Kafkas Univ Vet Fak Derg
23 (2): 241-246, 2017
DOI: 10.9775/kvfd.2016.16359

Kafkas Universitesi Veteriner Fakultesi Dergisi
Journal Home-Page: http://vetdergi.kafkas.edu.tr
Online Submission: http://vetdergikafkas.org

Research Article

Morphologic and Morphometric Structure and Arterial Vascularization of Glandula Interdigitalis in Male Hemshin Sheep

İftar GÜRBÜZ [1] Yasin DEMİRASLAN [1] Ebru KARADAĞ SARI [2] Kadir ASLAN [3]

[1] Department of Anatomy, Faculty of Veterinary Medicine, Mehmet Akif Ersoy University, TR-15030 Burdur - TURKEY
[2] Department of Histology and Embriyology, Faculty of Veterinary Medicine, Kafkas University, TR-36030 Kars - TURKEY
[3] Department of Anatomy, Faculty of Veterinary Medicine, Kafkas University, TR-36030 Kars - TURKEY

Article Code: KVFD-2016-16359 Received: 16.06.2016 Accepted: 23.09.2016 Published Online: 26.09.2016

Citation of This Article

Gürbüz İ, Demiraslan Y, Karadağ Sarı E, Aslan K: Morphologic and morphometric structure and arterial vascularization of glandula interdigitalis in male Hemshin sheep. *Kafkas Univ Vet Fak Derg,* 23 (2): 241-246, 2017. DOI: 10.9775/kvfd.2016.16359

Abstract

The purpose of this study was to determine morphologic and morphometric structure and arterial vascularization of glandula interdigitalis in male Hemshin sheep. In the study, 40 feet (20 fore-feet, 20 hind-feet) were used as material. Latex was injected into arteries of fore- and hind-feet in order to determine vascularization of glandula interdigitalis. In the study, 6 measurements were taken from different points of glandula interdigitalis in order to determine its morphometric values. These values were statistically analyzed. Consequently, length of the gland was measured as 30.18±1.93 mm in fore-feet and 25.67±1.77 mm in hind-feet. The gland in fore-feet was determined to be considerably greater than the gland in hind-feet (P<0.05). It was found that the gland was vascularized by branches separated from arteriae digitales palmares communis II, III, and IV in fore-feet and arteria digitalis dorsalis communis III and arteriae digitales plantares propriae III and IV in hind-feet.

Keywords: *Arter, Interdigital gland, Morphology, Morphometry*

Erkek Hemşin Koyununda Glandula İnterdigitalis'in Morfolojik ve Morfometrik Yapısı ile Arterial Vaskularizasyonu

Özet

Araştırmada erkek Hemşin koyununda glandula interdigitalis'in morfolojik ve morfometrik yapısı ile arterial vaskularizasyonunun belirlenmesi amaçlandı. Materyal olarak 40 adet (20 ön, 20 arka) ayak kullanıldı. Çalışmada glandula interdigitalis'in vaskularizasyonunun belirlenmesi amacıyla ön ve arka ayak arterleri içerisine latex enjekte edildi. Glandula interdigitalis'in morfometrik değerlerini belirlemek için farklı noktalarından 6 adet ölçü alındı. Bu değerler istatistiksel analize tabi tutuldu. Sonuç olarak bezin uzunluğu ön ayakta 30.18±1.93 mm, arka ayakta 25.67±1.77 mm olarak ölçüldü. Ön ayaktaki bezin arka ayaktakine göre önemli oranda büyük olduğu tespit edildi (P<0.05). Bezin ön ayakta arteriae digitales palmares communis II, III ve IV' ten ayrılan dallar tarafından, arka ayakta ise arteria digitalis dorsalis communis III ve arteriae digitales plantares propriae III ve IV tarafından vaskularize edildiği saptandı.

Anahtar sözcükler: *Arter, Glandula interdigitalis, Morfoloji, Morfometri*

INTRODUCTION

Hemshin sheep breeding is performed in North-Eastern Anatolian Region of Turkey. It is reported that the number of Hemshin sheep has been decreased in recent years due to various reasons and the breed is under the danger of extinction [1,2].

Skin glands such as glandula (gl.) tarsalis, gl. interdigitalis and gl. infraorbitalis which are closely related to reproductive activity in ruminants, are localized in different parts of the body [3]. Gl. interdigitalis secreting apocrine and holocrine in primates is a dermal gland located between hooves [4]. Shape, size and location of the gland vary depending on species [4,5]. This gland was described as a hoof-skin organ by Raesfeld [6], a growing organ by Sivachelvan et al.[7], sinus interdigitalis by Badvek [8]. Density and composition of gl. interdigitalis's secretions are diverse [9-11]. Secretion of this gland in animals acts as pheromones [12]. In addition, it is also reported that the secretion of the gland has fungicidal and bactericidal effect and is protective against ultraviolet rays [4].

İletişim (Correspondence)
+90 248 2132166
iftargurbuz@mehmetakif.edu.tr

In ruminants, arteriae (aa.) digitales palmares (or plantares) propriae axiales et abaxiales belonging to hooves III and IV are primarily responsible for the vascularization of digital area. Dorsal arteries of the feet (aa. digitales dorsales propriae III et IV), on the other hand, are less responsible for it [13]. Palmar and plantar digital arteries are separated from aa. digitales palmares communis II, III et IV and aa. digitales plantares communis II, III et IV in ruminants [14,15].

In literature reviews it is observed that there are a number of studies conducted morphology of gl. interdigitalis [4,9,16]. Hemshin sheep is a local breeds, in addition to there is not such a study on Hemshin sheep. Therefore, the purpose of this study was to determine morphologic and morphometric structure and arterial vascularization of gl. interdigitalis in male Hemshin sheep.

MATERIAL and METHODS

The healthy 10 male Hemshin sheep were used in this study. The Hemshin sheep were avarage of 42.70±5.07 kg, 8-9 months, and had not been castrated. Glandula interdigitalis in fore-feet and hind-feet of 10 male Hemshin sheep was assessed separately in the study. By considering that care and feeding conditions were the same, feet were provided from a slaughter house in Ardanuç district of Artvin in december. Approval required for conducting the study was received from Kafkas University Local Ethics Committee for Animal Trials (Date: 17.12.2015, Number: 119). While 5 of the sheep were used for morphological evaluations, the other 5 were used for determining the arterial vascularization of the gland.

For morphological evaluations, morphometric measurements were taken from 6 different points by dissecting gl. interdigitalis in feet separately. In addition, weight and volume of the gland were also calculated. Mean and standard deviation values of morphometric findings obtained from gl. interdigitalis in fore and hind feet were analyzed in SPSS (20.0 version) packaged software. The feet were randomly collected due to the slaughter-hause conditions, therefore differences between gl. inter-digitalis in fore and hind feet, on the other hand, were determined by using Independent Samples T test.

Latex stained with red colored rotring ink was injected to arteria (a.) mediana and a. saphena in order to examine arterial vascularization of gl. interdigitalis in feet of Hemshin sheep [17]. Arteries vascularizing the gland were revealed by dissecting after latex injected feet were kept in 10% formaldehyde for 24 hours.

For histological examinations, the interdigital gland samples of Hemshin sheep were kept in 10% formalin for fixation at room temperature, the routine procedure was applied and then they were embedded in paraffin. Serial sections with a thickness of 5 µm were cut from paraffin blocks. Mallory's modified triple staining (Triple) was used to show general structure of the interdigital gland. The sections were examined with light microscope (Olympus BX51, Japan).

RESULTS

Gl. interdigitalis was determined to consist of the parts corpus *(Fig. 1,2,3,4/c)*, excretory duct *(Fig. 1,2,3,4/b)* and orifice *(Fig. 1,2,3,4/a)*. In all the feet, it was determined that orifice of excretory duct and proximal end of corpus of the gland were localized between distal ends of phalanx proximalis and its excretory duct and corpus were between phalanx media. The gland was observed to have a pipe-shape and white color. It was observed that while distal end of gland's corpus in fore-feet leaned to ligamentum (lig.) interdigitale *(Fig. 1/d)*, gland's corpus in hind-feet did not touch to lig. interdigitale *(Fig. 2/d)*. While intensive hairs were determined in orifice of gland's excretory duct, a small amount of hairs was present in its lumen *(Fig. 3)*.

Table 1 shows morphometric results obtained from gl. interdigitalis in fore- and hind-feet. Accordingly, length of the gland was measured as 30.18±1.93 mm

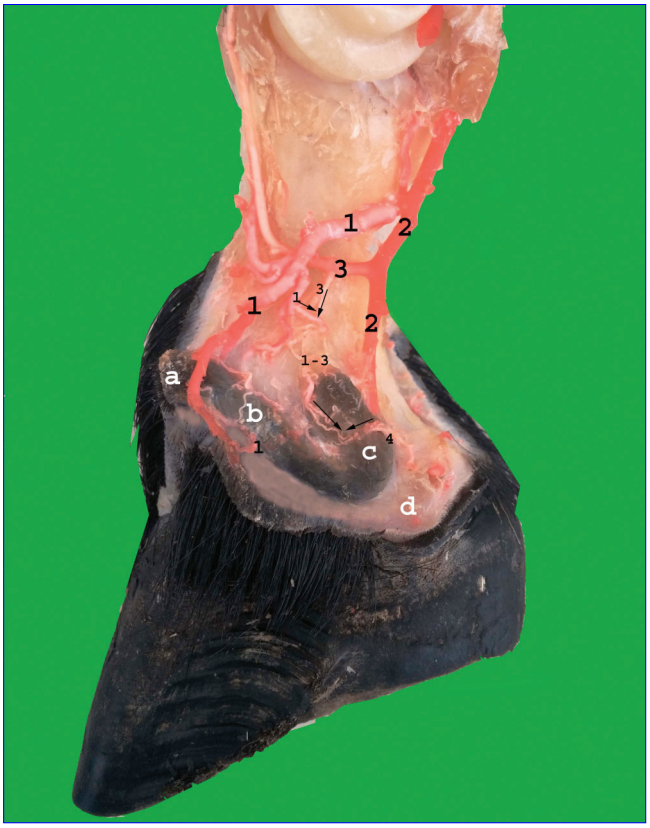


Fig 1. Interdigital region in fore hoof
1. Continuation of rami palmares phalangum proximalium in interdigital region, **2.** A. digitalis palmaris communis III, **3.** A. interdigitalis, **4.** A. digitalis palmaris propria, **a.** Orifice of excretory duct, **b.** Excretory duct, **c.** Corpus, **d.** Lig. interdigitale

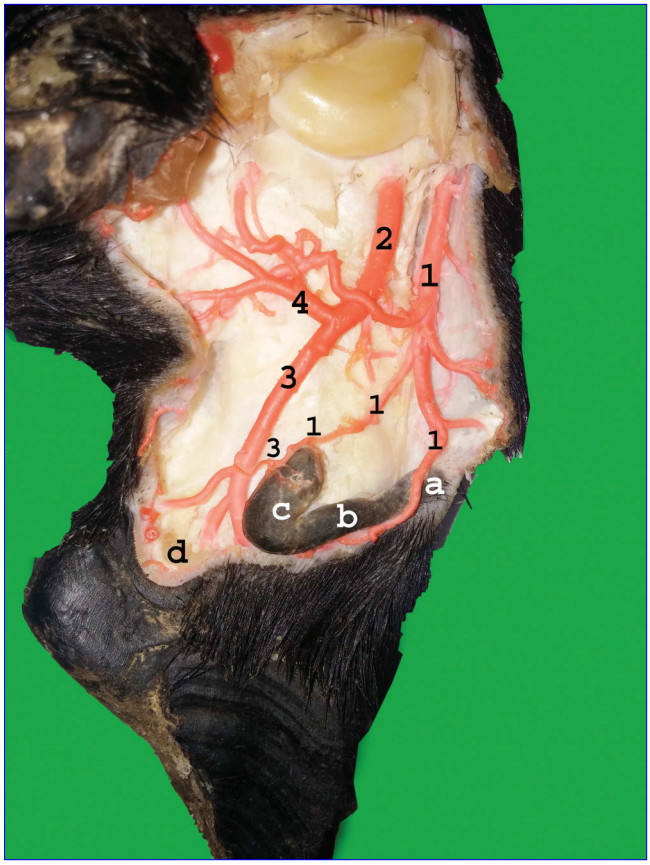


Fig 2. interdigital region in hind hoof
1. A. digitalis dorsalis communis III, **2.** A. metatarsea dorsalis III, **3.** Aa. digitales plantares propriae III et IV, **4.** A. digitalis plantaris communis III, **a.** Orifice of excretory duct, **b.** Excretory duct, **c.** Corpus, **d.** Lig. interdigitale

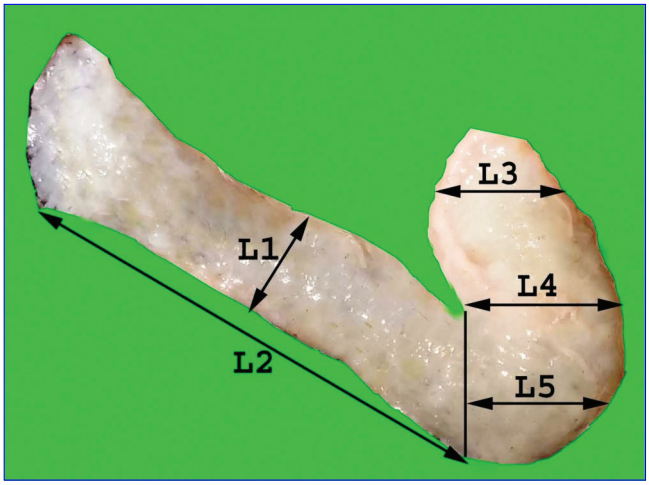


Fig 3. Morphometric measurements from gl. interdigitalis
L1; diameter of excretory duct, **L2;** length of excretory duct, **L3;** diameter of corpus's proximal end, **L4;** medium diameter of corpus, **L5;** diameter of corpus's distal end

palmares phalangum proximalium and a. interdigitalis *(Fig. 1/3)*, corpus was vascularized by a. digitalis palmaris communis III *(Fig. 1/2)* and a. digitalis palmaris propria *(Fig. 1/4)* which is one of the branches of aa. digitalis palmaris communis II et IV. Anastomosis developed rr. palmares phalangum

proximalium *(Fig. 1/1)*, a. interdigitalis and a. digitalis palmaris propria was observed on corpus of the gland. Rr. palmares phalangum proximalium in hooves of Hemshin sheep was determined to separate from a. digitalis palmaris communis II.

Table 1. *Mean length, weight, volume and standard deviation values of gl. interdigitalis found in fore- and hind-feet of male Hemshin sheep (*:P<0.05)*

Measurements	Gl. interdigitalis in fore-feet	Gl. interdigitalis in hind-feet
L1* (mm): Diameter of excretory duct	4.60±0.53	3.05± 0.47
L2* (mm): Length of excretory duct	20.90±1.95	18.95±1.50
L3* (mm): Diameter of corpus's proximal end	6.67±0.95	4.88±0.77
L4* (mm): Medium diameter of corpus	9.29±0.86	7.48±1.32
L5* (mm): Diameter of corpus's distal end	6.26±0.52	5.13±0.58
L6* (mm): Total length of the gland	30.18±1.93	25.67±1.77
W1* (gr): Weight of the gland	1.88±0.40	0.95±0.26
V1* (mL): Volume of the gland	2.00±0.39	1.00±0.28
** P<0.05*		

in fore-feet and 25.67±1.77 mm in hind-feet. The gland in fore-feet was larger than the gland in hind-feet in a statistically significant way (P<0.05).

Arterial Vascularization of Gl. Interdigitalis in Fore-Feet

The gland was determined to be vascularized by branches separated from aa. digitales palmares communis II, III et IV. It was found that while the gland's excretory duct was vascularized by continuation of rami (rr.)

Arterial Vascularization of Gl. Interdigitalis in Hind-Feet

It was determined that the gland's-excretory duct was vascularized by a. digitalis dorsalis communis III *(Fig. 2/1)*, corpus was vascularized by a. digitalis dorsalis communis III and aa. digitales plantares propriae III et IV *(Fig. 2/3)*. A. digitalis dorsalis communis III and aa. digitales plantares propriae III et IV developed anastomosis on corpus of the gland. A. metatarsea dorsalis III *(Fig. 2/2)* and a. digitalis plantaris communis III *(Fig. 2/4)* were observed to develop

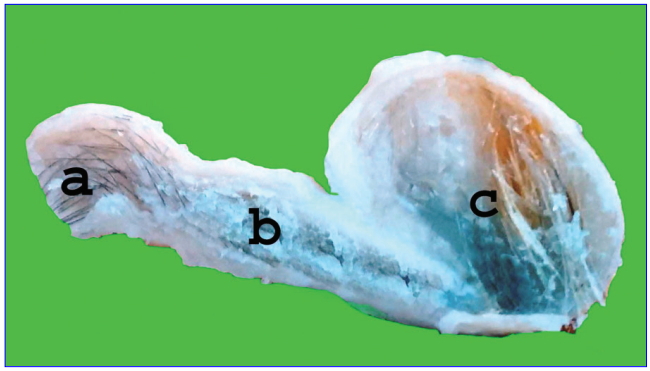


Fig 4. Cross section of gl. interdigitalis
a. Orifice of excretory duct, **b.** Excretory duct, **c.** Corpus

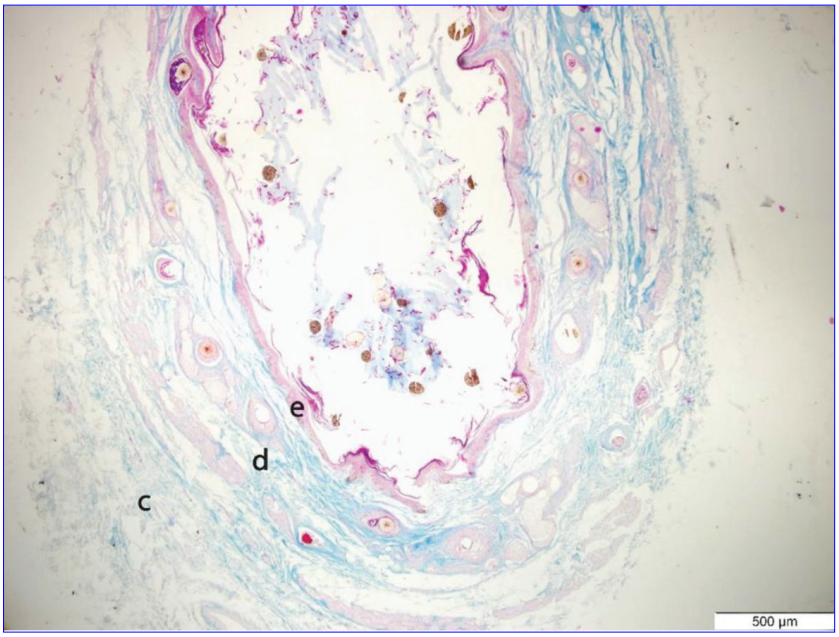
anastomosis in interdigital area at mid-level of phalanx proximalis.

The wall structure of the interdigital gland of the Hemshin sheep was composed of the epidermis, dermis and a capsule. The epidermis consisted of keratinized stratified squamous epithelium. Hair follicles, sebaceous glands, sweat-glands, muscle fibers, and apocrine glands were observed in the dermis *(Fig. 5,6)*.

DISCUSSION

Due to decrease in number of Hemshin sheep in recent years [2] slaughtering female Hemshin sheep in

Fig 5. Interdigital gland of Hemshin sheep. **e.** epidermis, **d.** dermis, **c.** capsule. Triple



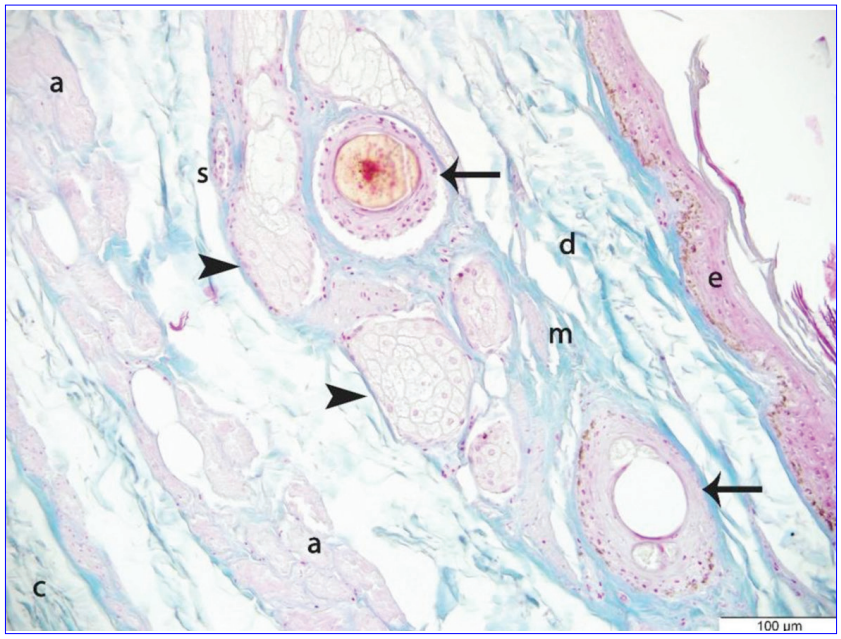


Fig 6. Interdigital gland of Hemshin sheep. **e.** epidermis, **d.** dermis, **c.** capsule, *arrows:* hair follicles, *arrow heads:* sebaceous glands, **s.** sweat gland, **m.** muscle fiber, **a.** apocrine glands. Triple

slaughterhouse has been limited. Therefore, differences of gl. interdigitalis in terms of sex could not be evaluated. Morphologic and morphometric differences of gl. interdigitalis in fore- and hind-feet of male Hemshin sheep were determined in the study.

It was previously reported that gl. interdigitalis was anatomically located between hooves of fore- and hint-feet in sheep, had a duct opening outside and had a shape pipe like dermal fold [18-21]. The gland was reported to be rudimentary in goats [5,22] and it was not found in fore-feet of male roebuck [23]. Avdic et al.[24] stated that the very proximal end of the gland in sheep had fundus, fundus was located on distal of phalanx proximalis, corpus and excretory duct were located between phalanx media; in Hemshin sheep, on the other hand, the very proximal end of the gland was observed to be orifice of excretory duct. The orifice of excretory duct was located at the proximal interphalangeal articulation in Baladi sheep [25]; in Hemshin sheep, it was located between distal ends of phalanx proximalis. In the line with the literature [4,24,26], it was determined that gland's-fundus was at the level of distal of phalanx proximalis and corpus was at the level of phalanx media.

Some morphometric findings regarding the gland were found in literature reviews. Atoji et al.[9], stated that the total length of the gland was 25-40 mm in Japanese serow, Getty [27] reported that its total length was 25-30 mm in sheep. Length of the gland's excretory duct was reported as 23 mm by Çalışlar [18], 18-20 mm by Nickel et al.[20], 10 mm by Atoji et al.[9], 15 mm by Awaad et al.[25] and 16.74 mm by Süzer et al.[28]. Length of the gland's corpus was determined as 6.95 mm in female Kıvırcık sheep by Süzer et al.[28] and 9 mm in Akkaraman sheep by Çalışlar [18]. In Hemshin sheep, total length of the gland was determined as averagely 27.92 mm, length of its corpus as 8.39 mm and length of its duct as 19.92 mm.

Uğurlu [21] reported that there was no significant morphologic difference between sinus interdigitalis in fore- and hind-feet in sheep. It was determined that diameter of gl. interdigitalis' corpus in fore- and hind- feet of male Kıvırcık sheep was 4.29 mm and 5.14 mm, respectively; and length of its excretory duct was 25.03 mm and 27.23 mm, respectively [16]. These values in Hemshin sheep were found as 9.29 mm, 7.48 mm and 20.90 mm, 18.95 mm, respectively. Differently from the researchers [16,21], the gland in fore feet of Hemshin sheep was determined to be considerably larger compared to the hind feet as was reported in the literature [4,8,24] ($P<0.05$).

Aslan et al.[26] reported that arterial vascularization of the gland in Tuj sheep was provided by a. digitalis palmaris et dorsalis III, IV in fore-feet and by a. digitalis plantaris III, IV in the hind feet. It was determined in Hemshin sheep, on the other hand, arterial vascularization of the gland was provided by a. digitales palmares II, III et IV in fore-feet and by a. digitalis dorsalis communis III and aa. digitales plantares propriae III et IV in hind-feet.

The histological, histochemical, immunohistochemical and electronmicroscopic features of the interdigital gland in native sheep breeds were described [4,16,22,26,28,29]. The wall structure of the Hemshin sheep' interdigital gland was composed of epidermis, dermis, and a capsule and hair follicles, sebaceous glands, sweat glands, muscle fibers, and apocrine glands were observed in the interdigital glands of the Hemshin sheep like Kıvırcık [16] and Akkaraman [22] sheep. It was not run across the nerve plexus as described in Kıvırcık [16] sheep and lymph follicles as described in Tuj [26] sheep.

Consequently, length of the gland was measured as 30.18±1.93 mm in fore-feet and 25.67±1.77 mm in hind-feet. The gland in fore-feet was determined to be considerably greater than the gland in hind-feet ($P<0.05$). It was found that the gland was vascularized by branches separated from arteriae digitales palmares communis II, III, and IV in fore-feet and arteria digitalis dorsalis communis III and arteriae digitales plantares propriae III and IV in hind-feet.

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