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The effect of rangeland quality on the mohair quality of Angora goats fed on the natural rangelands

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Abstract: The aim of this study is to determine the effect of the rangeland quality of Ankara goats fed on some natural rangeland in Ankara on the mohair quality. The research was carried out in 3 different quality natural rangelands in Ankara province. Crude protein, ether extract, Ca, Fe, N, energy contents and digestibility, in vitro gas production, and relative feed values of good quality rangeland plants were the highest compared to other rangelands, but the crude fiber, acid detergent fiber, and neutral detergent fiber were the lowest ($p < 0.05$). In the study were used a total of 120 animals (20 males, 20 females in each farm) from 3 farms where Angora goats are raised in the region of rangelands. The mohair quality was determined in mohair samples taken from 6 month old, 1.5, and 2.5-year-old animals. Rangeland quality significantly affected mohair lengths, fineness, elasticity, tenacity, and clean mohair yield, in males and females ($p < 0.05$). The highest values were obtained from goats fed good quality rangeland ($p < 0.05$). The effect of age on these features was also important. The mohair quality (length, elasticity, tenacity) increased with increasing age ($p < 0.05$). The effect of the rangeland quality on the nozzle number was not significant, but the effect of age was significant. and, the nozzles number increased with increasing age. The nozzle depth was affected by the rangeland quality and age. The nozzle depth has increased due to the increase in rangeland quality and age. While the mohair Ca, Mg, S, Fe, and N content of male and female goats were higher in goats fed on good quality rangeland, these were lower in goats fed low-quality rangeland ($p < 0.05$). While mohair Na content positively affected rangeland quality in females ($p < 0.01$), was insignificant in males.

Key words: Angora goat, rangeland quality, mohair quality

1. Introduction

There are 223 874 head Angora goats in Turkey and 165,904 heads of these are in Ankara province, and this constitutes 74% of the total Angora goats in Turkey [1]. The Angora goat (*Capra hircus ancryrensis*) originates from Central Asia, it has adapted to the climatic characteristics of Central Anatolia, and has become an animal unique to Ankara in time. Although the Ankara goat is grown in all districts of Ankara, it is mostly located in Ayaş, Beypazarı, Güdül, and Nallıhan districts. The main yield of Angora goat is mohair, and the body is covered with nuzzling mohair up to the feet. Mohair is durable, shiny, and has high elasticity [2]. Mostly the highest mohair yield is obtained from goats aged 3–5, and the thinnest, hence the best quality mohair is obtained from goats aged 1–2 and males give more mohair than females. As the age progresses, mohair quality decreases as age progresses, mohair fiber thickens, hardens, becomes sparse, and the elasticity and tenacity required by the industry are lost [3]. The income from mohair in Angora goats constitutes a very large part of total income, so the quantity of mohairs is as important as the quantity [4]. Although mohair yield depends on the genetic capacity of goats, environmental factors, especially good care and nutrition, have an important effect on the emergence of individual capacity. Good care and nutrition are essential for high-quality mohair yield [2].

Angora goats are subjected to extensive conditions primarily for mohair production. Thus, all the nutrients needed by goat should be met by natural grazing as much as possible. Angora goats have high nutritional requirements in various physiological stages. Since goats do not have clefts on their upper lips like sheep, they cannot graze near the ground. They can easily make use of a large number of roughages including green plants, leaves, weeds, woody shrubs, and bark [5]. Despite insufficient feeding and quality roughages not being given, Angora goats have an extraordinary ability to convert existing food into mohair [6,2].

Angora goat breeding in Turkey is carried out depending on grassland in areas with a continental

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climate. The vegetation in the pastures-rangeland is rich only in March-May months when rainfall is abundant. In most of the rangelands, low annual rainfall affects the growth, nutrient content, feed value and quality of feeds, therefore, seasonal variations occur in the malnutrition of most animals grazing on grassland, including goats. It is known that the nutrient content of the plants in the grassland areas of Turkey varies according to the plant species [7].

Mohair is affected by environmental conditions and grassland changes and loses its properties [8]. Length, fineness, nuzzle number, brightness, clean mohair yield, flexibility, and tenacity are considered as quality criteria in mohair. Nutrient deficiency decreases mohair growth [6]. There is not enough study on the effect on mohair quality of feeding on grassland to Angora goats. The current study aims to determine the effect on mohair quality of feeding on different quality natural rangeland to Angora goats. In addition, this study also was investigated the effect of age on mohair quality for both sexes.

2. Materials and methods

2.1. Materials

2.1.1. The rangeland location

The feed material of the study was composed of plants collected from rangelands of 3 different qualities, (good, medium, and low-quality) determined on the based on characteristics such as nutrient content, in vitro gas production, methane production (MP) capacity, and relative feed value (RFV).

2.1.2. Animals

Good quality rangeland is located in Ayaş-Başbereket (altitude 1200 m), medium quality rangeland in Ayaş-Ilıca (altitude 750 m), poor quality rangeland in Nallıhan-Çayırhan (altitude 503 m) villages in Ankara province. For mohair quality, a total of 120 Angora goat's kids, including 20 males and 20 females born in the 2016, were selected from each of 3 separate farms with different quality rangelands and mohair obtained at different ages from these animals was used.

2.2. Methods

2.2.1. Rangeland quality

To determine 3 different quality rangelands in Ankara province; a preliminary study was carried out in the 2015 year and plant samples were collected in rangelands areas where there are approximately 30 Ankara goat breeding enterprises.

Nutrient contents (dry matter; DM, crude protein; CP, ether extract; EE, Ash), cell wall components (crude fiber; CF, neutral detergent fiber; NDF, acid detergent fiber; ADF, acid detergent lignin; ADL), minerals (Ca, P, Mg, Na, K, S, N, Fe, Cu, Zn, Mn and Si), in vitro feed value (gas production; GP, dry matter digestibility, DMD, and organic matter digestibility; OMD, metabolisable energy; ME, net energy lactation; NEL and MP) were determined in collected samples and then their RFV values is calculated. According to the analysis results, in terms of these criteria; 3 grasslands were determined as good, medium, and low quality. The current study was conducted between 2016–2019 in the enterprises where these rangelands are located. The same analyses were repeated by taking plant samples every 15 days in May, June, July, and August in 2016–2017 and 2018 from 3 rangelands determined rangeland quality, and average values of 3 years were evaluated (Table 1).

All procedures of the present were performed with the approval of the Ankara University animal experiments local ethics committee (2016-8-83-430/3642).

2.2.2. Mohair quality

Animals (a total of 120 kids) born in the 2016, selected from each farm, to determine the mohair quality of Ankara goats, were not allowed to be sold for three years. Kids were fed completely in the rangeland without any additional feeding after weaning, and met their water needs from natural water resources in the rangelands.

The first mohair samples were taken from the flank (rib) area (over the last costae) of each animal in April, about 30 g with shears when the kids were 6 months old, then the same kids continued to be fed in rangeland. To avoid seasonal differences, when Angora goats reached 1.5 and 2.5 years of age, the mohair samples were taken from the same area, placed in bags and labelled. Length (H, B), fineness, elasticity, tenacity, efficiency, fleece length (cm), stable length (cm), nozzle number, nozzle depth, flake, and mineral analyses were performed on mohair samples.

2.2.3. Chemical composition

Chemical composition (DM, CP, EE, and ash) of the rangeland plants were determined according to A.O.A.C. [9], and Van Soest and Robertson (CF, ADF, NDF, and ADL) [10] using ANKOM-200 Fiber Analyzer (ANKOM Technology Corp. Fairport, NY, USA). The GP, OMD, DMD and ME values of rangeland plants were analyzed according to the methods described by Menke et al. [11] in a daisy incubator (ANKOM Technology Corp., Fairport, NY, USA). NEL content was determined according to the methodology described by Menke and Steingass [12], and metan production (MP) was analyzed according to the method reported by Goel et al. [13] using MP Infrared methane analyzer (sensors Europa Analysentechnik GmbH, Erkrath, Germany). The relative feed value (RFV), was calculated using the formulas described by Van Dyke and Anderson [14]. The length, fineness, elasticity, tenacity, and clean mohair yield characteristics of the mohair samples were analyzed in the Ministry of Agriculture and Forestry, International Livestock Research and Training Center (ULHAEM) Wool-Mohair Laboratory.

Table 1. Nutrient content, feed value, and quality of rangelands in DM %.

	Rangelands			Sign
	Good	Middle	Low	
CP, %	14.95 ± 0.13^{a}	12.56 ± 0.11^{b}	10.67 ± 0.19^{c}	0.000
EE, %	1.91 ± 0.17^{a}	1.7 ± 0.05^{ab}	1.45 ± 0.05^{b}	0.010
Ash, %	3.18 ± 0.33	3.87 ± 0.53	4.82 ± 0.69	0.097
CF, %	36.58 ± 0.13^{c}	39.41 ± 0.21^{b}	42.48 ± 0.20^{a}	0.001
ADF, %	36.83 ± 0.18^{c}	43.84 ± 0.19^{b}	47.36 ± 0.45^{a}	0.000
NDF, %	45.57 ± 0.18^{c}	54.91 ± 0.17^{b}	58.98 ± 0.28^{a}	0.000
ADL, %	8.15 ± 0.04^{c}	9.67 ± 0.09^{b}	12.52 ± 0.07^{a}	0.000
ME,M kal/kg DM	2.41 ± 0.08^{a}	2.05 ± 0.02^{b}	1.95 ± 0.08^{b}	0.000
NEL, Mcal/kg DM	1.51 ± 0.03^{a}	1.27 ± 0.03^{b}	1.19 ± 0.05^{b}	0.000
GP, %,	55.30^{a} ± 0.87^{a}	46.33b ± 0.32^{b}	44.98^{ab} ± 0.32^{c}	0.015
OMD, %	68.95 ± 0.11^{a}	66.24 ± 0.07^{b}	64.79 ± 0.06^{c}	0.012
DMD, %	61.33 ± 0.9^{a}	56.65 ± 0.03^{b}	53.44 ± 0.08^{c}	0.000
Metan, %	14.36 ± 0.13	14.2 ± 0.09	14.01 ± 0.20	0.229
RFV	122.88 ± 0.26^{a}	92.73 ± 0.02^{b}	82.00 ± 0.016^{c}	0.002
Ca, %	1.28 ± 0.01^{a}	0.54 ± 0.01^{b}	0.3 ± 0.01^{c}	0.000
P, %	0.24 ± 0.01^{a}	0.17 ± 0.01^{b}	0.11 ± 0.01^{c}	0.012
Mg, %	0.42 ± 0.03^{a}	0.37 ± 0.01^{b}	0.27 ± 0.03^{c}	0.002
Na, %	0.17 ± 0.02	0.17 ± 0.01	0.16 ± 0.01	0.834
K, %	2.23 ± 0.03^{a}	1.98 ± 0.03^{ab}	1.69 ± 0.09^{c}	0.001
S, %	0.115 ± 0.01^{a}	0.095 ± 0.02^{b}	0.051 ± 0.02^{c}	0.009
Fe, %	2.79 ± 0.02^{a}	2.70 ± 0.02^{b}	1.32 ± 0.03^{c}	0.000
Cu, %	0.24 ± 0.37	0.22 ± 0.42	0.17 ± 0.39	0.542
Zn, %	0.03 ± 0.00	0.03 ± 0.00	0.03 ± 0.00	0.763
Mn, %	1.30 ± 0.04	1.35 ± 0.02	1.32 ± 0.03	0.652
N, %	1.55 ± 0.01^{a}	1.28 ± 0.01^{b}	1.12 ± 0.01^{c}	0.000
Si, %	0.04 ± 0.05	0.07 ± 0.03	0.09 ± 0.04	0.355

$^{a, b, c}$ Means with different superscripts in the same line are significantly difference, ($p < 0.05$).

To determine the fiber length (Hauter, H according to the number of fibers; Barbe, B, according to the fiber volume and weight), are used "USTER FL 100" devices. This device was used according to analysis methods of IWTO-TM-17-85 (IWTO: International Wool Textile Organization) [15]. Mohair fiber fineness (diameter), was measured by "USTER OFDA 100 Instrument for Measuring Wool Diameter" (OFDA; optical-based fiber diameter analyzer), and elasticity (flexibility) (%) and tenacity (cN/tex) analysis were done using single fiber tensile tester single fibre tensile tester FAFEGRAPH HR+ME devices by examining a minimum of 50 mohair fibers. Samples of 10–15 g were taken from dirty samples to determine clean mohair efficiency, pre-washing, washing with detergent, washing with soda water and rinsing processes respectively, then they were dried at 105 °C for 6 h and the clean mohair samples were weighed [16]. The fleece length (cm) without correcting folds of a single fiber, stable length (cm) was measured with a millimetric ruler on a black background by correcting (stretching) the fiber folds. The nozzle number (pcs/100 mm), and nozzle depth (mm) were determined on 50 mohair fibers from each of the samples taken during the natural length measurement of mohair fibers. The nozzle number and fold depth were determined according to Doehner and Reumuth [17]. In measuring nozzle depth; it was assumed that along the length of the fiber, an axis passes through the middle of fiber, was averaged of distance to the axis of bottom and top points of folds and this value is accepted as fold depth of a single fiber. These features are made separately for mohair of animals of all ages and sexes.

Mineral analysis (Ca, P, Mg, S, Na, K, Fe, Cu, Zn, Mn, and Si) in the ash of plant and mohair samples, in ash was determined by ICP-OES device (inductively coupled plasma-optical emission spectrometry, Perkin Elmer Model DV 2100) [18]. Total nitrogen was determined according to the Kjeldahl method as reported by Bremner [19]. In addition, mohair samples were kept in the oven for 3 h and then they were imaged and examined for scaling. Stereo microscope (microscope, Leica, S GD; camera, Leica, DFC 295, Light source, Leica, CLS-150X ve CLS 150 XE) and LAS 4.3 version program were used for imaging of mohair.

2.2.4 .Statistical analysis

The normality assumption of the data of the lint properties was determined by the Shapiro–Wilk test and the homogeneity of the variances measured by the Levene test to be suitable for the analysis of variance analysis ($p > 0.05$). Therefore, one-way analysis of variance was used in the analysis of the data. Differences between means were determined by Duncan multiple comparison test [20,21]. The SPSS v. 22.0 package program was used to analyze the data.

3. Results

3.1. Rangeland quality

CP, EE, ME, NEL, GP, DMD, OMD, Ca, P, Mg, K, Fe, and N contents of the plant samples collected from rangeland in May, June, July, and August months in 2016–17-18 years, were found the highest in rangeland in Ayaş-Başbereket as in the 2015 year, and also CF, ADF, NDF, and ADL values were the lowest. While RFV value of rangeland in Ayaş–Başbereket is classified as good quality because it is the highest compared to the other rangeland, rangeland in Ayaş-Ilıca is classified as medium quality, and the rangeland in Nallıhan-Çayırhan is classified as low quality. Thus, the results of the preliminary study conducted for rangeland quality in the 2015 year were also confirmed. According to the data averages of 2016–2017-2018 years, differences between rangelands in terms of nutrient content, in vitro feed value and quality of rangeland plants were found to be significant ($p < 0.05$) (Table 1).

3.2. Mohair quality

The mohair properties of male and female Angora goats fed on good, medium and low-quality rangelands are given in Tables 2 and 3, respectively.

According to Tables 2 and 3, while mohair fiber length (H and B), fleece length (cm), and stable length (cm) values of male and female animals 6-month-old, 1.5 and 2.5-year-old were the highest in those fed with good quality rangelands. It was significantly lower in those fed on low-quality rangeland ($p < 0.05$). In addition, the effect of age on mohair fiber length was also important in all of goats fed on good, medium, and low-quality rangelands, and mohair fiber lengths (H and B, fleece length and stable length) increased significantly with increasing age. The highest length was detected in 2.5-year-old animals, and was the lowest length in 6-month-old kids ($p < 0.05$).

The effect of rangeland quality and age on fiber fineness of male and female goats was significant ($p < 0.05$). The thinnest fiber in male and female Angora goats was determined fed in good-quality rangeland and 6-month-old kids, the thickest fiber was determined in low quality rangeland and 2.5-years-old goats. Fiber thickened as the animals got older.

Mohair elasticity and tenacity values of 6-month-old 1.5 and 2.5-year-old male and female Angora goats fed on good quality rangeland were found to be the highest compared to other rangelands ($p < 0.05$), and the difference between rangelands was significant ($p < 0.05$). But no significant difference was found between good and medium quality rangelands in terms of elasticity for both sexes. The effect of age on the elasticity, tenacity, and clean mohair yield of Angora goats fed in all three rangelands was also found to be significant ($p < 0.05$). Also the elasticity and tenacity increased significantly as the age of the goats fed in all three rangelands increased ($p < 0.05$), the highest was determined in 2.5-year-olds.

While clean mohair yield was the highest in 6-month-old kids, it was the lowest in 2.5-year-olds ($p < 0.05$), and the difference between ages was significant ($p < 0.05$).

Effect on nozzle number of rangeland quality in male and female Angora goats has not been significant, but, the effect of age on nozzle number was significant. Nozzle number increased significantly in 1.5 and 2.5-year-olds compared to 6-month old kids in all three rangelands ($p < 0.05$).

The effect on nozzle depth of rangeland quality and age was significant. While the highest nozzles depth was determined in good quality rangelands, nozzle depth has decreased as rangeland quality decreases. On the other hand, the nozzle depth has increased significantly with increasing age ($p < 0.05$). Thus, minimum nozzle depth was determined in 6-month-old kids, and was the highest in 2.5-year-olds, and the differences between ages were significant ($p < 0.05$).

3.3. Mohair mineral content

The mohair mineral properties of male and female Angora goats fed on good, medium, and low-quality rangelands are given in Tables 4 and 5.

The influence of rangeland quality on the mohair Ca, Mg, S, Fe, and N content was significant in male Angora goats. While these minerals were the highest in goats

Table 2. Effect of rangeland quality and age on mohair characteristics of male Angora goats.

Properties	Age	Rangeland quality			Sign
		Good	Middle	Low	
Length (H), mm	6 month	47.16 ± 0.21^{Ca}	45.14 ± 0.85^{Cb}	43.32 ± 0.82^{Cc}	0.023
	1.5 age	62.06 ± 0.70^{Ba}	54.54 ± 1.09^{Bb}	47.05 ± 0.57^{Bc}	<0.001
	2.5 age	75.57 ± 0.39^{Aa}	64.50 ± 0.14^{Ab}	55.15 ± 0.54^{Ac}	<0.001
	Sign	0.005	0.030	<0.001	
Length (B), mm	6 month	79.86 ± 1.10^{Ca}	73.28 ± 1.67^{Cb}	67.91 ± 1.66^{Cc}	0.001
	1.5 age	108.94 ± 1.07^{Ba}	96.14 ± 1.68^{Bb}	89.81 ± 1.75^{Bc}	0.001
	2.5 age	123.02 ± 1.17^{Aa}	112.18 ± 1.22^{Ab}	98.67 ± 1.52^{Ac}	0.001
	Sign	0.001	0.009	<0.001	
Fleece length, cm	6 month	10.30 ± 0.17^{Ca}	09.25 ± 0.14^{Cb}	08.74 ± 0.08^{Cb}	0.005
	1.5 age	13.71 ± 0.17^{Ba}	12.71 ± 0.14^{Bb}	12.35 ± 0.10^{Bb}	0.001
	2.5 age	16.06 ± 0.12^{Aa}	15.06 ± 0.10^{Ab}	14.93 ± 0.13^{Ab}	0.001
	Sign	0.003	<0.001	<0.001	
Stable length, cm	6 month	13.52 ± 0.11^{Ca}	12.49 ± 0.12^{Cb}	11.30 ± 0.16^{Cc}	0.001
	1.5 age	16.72 ± 0.15^{Ba}	15.72 ± 0.15^{Bb}	14.52 ± 0.14^{Bc}	0.001
	2.5 age	19.74 ± 0.14^{Aa}	18.99 ± 0.18^{Ab}	16.81 ± 0.19^{Ac}	0.001
	Sign	0.017	<0.001	0.007	
Fineness, µm	6 month	22.14 ± 0.17^{Cc}	24.59 ± 0.15^{Cb}	31.51 ± 0.18^{Ca}	0.001
	1.5 age	24.98 ± 0.11^{Bc}	25.81 ± 0.17^{Bb}	33.33 ± 1.05^{Ba}	0.002
	2.5 age	25.64 ± 0.14^{Ac}	27.37 ± 0.21^{Ab}	35.56 ± 1.10^{Aa}	0.001
	Sign	0.030	0.180	0.012	
Elasticity, %	6 month	36.76 ± 0.11^{Ca}	36.09 ± 0.06^{Ca}	34.66 ± 0.02^{Cb}	0.001
	1.5 age	38.49 ± 0.08^{Ba}	37.17 ± 0.09^{Bab}	35.65 ± 0.02^{Bb}	0.002
	2.5 age	40.98 ± 0.12^{Aa}	38.61 ± 0.10^{Ab}	36.72 ± 0.06^{Ac}	0.001
	Sign	0.002	0.001	0.001	
Tenacity, Cn/Tex	6 month	18.51 ± 0.09^{Ca}	17.17 ± 0.15^{Cb}	15.72 ± 0.06^{Cc}	0.001
	1.5 age	19.39 ± 0.11^{Ba}	18.27 ± 0.13^{Bb}	17.26 ± 0.14^{Bc}	0.002
	2.5 age	20.94 ± 0.07^{Aa}	19.70 ± 0.19^{Ab}	18.37 ± 0.13^{Ac}	0.008
	Sign	0.015	0.018	0.001	
Clean mohair yield, %	6 month	86.31 ± 0.24^{Aa}	81.06 ± 0.13^{Ab}	77.63 ± 0.31^{Ac}	0.001
	1.5 age	79.85 ± 0.13^{Ba}	73.65 ± 0.32^{Bb}	66.13 ± 0.39^{Bc}	0.001
	2.5 age	74.72 ± 0.33^{Ca}	70.78 ± 0.44^{Cb}	60.15 ± 0.33^{Cc}	0.001
	Sign	<0.001	0.009	0.001	
Nozzles number	6 month	3.57 ± 0.18^{B}	3.37 ± 0.55^{B}	3.59 ± 0.27^{B}	0.187
	1.5 age	4.47 ± 0.49^{A}	4.90 ± 0.25^{A}	4.93 ± 0.19^{A}	0.723
	2.5 age	4.82 ± 0.26^{A}	5.02 ± 0.18^{A}	4.14 ± 0.26^{A}	0.701
	Sign	0.039	0.001	0.001	
Nozzle depth, cm	6 month	0.32 ± 0.03^{Ca}	0.29 ± 0.03^{Cb}	0.29 ± 0.22^{Cc}	0.014
	1.5 age	0.38 ± 0.06^{Ba}	0.36 ± 0.03^{Bb}	0.32 ± 0.06^{Bc}	0.013
	2.5 age	0.48 ± 0.03^{Aa}	0.46 ± 0.02^{Ab}	0.42 ± 0.01^{Ac}	0.001
	Sign	0.005	<0.001	0.001	

$^{a, b, c}$ Means with different superscripts in the same line are significantly difference, ($p < 0.05$).
^{A,B,C} Means with different superscripts in the same column are significantly difference, ($p < 0.05$).

Table 3. Effect of rangeland quality and age on mohair characteristics of female Angora goats.

Properties	Age	Rangeland quality			Sign
		Good	Middle	Low	
Length (H), mm	6 month	47.43 ± 0.12^{Ca}	45.55 ± 0.74^{Cb}	43.90 ± 0.22^{Cc}	0.003
	1.5 age	63.17 ± 0.39^{Ba}	55.26 ± 0.73^{Bb}	49.5 ± 1.02^{Bc}	0.017
	2.5 age	76.15 ± 0.40^{Aa}	64.80 ± 0.14^{Ab}	56.24 ± 1.16^{Ac}	<0.001
	Sign.	0.003	0.009	<0.001	
Length (B), mm	6 month	79.99 ± 0.40^{Ca}	74.95 ± 0.28^{Cb}	68.00 ± 0.42^{Cc}	0.001
	1.5 age	109.36 ± 0.33^{Ba}	96.54 ± 0.12^{Bb}	90.81 ± 0.65^{Bc}	0.002
	2.5 age	121.00 ± 0.37^{Aa}	111.27 ± 0.18^{Ab}	99.66 ± 0.67^{Ac}	0.001
	Sign.	<0.001	0.002	<0.001	
Fleece length, cm	6 month	11.46 ± 0.12^{Ca}	10.28 ± 0.14^{Cb}	09.23 ± 0.07^{Cb}	0.003
	1.5 age	14.82 ± 0.15^{Ba}	12.89 ± 0.12^{Bb}	12.50 ± 0.17^{Bb}	0.006
	2.5 age	17.05 ± 0.15^{Aa}	15.81 ± 0.16^{Ab}	15.74 ± 0.17^{Ab}	0.002
	Sign	<0.001	<0.001	0.002	
Stable length, cm	6 month	13.26 ± 0.05^{Ca}	12.47 ± 0.12^{Cb}	11.47 ± 0.12^{Cc}	0.003
	1.5 age	16.84 ± 0.12^{Ba}	15.36 ± 0.09^{Bb}	14.72 ± 0.05^{Bc}	0.003
	2.5 age	19.93 ± 0.09^{Aa}	18.26 ± 0.05^{Ab}	16.99 ± 0.08^{Ac}	0.012
	Sign,	0.005	<0.001	0.007	
Fineness, µm	6 month	22.56 ± 0.12^{Cc}	25.39 ± 0.15^{Cb}	31.80 ± 0.17^{Ca}	0.001
	1.5 age	24.46 ± 0.11^{Bc}	26.12 ± 0.14^{Bb}	33.08 ± 0.02^{Ba}	0.001
	2.5 age	25.11 ± 0.13^{Ac}	28.12 ± 0.18^{Ab}	34.78 ± 0.04^{Aa}	0.001
	Sign.	0.019	0.013	0.023	
Elasticity, %	6 month	36.86 ± 0.19^{Ca}	36.10 ± 0.16^{Ca}	34.88 ± 0.17^{Cb}	0.002
	1.5 age	38.34 ± 0.16^{Ba}	37.05 ± 0.15^{Bab}	35.00 ± 0.12^{Bb}	0.002
	2.5 age	41.15 ± 0.09^{Aa}	39.60 ± 0.18^{Ab}	37.40 ± 0.10^{Ac}	0.008
	Sign	0.018	0.037	0.024	
Tenacity, Cn/Tex	6 month	18.90 ± 0.10^{Ca}	17.45 ± 0.05^{Cb}	17.27 ± 0.11^{Cc}	0.142
	1.5 age	19.86 ± 0.08^{Ba}	18.92 ± 0.07^{Bb}	18.66 ± 0.13^{Bc}	0.135
	2.5 age	21.23 ± 0.09^{Aa}	19.97 ± 0.08^{Ab}	18.70 ± 0.10^{Ac}	0.001
	Sign	0.029	0.025	0.022	
Clean mohair yield, %	6 month	87.52 ± 0.42^{Aa}	80.70 ± 0.28^{Ab}	78.60 ± 0.26^{Ac}	0.001
	1.5 age	80.09 ± 0.20^{Ba}	76.63 ± 0.56^{Bb}	65.76 ± 0.18Bc	0.001
	2.5 age	75.37 ± 0.32^{Ca}	71.77 ± 0.60^{Cb}	62.78 ± 0.89^{Cc}	0.001
	Sign	<0.001	0.001	0.012	
Nozzle number	6 month	3.59 ± 0.21^{B}	3.49 ± 0.25^{B}	3.64 ± 0.28^{B}	0.325
	1.5 age	4.80 ± 0.13^{A}	4.98 ± 0.27^{A}	4.95 ± 0.19^{A}	0.137
	2.5 age	5.08 ± 0.16^{A}	5.07 ± 0.16^{A}	4.16 ± 0.26^{A}	0.095
	Sign	<0.001	<0.001	0.003	
Nozzle depth, cm	6 month	0.34 ± 0.03^{Ca}	0.31 ± 0.03^{Cb}	0.29 ± 0.23^{Cc}	0.045
	1.5 age	0.40 ± 0.02^{Ba}	0.38 ± 0.05^{Bb}	0.33 ± 0.06^{Bc}	0.017
	2.5 age	0.50 ± 0.03^{Aa}	0.49 ± 0.02^{Aa}	0.43 ± 0.01^{Ab}	0.040
	Sign.	<0.001	0.002	0.005	

$^{a,\ b,c}$ Means with different superscripts in the same line are significantly difference, ($p < 0.05$).
^{A,B,C} Means with different superscripts in the same column are significantly difference, ($p < 0.05$).

Table 4. Mohair mineral content of male Angora goats of different ages fed in different quality rangeland.

Minerals	Age	Good	Middle	Low	Sign
Ca, %	6 month	1.30 ± 0.01^{Ca}	0.80 ± 0.09^{Cb}	0.61 ± 0.01^{Cc}	0.006
	1.5 age	1.52 ± 0.01^{Ba}	1.23 ± 0.03^{Bb}	0.68 ± 0.01^{Bc}	0.005
	2.5 age	2.05 ± 0.03^{Aa}	1.30 ± 0.07^{Ab}	1.01 ± 0.01^{Ac}	<0.001
	Sign.	0.001	0.001	0.003	
P, %	6 month	0.14 ± 0.01	0.13 ± 0.00	0.13 ± 0.01	0.174
	1.5 age	0.15 ± 0.01	0.14 ± 0.01	0.13 ± 0.00	0.092
	2.5 age	0.18 ± 0.01	0.18 ± 0.01	0.17 ± 0.01	0.121
	Sign	0.104	0.853	0.866	
Mg, %	6 month	0.22 ± 0.03^{Ba}	0.17 ± 0.01^{Bb}	0.15 ± 0.00^{c}	0.004
	1.5 age	0.28 ± 0.03^{Aa}	0.21 ± 0.01^{Ab}	0.15 ± 0.00^{c}	0.039
	2.5 age	0.28 ± 0.01^{Aa}	0.20 ± 0.02^{Ab}	0.15 ± 0.00^{c}	<0.001
	Sign	0.007	<0.001	0.723	
S, %	6 month	1.7 ± 0.01^{Ca}	1.5 ± 0.01^{Cb}	1.3 ± 0.01^{Cc}	0.001
	1.5 age	2.1 ± 0.06^{Ba}	1.8 ± 0.06^{Bb}	1.5 ± 0.03^{Bc}	0.002
	2.5 age	2.27 ± 0.09^{Aa}	2.21 ± 0.08^{Ab}	2.15 ± 0.07^{Ac}	0.001
	Sign	0.003	0.001	0.001	
Na, %	6 month	0.18 ± 0.01	0.18 ± 0.01	0.17 ± 0.13	0.943
	1.5 age	0.19 ± 0.01	0.18 ± 0.01	0.17 ± 0.001	0.166
	2.5 age	0.18 ± 0.01	0.18 ± 0.001	0.18 ± 0.01	0.240
	Sign	0.760	0.195	0.752	
K, %	6 month	0.36 ± 0.06	0.37 ± 0.02	0.38 ± 0.03	0.155
	1.5 age	0.36 ± 0.06	0.38 ± 0.01	0.37 ± 0.01	0.912
	2.5 age	0.37 ± 0.01	0.36 ± 0.04	0.36 ± 0.02	0.141
	Sign.	0.982	0.193	0.194	
Fe, %	6 month	0.15 ± 0.01^{Ca}	0.12 ± 0.01^{Cb}	0.10 ± 0.01^{Cc}	0.001
	1.5 age	0.17 ± 0.01^{Ba}	0.14 ± 0.01^{Bb}	0.12 ± 0.01^{Bc}	0.001
	2.5 age	0.20 ± 0.01^{Aa}	0.19 ± 0.01^{Ab}	0.15 ± 0.01^{Ac}	0.001
	Sign	0.005	0.000	0.001	
Cu, %	6 month	$3.5 \times 10^{6} \pm 0.29 \times 10^{4}$	$3.4 \times 10^{6} \pm 0.29 \times 10^{6}$	$3.3 \times 10^{6} \pm 0.27 \times 10^{4}$	0.092
	1.5 age	$3.8 \times 10^{6} \pm 0.30 \times 10^{6}$	$3.6 \times 10^{6} \pm 0.26 \times 10^{6}$	$3.5 \times 10^{6} \pm 0.27 \times 10^{4}$	0.111
	2.5 age	$4.9 \times 10^{6} \pm 0.31 \times 10^{4}$	$3.9 \times 10^{6} \pm 0.31 \times 10^{6}$	$3.8 \times 10^{6} \pm 0.30 \times 10^{4}$	0.131
	Sign	0.311	0.317	0.271	
Zn, %	6 month	0.01 ± 0.001	0.011 ± 0.002	0.011 ± 0.001	0.166
	1.5 age	0.011 ± 0.001	0.009 ± 0.001	0.008 ± 0.002	0.191
	2.5 age	0.008 ± 0.001	0.013 ± 0.002	0.011 ± 0.001	0.241
	Sign	0.401	0.321	0.542	
Mn, %	6 month	0.002 ± 0.001	0.002 ± 0.00	0.002 ± 0.00	0.346
	1.5 age	0.002 ± 0.001	0.002 ± 0.00	0.002 ± 0.00	0.373
	2.5 age	0.002 ± 0.001	0.002 ± 0.00	0.002 ± 0.00	0.351
	Sign	0.536	0.220	0.341	

Table 4. (Continued).

N, %	6 month	14.95 ± 0.11[a]	13.70 ± 0.12[b]	12.08 ± 0.12[c]	0.002
	1.5 age	14.88 ± 0.10[a]	13.82 ± 0.13[b]	12.19 ± 0.10[c]	0.001
	2.5 age	14.94 ± 0.12[a]	13.85 ± 0.07[b]	12.35 ± 0.10[c]	0.001
	Sign	0.259	0.322	0.355	
Si, %	6 month	0.005 ± 0.002	0.005 ± 0.01	0.004 ± 0.01	0.130
	1.5 age	0.008 ± 0.01	0.006 ± 0.01	0.006 ± 0.02	0.328
	2.5 age	0.008 ± 0.001	0.007 ± 0.00	0.008 ± 0.03	0.168
	Sign	0.313	0.253	0.380	

[a, b,c] Means with different superscripts in the same line are significantly difference, ($p < 0.05$).
[A,B,C] Means with different superscripts in the same column are significantly difference, ($p < 0.05$)

fed on good quality rangeland, was the lowest in low-quality rangeland and the difference between the groups was found to be significant ($p < 0.05$). The effect of age on the mohair Ca, Mg, S, and Fe content was significant, and these minerals in mohair increased significantly as the age progressed ($p < 0.05$). The highest was determined in 2.5-year-olds and the lowest in 6-month-old kids ($p < 0.05$). The effect of rangeland quality and age on mohair P, Na, K, Cu, Zn, Mn, and Si content in males was not found to be significant, but, mohair P content increased numerically in all rangeland groups as the age progressed.

According to Table 5, the effect of rangeland quality on mohair Ca, P, Mg, S, Na, Fe, and N content of female Angora goats was significant, these minerals were found the highest in good quality rangeland compared to other rangelands ($p < 0.05$). The effect of age on mohair Ca, Fe, and S content was also important in female goats, the highest was determined in 2.5-year-olds and the lowest 6-month-old kids, and the differences between age groups were found significant ($p < 0.05$). There was no significant effect of age on mohair P, Mg, Nai and N contents in female goats. Rangeland quality and age had no significant effect on mohair Cu, Zn, Mn, and Si content.

3.4. Mohair fiber flake structure

No flaking was observed in the mohair fibers of 6-month-old male and female Angora goats fed on all three pastures. Although there was no flaking and cracks in the mohair fibers of 1.5 and 2.5-years-old male and female Angora goats fed on good and medium quality rangeland, cracks in the cuticle layer of the mohair fibers were observed in only one of the male animals fed on low-quality rangeland, especially in those who were exposed to the sun for a long time (Figure 1).

4. Discussion

4.1. Rangeland quality

Nutrient contents, GP, DMD and OMD, ME, and NEL were the highest in good quality rangeland, CF and cell wall substances (ADF, NDF, and ADL) were the lowest. The low level of fibrous materials in good quality rangeland resulted in increased digestibility of plants, thus increased the feed value and quality of rangeland. As the nutrient contents and digestibility decreased, the feed value and quality of rangeland also decreased. Cell wall substances are associated with the presence of mature cells rather than young cells. There is an increase in cell wall substances, depending on the maturation in plants especially in July and August. On the other hand, depending on the progress of maturation in plants, the leaf and stem parts start to decrease and thus, there are increases in cell wall substances (NDF, ADF and ADL) [22]. This causes to decrease in the digestibility of the plants. Çaçan et al. [23] conducted a study with grazing grassland CP, ADF, RFV values of rangeland respectively; as 15.40%, 37.76% and 111.85 were similar to the values of good quality rangeland in the present study, but NDF (50.86%), DMD (59.48%) values reported by researchers were found quite different than the finding of the current study. The differences between the research results may be due to the differences in the geographical region, soil, climate, altitude, and plant type in the rangeland areas. The reason for the high CP content in good-quality rangeland in this study is the presence of legumes with high protein content in the botanical composition [7].

In our study, no significant difference was found for MP between rangelands. The methane level in all three rangelands was determined as 14%, which indicates that the plant composition in rangelands has a low antimetanogenic effect. Indeed, Lopez et al. [24] reported that in the gas formed as a result of fermentation, 11%–14% methane gas-forming additives have low, 6%–11% methane gas-forming additives medium and 0 - 6% methane gas-forming additives have high antimetanogenic potential.

4.2. Mohair quality

The length (H) mm, (B) mm, fleece length (cm), and stable length (cm) of mohair of male and female Angora goats, fed on natural rangeland varied according to rangeland quality

Table 5. Mohair mineral content of male Angora goats of different ages fed in different quality rangeland.

Minerals	Age	Rangelands			
		Good	Midle	Low	Sign
Ca, %	6 month	1.14 ± 0.06^{Ca}	0.54 ± 0.01^{Cb}	0.21 ± 0.01^{Bc}	<0.001
	1.5 age	1.27 ± 0.10^{Ba}	0.67 ± 0.02^{Bb}	0.28 ± 0.01^{Ac}	<0.001
	2.5 age	1.32 ± 0.04^{Aa}	0.80 ± 0.01^{Ab}	0.29 ± 0.01^{Ac}	<0.001
	Sign	0.229	0.019	0.003	
P, %	6 month	0.13 ± 0.03^{a}	0.11 ± 0.02^{b}	0.08 ± 0.01^{c}	0.001
	1.5 age	0.13 ± 0.02^{a}	0.12 ± 0.01^{b}	0.10 ± 0.01^{c}	0.012
	2.5 age	0.13 ± 0.01^{a}	0.10 ± 0.01^{b}	0.07 ± 0.03^{c}	0.001
	Sign	0.145	0.133	0.853	
Mg, %	6 month	0.23 ± 0.01^{a}	0.14 ± 0.01^{b}	0.05 ± 0.001^{c}	<0.001
	1.5 age	0.22 ± 0.01^{a}	0.13 ± 0.01^{b}	0.05 ± 0.001^{c}	<0.001
	2.5 age	0.23 ± 0.01^{a}	0.12 ± 0.01^{b}	0.05 ± 0.001^{c}	<0.001
	Sign	0.873	0.294	0.723	
S, %	6 month	1.6 ± 0.01^{Ca}	1.5 ± 0.01^{Cb}	1.3 ± 0.01^{Cc}	0.001
	1.5 age	1.9 ± 0.098^{Ba}	1.7 ± 0.098^{Bb}	1.4 ± 0.008^{Bc}	0.001
	2.5 age	2.29 ± 0.01^{Aa}	2.19 ± 0.01^{Ab}	2.16 ± 0.09^{Ab}	0.001
	Sign	0.002	0.001	0.001	
Na, %	6 month	0.20 ± 0.01^{a}	0.18 ± 0.01^{b}	0.11 ± 0.01^{c}	<0.001
	1.5 age	0.19 ± 0.00^{a}	0.19 ± 0.01^{a}	0.12 ± 0.00^{b}	<0.001
	2.5 age	0.17 ± 0.01^{a}	0.18 ± 0.01^{a}	0.11 ± 0.00^{b}	<0.001
	Sign	0.112	0.752	0.679	
K, %	6 month	0.34 ± 0.02	0.30 ± 0.02	0.30 ± 0.02	0.311
	1.5 age	0.30 ± 0.01	0.29 ± 0.01	0.28 ± 0.01	0.248
	2.5 age	0.36 ± 0.01	0.30 ± 0.01	0.27 ± 0.02	0.091
	Sign	0.317	0.102	0.308	
Fe, %	6 month	0.16 ± 0.01^{Ca}	0.13 ± 0.01^{Cb}	0.10 ± 0.001^{Cc}	<0.001
	1.5 age	0.19 ± 0.00^{Ba}	0.15 ± 0.01^{Bb}	0.12 ± 0.01^{Bc}	<0.001
	2.5 age	0.22 ± 0.00^{Aa}	0.20 ± 0.01^{Ab}	0.15 ± 0.00^{Ac}	<0.001
	Sign	0.004	0.002	0.001	
Cu, %	6 month	3.8 x 10^6 ± 0.43 x 10^4	3.6 x 10^6 ± 0.30 x 10^6	3.6 x 10^6 ± 0.25 x 10^4	0.121
	1.5 age	4.2 x 10^6 ± 0.24 x 10^6	3.8 x 10^6 ± 0.28 x 10^6	3.7 x 10^6 ± 0.32 x 10^4	0.112
	2.5 age	5.6 x 10^6 ± 0.30 x 10^4	4.1 x 10^6 ± 0.38 x 10^6	3.9x10^6 ± 0.31x10^4	0.091
	Sign	0.321	0.256	0.421	
Zn, %	6 month	0.001 ± 0.001	0.001 ± 0.00	0.001 ± 0.00	0.856
	1.5 age	0.001 ± 0.001	0.001 ± 0.00	0.001 ± 0.00	0.823
	2.5 age	0.001 ± 0.001	0.001 ± 0.00	0.001 ± 0.00	0.789
	Sign	0.953	0.216	0.542	
Mn, %	6 month	0.002 ± 0.001	0.002 ± 0.00	0.002 ± 0.00	0.133
	1.5 age	0.002 ± 0.001	0.002 ± 0.00	0.002 ± 0.00	0.142
	2.5 age	0.01 ± 0.001	0.002 ± 0.00	0.002 ± 0.00	0.135
	Sign	0.989	0.764	0.781	

Table 5. (Continued).

N, %	6 month	14.14 ± 0.11[a]	13.70 ± 0.11[b]	12.35 ± 0.07[c]	0.001
	1.5 age	14.77 ± 0.19[a]	13.38 ± 0.06b	12.00 ± 0.22[c]	0.001
	2.5 age	14.61 ±0.18[a]	13.34 ± 0.11[b]	12.09 ± 0.10[c]	0.001
	Sign	0.569	0.316	0.341	
Si, %	6 month	0.002 ± 0.009	0.005 ± 0.001	0.006 ± 0.001	0.095
	1.5 age	0.004 ± 0.009	0.005 ± 0.001	0.004 ± 0.001	0.127
	2.5 age	0.007 ± 0.002	0.005 ± 0.001	0.008 ± 0.002	0.111
	Sign.	0.458	0.949	0.381	

[a, b,c] Means with different superscripts in the same line are significantly difference, ($p < 0.05$).
[A,B,C] Means with different superscripts in the same column are significantly difference, ($p < 0.05$).

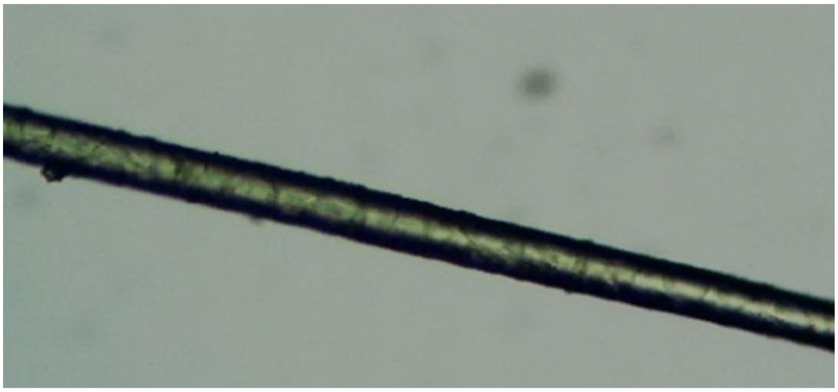

Figure 1. Crack seen in mohair from 2.5-month old male Angora goat fed on low quality rangeland.

As the rangeland quality increased, the fiber length of mohair increased. The longest fiber was determined on good quality rangeland. According to the results of the current research, the feeding affected fiber length. In many studies, has been determined that there is a large difference in wool production of animals fed above and below the need for living in poor and lush rangelands and there is a linear relationship between wool growth and feed intake of animal [25,26], These results explain the relationship between fiber yield and quality and feeding. Jia et al. [27] stated that fiber length increased from 4.8 to 5.2 cm and fiber diameter from 30.6 to 32.2 when fed Angora goats with 8% and 16% protein rations. The reason why mohair fiber length is longer in good quality rangeland (14.95% CP) compared to medium quality rangeland (CP: 12.56%) and low-quality rangeland (CP: 10.67%) can be explained by the fact that Angora goats met their nutritional needs better than good quality rangeland. In addition, mohair fiber length in rangelands has also increased depending on age. In the study conducted by Kasimov et al. [28], it was reported that Angora fiber length ranged between 137.3 and 174.7 mm between the ages of 1, 2, and 3–5. The results of the researcher are consistent with the result of the present study. On the contrary of this stady, Gallico [29] determined that the fiber length is in newborn, kid and young Angora goats 15 and over, 125–150, 100–125 mm. respectively. Factors such as the age and genetic characteristics of the goat from which mohair is obtained have a significant impact on mohair quality. Trana and Sepe [30] stated that the best quality mohair was obtained from the first shearing done in 6–month-old kids, and Turkish mohair is longer because it is obtained from one shearing per year.

Mohair fineness is the most important feature in determining the mohair quality. In the current study, the thinnest fiber was obtained from male and female goats fed on good quality rangeland, while the thickest fiber was obtained from those in low-quality rangeland. Mohair fiber fineness in 6-month-old goats, 1.5-years-old and 2.5-years-old male and female goats fed on good, medium and low quality rangeland were determined between 22–31, 24–33 and 25–35 μm respectively. Similarly, Kosimov et al. [28] stated that the fiber thickness in male Angora goats varied between 6-months-old (24.4 μm), 1-year old

(27.3 µm), 2 aged (31.3 µm), and 3–5 old (34.6 µm). The results determined for mohair fiber fineness of animals fed on good and medium quality rangeland in the present study were determined by Gallico [29] for newborn kids (24.0–26.5 µm (A)), kid goats (26.5–29.5 µm (B)), and young goats (29.5–34 µm (C)), but the fibers of goats fed on low quality rangeland in this study were thicker. The findings of the studies are consistent with the results of our study despite the geographical conditions and nutritional differences. Bassett and Engdahl, [31] have suggested that the seasonal change in mohair fibers is due to seasonal changes in nutrition, and that the mohair fiber fineness is affected by nutritional changes. In addition, in the present study, the fiber became thicker as the age got older in male and female goats. While the thinnest fiber was determined in 6-month-old male and female goats, the thickest fiber was obtained from 2.5-year-old animals. It has been reported that mohair production in Angora goats varies depending on the age, nutrition and genetic potential of the animals [32], the diameter of the mohair increases with the age of the animal, and the best and most valuable fiber obtained from Angora goats is obtained from the youngest goats [33].

Elasticity and tenacity are also important features in mohair. In the present study, elasticity was affected by rangeland quality in male and female Angora goats. As the quality of the rangeland decreased, the elasticity decreased. In addition, it was determined that age has a significant effect on elasticity, and elasticity increased as age progressed in males and females. Tuncer [34] stated that the elasticity of Angora goats in the Van region was 27.74% in aged 2 and 29.52% in aged 3; Odabaşoğlu et al. [35] also found that the elasticity of male and female Angora goats was (32.9% and 31.1%) lower than in this study. On the contrary, Şen [36] found that Angora goat mohair fiber elasticity was higher than the result of this study, 43.25% in males and 45.26% in females. This difference can be explained by the different breed, growing conditions, age, and feeding conditions.

The effects of rangeland quality and age on tenacity in males and females were significant. While the decrease in quality of the rangeland causes tenacity to decrease, tenacity increases as age increases. In the current study, tenacity for males and females was found in the range 15–20 and 17–21 Cn/Tex respectively. These results are similar to the results of some researchers (14.4–25.7 Cn/Tex) [37,38]. But these were higher than results (7.2 ± 0.3 and 7.3 ± 0.3) reported by Odabaşıoğlu et al. [35] for male and female. On the other hand, in this study, although the fiber diameter increases as the age of the angora goats' increases, it is seen that the tenacity decreases.

In the present study, mohair clean yield varied between 60%–86% in males and 63%–79% in females. The yield was higher in 6 months old animals. Since the fiber does not hold much gravel and dust, the mohair clean yield of fiber of young animals was generally high. Some researchers have reported that the mohair clean yield of Angora goats was between 61.8%–84.5% [39,40]. Findings obtained in the study are within these limits. Mohair clean yield decreased with age in males and females. Although the effect of rangeland quality on mohair clean yield is significant in females and males, it has been observed that fiber is less contaminated in good quality rangeland unlike low-quality rangeland.

In the present study, the nozzle numbers in males and females varied between 3–5. As the fiber length increased in mohair fibers, the number of crimps increased. These results are lower than some studies (7.24–7.73) by Öztürk and Örkiz [37] and (7.2–7.7) by Shelton [41]. It is seen that rangeland quality, so feeding, has no effect on nozzle number, and age is effective. Tiffany-Castiglioni [42] stated that the main factor affecting the modulation rate of fibers is genetics and age, and that nutrition has no effect. The reason for the difference between the current study and the literature reports in terms of the number of nozzles may be due to the differences in genetics, age, and nozzle length.

4.3. Mohair mineral content

The effect of rangeland quality on angora fiber Ca, Mg, S, Fe, and N content was significant in male Angora goats. While the effect of age on the mohair Ca, Mg, S, and Fe content was found to be significant, a significant increase was observed in these minerals in mohair as the age progressed. The effect of rangeland quality on the content of Ca, P, Mg, S, Na, Fe, and N in the mohair of female Angora goats was significant. The effect of age on Mohair Ca, Fe, and S content was also significant, and the highest Ca, S, and Fe content was determined in 2.5-year-olds and the lowest in 6-month-old kids. It can be thought that these differences are related to the pH of the soil structure, especially the pH limit of the soil structure and the mineral content of the plants growing in those soils, the climate and the type of plant consumed by the animal. As a matter of fact, in the present study, it is seen that the Ca, P, Mg, K, S, Fe, and N contents of the plants also change according to the rangeland quality, these minerals are higher in good quality rangeland, and the mineral content decreases as the quality decreases (Table 1). The results of potassium (2.04%) and phosphorus (0.28%) determined for grazing pasture by Çaçan et al. [23], were similar to the results of good-quality rangeland in the present study, but researchers found the content of calcium (1.17%) and magnesium (0.25%) of pasture plants quite different from this study. These differences may have resulted from differences in soil, climate, altitude, vegetation, and lice diversity. It was determined that rangeland quality did not have a significant effect on mohair Na, Cu, Zn, Mn, and Si contents in male Angora goats. There was no significant effect of rangeland quality on mohair P, Cu, Zn, Mn, and Si content in females. Similarly, Imik et al. [43] stated that when manganese, copper, zinc, and iron minerals were added to the ration, it did not effect on the chemical structure of mohair.

The reason for the high Ca and S content in the mohair of Angora goats feeding on good quality pastures may be due to the presence of legumes such as astragalus, alfalfa, vetch in rangeland. [7].

4.4. Mohair fiber flake structure

In our study, a crack was observed in the mohair fiber of one of the 2.5-year-old male animals fed only on low-quality grassland. Franck [44] reported that the flake layer of the lint fiber was barely visible under the microscope. No flaking or cracks were detected in the lint of any of the Angora goats fed on good and medium quality rangeland. This shows that the Angora goats are not fed badly on the rangeland enough to cause scaling in their fibers.

Conclusion: Natural rangelands are the cheapest feed source for Ankara goats, as well as for other ruminants. In good quality rangeland, CP content, DMS, OMS, GP, and energy values were higher, cell wall components were lower. On the contrary, in plants with low rangeland quality, nutrient content and digestibility were lower, CF group and cell wall components were high. It has been observed that rangeland quality and age has an effect on mohair quality in males and females. Mohair Ca, Mg, S, Fe, and N content was higher in those fed good quality rangeland, while it was lower in those fed low-quality rangeland. While mohair Na content positively affected rangeland quality in females, it was found to be insignificant in males. Besides mohair growth in Angora goats; the nutrient needs of animals for growth, reproduction, and mating are increasing. Since the nutrient needs of Angora goats cannot be met sufficiently due to low and insufficient plant nutrients especially in low-quality rangelands in July and August, it will be appropriate to feed the animals with supplementary feed during growth especially for quality mohair.

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