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Research Article

The hair characteristics of Turkish Angora and Van cats

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Abstract: The primary aim of this study was to determine the hair characteristics of Turkish Angora and Van cats, and also to see if there were seasonal, sex, age, or eye color effects on the traits measured. A total of 41 cats, 26 Turkish Angora and 15 Turkish Van, were used. The ages of the cats ranged from 1 to 8 years old. Analyzed traits included fiber diameter (FD), fiber lengths of hauteur (H) and barbe (B), fiber tenacity (T), and elongation (EL). Terms included in the statistical models were breed, season, sex, age, and eye colors of the cats and 2-way interactions that had P-values of less than 0.2 among the main effects. The difference in the FD of the Turkish Angora (23.5 µm) and Van (25.6 µm) cats was not significant (P = 0.0579). The H (27.5 versus 20.1 mm), B (33.1 versus 23.4 mm), and EL (33.8% versus 24.0%) values were all greater (P < 0.0001) for the Turkish Angora cats, while only the T value (12.1 versus 7.6 g/den) was greater (P = 0.0001) for the Turkish Van cats. Significant phenotypic correlations were found between FD and T (0.36, P = 0.0191), between H and B (0.98, P < 0.0001), between H and T (–0.58, P < 0.0001), between H and EL (0.31, P = 0.0480), between B and T (–0.56, P = 0.0001), and between B and EL (0.34, P = 0.0315). The present study defines the hair characteristics of the Turkish Angora and Van cats. These results may help to understand the phenotypes of these cats better and could also be a source for further studies.

Key words: Turkish Angora cat, Turkish Van cat, cat hair

Ankara ve Van kedileri'nin tüy özellikleri

Özet: Bu çalışmada, Ankara ve Van kedileri'nin tüy özelliklerini belirlenmesi ve bu özelliklere mevsim, cinsiyet, yaş ve göz rengi etkilerinin araştırılması amaçlanmıştır. Araştırmada yaşları 1-8 yıl arasında değişen 26 Ankara ve 15 Van kedisi'ne ait toplam 41 kayıt kullanıldı. Tüy özelliklerininin değerlendirilmesinde; kıl inceliği (Kİ), kıl uzunluğu [hauter (H) ve barbe (B) olarak], kıl mukavemeti (KM) ve elastikiyeti (KE) gözönüne alındı. İstatistiki model ırk, mevsim, cinsiyet, yaş, ve göz rengi ile bu etkiler arasında P değeri 0.2 den az olan ikili etkileşimleri içerdi. Kİ değeri açısından, Ankara (23,5 µm) ve Van kedileri (25,6 µm) arasındaki farklılık önemli bulunmadı (P = 0,0579). H (27,5 ; 20,1 mm), B (33,1 ; 23,4 mm) ve KE (%33,8 ; %24,0) değerleri Ankara kedileri için yüksek bulunurken (P < 0,0001) sadece KM değeri (12,1 ; 7,6 g/den) Van kedisi için yüksek bulunmuştur (P = 0,0001). Önemli fenotipik korelasyonlar Kİ ve KM (0,36, P = 0,0191); H ve B (0,98, P < 0,0001); H ve KM (–0,58, P < 0,0001); H ve KE (0,31, P = 0,0480); B ve KM (–0,56, P = 0,0001); ve B ve KE (0,34, P = 0,0315) arasında şekillenmiştir. Sonuç olarak, bu çalışma ile Ankara ve Van kedilerinde tüy özellikleri tanımlanarak, her iki kedi ırkının fenotipik özelliklerinin daha iyi anlaşılmasına katkıda bulunulabileceği ve ileriki çalışmalara kaynak oluşturabileceği düşünülmektedir.

Anahtar sözcükler: Ankara Kedisi, Van Kedisi, kedi tüyü

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Introduction

The Turkish Angora and Van cats are ancient breeds that were developed in the distinct geographical regions of Turkey from which they derive their names. The Turkish Angora cat is known to get its name from Ankara (formerly known as Angora), the capital city of Turkey (1). Ankara is also known as the home of Angora rabbits and goats, which have finely textured, silky long coats (2-4). The Turkish Van cat, which likes swimming, has existed in the Lake Van region of eastern Turkey for thousands of years (5). The Turkish Van can have gold, blue, or odd eyes (6-8). The eyes of the Turkish Angora can also be any variety of blue, gold, or odd (1). The majority of Angora cats (over 90%) with blue eyes and some odd-eyed cats are born deaf, while deafness is less common (2%-3%) in Van cats (9,10). Both cats have fur with no undercoat or are described as single-coated (11,12).

The Turkish cats are similar to each other and there has been debate about their origins. It was suggested that the Turkish Van is a white, gray, and red tabby variety of the Turkish Angora in eastern Turkey (7). In contrast, Güre (9) suggested that the Turkish Angora cat might be a variety of the Turkish Van cat. Arikan et al. (1) reported that the origins of the Turkish Angora and Van cats might have been the similar due to the high prevalence of type B blood in both pedigreed cats. Both the Turkish Van and Angora cats are known and treasured for their solid white color in Turkey. If these cats have different colors other than white, most Turkish people are reluctant or hesitant to call these cats Turkish Van or Angora cats. Odd-eyed cats are even more treasured among Turkish Van cats in Turkey. Helgren (5) observed that the preferred look for the Turkish Van is a glistening chalk-white body with colored patches confined to the head and tail, also known as "the Van Pattern."

The scientific data published on these 2 cat breeds are very limited and little is known about some specific characters of these cats, such as hair characters. This could be partly due to the fact that the numbers of Turkish Van and Angora cats are limited, even in their home country. Recent works (13,14) described some of the body characteristics and biochemical parameters of the Turkish cats, but more research needs to be done in order to better understand and prevent confusion about these invaluable cats.

Therefore, in this study, we primarily aimed to determine the hair characteristics of Turkish Angora and Van cats, and we also investigated possible seasonal, sex, age, and eye color effects on the hair characteristics of these pedigreed Turkish cats.

Materials and methods

Source of data

The cat records (n = 41) used in this study came from the Ankara Zoo in Turkey. The data were collected in mid-March (spring data) and mid-September (fall data), consisting of 26 Turkish Angora and 15 Turkish Van cat records. All cats were solid white in color and their ages ranged from 1 to 8 years. The mean body weights were 3.6 kg and 3.8 kg for Turkish Angora and Van cats, respectively. Of the records, 31 were from females and 25 were from odd-eyed cats. Table 1 shows the numbers of Turkish Angora and Van cats by season, sex, age group, and eye color. All cats were sexually intact.

Management

The cats in the Ankara Zoo were housed in 10 separate rooms, each with outdoor spaces. The size of the each indoor room and outdoor space was approximately 6.25 and 8 m^2, respectively. The cats had free run of the indoor and outdoor spaces. Feeding of the cats occurred twice a day (morning and evening) and the diet consisted of mostly liver, fish, dry food, and cooked meat. The cats were exposed to natural daylight and temperatures.

Measurement

Hair samples were taken from the right and left costal areas of each cat. Scissors were used to cut enough hairs for analysis. Hairs were cut as close as possible to the skin. Each sample was placed in a nylon bag and labeled, and samples were sent to Lalahan Livestock Central Research Institute's wool and mohair laboratory, located in Ankara, for analysis of hair traits.

For fiber diameter (FD) analysis, an Uster OFDA 100 instrument for measuring wool diameter was used (Uster Technologies, Uster, Switzerland). The mean number of individual hairs for analyzing FD

Table 1. The numbers of Turkish Angora and Van cats by season, sex, age group, and eye color.

Cat breed by season		N	Cat breed by age group*		N
Angora	Fall	14	Angora	Age group 1	20
Angora	Spring	12	Angora	Age group 2	6
Van	Fall	6	Van	Age group 1	8
Van	Spring	9	Van	Age group 2	7
Cat breed by sex		N	Cat breed by eye color†		N
Angora	Female	21	Angora	Nodd	12
Angora	Male	5	Angora	Odd	14
Van	Female	10	Van	Nodd	4
Van	Male	5	Van	Odd	11

*Age group 1 = from 1 to 4 years old; age group 2 = from 5 to 8 years old.
†Nodd = non-odd-eyed; Odd = odd-eyed

was 4703 for Turkish Angora and 5437 for Turkish Van cats. For fiber length analysis, an Uster AL 100 instrument (Uster Technologies) was used. With this instrument, 2 values were calculated: hauteur (H) and barbe (B). H is the cross-section biased length. B is the certified measurement and the weight equivalent percentages of fiber lengths. For the tenacity (T) and elongation (EL) analyses, a FAFEGRAPH HR + ME single fiber tensile tester instrument (Textechno, Mönchengladbach, Germany) was used. T, also known as resistance or strength, is defined as the greatest longitudinal stress a substance can bear without tearing asunder, usually expressed with reference to a unit area of the cross-section of the substance. In this study, T was measured as g/denier (g/den), a force necessary to produce a rupture for an individual hair. EL was the elongation at break and was measured as a percentage (15-18).

Statistical analysis

The data were analyzed using generalized least squares. Analyzed traits included FD, fiber lengths of H and B, T, and EL. Terms included in the statistical models were cat breed, season, sex, age of cat, and eye status of cat based on eye color. Cat ages were divided into 2 groups, group 1 and group 2, for statistical analysis. Group 1 included cats aged from 1 to 4 years and group 2 included cats aged from 5 to 8 years. Eye status of cats was defined as odd-eyed if one eye was blue and the other was yellow or amber, and non-odd-eyed if both eyes were the same color. All effects in the model were considered fixed. All 2-way interactions among cat breed, season, sex, age of cat, and eye status of cat were included in the initial model. Those interactions that were clearly nonsignificant ($P < 0.2$) (19) were eliminated from the models. The phenotypic correlations were also computed between the hair traits of the cats. Differences were significant at $P < 0.05$. The GLM and CORR procedures of SAS (SAS Institute, Cary, NC, USA) were used to perform the statistical analysis.

Results

Least squares means and standard errors of the main effects, and the significance levels of model terms for the hair traits, are presented in Tables 2 and 3, respectively.

FD was significantly affected by season, sex, age, and eye color of the cats. The hairs collected in fall were thicker ($P = 0.0492$) than the hairs collected in spring. The hairs of female cats were 5.37 µm finer ($P = 0.0003$) than the hairs of male cats. The cats in age group 1 had smaller FD values ($P = 0.0396$) than the cats in age group 2 .The hairs from odd-eyed cats were 3.77 µm finer ($P = 0.0096$) than the hairs from non-odd-eyed cats. The significant interaction detected for FD was sex × eye color ($P = 0.0032$), where the

Table 2. Least squares means and standard errors for fiber diameter (FD), hauteur (H), barbe (B), tenacity (T), and elongation (EL).

Effect	No. of records	FD (μm)	H (mm)	B (mm)	T (g/den)	EL (%)
Breed			***	***	***	***
Turkish Angora	26	23.48 ± 0.78	27.48 ± 1.05	33.10 ± 1.25	7.55 ± 0.78	33.78 ± 1.09
Turkish Van	15	25.62 ± 0.97	20.10 ± 1.18	23.39 ± 1.39	12.14 ± 0.87	23.98 ± 1.23
Season		*	***	***	***	
Spring	21	23.56 ± 0.83	27.20 ± 1.10	32.17 ± 1.29	7.87 ± 0.81	28.68 ± 1.14
Fall	20	25.54 ± 0.85	20.38 ± 1.06	24.32 ± 1.26	11.82 ± 0.79	29.08 ± 1.14
Sex		***				
Female	31	21.87 ± 0.59	23.22 ± 0.82	27.33 ± 0.97	10.17 ± 0.61	30.21 ± 0.86
Male	10	27.24 ± 1.21	24.36 ± 1.42	29.17 ± 1.68	9.52 ± 1.05	27.56 ± 1.53
Age		*				*
Group 1	28	23.40 ± 0.81	22.81 ± 0.95	26.77 ± 1.13	9.95 ± 0.70	31.24 ± 1.02
Group 2	13	25.70 ± 0.94	24.77 ± 1.26	29.72 ± 1.49	9.74 ± 0.94	26.53 ± 1.44
Eye color		***				
Odd-eyed	25	22.67 ± 0.68	23.31 ± 0.92	27.59 ± 1.09	8.92 ± 0.68	28.57 ± 0.98
Non-odd-eyed	16	26.44 ± 1.20	24.28 ± 1.25	28.91 ± 1.48	10.77 ± 0.93	29.19 ± 1.29

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Table 3. Significance levels of model terms for fiber diameter (FD), hauteur (H), barbe (B), tenacity (T), and elongation (EL).

Effect	FD	H	B	T	EL
Breed (B)	0.0579	<0.0001	<0.0001	0.0001	<0.0001
Season (S)	0.0492	<0.0001	<0.0001	0.0003	0.7840
Sex (G)	0.0003	0.4737	0.3317	0.5780	0.1362
Age (A)	0.0396	0.1876	0.0964	0.8437	0.0111
Eye color (EC)	0.0096	0.4933	0.4317	0.0823	0.6704
B × S					0.0266
G × A					0.0187
G × EC	0.0032				

FD values of non-odd-eyed males were significantly greater than those of non-odd-eyed females (P = 0.0002), odd-eyed females (P = 0.0003), and odd-eyed males (P = 0.0022). Even though Turkish Angora cats had hairs finer than hairs from Turkish Van cats, this difference between the FD values of both cat breeds was not statistically significant at P < 0.05 (P = 0.0579)

Two values, H and B, were calculated for fiber length. Breed and season main effects were significant for both the H and B values. The H and B values of Turkish Angoras were greater (P < 0.0001) than the H and B values of the Turkish Vans. Spring hairs were longer (P < 0.0001) (both H and B) than fall hairs. No significant interactions were observed for either H or B.

Effects of breed and season were also significant for T. The strength of the Turkish Van cat hair was significantly (P = 0.0001) greater than the strength of the Turkish Angora hair. Fall hairs of the cats had greater T values than spring hairs (P = 0.0003). There were no significant interactions for the T values.

EL was significantly affected by breed and age. The EL value was greater (P < 0.0001) for the Turkish Angora than for the Turkish Van cats. The cats in age group 1 also had greater EL values than cats in age group 2 (P = 0.011). Significant interactions for EL were breed × season (P = 0.0266) and sex × age (P = 0.0187). The EL values of Turkish Angoras in the fall were greater than the EL values of Turkish Angoras in the spring (P = 0.0388) and greater than those of Turkish Vans in the fall (P < 0.0001) and spring (P < 0.0001). The EL values of Turkish Angoras in the spring were also greater than the EL values of Turkish Vans in the fall (P = 0.0002) and spring (P = 0.0022). The EL values of the males in age group 2 were significantly lower than the EL values of the females in age group 1 (P = 0.0113), the females in age group 2 (P = 0.0213), and the males in age group 1 (P = 0.0056).

Significant phenotypic correlations were found between FD and T (0.36, P = 0.0191), between H and B (0.98, P < 0.0001), between H and T (–0.58, P < 0.0001), between H and EL (0.31, P = 0.0480), between B and T (–0.56, P = 0.0001), and between B and EL (0.34, P = 0.0315) (Table 4). Both H and B are related to fiber length. Therefore, a strong positive correlation between them is expected. There was a moderate, negative correlation between both the H and B values of the fiber length and the T values, indicating that the strength of the individual fiber decreases when the length of the fiber increases.

Discussion

The FD values of the Turkish Angora and Van cats in the present study indicate that the hairs of both Turkish cats were finer than the hairs of 5 mongrel cats for which Sato et al. (20) found maximum and minimum hair diameters of 59.3 µm (range: 25.5-102.1 µm) and 49.4 µm (range: 24.0-85.5 µm), respectively, using a microscope equipped with a micrometer. Analysis of hair characteristics is usually conducted for other animal species such as sheep, goats, and rabbits (3,16,21-25). Some of the reported fiber diameters ranged from 18.1 µm to 38.5 µm for the wool of different sheep breeds (16,21,23-25),

Table 4. Phenotypic correlations between the hair traits of Turkish Angora and Van cats.

Trait	Fiber length (H)	Fiber length (B)	Fiber tenacity	Elongation
Fiber diameter	–0.20	–0.15	0.36*	–0.24
Fiber length (H)		0.98***	–0.58***	0.31*
Fiber length (B)			–0.56***	0.34*
Fiber tenacity				–0.20

* P < 0.05, *** P < 0.001

from 22.1 μm to 36.6 μm for Angora goat mohair (16), and from 11.0 μm to 19.8 μm for Angora rabbit wool (3,22), indicating that hairs of the Turkish cats in the current study were finer or coarser than the wool of some sheep breeds and the mohair of goat, and coarser than the wool of Angora rabbits. The present study also found that the cats in age group 2 had greater FD values, indicating that cat hairs become coarser as cats get older.

Sato et al. (20) measured hair length with a ruler by straightening the hair samples in 5 mongrel cats. Their mean measurement for cat hair length was 25.4 mm (range: 7.5-49.0 mm). They commented that hair length may be affected in breeds of cats with long hair or short hair. Our results showed that both the H and B hair length values decreased significantly in fall ($P < 0.0001$). Seasonal changes in hair length and density are expected. The summer coat is short and sparse, while the winter coat is long and dense (12,26). The spring coat in the present study was longer than the fall coat. Considering the time of hair collection in the present study (March and September), it might be said that the cats in spring could still have had the winter coat. Ryder (27) found that the outer coat and undercoat lengths of 4 cats varied from 25.0 mm and 12.0 mm in summer to 30.0 mm and 15.0 mm in winter. The outer coat length of that study in summer and winter was somewhat similar to the coat lengths of spring and fall in the present study, but one should keep in mind that both Turkish cat breeds have hairs with no undercoat (single-coated).

In studies by Arık et al. (23) and Ünal et al. (25), the T and EL values of wool ranged from 4.7 g/den and 26.4% to 23.6 g/den and 30.8%, respectively, for different breeds of sheep. This suggests that the hairs of the Turkish cats are both stronger and weaker and have more or less elasticity as compared to the wool of different sheep breeds.

The results of the present study define the hair characteristics of the Turkish Angora and Van cats so that the phenotypes of these cats are better known. Both cats are still relatively rare, even in regions where they have been known for centuries. Dangers such as crossbreeding and road accidents also decrease the number of pure Turkish Angora and Van cats. This is why we had limited numbers of cats in the present study. It is, therefore, recommended that strict pure-breeding within the breeds should be practiced along with selection programs, and further studies need to be done in order to understand these Turkish pedigreed cats better.

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