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Research Article
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Effects of genotype, horn and social rank on agonistic behaviours during food competition in goats*

Keçilerde Yem Rekabeti Sırasında Gözlenen Agonistik Davranışlar Üzerine Genotip, Boynuz ve Baskınlık Sırasının Etkisi

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Keywords:
Turkish Saanen, Maltese, feeding, interaction, aggressive biting

ABSTRACT

Objective: This study aimed at investigating the agonistic interactions among goats in food competition based on genotype, horn and dominance rank.

Material and Methods: After determining the dominance rank of the Maltese and Turkish Saanen genotypes, a mixed group consisting of horned, polled and both horned and polled animals, 2 to 5 years old, consisting of 54 heads in total, nine heads each and a total of 6 groups with linear social rank were formed. The observations were evaluated on the basis of their agonistic behaviors in competition for roughage (oat hay) placed in the feeders.

Results: Genotype significantly affected the frequency of agonistic behaviors except for displacement behavior in feeder (P≤0.05). Aggressive biting and threatening behaviors in Turkish Saanen were 2.36 and 1.78 times higher than in Maltese (P≤0.0001). The rate of absence at through of Turkish Saanen goats, which displayed higher aggression frequency was higher that of Maltese goats (P=0.0159). The frequency of agonistic behaviors except for flank butting differed according to horn groups (P≤0.05). Total mean frequency of total aggressive behaviors in the descending order ranked 27.73 times/h for hornless, 23.47 times/h for mixed and 18.48 times/h for horned groups. The absence at the feeder differed in horned groups and ranked in the descending order 38% for horn, 16% for mixed and 8% for hornless (P<0.0001).

Conclusion: Maltese genotype is more peaceful than the Turkish Saanen genotype and this peacefulness may be useful in terms of food competition.

Anahtar Kelimeler:
Türk Saanen, Maltız, beslenme, etkileşim, agresif ısırma

ÖZ

Amaç: Bu çalışmada, yem rekabetindeki keçiler arası agonistik etkileşimler, genotip, boynuz ve baskınlık sırası temelinde araştırılmıştır.

Materyal ve Metot: Malta ve Türk Saanen genotiplerinin kendi içinde baskınlık sırası belirlendikten sonra boynuzlu, boynuzsuz ve hem boynuzlu hem boynuzsuz hayvanların bulunduğu karışık grup olmak üzere 2-5 yaşlı, toplam 54 baştan oluşan her birinde dokuzar başlı, doğrusal sosyal sıraya sahip toplam 6 grup oluşturulmuştur. Gözlemler yemliklere konan kaba yem (yulaf kuru otu) rekabetinde gösterdikleri agonistik davranışlar temelinde değerlendirilmiştir.

Bulgular: Genotipin, yemlikte yerini alma davranışı dışında agonistik davranış sıklıklarını önemli derecede etkilediğini göstermiştir (P≤0.05). Türk Saanen genotipi Malta genotipinden 2.36 kat daha fazla agresif ısırma ve 1.78 kat daha fazla korkutma davranışı sergilemiştir (P≤0.0001). Malta genotipinden daha yüksek agresyon sıklığı gösteren Türk Saanen genotipinin bireylerinin yemlikte gözlenmeme oranı Malta genotipine göre daha yüksektir (P=0.0159). Boynuz sallama davranışı dışındaki agonistik davranış sıklıklarının boynuz gruplarına göre önemli düzeyde farklılaştığı belirlenmiştir (P≤0.05). Toplam agresif davranışların toplam ortalama sıklığı, en yüksekten en düşüğe boynuzsuz 27.73 kez/saat, karışık 23.47 kez/saat ve boynuzlu grup 18.48 kez/saat şeklinde sıralanmıştır. Yemlikte gözlenmeme özelliğinin boynuz gruplarında önemli düzeyde farklılaştığı en yüksekten en düşüğe sırasıyla boynuzlu %38, karışık %16 ve boynuzsuz %8 grup şeklinde olduğu gözlenmiştir (P<0.0001).

Sonuç: Malta genotipinin Türk Saanen genotipine göre daha uysal bir yapıda olduğu ve bu uysallığın yem rekabeti anlamında olumlu olabileceği ifade edilebilir.

INTRODUCTION

It can be stated that the basis of intra-species aggression is triggered by a phenomenon, which enables individuals to form identical distances in a given area. This situation, causes selection by means of competitive struggles and protects future generations. It is known that interactions among animals are observed more during the use of resources than at other times (Immelman et al., 1996).

Agonistic behaviors, which can be classified as agonistic behaviors with physical interactions and with non-physical interactions (Kondo and Hurnik, 1990), include threat, aggression, defense, appeasement and fleeing. In threat, a behavior with non-physical interaction, vocalizations, odors, appearance, facial interaction and certain body movements play a role (McGlone, 1986). During intra-species aggressive encounters in herbivores, biting and kicking in horses and donkeys (Aganga and Tsopito, 1998; Christensen et al., 2002) as well as butting in cattle, sheep, goats and deer is observed (Addison and Baker, 1982; Sherwin and Johnson, 1987; Pollard and Littlejohn, 1996; Nielsen et al., 1997). It is known that biting behavior as an intra-species aggressive action is quite high particularly in pigs and that this behavior is a serious problem in pig production industry (Bracke et al., 2004). On the other hand, it has been reported that aggressive biting behavior is also displayed in goats which is, a ruminant having horns as a weapon (Tölü ve Savaş, 2007).

Husbandry system (Cornetto et al., 2002; Morrison et al., 2003) and group size (Andersen and Boe, 2007; Van et al., 2007) are stated to be important factors that affect the frequency and type of social interactions in farm animals. Further, it has been determined that breed may also be a significant factor for this issue (Savaş and Şamlı, 2000; Breuer et al., 2003). Physiological and morphological traits such as live weight and yield and, therefore, dietary requirements may play a role in determining inter-breed variation. Apart from the fact that inter-breed aggression level and type vary, there is no doubt that the environmental conditions that these breeds are exposed to also play a role in the shaping of aggression level.

Horn is a significant weapon for intra-specific aggressive interactions. Horned animals are among the top ranked animals in social hierarchy (Barroso et al., 2000). In addition to the existence of horns in animals, shape and size of horns are also important factors in dominance (Cote, 2000). Further, horns may be effective in determination of the level of aggressive behavior frequency (Menke et al., 1999; Loretz et al., 2004; Tölü and Savaş, 2007).

Within animals living in groups, social order is possible through the establishment of social hierarchy where all group members accept each other (Barroso et al., 2000). Horn, live weight and age are the most important factors that are effective on the establishment of social hierarchy (Barroso et al., 2000; Cote, 2000).

The dominance rank in social animals is useful for maintaining aggressive interactions within specific limits. Genuine interactions are mostly inevitable for the formation of a stable dominance rank (Lorenz, 1999). Later on, intra-group interactions are observed as threatening and driving away rather than active attacks. This prevents unnecessary use of energy.

Under free feeding conditions, aggressive behaviors and social hierarchy are not so much effective. However, under restricted feeding conditions, aggressive activity disrupts feeding behaviors considerably. Under conditions, where feeding time is restricted, dominant animals are more aggressive and their feed consumption rates are high (Vargas et al., 1987).

Food competition is a good method, which can be used for observing agonistic interactions. Determining agonistic inter-behavioral relationships and the factors effective on the concerned behaviors is important for practice particularly under restricted conditions. The demonstration of these relationships can contribute significantly to animal welfare practice. This study has intended to (i) determine the interactions observed among goats during food competition and their frequencies, (ii) demonstrate variations of interactions on the grounds of genotype, horns and dominance rank, and (iii) examine the effect of the designated factors on feeding activity in goats.

MATERIALS and METHODS

Animals and management

This study was conducted in the experimental barns of the Goat Husbandry Unit at the Technological and Agricultural Research Center (TETAM) of Çanakkale Onsekiz Mart University between September 2007 and January 2008. Two to five-year-old Maltese and Turkish Saanen goats were used in the study. Prior to their transportation to the unit, the Maltese goats, which had been raised under a semi-extensive system, were obtained from the herders and brought to the Center in October 2006. The Turkish

Saanen genotype, raised under semi-intensive system at the Center since 1995, was obtained through backcrossing by providing landrace goats to Saanen bucks in a process of 30 years. The mean live weights were detected to be 49.4 kg and 54.9 kg in these Maltese and Turkish Saanen goats, respectively, which were four months pregnant. While the feeding conditions required by semi-intensive system were provided at the enterprise, the goats in their last 1.5 months of gestation were fed 0.6 kg/head concentrate feed (890 g DM/kg, 210 g CP/kg DM, 2.8 Mcal ME/kg DM) in the evenings. Depending on weather and pasture conditions, the animals, having stayed on pasture for 5 hours, were fed oat hay (890 g DM/kg, 82 g CP/kg DM, 2.1 Mcal ME/kg DM) 1.5 kg/head.

Behavior observations

The goat genotypes were housed in separate groups. The interaction between the animals in the group was observed in order to determine social hierarchy within genotypes. The observations were made from September to December (four month). As a result of these observations, the dominance rank of each individual was determined (Tölü and Savaş, 2007). A total of 6 groups, containing horned, hornless and both horned and hornless animals (mixed group), were formed from each genotype. The number of animals in the groups was fixed of nine heads. In this manner, a linear dominance ranking was established in the groups. Of the animals in the mixed groups, three animals in the high ranks of the hierarchy were horned and the rest of them were hornless. The hornless goats in the groups were either genetically hornless or disbudded animals. The observations were performed both directly and by video recording in January 2008. The animals were marked by spray paint in both directions of their chest. In the morning (10:00-11:00), all groups were fed 1.6 kg/goat oat-hay in combined feeders (Figure 1) that were 2.5 m (0.5 x 2.5 m) long in paddocks of 30 square meter (5 x 6 m). Upon the provision of feed, the groups were observed for one hour within five consecutive days. The agonistic behavioral traits defined; *Front Butting:* The goat stops consuming feed, stretches, moves forward rapidly and hits its group mate with its head (horns), *Flank butting:* The goat hits or shakes its head (horns) towards the neighboring group mate without changing its place, *Aggressive biting:* The goat pulls and bites any place in the body of another goat (especially ears), *Threatening:* Without any interactions with the other goat, the goat drives it away from the resource by threatening through vocalization or some other behaviors (such as by puffing up and particularly by raising dorsal hairs), *Displacement:* The goat displaces another goat without entering into any aggressive struggle.

Among the above-defined traits, front butting, flank butting and aggressive biting are classified as "aggression with physical interaction" while threatening is classified as "aggression with non-physical interaction" and displacement as "interaction with non-aggression" in the study. The individual displaying aggressive behaviors in the observations was recorded as the aggressive individual and the submissive individual exposed to these behaviors was recorded as the subordinate and defeated individual. During the analyses, one hour observation periods were used for each of the above-defined behavior of each goat. Furthermore, it was also recorded with the help of the video images whether each goat was present at the feeder by time sampling at 5-min intervals at the one-hour observation time.

Figure 1. Maltese (left) and Turkish Saanen (right) goats during food competition in combined feeders

Şekil 1. *Kombine yemlikte yem paylaşımındaki Maltız (solda) ve Türk Saanen (sağda) keçileri*

Statistical analysis

Logarithmic transformation was applied to the frequencies of continuously observed agonistic behaviors to ensure the prerequisites for the variance analysis. Genotype (Maltese, Turkish Saanen) and horn (horned, hornless, and mixed) as well as their interactions were involved in the statistical analyses performed by repeated variance analysis. Tukey test was utilized in *post-hoc* analyses. On the other hand, the statistical analysis of the presence or absence of the goats at the feeder displaying a binomial distribution was subjected to analysis according to the method of generalized estimating equations (GEE). SAS (1999) statistical package program was utilized in the analyses.

RESULTS

It was determined that goat genotype considerably affected the frequencies of agonistic behaviors except for the displacement behavior (Table 1). It was found out that the agonistic behavior

frequencies in the Turkish Saanen genotype were displayed at higher levels than in the Maltese genotype. The total aggressive interaction was 17.59 times/h on average in the Maltese genotype whereas it was 28.82 times/h in the Turkish Saanen genotype. In the genotypes with close averages in terms of front butting and flank butting behaviors, the difference in aggressive biting behavior occurred 2.36 times more in favor of the Turkish Saanen genotype. Likewise, threatening was displayed 1.78 times more in the Turkish Saanen genotype whereas the displacement behavior occurred at close frequencies in both genotypes (P=0.7077). In addition, intra-genotype behavior frequencies varied as well. Front butting occurred at low levels in both genotypes, while the highest frequency of behavior was displayed as flank butting in the Maltese genotype, threatening and aggressive biting behaviors were observed at the highest frequency in the Turkish Saanen genotype. The individuals of Turkish Saanen genotype, which displayed a higher aggression frequency than the Maltese genotype did, had a higher rate of absence at the feeder (P=0.0159).

Table 1. The means and standard deviations (SD) of the agonistic behaviour traits and absence at the feeder of genotypes and P values
Çizelge 1. *Genotiplere göre agonistik davranış özellikleri ve yemlikte gözlenmeme özelliğine ait ortalama, standart sapma (SD) ve P değerleri*

Genotype	Maltese		Turkish Saanen		P
Behaviour	Mean	SD	Mean	SD	
Front butting*	2.28	3.93	2.94	4.94	0.0389
Flank butting*	6.18	6.35	7.33	8.68	0.0137
Aggressive biting*	3.90	6.33	9.24	13.10	<0.0001
Threat*	5.23	7.00	9.31	13.22	0.0001
Displacement*	4.69	4.95	4.85	7.44	0.7077
Absence at the feeder**	0.16	0.36	0.24	0.42	0.0159

*times/h; ** the mean frequencies of absence of goats at the feeder time sampling observation 5 min. intervals. *kez/60 dk.;**5 dakika aralıklarla gerçekleşen anlık kayıtlarda yemlikte olmayan hayvanların ortalama sıklıkları

Table 2. The means and standard deviations (SD) of the agonistic behaviour traits and absence at the feeder of horn groups and P values
Çizelge 2. *Boynuz gruplarında agonistik davranış özellikleri ve yemlikte gözlenmeme özelliğine ait ortalama , standart sapma (SD) ve P değerleri*

Groups	Horned		Hornless		Mixed		P
Behaviour	Mean	SD	Mean	SD	Mean	SD	
Front butting*	1.98^{a}	2.34	2.55^{a}	5.05	3.27^{b}	5.29	0.0077
Flank butting*	6.47	7.40	6.80	6.35	7.02	8.99	0.1572
Aggressive biting*	2.54^{a}	5.55	12.03^{b}	11.66	5.07^{c}	11.17	<0.0001
Threat*	7.49^{ac}	8.71	6.35^{ab}	9.79	8.11^{c}	13.32	0.0561
Displacement *	4.64^{a}	4.17	5.34^{a}	6.28	4.33^{b}	7.90	0.0017
Absence at the feeder**	0.38^{a}	0.48	0.08^{b}	0.27	0.16^{c}	0.37	<0.0001

Different letters in the same line indicated significance, P≤0.05; * times/h; ** the mean frequencies of absence at the feeder time sampling observation 5 min. intervals.
Aynı satırda farklı harflerle gösterilen ortalamalar arasındaki farklılıklar istatistiksel olarak önemlidir (P<0,05). *kez/60 dk.; **5 dakika aralıklarla gerçekleşen anlık kayıtlarda yemlikte olmayan hayvanların ortalama sıklıkları

It was found out that except for the flank butting behavior the frequencies of agonistic behaviors varied considerably according to horn groups (Table 2). It was observed that front butting behavior in the mixed group had a significantly higher frequency than the horned and hornless groups. The highest values in aggressive biting and displacement behaviors were recorded in the hornless group. Except for aggressive biting, the mean behavior frequencies in the horned group and the hornless group were close. Nevertheless, the total mean frequencies of aggressive interactions were ranked in the descending

order as the hornless group (27.73 times/h), mixed group (23.47 times/h) and horned group (18.48 times/h). The proportion of aggressive biting behavior of the hornless group in this sum is remarkable (56%). The aggressive biting behavior in the hornless group occurred 4.73 times more than in the horned group and 2.37 times more than in the mixed group. In displacement behavior, the mixed group varied significantly from the other groups with its low frequency while the highest frequency occurred in the hornless group ($P<0.0017$). Front butting had the lowest frequency in all horn groups whereas the highest frequency belonged to threatening behavior in the horned and mixed groups and to aggressive biting behavior in the hornless group.

It was found out that there were significant differences among horn groups in terms of absence at the feeder ($P<0.0001$; Table 2). Horned animals (38%) had the highest rate in terms of absence at the feeder while the lowest rate occurred in the hornless group (8%). The value of this trait in the mixed group of goats was in the middle of the other two groups (16%).

When we consider the distributions of all behaviors in dominance rank, it is observed that, except for the 2nd-ranking animal, as the dominance rank descends, the aggressive behavior frequency also decreases (Figure 2). The total mean frequencies of aggressive interactions observed in 1 hour were 37.2, 62.6, 29.7, 24.0, 20.9, 16.8, 8.0, 6.4 and 0.2 depending on the dominance rank.

In front butting behavior, the 1st- and 2nd-ranking animals were distinguished from the others with their high frequencies. However, the front butting frequencies of other animals occurred at close levels while this behavior was almost nonexistent in the omega animal. The flank butting behavior was observed with the highest frequency in the three highest-ranking animals in the hierarchy. In the aggressive biting behavior, the 2nd-ranking animal in the hierarchy had a clearly higher frequency than the 1st and 3rd animals. In line with the previous observations, aggressive biting was not observed in the 9th-ranking animal. In the threatening behavior of animals which they use to drive away their group mates without any physical interactions, the 2nd-ranking animal again had a clearly higher frequency (approximately two times more than the 1st and the 3rd animals) than other animals. The frequency of this behavior decreased in parallel to the descent in the hierarchy. In the displacement behavior, a non-aggression interaction, the high- and middle-ranking animals in the hierarchy had similar frequencies whereas the low-ranking animals had low frequencies. The displacement behavior was regular from the 1st-ranking animal to the 6th-ranking animal but then displayed a sharper descending trend.

Although a descending trend was observed from high ranks towards low ranks in most agonistic behaviors, the slope reversed completely in the trait of absence at the feeder (Figure 2). Absence at the feeder had similar rates in the first 4 animals while it had a continuous increase after the 5th animal and reached the highest rate in the 9th-ranking animal. It is worthwhile to note that, the trait of absence at the feeder displayed a quadratic slope among the social ranks.

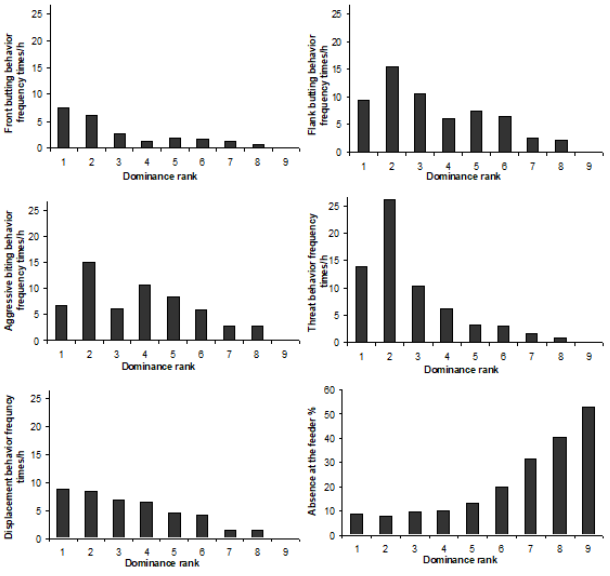

Figure 2. Distributions of agonistic behaviours and absence at the feeder traits of dominance rank.

Şekil 2. *Baskınlık sırasına göre agonistik davranışların ve yemlikte gözlenmeme durumunun dağılımı*

DISCUSSION

The findings obtained from the study demonstrated that the differences in the frequencies of aggressive interactions among genotypes were significant (Table 1). It was noted that the Turkish Saanen genotype displayed aggressive behavior (both with and without physical interaction) at higher levels than the Maltese genotype. In their study on three pig breeds, Breuer et al. (2003) stated that a certain breed displayed aggression significantly more frequently than other breeds did in total and in some specific aggressive behaviors. The aggressive behavior frequencies observed in the Maltese genotype at lower levels than in the Turkish Saanen genotype may also be genetically. These two genotypes have materialized under different husbandry conditions. In general, while the husbandry of Maltese genotype

was performed in the extensive conditions, the goats of Saanen breed, used in forming the Turkish Saanen genotype, has taken shape under intensive husbandry. It is likely that since the individuals that are advantageous in terms of food competition in the Turkish Saanen genotype have high milk and offspring yields, their probabilities of being used in breeding have increased. Such a selection might have inadvertently supported intra-species aggression. Further, the Turkish Saanen genotype, with both a higher milk yield and bigger body size, also has a higher food consumption need. Thus, among the genotype groups presented with equal amounts of feed, the Turkish Saanen goats might have created more restricted conditions than the Maltese goats and as a consequence Turkish Saanen goat performed more agonistic behaviors for a more rapid consumption.

In terms of the variations of inter-genotype aggressive behavior frequencies, particularly aggressive biting behavior was observed clearly higher in the Turkish Saanen genotype. No reports were encountered concerning aggressive biting in horned ruminants. However, with respect to goats, Sambraus (1978) reported that hornless animals developed the biting behavior as a fighting strategy. Tölü and Savaş (2007) determined that aggressive biting behavior was used intensively in intra-species interactions in the Turkish Saanen genotype. The authors expressed that the requirement to investigate whether the phenomenon of aggressive biting was unique to genotype or herd. This study put forth that the genotypes other than the Turkish Saanen genotype also used aggressive biting in intra-species interactions.

It was noted that agonistic behavior frequencies varied significantly according to horn groups except for flank butting behavior (Table 2). In their study on dairy cattle, Menke et al. (1999) found out that hornless animal group had a higher level of interaction than the horned animals. On the contrary, Loretz et al. (2004) did not observe any significant difference in horned and hornless goats in terms of agonistic interaction frequencies. The findings of this study point out to the fact that social distance decreases among the hornless animals. Because, within the hornless group, aggressive biting behavior was observed at a considerably higher level than the other two groups (4.73 times more than the horned group and 2.37 times more than the mixed group). Further, the displacement behavior, which is considered as a non-aggression interaction behavior, also reached the highest frequency in the hornless animal group. Tölü and Savaş (2007) draw attention to the fact that aggressive biting frequency increases under the conditions, where social distance decreases, while DeVeries et al. (2004) express that 57% less aggressive interaction was observed in animals where, social distance is 1m, in comparison to the condition, where the concerned distance is 0.5m. Although the hornless animals have a high value in terms of total aggressive behavior frequencies, mixed group and horned group have higher mean frequencies in terms of threatening behavior. These findings show that horn is considered as a weapon (Barroso et al., 2000; Cote, 2000) and that hornless animals, depending on conditions (in this study: feed), hardly venture into aggressive interactions. In addition, the rates of absence at the feeder also indicate that social distance is less in the hornless group of goats. These rates demonstrate that horn plays an important role in food competition and that horned animals require a broader feeder space. A similar case was also reported by Loretz et al. (2004).

Among the high-ranking animals in the hierarchy, the aggressive behavior frequency is obvious in comparison to the low-ranking animals (Figure 2). Studies conducted to this regard are also supportive of these findings (Barroso et al., 2000; Cote, 2000; Araba et al., 1994). Further, Lehmann et al. (2006) expressed that 95% of the aggression observed among animals was against subordinate individuals. It is worthwhile to note that the fighting is generally initiated by dominant individuals (Cote, 2000). In the last-ranking animals (ω-goat), agonistic behaviors were observed to be almost non-existent. Probably, these behaviors were performed by ω-goat in order to mitigate the assault of a higher-ranking animal. In other words, it is a defensive behavior. Hasegawa et al. (1997) also reported that subordinate individuals resisted the dominants with the aim of defense particularly under feeding conditions.

When agonistic behavior frequencies are considered according to dominance rank, it is observed that the mean value of the sum of behaviors of α-goat (1st goat in the dominance ranking) is considerably less than the frequency of β-goat (2nd goat in the dominance ranking) (Figure 2). This shows that α-goat was approached less. The threatening behavior is particularly clear in β-goat. The fact that the agonistic interactions are displayed comparatively less by β-goat may be a strategy in order not to draw the attention of α-goat. Further, the distance between this animal and the others is probably less than it is with the α-animal and, therefore, aggressive behaviors are displayed more frequently by this animal. The

clear high rate of absence at the feeder towards the low ranks of the hierarchy is remarkable. Accordingly, α-goat spends 8% of the feeding time outside the feeding space whereas this rate is 52% in ω-goat. Thus, the subordinate individuals, exposed to aggression, are also unable to perform their feeding activities at a serious rate. This is supported by some other studies, too (De Veries et al., 2004; Lehmann et al., 2006; Jorgensen et al., 2007).

In conclusion, it may be noted that the Maltese genotype is more peaceful than the Turkish Saanen genotype and that this peacefulness may be useful in terms of food competition. The fact that the Maltese genotype, claimed to be more peaceful in comparison to the Turkish Saanen genotype, also displays aggressive biting behavior demonstrates that aggressive biting is not unique to a specific genotype or herd in goats, which are one of horned animal species. Another outstanding finding of the study is that hornless goats risk entering into aggressive interaction during resource sharing and that horn is quite deterrent in this sense. In addition, aggression is a serious handicap in resource sharing for low-ranking animals, depending on genotype and horns in goat groups.

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