietary supplementation in sheep. *Animals, 10*(8), 1-9. https://doi.org/10.3390/ani10081390

Estefan, G.; Sommer, R. & Ryan, J. (2013). Methods of soil, plant, and water Analysis: A manual for the west Asia and North Africa region, 3ed., ICARAD (International Center for Agricultural Research in the Dry Areas). Beirut, Lebnan, 243p. https://repo.mel.cgiar.org/items/14bb2a3f-dc9e-455b-99e3-97f27ceb9e42

Fernandez, A.D., Irabuena, O., Sterla, S., & Hernandez, R. Z.(20&20). Effect of the shearing date on wool growth on native pasture in Merino sheep. *International Journal of Zoology and Animal Biology, 3*(5),1-5. https://medwinpublishers.com/article-description.php?artId=5931

Gabryszuk, M., Baranowski, A., Czauderna, M., Klewiec, J., & Kowalczyk, J. (2001). Content of mineral elements in the blood plasma and wool of Booroola and Polish Merino sheep. *Biuletyn Magnezologiczny.,6 (3), 253-25*. *(In* Polish *)* https://www.infona.pl/resource/bwmeta1.element.agro-article-26bfc8fb-f069-4cc7-ab7e-3a45c7d34801

https://link.springer.com/article/10.1385/BTER:75:1-3:187 .

Cruz, R.E.S., Rocha, F.M., Sena, C.V.B., Noleto, P.G., Guimarães, E.C., José, A.G.J.A., & Mundim, A.V. (2017). Effects of age and sex on blood biochemistry of Dorper lambs. *Semina: Ciências Agrárias, 38*(5), 3085-3094. https://ojs.uel.br/revistas/uel/index.php/semagrarias/article/view/26313/21810

of Human Hair. *Microchemical Journal, 59*, (2), 187-193. https://doi.org/10.1006/mchj.1998.1573

Gratacos-Cubarsi, M., Castellari, M., Valero, A., Garcia- Regueiro, J.A.(2006). Hair analysis for veterinary drug monitoring in livestock production. *Journal of Chromatography B, 834*: 14-25. https://doi.org/10.1016/j.jchromb.2006.03.007

Gül ,Si., & Dikme ,M.(2023). Investigation of some physical and morphological characteristics of wool of Malya sheep. *Journal of Natural Fibers*, *20*(1), 1-11. https://doi.org/10.1080/15440478.2023.2166646

Hafetd, M. A., Rahman, H., & Azhar ,A. J.(2021).The Relationship between Some Blood Components and Wool Production and Some of its Physical Traits in the Local Arabian Sheep *Medico-legal Update, January- . 21,.* (1). https://doi.org/10.37506/mlu.v21i1.2499

Kassim, W. Y., AL-Asadi, F. A., & Mohsen B. S. (2019). Effect of treatment with a mixture of amino acids at different levels on some biochemical parameters and wool, carcass characterizes in the Arabi lamb's breed. *Advances in Animal and Veterinary Sciences., 7* (4), 383-388. http://doi.org/10.17582/journal.aavs/2019/7.5.383.388

Kassim W, Y. & Al-Helou, M. F. (2024). The impact of folic acid and B12 administration on growth, some hormones concentrations of male Arabi lambs. *Journal of Global Innovations in Agricultural Sciences, 12*(2), 365-372. https://doi.org/10.22194/JGIAS/24.1162

Kazmi, A., Wan,i S.A., Sofi, A.H., Mir, M.S., & Khan, H.M. (2017). Effect of sex and body region on the wool follicular characteristics of Bakarwal sheep. *Indian Journal of Small Ruminants, 23*(1), 131-133. https://www.indianjournals.com/ijor.aspx?target=ijor:ijsr&volume=23&issue=1&article=021

Kempson, I.M. & Lombi, E.(2011). Hair analysis as a bio monitor for toxicology, disease and health status. *Chemical Society Reviews, 40, 39*15-3940. https://doi.org/10.1039/C1CS15021A

Kołłacz, R., Bodak, E., Dobrzański, Z., & Patkowska-Sokoła, B. (1999). Trace elements in the wool of Polish merino sheep grazed in polluted and unpolluted environment. *Czech Journal of Animal Science, 44*, 509-514. (Abstract). https://hero.epa.gov/hero/index.cfm/reference/details/reference_id/8341007

Liu, A.H., Wickham, G.A., & Blair, H.T. (1994). Effect of selection for greasy fleece weight on the components of fleece weight in New Zealand Romney sheep. *Proceedings of the New Zealand Society of Animal Production. 54*, 243-246.https://www.nzsap.org/proceedings/1994/effect-selection-greasy-fleece-weight-components-fleece-weight-new-zealand-romney

McDowell, L. R .(1992).*Minerals in Animal and Human Nutrition.* Academic Press, Inc., San Diego, USA. Pp: 524. https://www.sciencedirect.com/book/9780444513670/minerals-in-animal-and-human-nutrition

Miroshnikov ,S.A., Zavyalov O.A., Frolov A.N., Bolodurina I.P., Kalashnikov V.V., Grabeklis A.R., Tinkov A.A., & Skalny A.V.(2017).The reference intervals of hair trace elements content in Hereford cows and Heifers (Bos Taurus*). Biological Trace Element Research., 180* , 56-62. https://doi.org/10.1007/s12011-017-0991-5

Nabeel ,N. A., Samem ,F. Al-Dabbagh., & Nabeel ,A.J AL-Masry .(2012).Study of Some Genetic and Non-genetic Factors Affecting Wool Growth and It's Relation with Some Blood Biochemical Components in Iraqi Sheep. *Journal of Tikrit University for Agriculture Sciences,12(1).*

Patkowska-Sokoła, B., Dobrzański ,Z., Khalil,O., Robert ,B., & Katarzyna, Z.(2009). The content of chosen chemical elements in wool of sheep of different origins and breeds. *Archives Animal Breeding, 52* (4), 410-418. https://doi.org/10.5194/aab-52-410-2009

Pavlata,.L. M., Chomat, A., Pechova., L., Misurova, R. & Dvorak.(2011). Impact of long-term supplementation of zinc and selenium on their content in blood and hair in goats. *Veterinarni Medicina, 56, (2*), 63–74. https://doi.org/10.17221/1581-VETMED

Ramirez-Perez,A.H., Buntinx, S.E., Tapia-Rodríguez, C., & Rosiles, R. (2000). Effect of breed and age on the voluntary intake and the micromineral status of non-pregnant sheep. 1. Estimation of voluntary intake. *Small Ruminant Research*., 37(3), 223-229. https://doi.org/10.1016/s0921-4488(99)00141-8

Sedat,B. M ., Sabri, G., Engin, Ü. & Abdülkadir, E.(2022).Effects of age, body Region and mineral contents on the fleece characteristics of central Anatolian Merino Sheep. *TEKSTİL ve KONFEKSİYON 32(2*). https://doi.org/10.32710/tekstilvekonfeksiyon.946761

Selçuk, S. T. (2018). Some cashmere characteristics of hair goats raised in Van province. *Austral Journal of Veterinary Sciences*, *50*(3), 125-128. http://doi.org/10.4067/S0719-81322018000300125

Sousa ,I.K.F.D., Hamad Minervino, A.H., Sousa ,R.D.S., Chaves, D.F., Soares, H.S., Barros, .ID.O., Araújo, C.A.S.C.D., Júnior, R.A.B., & Ortolani, E.L. (2012). Copper deficiency in sheep with high liver iron accumulation. *Veterinary Medicine International, 5*, 1-4.

SPSS, Statistical Package for the Social Sciences (2019). SPSS User's Guide Statistics Version 26. Copyright IBM, SPSS Inc., USA.

Steel, R. G., & Torrie, J. H. (1980). *Principles and procedures of statistics.* 2nd ed., McGraw-Hill Book Company, New York .https://cir.nii.ac.jp/crid/1573387450367822720

Suttle, N.F., & McMurray, C.H. (1983). Use of erythrocyte copper:zinc superoxide dismutase activity and hair or fleece copper concentrations in the diagnosis of hypocuprosis in ruminants. *Research in Veterinary Science, 35:* 47–52. https://doi.org/10.1016/S0034-5288(18)32201-X

Taha, N. T. (2011). Estimation of phenotypic correlations and repeatability of some economic traits in Awassi and Hamdani ewes. *Mesopotamia Journal of Agriculture, 39* (4), 146-158. https://magrj.mosuljournals.com/index.php/magrj/article/view/667

Taherpour,N., Salehi, M. & Mirzaei, F.(2012). Evaluation certain environment factors on wool characteristics of Arabi sheep breeds. *Open Journal of Animal Sciences, 2*(1), 11-14 http://doi.org/10.4236/ojas.2012.21002

Wichert, B., Frank, T. & Kienzle, E .(2002.). Zinc, copper and selenium status of horses in Bavaria. *The Journal of Nutrition,* 132, 1776-1777. https://doi.org/10.1093/jn/132.6.1776S

Wnuk,W., Odój,J., Bis-wencel,H., Saba,L., Nowakowicz-dębek,B. & Bombik ,T.(2003). Milk and hair coat as indicators of macroelements content

in cows at different stages of lactation. *Annales Universitatis Mariae Curie-Skłodowska*., vol. XXI, N2, 96, sectio EE, 333-338 https://hdl.handle.net/20.500.12838/4a863a0f-c250-478c-8c9d-b82130192b17

العلاقة بين نمو وتطور صوف الأغنام وشعر الماعز مع مكوناتها المعدنية وبعض المعايير الكيموحيوية في الدم

منال علي احمد وعلياء جري شبيب ووليد يوسف قاسم

قسم الانتاج الحيواني، كلية الزراعة، جامعة البصرة، البصرة، العراق

المستخلص: تهدف هذه الدراسة لتحديد العلاقة بين نمو الصوف في الاغنام والشعر في الماعز ومحتواها من المعادن وبعض معايير الدم الكيموحيوية. استخدم في الدراسة اثني عشر حيوانا"، تتراوح أعمارهم بين ستة أشهر وحوالي 20.85 كجم من وزن الجسم بما في ذلك ستة من الحملان العرابية وستة من الماعز المحلي. تم قياس خصائص الصوف والشعر، وكذلك تركيز الزنك والنحاس في منطقة الكتف والورك، وقد اوضحت النتائج زيادة في محتوى الزنك في الصوف والشعر في الشهر الثالث من التجربة، وكان الارتفاع متناسبا" مع منطقة الكتف والورك في الأغنام. تم تسجيل ارتباط معنوي بين وزن الصوف النظيف وطول الخصلة في منطقة الكتف وفي منطقة الورك. كان هناك ارتباط معنوي بين وزن الصوف الخام والنظيف. بينما في الماعز، تم تسجيل ارتباط معنوي في منطقة الكتف بين وزن الشعر الخام وطول الخصلة، كما تم تسجيل ارتباط عالي المعنوية في منطقة الورك بين وزن الشعر الخام ووزن الجزه النظيف. ووجد ارتباط معنوي بين تركيز الكوليسترول وكلا من طول الألياف ووزن الصوف الخام والنظيف في مناطق الكتف والورك. في الماعز، تم تسجيل ارتباط معنوي في منطقة الكتف والورك بين تركيز الكلوكوز ووزن الشعر النظيف. لذلك يمكننا أن نستنتج وجود ارتباطات ملحوظة بين انتاج الصوف والشعر وبعض مؤشرات الدم الكيموحيوية.

الكلمات المفتاحية: الشعر، الصوف، الزنك، النحاس، معايير الدم.