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MEASUREMENTS OF HEALTHY HOOVES, THEIR INTERRELATION AND CORRELATION WITH BODY MASS IN SOME IMPROVED GOAT BREEDS

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ABSTRACT

The aim of this paper was to determine the measures of the hoof and its relationship with body mass of different goat breeds, raised in semi-intensive conditions at subtropical Mediterranean region of Turkey. For this aim, four improved goat breeds as Saanen, Alpine, Damascus, Boer, were raised in Research Farm unit of Cukurova University, Agricultural Faculty, Dairy Goat Research Farm, were used as animal material. All does were 2 years old and in first lactations. The herd dense was 500 heads live in the semi-open barn of which has 1.5 m2 surface area per animals. Measured traits were length of hoof, height of hoof, height of heel, diagonal diameter of hoof, width of hoof, bulb length, claw length, and dorsal wall angle. At the end of the study there were significant differences found between hoof dimensions and dairy and meat type goats in intensive conditions. The meat type goats, Damascus and Boer had higher hoof dimensions than the dairy Alpine and Saanen goats. On contrary to this the front claw of the goats were larger than the back side. The significant differences between adult live weights of genotypes were determined as expected. By examining correlation coefficient between body mass and claw length, height of hoof, diagonal diameter of hoof and bulb height, there were positive and significant correlation. On contrary negative and significant correlation with length of hoof and body weight of intensive goats, as well.

Keywords: Goat breeds, hooves, body mass, health, measurements

Introduction

The hoof is a complex structure that plays a key role in many aspects of the animal's overall health and productivity. Healthy hooves lead to healthy animals, which raises productivity and income. When hooves are kept in good condition, it reduces the losses that stem from treating lame animals and the production losses that result from their discomfort. A lame animal is not only in pain, but it is an extra expense that most producers cannot afford. By maintaining a sound hoof management routine, animal owners can reduce their economic losses and increase their

chances for profit in the future. The high incidence of claw lesions (Cook and Nordlund, 2009) indicates that the feet of dairy animals are not adapted well to man-made housing systems.

The bovine hoof consists of a hard outer casing or hoof horn, the corium, which contains the blood vessels and horn forming cells, and the skeletal portion of the foot. The coffin bone is the large, terminal, weight-bearing bone around which the hoof is formed and to which the tendons are attached. The hoof wall, sole, and heel are made of keratin (like hair and the cow's horn) and water. They are not very thick and cover tissues, which hold nerves and blood vessels. The junction between the horn forming tissues of the hoof wall and sole, called the white line, is located around the circumference of the bottom of the hoof. This area is susceptible to physical damage and bacterial invasion (Ishler et al., 1999).

Ruminants are cloven-footed animals, meaning that the hoof consists of two digits, instead of one solid entity like that of a horse. The two digits are analogous to the third and fourth fingers of the human hand. The claws are named by their relative location on the foot. There is the outer, or lateral claw, and the inner, or medial claw. The space between the two claws is called the interdigital clef; the area of skin is called the interdigital skin. The different surfaces of the claws are named according to their relative position to the interdigital cleft: the abaxial surface is the outer wall of each claw, and the axial surface is the inner wall. The distal part of the digit is protected by the claw. On the palmar/plantar side of the pastern joint there are two rudimental digits also protected with horn called dewclaws. The claw is a unique structure design to protect the distal part of the digit and has several different segments. Each segment has different function and also different rates of horn growth and abrasion (Prentice, 1973).

Cattle toe length and sole thicknesses are associated. (Toussaint Raven, 1989) published that a dorsal wall length of 7.5 cm was associated with sole thickness of 5 to 7 mm. In another study, anatomical measurements of adult bovine cadaver claws with a dorsal wall length of 7.5 cm had an average sole thickness of 8.2 mm (Van Amstel et al., 2002). The determination of characteristics for claw quality is needed to understand claw disorders (Vermunt and Greenough, 1995). Claw quality is the product of horn characteristics, claw shape and the anatomy and physiology of the inner structures of the claw (Politiek, 1986).

Goats have strong feet and legs, and they indeed have good balance that allows them to climb along steep hills and narrow mountain pathways. Hooves on a goat are very important to the goat's overall health, so trimming goat hooves every 3 - 4 months, or at least twice per year, is vital to preventing painful hoof overgrowth and many problems (Anonymous, 2016a).

Recent major improvements in goat farming have mostly been concerned with welfare concepts and improvements in housing to provide improved environmental conditions. However, changes to increase goat production can cause the animal to stand on inadequate flooring, which often results in the development of hoof defects. Goat lameness, mortality, and longevity are

becoming serious concerns within the goat industry. However, there has been little research published in this area (Anonymous, 2016b).

The information about the goat characteristics, claw shape and the anatomy and physiology of the inner structures of the claw is limited. The aim of this paper was to determine the measures of the hoof of different type of dairy goats, raised in semi-intensive conditions at subtropical Mediterranean region of Turkey.

Material methods

Animal material

The experimental procedures were approved by the ethics committee the Faculty of Agriculture of Cukurova University. The study was carried out on 80 heads, 2 years old, female goats at the Dairy Goat Research Farm of Faculty of Agriculture of Cukurova University from beginning one week in April. The farm is located in the Eastern Mediterranean region of Turkey (40 m in altitude; 36 59' N, 35 18'E), in which subtropical weather conditions prevail. The annual precipitation in the area is 450 mm. The actual average temperatures and relative humidity of the pens where the goats were maintained were recorded daily with a thermometer and a barometer in a nearby climatic station, that of established by University.

The goats were housed in semi-open barns (the south side of the barn was opened) and intensive conditions. The floor surface was concrete and due to summer season there were no bedding. They were grazed in natural grassland from 9.00 to 15.00. Only the experimental days they were kept inside of the barn. The goats were fed concentrate and alfalfa hay for *ad-libitum* twice daily at 8-9 am and 14-15 pm during experimental period with a diet containing 40% alfalfa hay and 60% concentrate; fresh water was available at all times.

The concentrated feed composition was dry matter (DM) 88%; crude protein (13%), crude cellulose (14%, maximal content), crude ash (9%, maximal content), calcium (between 0.6 and 1.2%), sodium (between 0.3 and 0.6%), phosphorus (0.4%). The alfalfa hay composition (according to conventional feed analysis in the university nutritional laboratory) was: DM (88.5%), crude protein (13%), crude ash (6.4%), acid detergent fiber (ADF, 45.4%), neutral detergent fiber (NDF, 52.9%), crude fat (0.91%). Ten days were given for adaptation to diet and experimental unit.

Four improved goat breeds were animal materials of this study. Two of them are improved dairy goat types as Saanen and Alpine, one of them native Damascus, the last one was improved meat type, Boer goats. All of them have single birth. The herd dense was 500 heads live in the semi-open barn of which has 1.5 m^2 surface area per animals.

The macroscopically normal front feet of 20 Saanen, 20 Alpine, 20 crossbred of Damascus and 20 Boer goats were used for measurements. All does were 2 years old and in first

lactations. The median age of the goats were 23 months (range: 20-24 months). The median body weights were Damascus, Saanen, Boer and Alpine does were;51,8 kg (ranged: 50,9-53,4 kg), 54 kg (ranged: 50,2-61,8 kg), 64 kg (ranged: 60,3-69,3 kg), and 53 kg (ranged: 50,2-58,3 kg), respectively.

Hoof measurement

Procedures to measure objectively hooves of goats were developed and tested for ease of use in typical herds. Measured traits were length of hoof, height of hoof, height of heel, diagonal diameter of hoof, width of hoof, bulb length, claw length, and dorsal wall angle. Three observers repeated measurements on a group of goats to quantify variance among and within observers.

Goats were immobilized with a ropes and chains. The hooves were trimmed with pliers, the excess horn on the soles and in the interdigital space were removed with a knife and final, delicate treatment of all the surfaces was performed with an electric grinder. A caliper was used for measuring the dimensions of the trimmed hooves.

The length of the hoof was measured from the border between the skin and the coronet to the distal end of the dorsal wall and parallel to the digital axis, the height of the hoof was measured from the border between the skin and the coronet to the vertical point of the sole, the height of the heel was measured along a line perpendicular to an imaginary caudal extension of the sole to the highest point of the heel, the diagonal of the hoof was measured from distal end of the dorsal wall to the highest point of the heel, and the width of the hoof was measured along the line intersecting the sole length at its widest part (Fig. 1).

The measurements were performed on live animals, so we trimmed the sole to the healthy part of the hoof horn, taking care to avoid injury to the corium. After measuring these dimensions, their mean values were calculated, and a statistically significant difference was determined between values within each group of parameters and a certain correlation between the mean values and weight of each does.

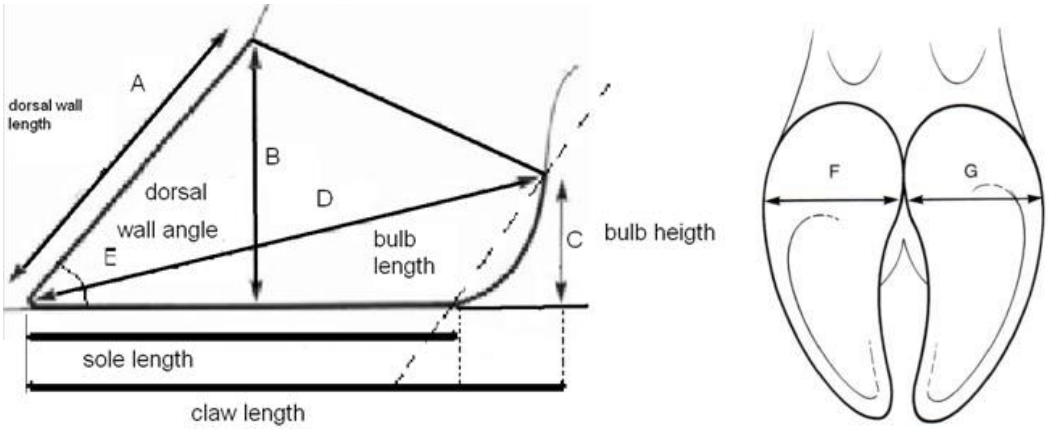

Fig. 1. A- Length of the hoof; B-height of the hoof; C-height of the heel; D-diagonal diameter of The hoof; F+G-width of the hoof (Greenough et al., 1997).

The means of all values were analyzed and a statistically significant difference between values within each group of parameters was determined using the Mann-Withney U test. Differences were considered statistically significant at $P<0.05$. Correlations between hoof length, hoof height, heel height, surface of a digit and body mass were calculated using Spearman's rank test. The software used for statistical calculation was STATISTICA 8.1.

Results and Discussion

The descriptive data for each of the measures of average live weights, hoof and heel digits of different goat types were shown in Table 1.

Table 1. Comparison of mean for eight claw conformation measures and live weight of four goat types

Body Characteristics	**Alpine**	**Saanen**	**Damascus**	**Boer**	**SEM**	**P**
Live weight (kg)	**53.0^{a}**	**54.0^{a}**	**61.8^{b}**	**64.0^{b}**	**0.87**	**0.001**
Lenght of hoof (forelimbs,cm)	**3.9 ^{a}**	**3.9 ^{a}**	**4.4 ^{b}**	**4.1 ^{b}**	**0.07**	**0.006**
Lenght of hoof (hindlimbs, cm)	3.7	3.7	3.8	4.0	0.07	0.334
Height of hoof (forelimbs,cm)	3.5	3.3	3.7	3.5	0.05	0.026
Height of hoof (hindlimbs, cm)	3.2	3.0	3.4	3.4	0.06	0.202
Height of heel (forelimbs,cm)	3.1	2.8	3.0	3.1	0.06	0.016

Height of heel(hindlimbs, cm)	**2.6** [a]	**2.7** [a]	**3.2** [b]	**3.2** [b]	**0.08**	**0.034**
Diagonal diameter of hoof (forelimbs,cm)	**2.0** [a]	**1.8** [a]	**2.2** [b]	**2.3** [b]	**0.05**	**0.003**
Diagonal diameter of hoof (hindlimbs, cm)	**1.7** [a]	**1.6** [a]	**1.9** [b]	**2.0** [b]	**0.07**	**0.004**
Witdh of hoof (forelimbs,cm)	2.1	2.0	2.2	2.2	0.06	0.527
Witdh of hoof (hindlimbs, cm)	1.8	1.7	1.9	1.8	0.06	0.497
Bulb height (forelimbs,cm)	**4.8** [a]	**4.6** [a]	**5.2** [b]	**5.4** [b]	**0.11**	**0.014**
Bulb height (hindlimbs, cm)	**4.3** [b]	**4.5** [b]	**4.9** [a]	**5.4** [a]	**0.11**	**0.001**
Claw lenght (forelimbs,cm)	**5.6** [a]	**5.8** [a]	**6.3** [b]	**6.0** [b]	**0.10**	**0.044**
Claw lenght (hindlimbs, cm)	**5.1** [a]	**5.3** [a]	**5.8** [b]	**6.1** [b]	**0.12**	**0.006**
Dorsal wall angle (forelimbs,cm)	**64.1**	**59.6** [a]	**66.3** [b]	**65.4** [b]	**1.12**	**0.202**
Dorsal wall angle (hindlimbs, cm)	**60.1** [a]	**58.7** [a]	**64.3** [b]	**63.9** [b]	**1.29**	**0.483**

The difference between live weight of the four breeds were significant, as well ($p<0.01$). The Alpine and Saanen goats are dairy type while Damascus and Boer were meat type. Thus the significant differences between adult live weights of genotypes were determined. The average of the body weights were supported by previous studies (Güney and Darcan, 2005; Darcan and Güney, 2002).

In eight claw variables (Table 1) there were significant differences in the measurements between length of fore hoof, height of hind heel, diagonal diameter of hoof, bulb height, claw length and dorsal wall angle of genotypes ($p<0,01$).

Linear measurement parameters allow a statement on the size of a claw. The assumption is that having bigger and steeper horn capsules would implicate higher amounts of mineralized and soft tissue inside the claw enabling the claw to burden a higher load (Nüske et al., 2003).The meat type goats, Damascus and Boer had higher hoof dimensions. In cattle, the lateral claw is slightly larger in the back feet, while medial claw is the larger claw in the front feet (Anonymous, 2016b). On contrary to this the front claw of the goats were larger than the back side. Relative little information is available for the claw of goats. According to these data, it can be concluded that, it is assumed to be a result of permanent overloading in the daily walking process as indicated by Nüske et al. (2003). Claw development can be expressed as shape measured linearly, volume and density of the contents of the capsula ungulae (Nüske et al., 2003). As it was indicated in previous studies difference in length of the lateral and medial digits of cattle plays an important role in the particular anatomical characteristics (Anderson and Lundström, 1981).

The ratio between wall length and bulb length is one of the most often used parameters to describe claw quality (Utz, 1998). Damascus and Boer goats had significantly longer bulb than the other dairy types. The medial hooves of the forelimbs bear more than the lateral hooves (Toussaint Raven, 1989; Van der Tol et al., 2002).

The goats are very active grazers and can climb everywhere. Their front legs are well-developed. They are good browser and climbers particularly rocky and hilly areas. They can reach 2m. high of the trees. These traits of goats could be effected to the claw dimensions and shapes Diagonal diameter and bulb height dimensions are the most used parameters to describe claw quality. As seen in Table, the meat type goats' had better dimensions than the dairy goats.

The correlation between body mass and some significant digits of hoof were examined for all breeds, as well. The results of these determinations were given in Table 2.

Table 2. Correlation between body mass, and some hoof digits of all breeds

Variables	**Body mass (kg)**
Height of hoof	-0.7
Diagonal diameter of hoof	+0.8
Bulb height	+0.8
Claw lenght	+0.7
Lenght of hoof	-0.9

By examining correlation coefficient between body mass and claw length, height of hoof, diagonal diameter of hoof and bulb height, there were positive and significant correlation. On contrary negative and significant correlation with length of hoof and body weight of intensive goats. This is accounted for by the fact that the median value of heel height and length of hoof could be accounted for by the fact that the trimming of the hind leg hooves were easier and more precise, whereas the hoof horn were much firmer. The length of hoof were decrease when the live weight of the goats increase. These date indicate that the increase body mass overburden the legs, and therefore their heel and hoof parts as well. The average surface area of the hoof increase with increasing body weight.

The bulb height and claw length were related to goats' grazing behaviour. They are browser and position of grazing affects their claw and bulb dimensions. The reason of larger fore hind of goats is their legs and claws positions during this period. They open their legs as 45° and state their hoof inside of claw. The body weight of the grazing goats' are loaded on the fore hind during grazing at grassland. The same habit of the goats can be observed feeding in barn conditions. With higher live weight heel-horn erosions could be easily developed and the height and length of hoof could be negatively affected by the high live weight in goats.

CONCLUSION

Intensive dairy goat farming is well-developed during last decades in Turkey. Foot health and lameness are major issues facing intensive goat producers as dairy cattle farming, because of their common occurrence and the tremendous economic losses incurred. This study showed that there were significant difference between dimensions of the hoof of dairy and meat type goats and the body mass could effect to the these traits. Our results showed that in favour of at least two claw trimmings especially for meat type goats per year will be good practice to improve goats' welfare in intensive farms. These kinds of measurements have been done to develop improved trimming methods, stronger activities to prevent some leg and claw problems in farms.

REFERANCE

Anderson, L., Lundström, K., 1981. The influence of breed, body weight and season on digital diseases and hoof size in dairy cows. Zentralbl. Veterinaermed., 28 A, 141-151.

Anonymous, 2016a. Goats hoof care. http://www.tractorsupply.com/know-how_pets-livestock_livestock-other_goat_goat-hoof-care Acc. Date : 26.01.2016

Anonymous, 2016b. Hoof Anatomy, Care and Management in Livestock. Purdue Extension, Hepworth, K., Neary, M., Kenyon, S., ID-321-W, Purdue University. Acc. Date:03.02.2016

Darcan, N., Güney, O., 2002. Comparative Study on the Performance of Crossbred Goats Under Çukurova Subtropical Climate. J. Applied Animal Research, 22 (2), 61-64.

Greenough, P. R., Mcdaniel, B. T., Leipold, H. W., 1997. Conformation, Growth, and Heritable Factors. In: Lameness in Cattle. (Greenough, P. R., A. D. Weaver, Eds.), Saunders Elsevier, Philadelphia, London, Toronto, Montreal, Sydney, Tokyo, pp. 71-86.

Guney,O. Darcan, N., 2005. Perspectives and Structures of Dairy Goat in Mediterranean Basin of Turkey. International Goat-Forest-Erosion Symposium, 12-13 April 2005,Adana, TURKEY.

Ishler, V., Wolfgang, D., Griswold, D., 1999. Prevention and Control of Foot Problems in Dairy Cows. PENNSTATE, College of Agricultural Sciences. Cooperative Extension. DAS 99-20 and VSE 99-1.

Nüske, S., Scholz, A., Förster, M., 2003. Studies on the Growth and the Development of the Claw Capsule in New Born Calves of Different Breeding Lines Using Linear Measurements. Arch.Tierz., Dummerstorf 46 (6), 547-557.

Prentice, D. E., 1973. Growth and wear rates of hoof horn in Ayrshire cattle. Res Vet Sci 14: 285-290.

Radišić, B., Matičić, D., Vnuk,D., Lipar, M., MajićBalić, I., İtko, B., Smolec, O., Orak,A. H, Capak, H., Kos, J., 2012. Measurements of healthy and pathologically altered hooves, their interrelation and correlation with body mass in Simmental breeding bulls. VeterinarskiArhiv 82 (6), 531-544.

Toussaint Raven, E. 1989. Structure and function of the claw. Cattle footcare and claw trimming. Farming press books, Ipswich.

Utz, J., 1998. Exterieurbeurteilung Rind. In: BREM G., ed. ExterieurbeurteilunglandwirtschaftlicherNutztiere. Stuttgart, Germany, Eugen Ulmer Verlag, 180-181

Van Amstel, S. R., Palin, F.L., Shearer, J. K., Robinson, R. A, 2002. Anatomical Measurement of Sole Thickness in Cattle following Application of Two Different Trimming Techniques. The Bovine Practitioner 36, 136-140.

Van der Tol, P.P., Metz, J.H., Noordhuizen-Stassen, E.N., Back, V., Braam, C.R., Weijs, W.A., 2003. The vertical ground reaction force and the pressure distribution on the claws of dairy cows while walking on a flat substrate. Journal of Dairy Science, 86, 2875-2883.

Vermunt, J. J., Greenough, P.R., 1995. Structural characteristics of the bovine claw: Horn growth and wear, horn hardness and claw conformation. Br. Vet. J. 151, 157-180.