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Lectin-Based Histochemical Analysis of Sugar Residues in the Gastrointestinal Tract of New Zealand White Rabbit*

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Abstract: The gastrointestinal system of mammals exhibits interspecific variability both physically and functionally. The diversity in the gastrointestinal system reflects unique and functional traits among vertebrate animals. Lectin histochemistry is a method that uses lectins to identify and attach to glycosidic linkages in polysaccharides, glycoproteins, and glycolipids. This particular binding enables the identification of complex structures by determining terminal sugars, hence elucidating physiological or pathological alterations in cells, intercellular relationships, and intracellular transport mechanisms. The present study aimed to identify and illustrate the distribution and density of glycans throughout the gastrointestinal system of the New Zealand White rabbit, spanning from the stomach to the rectum, utilizing lectin histochemistry. Paraffin sections of Bouin-fixed rat tissues were taken 5-µm thick and were examined for the binding of lectins specific to GalNAc (HPA), Gal (PNA), GlcNAc (WGA), and mannose and/or glucose (Con A) using the lectin histochemical method. The lectin binding patterns in the stomach both the small and large intestines exhibited alterations, signifying a diverse composition of carbohydrates. The data indicate that mucin glycosylation differs across various anatomical locations and likely represents a responsive mechanism tailored to local physiological requirements.

Keywords: Gastrointestinal system, intestine, lectin histochemistry, rabbit, stomach.

Yeni Zelanda Beyaz Tavşanının Gastrointestinal Sistemindeki Şeker Kalıntılarının Lektin Bazlı Histokimyasal Analizi

Öz: Memelilerin gastrointestinal sistemi hem fiziksel hem de işlevsel olarak türler arası değişkenlik gösterir. Gastrointestinal sistemdeki çeşitlilik, omurgalı hayvanlar arasında benzersiz mimari ve işlevsel özellikleri yansıtır. Lektin histokimyası, lektinleri kullanarak polisakkaritler, glikoproteinler ve glikolipidlerdeki glikozidik bağlantıları tanımlayan ve bunlara bağlanan bir yöntemdir. Bu özel bağlanma, terminal şekerleri belirleyerek karmaşık yapıların tanımlanmasını sağlar ve böylece hücrelerdeki fizyolojik veya patolojik değişiklikleri, hücreler arası ilişkileri ve hücre içi taşıma mekanizmalarını açıklar. Mevcut çalışma, lektin histokimyasını kullanarak Yeni Zelanda Beyaz tavşanının mideden rektuma kadar uzanan gastrointestinal sistemi boyunca glikanların dağılımını ve yoğunluğunu tanımlamayı ve göstermeyi amaçlamaktadır. Bouin fiksasyonlu sıçan dokularının parafin kesitleri 5 µm kalınlığında alındı ve lektin histokimyasal yöntemi kullanılarak GalNAc (HPA), Gal (PNA), GlcNAc (WGA) ve mannoz ve/veya glikoza (Con A) özgü lektinlerin bağlanması açısından incelendi. Midedeki ve hem ince hem de kalın bağırsaklardaki lektin bağlanma desenleri, karbonhidratların çeşitli bir bileşimini gösteren değişiklikler gösterdi. Veriler, mün glikozilasyonunun çeşitli anatomik konumlarda farklılık gösterdiğini ve muhtemelen yerel fizyolojik gereksinimlere göre uyarlanmış bir yanıt mekanizmasını temsil ettiğini göstermektedir.

Anahtar kelimeler: Bağırsak, gastrointestinal sistem, lektin histokimyası, mide, tavşan.

Introduction

The gastrointestinal (GI) system of mammals reveals interspecific diversity physically and functionally, albeit numerous striking similarities. This diversity in the GI system represents distinct structural and functional characteristics among vertebrate species (Treuting et al., 2018). Despite these observable dif-

ferences, the GI tract throughout all mammalian species is, by its function, continuously exposed to mechanical and chemical insults caused by ingested foods. In addition, the release of various digestive enzymes, bile acids, and hydrochloric acid into the gastrointestinal environment creates an environment in need of protection for the epithelium, which is responsible for many vital functions (Bansil and Turner, 2006). The epithelial surface of the GI tract is protected against abrasion, bacteria, parasitic infections, and noxious chemicals by a mucus coating composed primarily of water and mucins (Cornick et al., 2015; Caspe et al., 2024).

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GI mucins are chiefly produced by goblet cells. Mucins in membrane-bound and soluble-secreted forms are glycoproteins consisting predominantly of O-linked oligosaccharides (Bansil and Turner, 2006). Their functional tasks include lubricating and protecting the epithelial cells from mechanical, physical, and chemical abrasions. They also provide suitable anatomical sites for attachment and entry of pathogenic organisms into the underlying epithelium (Robbe et al., 2004; Kim and Ho, 2010). Therefore, detachment of this layer renders the GI tract more vulnerable to pathogen invasion. In this context, information obtained from commonly used laboratory animals, including mice, rats, and rabbits, is of the utmost importance for further understanding the structure and function of the human GI tract and its associated pathologies (Oglesbee and Lord, 2020). Therefore, a deeper understanding of glycohistochemical differences between the GI tract of various animal species may help us choose the proper animal model for providing valuable insights into glycohistochemical characterization of the human GI tract in health and disease.

Many GI diseases have been reported that may result from aberrant protein glycosylation (Reily et al., 2019; Verhelst et al., 2020; Morosi et al., 2021). The GI tract produces many glycoconjugates that may vary by species, sex, gender, anatomical region, cell type, functional status, and pathological scenario (Schumacher et al., 2004; Kudelka et al., 2020). Therefore, studying changes in glycoconjugate composition would help further understand their functional and pathological importance throughout the GI tract. Lectin histochemistry is a valuable means to identify differences between glycosylation patterns of glycoproteins (Corfield, 2017). While previous studies have indicated that lectin binding specificity mostly indicates the respective monosaccharide binding preference, the lectins used are likely to recognize different, more complex structures present in the sequence (Brooks, 2024). Recent bioinformatics studies have revealed that the majority of plant lectin sequences encode chimerolectins composed of more than one protein domain. In fact, these analyses showed that many lectins are multidomain proteins in which one lectin domain binds to one or more protein domains that serve another function (De Coninck and Van Damme, 2021). Therefore, lectin histochemistry studies are valuable for disease diagnostics and comparative purposes. These studies can detect variations between normal and pathologic conditions of given tissues, between different regions in the same organ, or between homologous areas of specimens of different ages, sexes, or species.

Several studies have reported the distribution of sugar residues in vertebrate GI tracts (Galotta et al., 2009; Boonzaier et al., 2013; Scillitani and Mentino, 2015; Tano De La Hoz et al., 2016; Gomez-Santos et

al., 2017). However, the literature review reveals only patchy evidence of glycan expression in the New Zealand White rabbit GI tract (Galotta et al., 2009; Zanuzzi et al., 2010). Therefore, we aimed to show the distribution of glycans in the GI tract of the New Zealand White rabbit from the stomach to the rectum and whether there are density differences using lectin histochemistry and image analysis.

Material and Methods

Animals

In this study, the gastrointestinal tract from the stomach to the rectum of ten adult male New Zealand rabbits with a weight range of 4-5 kg purchased from a local rabbit breeder in Isparta, Türkiye, were used as material. The Ethical Board of Experimental Animal Production and Experimental Research Laboratory at Süleyman Demirel University (SDU-HÜDAL B.30.2.SDÜ.0.05.06.00-186) provided approval for this study.

Tissue Processing

Samples of the gastrointestinal tract were collected from anesthetized animals using ketamine/xylazine (80/12 mg/kg; Alfasan/Bayer). After anaesthetizing, the abdominal cavities of the animals were opened. Samples harvested from the stomach, small, and large intestines were fixed in Bouin's solution for 15 h, dehydrated in a sequence of increasing ethanol concentrations, cleaned in xylene, and embedded in paraffin. Sections of 5-7 µm in thickness were cut and mounted on albumin-coated slides.

Lectin Histochemistry

Lectin histochemistry was employed to demonstrate the distribution and density of glycans in the gastrointestinal tract regions of the New Zealand White rabbit. Following this protocol, the sections were rinsed in distilled water subsequent to dewaxing in xylene and rehydrating in decreasing concentrations of ethanol. The sections were immersed in 0.3% H₂O₂ (v/v) 100% methanol at room temperature for ten minutes to inhibit endogenous peroxidase activity. Following rinsing in distilled water and washing in 0.01 M PBS (Phosphate Buffered Saline) (pH 7.2) with 1% BSA (Bovine Serum Albumin), the sections were treated for 30 minutes at room temperature with a panel of Horseradish Peroxidase (HRP)-conjugated lectins and subsequently washed in PBS (Çınar et al., 2016). Table 1 lists the HRP-conjugated lectins utilized in this study, along with their binding specificities and optimal concentrations. The sections were exposed to DAB (3,3-diaminobenzidine tetrahydrochloride) to visualize the lectin binding sites at room temperature for 10 minutes. Sections were counterstained in Mayer's Haematoxylin. Then, the sections were rinsed in distilled water, dehydrated in increas-

ing concentrations of alcohol, cleaned in xylene, permanently mounted with Entellan, examined under a light microscope (Olympus, CX 41), and photographed using DP72 digital camera (Olympus, Tokyo, Japan) mounted on the microscope. Control sections were immersed in PBS without the lectins for 30 minutes at room temperature, after which the same procedure was followed.

opposite pattern of staining was seen in the pyloric gland region. The surface mucous cells and some gastric pits were negative, while cells in the glands were intensely stained (Figure 1B). The cardiac glands showed a strong positive reaction to PNA in the different regions of the gastric mucosa. PNA reaction was confined to the surface mucous cells and the lower portions of the cardiac gland regions

Table 1. Lectins used in the study and their binding specificity

Source of lectin	abbreviation	Oligosaccharide specificity	Dilution	Company	Catalog no.
<i>Helix pomatia</i>	HPA	GalNAc α (1,3)GalNAc>Gal β (1,3)GalNAc	10 μ g/ml	Sigma	L6387
<i>Arachis hypogaea</i>	PNA	Gal β (1,3)GalNAc>Gal β (1,4)GlcNAc>Gal	25 μ g/ml	Sigma	L7759
<i>Canavalia ensiformis</i>	Con A	α -D-Man	50 μ g/ml	Sigma	L6397
<i>Triticum vulgaris</i>	WGA	GlcNAc(β 1,4GlcNAc)1-2> >Neu5Ac	β GlcNAc 20 μ g/ml	Sigma	L3892

Evaluation of the Staining

Staining in each experiment was evaluated by at least two independent observers from three histological sections from each sample and scored according to their intensity as (+++) strong reaction, (++) moderate reaction, (+) weak reaction, and (-) negative (Manning et al., 2004).

(Figure 1C). A comparable distribution of PNA lectin binding sites was seen in the pyloric gland region (Figure 1D).

Conversely, Con-A displayed a moderate reaction in the cardiac, fundic, and pyloric gland regions (Figure 2A-C). WGA exhibited greater intensity of binding pattern in the fundic gland region, with a more pronounced positive reaction in the higher sections of

Results

Table 2. Reaction of lectins with sugar residues in gastrointestinal tract regions of New Zealand White rabbits at different intensities

	HPA	PNA	Con A	WGA
Cardia	+++	+++	++	+++
Fundus	+++	+++	++	+++
Pylorus	+++	+++	++	+++
Duodenum	+++	-	++	+++
Jejunum	+++	-	++	+++
Ileum	+++	++	+	++/+++
Proximal Colon	+++	-/+	++	+++
Distal Colon	++	-/+	++	+++
Caecum	-	-/+	++	+++
Rectum	+	-/+	+	+++

The results of lectin histochemistry indicated that lectins reacted with sugar residues in the gastrointestinal tract areas of the New Zealand White rabbit at varying intensities. Table 2 summarizes our main findings.

Stomach

The upper region of the cardiac and fundic glands showed a stronger positive reaction to HPA. This positive reaction was observed in the surface mucous cells, gastric pits, and gastric glands (Figure 1A). The

the glands compared to their bases. The mucus released over the gastric mucosa had a substantial positive reaction to WGA in the cardiac, fundic, and pyloric gland regions. This strong reaction was seen in the surface mucous cells, stomach pits, and gastric glands (Figure 2D-F).

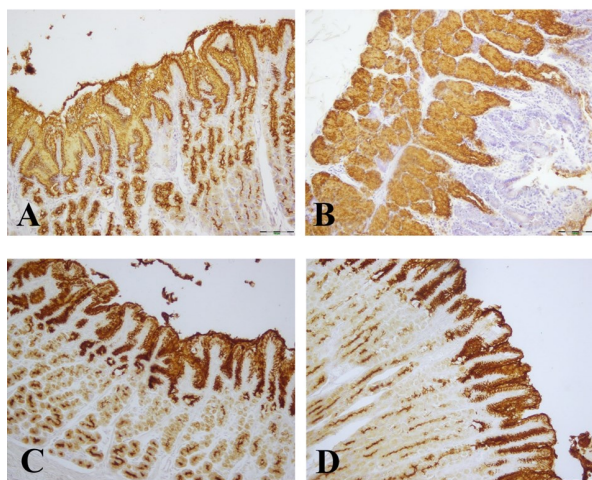


Figure 1. Lectin-binding sites of cardia, fundic, and pylorus regions. A. Cardia, Lectin HPA, Scale bar: 100 µm; B. Pylorus, Lectin HPA, Scale bar: 100 µm; C. Cardia and D. Fundus Lectin PNA, Scale bar: 100 µm.

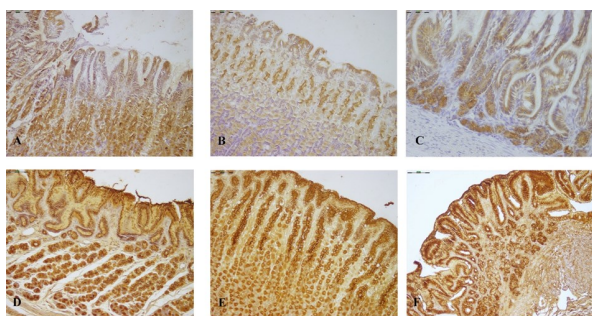


Figure 2. Lectin-binding sites of cardia, fundic, and pylorus regions. A. Cardia, Lectin Con A, Scale bar: 100 µm; B. Fundus, Lectin Con A, Scale bar: 100 µm; C. Pylorus, Lectin Con A, Scale bar: 50 µm; D. Cardia, Lectin WGA, Scale bar: 100 µm; E. Fundus, Lectin WGA, Scale bar: 100 µm; F. Pylorus, Lectin WGA, Scale bar: 100 µm.

Small and Large Intestine

A strong reaction to HPA was observed in the brush border, villi, and Brunner's glands within the duodenum (Figure 3a.A). HPA exhibited enhanced binding to the jejunal epithelium, but cells within the Lieberkühn crypts displayed intense staining (Figure 3a.B). HPA labeling exhibited increased reactivity in the brush border of the crypts, villi, and Lieberkühn glands in the ileum (Figure 3a.C). In the proximal colon, HPA binding was observed throughout the whole crypts (Figure 3b.A). Conversely, in the distal colon, only the cells of the few Lieberkühn glands at

the lower portion of the crypts exhibited a moderate reactivity to HPA (Figure 3b.B). HPA did not react with all regions of the caecum (Figure 3b.C). HPA exhibited a pronounced reaction with the brush border and the Lieberkühn glands in the rectum (Figure 3b.D).

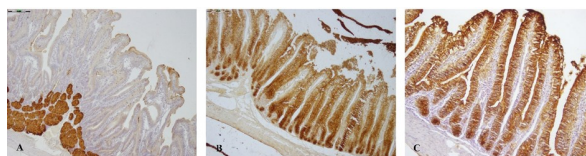


Figure 3a. HPA-binding sites of the small intestine regions. A. Duodenum, Scale bar: 200 µm. B. Jejunum, Scale bar: 200 µm. C. Ileum, Scale bar: 100 µm.

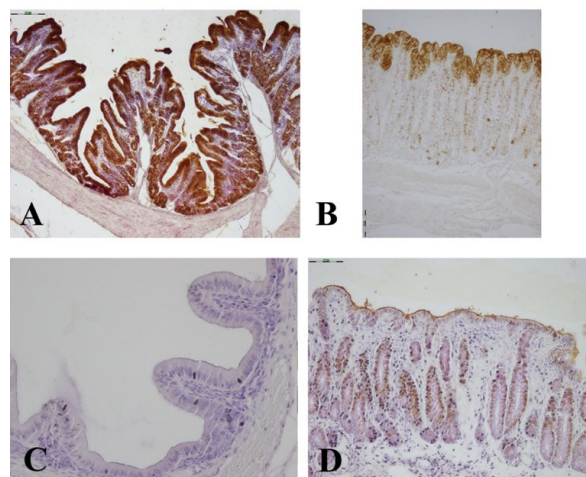


Figure 3b. HPA-binding sites of the small and large intestine regions. D. Proximal colon, Scale bar: 200 µm. E. Distal Colon, Scale bar: 100 µm. F. Caecum, Scale bar: 50 µm. G. Rectum, Scale bar: 100 µm.

The binding of Con A to the brush border of the duodenum and jejunum crypts and villi was stronger than that observed in the ileum while exhibiting weak reactivity in the upper regions of Brunner's gland. Goblet cells predominantly exhibited no reaction in the small intestines (Figure 4A-C). The proximal (Figure 4D), distal (Figure 4E), and caecal (Figure 4F) epithelia exhibited moderate Con A lectin binding, although certain cells within the Lieberkühn glands displayed weak staining.

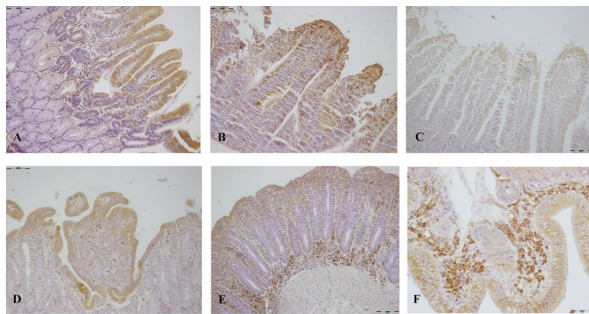


Figure 4. Con A-binding profile of the small and large intestine regions. A. Duodenum, Scale bar: 100 μ m., B. Jejunum, Scale bar: 100 μ m., C. Ileum, Scale bar: 100 μ m., D. Proximal colon, Scale bar: 100 μ m., E. Distal Colon, Scale bar: 100 μ m., F. Caecum, Scale bar: 50 μ m.

WGA exhibited considerable intensity of binding in the duodenum and jejunum, but cells in the ileum had lower staining (Figure 5a). WGA labeling was pronounced in the brush borders of the large intestine (Figure 5b). WGA exhibited a pronounced reaction in both the proximal and distal colon and a mild reaction with the Lieberkühn glands in the rectum (Figure 5b.D).

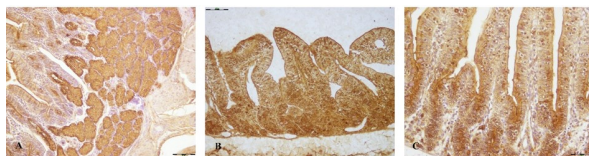


Figure 5a. WGA-binding profile of the small intestine regions. A. Duodenum, Scale bar: 50 μ m., B. Jejunum, Scale bar: 100 μ m., C. Ileum, Scale bar: 100 μ m.

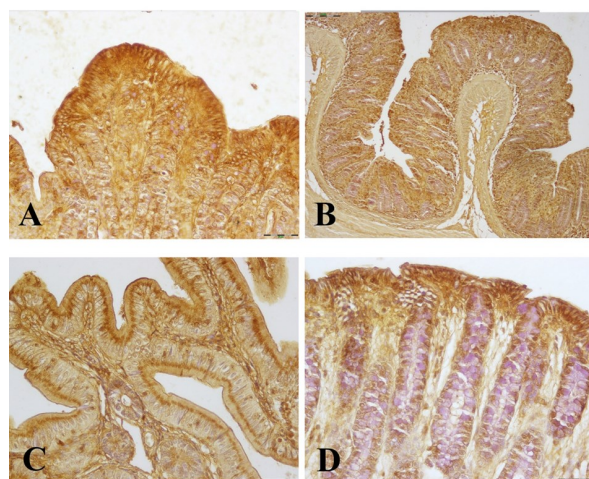


Figure 5b. WGA-binding profile of the large intestine regions. D. Proximal colon, Scale bar: 50 μ m., E. Distal Colon, Scale bar: 200 μ m., F. Caecum, Scale bar: 50 μ m., G. Rectum, Scale bar: 50 μ m.

PNA exhibited no reaction in the duodenum and jejunum, whereas a moderate reaction was noted in the ileal epithelial cells and brush border (Figure 6 A-B). The signals of both PNA-lectins were markedly weak in the crypts and the brush edge (Figure 6 C-D). PNA staining was very weak at both the crypts and brush border in the large intestine (Figure 6 C-D).

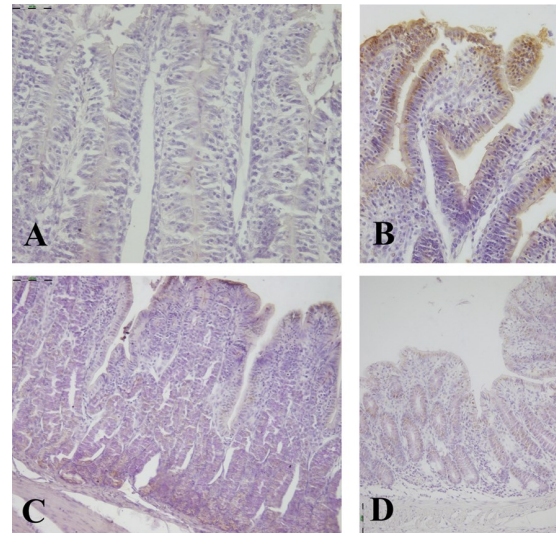


Figure 6. PNA-binding profile of the small and large intestine regions. A. Jejunum, Scala Bar: 50 μ m, B. Ileum, Scala Bar: 50 μ m, C. Proximal colon, Scale bar: 100 μ m, D. Distal Colon, Scale bar: 100 μ m.

Discussion

Certain proteins facilitate biological recognition, binding, and attachment to particular targets. This binding is highly specific to sugar residues and depends mostly on the ability to bind to surface sugars found in the animal, mainly human, digestive tract. Upon binding to specific targets, lectins can induce agglutination of fetal or neoplastic cells, promote lymphocyte proliferation, and impede tumor growth both in vivo and in vitro (Ghasempour and Freeman, 2023). Lectins are a widely used method to identify specific glycan motifs and determine their tissue and cellular localization in histochemical studies, providing important information about glycan diversity and their specific roles (Akimoto and Kawakami, 2014; Gomez-Santos et al., 2017; Sugahara et al., 2017; Tano de la Hoz et al., 2017; Ghasempour and Freeman, 2023). Many studies indicate that lectins attach to the glycoconjugates of the gastrointestinal structures in mammalian species, facilitating the comparison of intra- and inter-species variations in glycoconjugate distribution (Scillitani and Mentino, 2015; Strobel et al., 2015).

The lectin histochemistry approach, employed to map

out tissue glycosylation, has been extremely helpful in uncovering modifications in cellular glycosylation linked to cancer progression and metastasis. It has enabled the development of glycosylated biomarkers that may predict prognosis, and improve early diagnosis and screening efforts. This method is particularly effective for analyzing gastrointestinal carbohydrate changes in animal models designed to understand the pathogenesis of human colorectal diseases such as carcinoma and inflammatory bowel disease (Sharma and Schumacher, 2001; Enomoto et al., 2024). Prior research has indicated that the characteristics and prevalence of terminal sugars on cell surface glycoconjugates are altered in cancer cells within human colon adenocarcinoma (Arab et al., 2013; Strobel et al., 2015).

The constant exposure of intestinal epithelium to dietary constituents, local microbiota, and diverse microorganisms complicates the assessment of each component's involvement in both healthy and pathological conditions. Moreover, as many of these factors work synergistically, alterations in intestinal carbohydrate composition rely on multiple variables (Zanuzzi et al., 2010). The digestive system of rodents has a crucial ecological and physiological role, particularly due to its adaptability to various conditions and the histological structure of the colon depending on water and carbohydrate absorption (Moghaddam et al., 2009). Tano de la Hoz et al. (2017) asserted that observable variations in lectin (Con A, WGA, DBA, SBA, PNA, and UEA-I) histochemistry in the rodent colon may result from the interaction between mucins and bacteria traversing the colonic groove.

Strobel et al. (2015) evidenced the existence of GlcNAc on the mucosal surface, chief cells, neck cells, and parietal cells via WGA lectin binding models in the digestive system of bats. Their study on bats revealed that GalNAc was present in the glycocalyx of enterocytes in the small intestine, whereas similar cells were absent in the large intestine. WGA exhibited considerable reactivity in the duodenum, jejunum, and large intestine, while WGA labeling was less pronounced in the ileum. HPA exhibited pronounced reactivity in the small and large intestine regions, except the caecum. In cancer cells, cell surface terminal sugars and extracellular matrix glycoconjugates appear to be extensively modified. Studies showed that the positivity of glycoconjugates containing GalNAc and GlcNAc increased for different grades of neoplasia in colon adenocarcinoma (Arab et al., 2013).

A moderate PNA binding pattern was observed in the epithelial and mucous neck cells of the pyloric stomach region in *Rhinella icterica* (Machado-Santos et al., 2014). We observed a strong reaction to PNA in the same region. Another study indicated that the surface mucosal cells of the cardia, gastric pits, and

gastric gland areas in monkeys exhibited a pronounced positive reactivity to WGA. The positive reaction to WGA was observed in the fundic gland region, confined to the upper part of the glands and absent from their bases. The surface mucosal cells in the pyloric region and gastric pits exhibited negativity, although certain cells in the body and the base of the glands demonstrated mild staining. The same researchers indicated that the surface mucosal epithelium and foveolar epithelium in the cardiac, fundic, and pyloric gland regions had a negative reaction to Con-A, whereas the body and base of the glands demonstrated a substantial positive reactivity to Con-A (Fayed et al., 2010). We found moderate Con-A staining in the cardiac, fundic, and pyloric gland areas.

A study indicates that alterations in particular lectins and specific regions of the small intestine (PNA in the duodenum and jejunum and WGA in the jejunum) were primarily observed during *Solanum glaucophyllum* intoxication (Zanuzzi et al., 2010). In parallel with these findings, our study revealed that PNA did not exhibit reactivity in the duodenum, whereas WGA lectin labeling demonstrated a strong reaction in the jejunum. Another study indicated that Con-A and PNA labeling was moderate to strong in the jejunum and ileum of *Lagostomus maximus*, but WGA labeling was more pronounced in the jejunum compared to the ileum (Tano De La Hoz et al., 2016). Galotta et al. (2009) investigated the binding patterns of some lectins in the intestines of horses, pigs, and rabbits. Con A yielded negative results in the jejunum and ileum across all three species. WGA lectin binding was seen in the jejunum and ileum of all three species. PNA lectin binding was not present in the jejunum and ileum of pigs and rabbits, whereas it was detected at considerable levels in the same regions of horses. Furthermore, Con A binding was absent in the colons of horses, pigs, and rabbits, and exhibited minimal reactivity in the rectum. However, PNA exhibited no reactivity in the colon and rectum of all examined species (Galotta et al., 2009). Conversely, in our study, Con A showed reactivity in both the small and large intestines. PNA exhibited no reaction in the duodenum and jejunum, while a moderate reaction was noted in the epithelial cells and brush border of the ileum. PNA labeling was markedly weak in the crypts and brush border of the large intestine.

Normal gastrointestinal lectin histochemistry has shown that lectins can be used as reliable markers not only for cell identification but also for the search for similar glycans with subtle differences in sugar sequences. In conclusion, this study demonstrates that lectin binding patterns across the rabbit gastrointestinal tract reveal different compositions of carbohydrates. The observations indicate that mucin glycosylation differs among various anatomical locations, possibly forming a responsive system tailored to local

physiological needs. This data may also aid in establishing a comprehensive histochemical framework to serve as a comparative baseline for future research focused on the dietary physiology of this species. Additional investigations into the alterations in glycan expression in diseased situations may clarify their biological roles and functional importance.

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Carrier Plans of Veterinary Faculty Students After Graduation and Their Expectations Regarding Working Conditions

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Abstract: The objective was to determine the distribution of future carrier preferences of Istanbul University-Cerrahpaşa Veterinary Faculty students and the factors affecting this distribution. Data were collected via face-to-face questionnaires from 327 and 347 students who were in their 3rd, 4th, and 5th year and who responded to the survey in 2015 and 2021. The questionnaire consists of two parts: in the first part, students' gender, class, place of birth, grade point averages and income levels of their families. In the second part, the field they want to work in after graduation, their expectations regarding working conditions, and their monthly income were questioned. Gender has a highly significant effect on students' career choices in both years ($P<0.001$). While the first choice of female students in both years was the companion animal clinic, the first choice of male students was the farm animal practice in 2015 and the companion animal clinic in 2021. Monthly family income significantly affected student career choices in 2015 while not in 2021. It is seen that 39.4% of the students whose monthly family income is below 685 USD preferred farm animal practice. In comparison, 51.1% of students whose family income is 1601-2050 USD prefer to work in companion animal clinics. The study's findings of the study highlight the importance of gender, hometown and monthly family income considerations in shaping the career plans of veterinary students. There was also an apparent decrease in preference for farm animal practice and an increase in companion animal practice.

Keywords: Career choices, education, professional expectations, undergraduate, veterinary student

Veteriner Fakültesi Öğrencilerinin Mezuniyet Sonrası Kariyer Planları ve Çalışma Koşullarına İlişkin Beklentileri

Öz: Çalışmanın amacı, İstanbul Üniversitesi-Cerrahpaşa Veteriner Fakültesi öğrencilerinin gelecekteki meslek tercihlerinin dağılımını ve bu dağılımı etkileyen faktörleri belirlemektir. Veriler, 2015 ve 2021 yıllarında ankete yanıt veren 3., 4. ve 5. sınıfta okuyan 327 ve 347 öğrenciden yüz yüze anket yoluyla toplanmıştır. Anket iki bölümden oluşmaktadır: Birinci bölümde öğrencilerin cinsiyeti, sınıfı, doğum yeri, not ortalamaları ve ailelerinin gelir düzeyleri; ikinci bölümde ise veteriner hekim olarak aylık gelir beklentileri, mezuniyetten sonra çalışmak istedikleri alan ve çalışma koşullarına ilişkin beklentileri sorgulanmıştır. Cinsiyetin her iki yılda da öğrencilerin kariyer tercihleri üzerine oldukça anlamlı bir etkisi olduğu tespit edilmiştir ($P<0.001$). Kız öğrencilerin her iki yılda da ilk tercihleri küçük hayvan hayvan kliniği iken, erkek öğrencilerin ilk tercihi 2015 yılında çiftlik hayvanı pratiği, 2021 yılında ise küçük hayvan kliniği olmuştur. Aylık aile geliri öğrencilerin kariyer seçimlerini 2015 yılında önemli ölçüde etkilerken 2021 yılında etkilememiştir. Aylık aile geliri 685 ABD dolarının altında olan öğrencilerin %39.4'ünün çiftlik hayvanı pratiğini tercih ettiği görülmektedir. Aile geliri 1601-2050 ABD doları olan öğrencilerin %51.1'i küçük hayvan kliniklerinde çalışmayı tercih etmektedir. Çalışma bulguları, veterinerlik öğrencilerinin kariyer planlarını şekillendirmede cinsiyet, doğum yeri ve aylık aile geliri etkilerinin önemini vurgulamaktadır. Çiftlik hayvanı pratiğine olan ilgi belirgin bir azalma ve küçük hayvan pratiğinde ise artış olduğu da görülmüştür.

Anahtar kelimeler: Kariyer tercihi, eğitim, lisans, mesleki beklenti, veteriner fakültesi öğrencisi

Introduction

Several scientific studies have investigated the factors affecting the working area preferences of veterinary students and their expectations regarding working conditions. Demographic factors such as age, gender, and prior experience significantly affect career choices and attitudes toward different veterinary

fields. Background experience before admission to veterinary school and personal interests strongly influence the choice between small-animal practice, large-animal practice, research, and other specializations. People who experience interacting with animals during their childhood display long-term preferences and attitudes towards animals in the later stages of their lives (Serpell, 2004). Veterinary students are among the representatives of this idea (Serpell, 2005). Studies show that most veterinarian candi-

dates prefer the profession with a pre-existing interest and love for animals (Heath et al., 1996). It is reported that veterinarians who prefer companion animal clinics after graduation adopt animals in the early stages of their lives, and female veterinarians prefer farm animal practice less than men (Kinnison and May, 2013; Serpell, 2005). Veterinarians work in many different areas, especially in farm animal practice, companion animal clinics, food hygiene and safety, pharmaceutical and feed industries. The demand for veterinarians depends on various factors such as the prevalence of livestock farming, rates of pet ownership, and the level of development of the food, feed and pharmaceutical industries.

This study aimed to determine the distribution of future carrier preferences among Istanbul University-Cerrahpasa Veterinary Faculty students and the factors affecting this distribution. Knowledge of which fields veterinary medicine graduates would prefer to work in can contribute significantly to the planning of veterinary faculty education and to taking action to include graduates in practice areas that are less preferred. In addition, this study tested the hypothesis that the Turkish economic crisis and the pandemic impacted students' career choices and monthly income expectations. In this context, the survey results of 2015 and 2021 were compared.

Material and Methods

The Istanbul University-Cerrahpasa ethics committee approved the study's appropriateness (Approval number: 2021/304).

Questionnaire and Participants

In this study 327 and 347 students in their 3rd, 4th, and 5th year at Istanbul University-Cerrahpasa, the Faculty of Veterinary Medicine, responded to the survey in 2015 and 2021, respectively. No sampling was conducted within the scope of the study. All 3rd, 4th, and 5th-year students at the current IUC Faculty of Veterinary Medicine were invited to participate in this study. The data of the students who volunteered to participate in the study are presented in the article. The study conducted in 2015 was repeated in 2021 to reveal the post-graduation career preferences of IUC Faculty of Veterinary Medicine students and whether the factors affecting these preferences have changed after the pandemic and economic crisis. Within the scope of the study, a 10-question survey was conducted to determine the distribution of carrier choices of veterinary students and the factors affecting this distribution. The questionnaire consisted of two parts. In the first part, participants were asked to give demographic information such as gender, class,

hometown, grade points average (GPA), and family income. In the second part, students' career choices after graduation (farm animal practice, companion animal clinic, equine practice, poultry practice, feed industry, food hygiene and safety, pharmaceutical industry, public employee, academia), their monthly income expectations as a veterinarian, and their expectations regarding working conditions were questioned. The minimum wage was used to create monthly income expectation ranges. The monthly income expectation range was asked in TL to the students, and to compare income expectation in different time periods, it was converted to USD using the Central Bank of Türkiye exchange rate for the relevant period. Students' monthly income expectation range were <1140 USD, 1141 – 1370 USD, 1371 – 1600 USD, 1601 – 1830 USD, 1831 – 2050 USD, and >2050 USD. During the data editing, students' GPA information was transformed into the following four categories: i. <2, ii. 2.00-2.49, iii. 2.50-2.99, iv. >3.00. Hometown data consists of metropolis, city, and rural/village. Students were informed about the questionnaire, and participation in the study was voluntary. The questions about the identity information of the students were not included in the questionnaire.

Statistical Analyses

The study considered the student's daily working hours expectation, working time expectation, income expectation and career preference as dependent variables. The independent samples chi-square test of association was used to compare the subgroups of the student's gender, class, hometown, GPA and monthly family income, and year factors in terms of dependent variables. In case of statistical significance, pairwise chi-square or Fisher's exact test was applied to determine which subgroup differences were significant. The significance for averages with more than 3 letters was expressed in the tables by placing a hyphen between the first and last letters. The statistical significance level was determined as $P < 0.05$. To summarize the data, n (%) was used. All analyses were performed with the Jamovi 2.3.28 program (The Jamovi Project, 2025).

Results

Table 1 presents the demographic information of the respondents and percentages of students in each subgroup. Demographic information of respondents shows that most of the participants in 2015 and 2021 were male (57.80% and 51.9%). Approximately 92% of participants in both years came from metropolises and cities, while 7% of them came from rural areas. While the monthly income of the families of 44% of the

students who participated in the survey conducted in 2015 was below 1141 USD, it is seen that this proportion increased to 67.7% in 2021.

The effects of respondents' gender, class, hometown, GPA, and family income on the students' expectation of daily working time as a veterinarian are represented in Table 2. Gender has a significant effect on expectation of daily working time in 2021, while monthly family income has a significant effect in 2015 ($P < 0.05$). In 2021, whereas 69.7% of female students preferred an 8 h working in a day, 60.7% of male students preferred it. Moreover, 21.9% of male students preferred 8-12 h working in a day, while 11.5% of female students preferred it. On the other hand, the year generally effects on expectations of daily working time. The percentage of students preferring less than 8 h, and 8-12 h working a day in 2015 and 2021 decreased from 25.7% and 18.3% to 18.1 and 16.9%, respectively. In contrast, the students' 8 h working a day preference increased in 2021 compared to 2015.

Preferences for the time periods in which students want to work during the day are shown in Table 3. The results point out that gender, GPA, and monthly family income affect students' preferences for the working time period. Moreover, the effect of the year on the expectation of daily working period was also found significant. It is seen that the daytime preferences of students decreased from 76.8% to 57.3%, while "no

matter" preferences increased from 17.1% to 41.2% in 2021 compared to 2015.

The effects of respondents' gender, class, hometown, GPA, and family income on their income expectations in 2015 and 2021 are given in Tables 4 and 5. The results indicate that monthly family income can affect students' income expectations in 2015 and 2021, moreover gender and class also affect it in 2021.

The influence of respondents' gender, class, hometown, GPA, and family income on the career choices of veterinary students in 2015 and 2021 are represented in Tables 6 and 7. Considering the overall evaluation, while the career choices of the students in 2015 are listed as companion animal clinic, farm animal practice, food hygiene and safety, and public employee, those in 2021 are listed as companion animal clinic, academia, farm animal practice, and food hygiene and safety. Moreover, the effects of respondents' gender, hometown, GPA, and monthly family income on their career choices were significantly important in both years. In addition, Table 8 represents P-values for the year effect regarding monthly income expectation and students' career choices.

Table 1. Demographic information of respondents

Items	2015		2021	
	Frequency n	Percentage %	Frequency n	Percentage %
Gender				
Male	189	57.80	180	51.9
Female	138	42.20	167	48.1
Class				
3	110	33.64	101	29.1
4	117	35.78	85	24.5
5	100	30.58	161	46.4
Hometown				
Metropolis	187	57.19	222	64.0
City	115	35.17	98	28.2
Rural/village	24	7.34	27	7.8
GPA				
< 2	32	9.79	3	0.9
2.00 - 2.49	152	46.48	58	16.7
2.50 - 2.99	79	24.16	94	27.1
> 3.00	64	19.57	192	55.3
Monthly family income (USD)*				
< 685	35	10.70	108	31.1
685 - 1140	109	33.33	127	36.6
1141 - 1600	99	30.28	59	17
1601 - 2050	45	13.76	16	4.6
> 2050	39	11.93	37	10.7
TOTAL	327	100.00	347	100.00

*USD exchange rate calculations were made based on 2.19 for 2015 and 8.30 for 2021.

76 **Table 2.** The effects of student gender, class, hometown, GPA and family income level on students' daily work time expectations.

Item	2015						2021						P-value for year effect		
	< 8 h		8 h		8-12 h		< 8 h		8 h		8-12 h				
	n	%	n	%	n	%	n	%	n	%	n	%		P- value	
Gender															
Male	50	26.5	99	52.4	40	21.2	0.216	31	17.4 ^{bc}	108	60.7 ^a	39	21.9 ^b	0.036	0.104
Female	34	24.6	84	60.9	20	14.5		31	18.8 ^{bc}	115	69.7 ^a	19	11.5 ^c		0.271
Class															
3	35	31.8	60	54.5	15	13.6		22	21.8	68	67.3	11	10.9		0.157
4	30	25.6	62	53.0	25	21.4	0.193	9	10.7	54	64.3	21	25.0	0.060	0.036
5	19	19.0	61	61.0	20	20.0		31	19.6	101	63.9	26	16.5		0.768
Hometown															
Metropolis	46	24.6	103	55.1	38	20.3		35	16.0	151	68.9	33	15.1		0.015
City	35	30.4	64	55.7	16	13.9	0.293	20	20.6	58	59.8	19	19.6	0.314	0.208
Rural/village	3	12.5	16	66.7	5	20.8		7	25.9	14	51.9	6	22.2		0.437
GPA															
< 2	5	15.6	18	56.3	9	28.1		1	33.3	1	33.3	1	33.3		0.673
2.00 - 2.49	40	26.3	89	58.6	23	15.1	0.472	11	19.0	38	65.5	9	15.5	0.351	0.529
2.50 - 2.99	19	24.1	43	54.4	17	21.5		11	12.0	60	65.2	21	22.8		0.111
> 3.00	20	31.3	33	51.6	11	17.2		39	20.5	124	65.3	27	14.2		0.128
Monthly family income (USD)*															
< 685	14	40.0 ^{bc}	16	45.7 ^{abc}	5	14.3 ^{de}		20	18.7	67	62.6	20	18.7		0.037
685 - 1140	31	28.4 ^{cd}	65	59.6 ^a	13	11.9 ^e		25	19.8	85	67.5	16	12.7		0.301
1141 - 1600	22	22.2 ^d	59	59.6 ^a	18	18.2 ^{de}	0.014	5	8.6	42	72.4	11	19.0	0.324	0.087
1601 - 2050	12	26.7 ^{cd}	24	53.3 ^{ab}	9	20.0 ^{de}		2	12.5	10	62.5	4	25.0		0.510
> 2050	5	12.8 ^{de}	19	48.7 ^{ab}	15	38.5 ^{bcd}		10	27.8	19	52.8	7	19.4		0.107
Overall	84	25.7	183	56.0	60	18.3		62	18.1	223	65.0	58	16.9		0.032

*USD exchange rate calculations were made based on 2.19 for 2015 and 8.30 for 2021.
a-e: The differences between percentages without shared letters among subgroups of "the family income level x students' daily work time expectations" and "gender x students' daily work time expectations" are significant (P<0.05).

Table 3. The effects of student gender, class, hometown, GPA and family income level on students' daily working period expectations.

Item	2015					2021					P-value for year effect			
	Day-time		At night		No matter	P-value	Day-time		At night			No matter	P-value	
	n	%	n	%			n	%	n	%	n			%
Gender														
Male	135	71.4 ^b	12	6.3 ^d	42	22.2 ^c	0.014	82	46.9 ^b	3	1.7 ^d	90	51.4 ^b	<0.001
Female	116	84.1 ^a	8	5.8 ^d	14	10.1 ^d		114	68.3 ^a	2	1.2 ^d	51	30.5 ^c	<0.001
Class														
3	83	75.5	11	10.0	16	14.5		54	54.0	1	1.0	45	45.0	<0.001
4	89	76.1	6	5.1	22	18.8	0.263	44	53.0	1	1.2	38	45.8	<0.001
5	79	79.0	3	3.0	18	18.0		98	61.6	3	1.9	58	36.5	0.006
Hometown														
Metropolis	139	74.3	9	4.8	39	20.9		134	60.9	3	1.4	83	37.7	<0.001
City	92	80.0	10	8.7	13	11.3	0.198	48	50.5	2	2.1	45	47.4	<0.001
Rural/Village	19	79.2	1	4.2	4	16.7		14	51.9	0	0	13	48.1	0.041
GPA														
< 2	16	50.0 ^b	3	9.4 ^{cd}	13	40.6 ^b		1	33.3 ^{bc}	0	0 ^d	2	66.7 ^{ab}	0.647
2.00 - 2.49	121	79.6 ^a	4	2.6 ^d	27	17.8 ^c	0.001	22	38.6 ^b	3	5.3 ^{cd}	32	56.1 ^a	0.014
2.50 - 2.99	61	77.2 ^a	8	10.1 ^c	10	12.7 ^c		58	63.0 ^a	1	1.1 ^d	33	35.9 ^b	<0.001
> 3.00	53	82.8 ^a	5	7.8 ^{cd}	6	9.4 ^c		115	60.5 ^a	1	0.5 ^d	74	38.9 ^b	<0.001
Monthly family income (USD)*														
< 685	23	65.7 ^c	3	8.6 ^{gh}	9	25.7 ^e		56	52.8 ^{bc}	0	0 ^e	50	47.2 ^{bc}	0.002
685 - 1140	89	81.7 ^{ab}	7	6.4 ^{gh}	13	11.9 ^{fg}		68	54.0 ^{bc}	5	4.0 ^e	53	42.1 ^{cd}	<0.001
1141 - 1600	86	86.9 ^a	4	4.0 ^h	9	9.1 ^{gh}	0.004	36	63.2 ^{ab}	0	0 ^e	21	36.8 ^{cd}	<0.001
1601 - 2050	31	68.9 ^{bc}	3	6.7 ^{gh}	11	24.4 ^{ef}		9	56.3 ^{ab}	0	0 ^e	7	43.8 ^{bcd}	0.241
> 2050	22	56.4 ^{cd}	3	7.7 ^{gh}	14	35.9 ^{de}		27	73.0 ^a	0	0 ^e	10	27.0 ^d	0.127
Overall	251	76.8	20	6.1	56	17.1		196	57.3	5	1.5	141	41.2	<0.001

*USD exchange rate calculations were made based on 2.19 for 2015 and 8.30 for 2021.
^{a-h}: The differences between percentages without shared letters among subgroups are significant ($P<0.05$).

Table 4. The effects of student gender, class, hometown, GPA and family income level on student income expectations in 2015.

Item	Monthly income expectation of the student, USD*										P-value	
	< 1140 USD		1141 – 1370 USD		1371 - 1600 USD		1601 – 1830 USD		1831 - 2050 USD			> 2050 USD
	n	%	n	%	n	%	n	%	n	%	n	%
Gender												
Male	20	10.6	25	13.2	41	21.7	31	16.4	27	14.3	45	23.8
Female	10	7.2	25	18.1	35	25.4	25	18.1	16	11.6	27	19.6
Class												
3	10	9.1	11	10.0	31	28.2	19	17.3	18	16.4	21	19.1
4	5	4.3	22	18.8	25	21.4	23	19.7	13	11.1	29	24.8
5	15	15.0	17	17.0	20	20.0	14	14.0	12	12.0	22	22.0
Hometown												
Metropolis	22	11.8	27	14.4	37	19.8	34	18.2	23	12.3	44	23.5
City	7	6.1	20	17.4	34	29.6	16	13.9	15	13.0	23	20.0
Rural/village	1	4.2	3	12.5	5	20.8	5	20.8	5	20.8	5	20.8
GPA												
< 2	3	9.4	4	12.5	7	21.9	6	18.8	3	9.4	9	28.1
2.00 - 2.49	18	11.8	29	19.1	33	21.7	20	13.2	20	13.2	32	21.1
2.50 - 2.99	3	3.8	7	8.9	24	30.4	16	20.3	15	19.0	14	17.7
> 3.00	6	9.4	10	15.6	12	18.8	14	21.9	5	7.8	17	26.6
Monthly family income (USD)*												
< 685	3	8.6 ^{def}	7	20.0 ^{a-d}	8	22.9 ^{abc}	3	8.6 ^{def}	8	22.9 ^{abc}	6	17.1 ^{bcd}
685 - 1140	18	16.5 ^{cd}	25	22.9 ^{abc}	29	26.6 ^{abc}	17	15.6 ^{cd}	9	8.3 ^{def}	11	10.1 ^{de}
1141 - 1600	5	5.1 ^{ef}	12	12.1 ^{c-f}	26	26.3 ^{abc}	21	21.2 ^{bc}	11	11.1 ^{def}	24	24.2 ^{abc}
1601 - 2050	3	6.7 ^{def}	2	4.4 ^{ef}	8	17.8 ^{cd}	9	20.0 ^{a-d}	7	15.6 ^{cd}	16	35.6 ^{ab}
> 2050	1	2.6 ^f	4	10.3 ^{def}	5	12.8 ^{c-f}	6	15.4 ^{cd}	8	20.5 ^{abc}	15	38.5 ^a
Overall	30	9.2	50	15.3	76	23.2	56	17.1	43	13.1	72	22.02

*USD exchange rate calculations were made based on 2.19 for 2015 and 8.30 for 2021
a-f: The differences between percentages without shared letters among subgroups are significant (P<0.05).

Table 5. The effects of student gender, class, hometown, GPA and family income level on student income expectations in 2021.

Item	Monthly income expectation of the student, USD*																		P-value
	< 1140 USD			1141 – 1370 USD			1371 - 1600 USD			1601 – 1830 USD			1831 - 2050 USD			> 2050 USD			
	n	%		n	%		n	%		n	%		n	%		n	%		
Gender																			
Male	45	25.7 ^b		57	32.6 ^{ab}		10	5.7 ^{de}		2	1.1 ^f		18	10.3 ^{cd}		43	24.6 ^b	0.037	
Female	60	36.4 ^a		62	37.6 ^a		4	2.4 ^{ef}		1	0.6 ^f		16	9.7 ^{cd}		22	13.3 ^c		
Class																		0.032	
3	19	20.0 ^{bc}		28	29.5 ^{ab}		5	5.3 ^{def}		1	1.1 ^{fg}		14	14.7 ^c		28	29.5 ^{ab}		
4	29	34.1 ^a		28	32.9 ^a		3	3.5 ^{efg}		1	1.2 ^{efg}		10	11.8 ^{cd}		14	16.5 ^c		
5	57	35.6 ^a		63	39.4 ^a		6	3.8 ^{efg}		1	0.6 ^g		10	6.3 ^{de}		23	14.4 ^c		
Hometown																		0.379	
Metropolis	76	34.9		74	33.9		9	4.1		2	0.9		18	8.3		39	17.9		
City	23	24.0		38	39.6		4	4.2		0	0.0		12	12.5		19	19.8		
Rural/Village	6	23.1		7	26.9		1	3.8		1	3.8		4	15.4		7	26.9		
GPA																		0.782	
< 2	1	33.3		1	33.3		0	0.0		0	0.0		0	0.0		1	33.3		
2.00 - 2.49	24	41.4		18	31.0		3	5.2		1	1.7		2	3.4		10	17.2		
2.50 - 2.99	29	30.9		33	35.1		4	4.3		1	1.1		7	7.4		20	21.3		
> 3.00	51	27.6		67	36.2		7	3.8		1	0.5		25	13.5		34	18.4		
Monthly family income (USD)*																		0.043	
< 685	41	38.3 ^a		40	37.4 ^a		2	1.9 ^{gh}		1	0.9 ^{gh}		7	6.5 ^{def}		16	15.0 ^{cd}		
685 - 1140	41	33.1 ^a		39	31.5 ^{ab}		7	5.6 ^{efg}		1	0.8 ^{gh}		9	7.3 ^{def}		27	21.8 ^{bc}		
1141 - 1600	16	27.6 ^{ab}		23	39.7 ^a		4	6.9 ^{def}		0	0.0 ^h		8	13.8 ^{cde}		7	12.1 ^{cde}		
1601 - 2050	1	7.1 ^{d-g}		3	21.4 ^{bcd}		0	0.0 ^h		0	0.0 ^h		4	28.6 ^{abc}		6	42.9 ^a		
> 2050	6	16.2 ^{bcd}		14	37.8 ^a		1	2.7 ^{e-h}		1	2.7 ^{e-h}		6	16.2 ^{bcd}		9	24.3 ^{abc}		
Overall	105	30.9		119	35.0		14	4.1		3	0.9		34	10.0		65	19.1		

*USD exchange rate calculations were made based on 2.19 for 2015 and 8.30 for 2021.
^{a-h}; The differences between percentages without shared letters among interaction are significant ($P<0.05$).

Table 6. The effects of student gender, class, hometown, GPA and family income level on career choice in 2015.

Item	Student's Career Choice																		P- value
	Farm Anim. Practice		Companion Anim. Clinic		Equine Practice		Poultry Practice		Feed Industry		Food Hyg. and Safety		Pharm. Industry		Public Employee		Academia		
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Gender																			
Male	54	29.3 ^a	50	27.2 ^{ab}	1	0.5 ^j	10	5.4 ⁱ	9	4.9 ^{gh}	23	12.5 ^{cde}	6	3.3 ^{hij}	18	9.8 ^{d-g}	13	7.1 ^{e-h}	<0.001
Female	15	10.9 ^{c-f}	35	25.4 ^{ab}	4	2.9 ^{hij}	7	5.1 ⁱ	3	2.2 ^{ij}	20	14.5 ^{cd}	15	10.9 ^{c-f}	25	18.1 ^{bc}	14	10.1 ^{c-g}	
Class																			
3	25	22.9	30	27.5	3	2.8	8	7.3	4	3.7	10	9.2	6	5.5	14	12.8	9	8.3	
4	22	19.1	28	24.3	1	0.9	6	5.2	6	5.2	16	13.9	7	6.1	16	13.9	13	11.3	0.797
5	22	22.4	27	27.6	1	1.0	3	3.1	2	2.0	17	17.3	8	8.1	13	13.3	5	5.1	
Hometown																			
Metropolis	36	19.5 ^{cd}	57	30.8 ^b	3	1.6 ^j	9	4.9 ^{g-j}	7	3.8 ^{hij}	30	16.2 ^{cde}	7	3.8 ^{hij}	20	10.8 ^{efg}	16	8.6 ^{gh}	
City	21	18.6 ^{cde}	27	23.9 ^{bc}	2	1.8 ⁱ	6	5.3 ^{g-j}	5	4.4 ^{h-j}	11	9.7 ^{efg}	14	12.4 ^{def}	19	16.8 ^{cde}	8	7.1 ⁱ	0.003
Rural/ village	12	52.2 ^a	0	0 ^j	0	0 ^j	2	8.7 ^{e-i}	0	0 ^j	2	8.7 ^{e-i}	0	0 ^j	4	17.4 ^{c-f}	3	13.0 ^{c-g}	
GPA																			
< 2	9	30.0 ^{ab}	9	30.0 ^{ab}	0	0 ^j	1	3.3 ^{gh}	0	0 ^j	8	26.7 ^{ab}	0	0 ^j	2	6.7 ^{e-i}	1	3.3 ^{gh}	
2.00 - 2.49	36	24.0 ^{abc}	49	32.7 ^a	2	1.3 ⁱ	7	4.7 ^{gh}	6	4.0 ^{gh}	12	8.0 ^{efg}	8	5.3 ⁱ	26	17.3 ^{bcd}	4	2.7 ^{hi}	<0.001
2.50 - 2.99	12	15.4 ^{b-e}	19	24.4 ^{abc}	2	2.6 ^{hi}	3	3.8 ^{gh}	3	3.8 ^{gh}	14	17.9 ^{bcd}	8	10.3 ^{deg}	11	14.1 ^{b-e}	6	7.7 ^{e-h}	
> 3.00	12	18.8 ^{bcd}	8	12.5 ^{c-f}	1	1.6 ^{hi}	6	9.4 ^{d-g}	3	4.7 ^{ghi}	9	14.1 ^{bcd}	5	7.8 ^{e-h}	4	6.3 ^{e-h}	16	25.0 ^{abc}	
Monthly family income (USD)*																			
< 685	13	39.4 ^{ab}	5	15.2 ^{c-g}	0	0 ^j	4	12.1 ^{d-h}	0	0 ^j	2	6.1 ^{h-j}	2	6.1 ^{h-j}	3	9.1 ^{d-i}	4	12.1 ^{d-h}	
685 - 1140	23	21.5 ^{cd}	21	19.6 ^{cd}	2	1.9 ^{ij}	6	5.6 ^{g-j}	9	8.4 ^{e-h}	14	13.1 ^{d-g}	9	8.4 ^{e-h}	19	17.8 ^{cd}	4	3.7 ^{hij}	
1141 - 1600	18	18.2 ^{cd}	26	26.3 ^{bc}	1	1.0 ^j	6	6.1 ^{h-j}	1	1.0 ^j	16	16.2 ^{cde}	7	7.1 ⁱ	16	16.2 ^{cde}	8	8.1 ^{e-h}	0.002
1601 - 2050	5	11.1 ^{d-h}	23	51.1 ^a	1	2.2 ^{hij}	0	0 ^j	1	2.2 ^{hij}	4	8.9 ^{d-h}	0	0 ^j	3	6.7 ^{f-j}	8	17.8 ^{c-f}	
> 2050	10	26.3 ^{bcd}	10	26.3 ^{bcd}	1	2.6 ^{hij}	1	2.6 ^{hij}	1	2.6 ^{hij}	7	18.4 ^{cde}	3	7.9 ^{e-i}	2	5.3 ^{g-j}	3	7.9 ^{e-i}	
Overall	69	21.4	85	26.4	5	1.6	17	5.3	12	3.7	43	13.4	21	6.5	43	13.4	27	8.4	

*USD exchange rate calculations were made based on 2.19 for 2015 and 8.30 for 2021.
a-i: The differences between percentages without shared letters among interaction are significant (P<0.05).

Table 7. The effects of student gender, class, hometown, GPA and family income level on career choice in 2021.

Item	Student's Career Choice																		P-value
	Farm Anim. Practice		Companion Anim. Clinic		Equine Practice		Poultry Practice		Feed Industry		Food Hyg. and Safety		Pharm. Industry		Public Employee		Academia		
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Gender																			
Male	66	16.8 ^{cd}	114	29.1 ^b	22	5.6 ^{ghi}	23	5.9 ^{f4}	17	4.3 ⁱ	47	12.0 ^{de}	31	7.9 ^{e-h}	35	8.9 ^{efg}	37	9.4 ^{ef}	
Female	15	5.0 ^{hi}	108	36.1 ^a	15	5.0 ^{hi}	5	1.7 ^j	4	1.3 ^j	33	11.0 ^e	35	11.7 ^{de}	26	8.7 ^{e-h}	58	19.4 ^c	
Class																			
3	17	9.4 ^{def}	62	34.3 ^a	21	11.6 ^{b-e}	8	4.4 ^{gh}	6	3.3 ^{ghi}	17	9.4 ^{def}	13	7.2 ^{efg}	10	5.5 ^{fgh}	27	14.9 ^{bcd}	
4	28	17.5 ^b	56	35.0 ^a	5	3.1 ^{ghi}	4	2.5 ^{hi}	1	0.6 ⁱ	14	8.8 ^{ef}	13	8.1 ^{efg}	12	7.5 ^{efg}	27	16.9 ^{bc}	
5	36	10.3 ^{def}	104	29.6 ^a	10	2.8 ^{hi}	16	4.6 ^{gh}	14	4.0 ^{gh}	49	14.0 ^{bcd}	39	11.1 ^{cde}	39	11.1 ^{cde}	44	12.5 ^{b-e}	
Hometown																			
Metropolis	33	7.8 ^{gh}	149	35.4 ^a	26	6.2 ^{ghi}	16	3.8 ^{ij}	13	3.1 ^j	48	11.4 ^{ef}	41	9.7 ^{efg}	25	5.9 ^{ghi}	70	16.6 ^{bcd}	
City	28	13.5 ^{cde}	61	29.5 ^a	10	4.8 ^{hij}	7	3.4 ^{ij}	6	2.9 ^j	23	11.1 ^{def}	23	11.1 ^{def}	23	11.1 ^{def}	24	11.6 ^{def}	
Rural/village	14	27.5 ^{ab}	12	23.5 ^{abc}	1	2.0 ^j	4	7.8 ^{e-4}	2	3.9 ^{hij}	4	7.8 ^{e-4}	2	3.9 ^{hij}	2	3.9 ^{hij}	3	5.9 ^{ij}	
GPA																			
< 2	1	25.0 ^{a-g}	0	0.0 ⁱ	2	50.0 ^{ab}	1	25.0 ^{a-g}	0	0.0 ⁱ	0	0.0 ⁱ	0	0.0 ⁱ	0	0.0 ⁱ	0	0.0 ⁱ	
2.00 - 2.49	17	15.3 ^{bc}	32	28.8 ^a	6	5.4 ^{e-4}	5	4.5 ^{f-4}	3	2.7 ^{hi}	16	14.4 ^{bcd}	11	9.9 ^{c-f}	10	9.0 ^{c-g}	11	9.9 ^{c-f}	
2.50 - 2.99	30	14.6 ^{bc}	59	28.8 ^a	14	6.8 ^{e-h}	10	4.9 ^{f-4}	9	4.4 ^{ghi}	28	13.7 ^{cd}	18	8.8 ^{c-g}	17	8.3 ^{d-g}	20	9.8 ^{c-f}	
> 3.00	33	9.2 ^{c-f}	131	36.7 ^a	14	3.9 ^{hi}	12	3.4 ^{hi}	8	2.2 ⁱ	36	10.1 ^{cde}	36	10.1 ^{cde}	33	9.2 ^{c-f}	54	15.1 ^{bc}	
Monthly family income (USD)*																			
< 685	37	16.7	66	29.9	7	3.2	10	4.5	6	2.7	25	11.3	15	6.8	28	12.7	27	12.2	
685 - 1140	27	10.7	83	32.8	14	5.5	11	4.3	7	2.8	27	10.7	28	11.1	20	7.9	36	14.2	
1141 - 1600	9	7.6	37	31.1	8	6.7	6	5.0	6	5.0	17	14.3	11	9.2	11	9.2	14	11.8	
1601 - 2050	1	4.3	11	47.8	2	8.7	0	0.0	0	0.0	3	13.0	3	13.0	0	0.0	3	13.0	
> 2050	7	10.0	26	37.1	5	7.1	1	1.4	2	2.9	8	11.4	9	12.9	2	2.9	10	14.3	
Overall	81	11.8	222	32.1	37	5.4	28	4.1	21	3.0	80	11.6	66	9.6	61	8.8	95	13.7	

*USD exchange rate calculations were made based on 2.19 for 2015 and 8.30 for 2021.
a-i: The differences between percentages without shared letters among interaction are significant (P<0.05).

Table 8. P-values for year effect regarding monthly income expectation and career choice of the students.

Items	Monthly income expectation of the student	Student's Career Choice
Gender		
Male	<0.001	0.003
Female	<0.001	0.001
Class		
3	<0.001	0.002
4	<0.001	0.028
5	<0.001	0.034
Hometown		
Metropolis	<0.001	<0.001
City	<0.001	0.438
Rural/village	0.054	0.177
GPA		
< 2	0.588	0.002
2.00 - 2.49	<0.001	0.011
2.50 - 2.99	<0.001	0.710
> 3.00	<0.001	0.001
Monthly family income (USD)*		
< 685	<0.001	0.047
685 - 1140	<0.001	<0.001
1141 - 1600	<0.001	0.047
1601 - 2050	0.074	0.155
> 2050	0.004	0.363
Overall	<0.001	<0.001

*USD exchange rate calculations were made based on 2.19 for 2015 and 8.30 for 2021.

Discussion

This study was conducted to determine the career plans of veterinary faculty students after graduation and their expectations regarding working conditions. Twenty-five percent of the students who participated in the survey in 2015 and 15.3% of the students who participated in the survey in 2021 came from high-income families with a monthly income of \$ 1601 or more. On the other hand, the percentage of students from lower-income families (below \$685 per month) increased from 10.7% to 31.1%, depending on the year. The highly possible reason for this was the economic crisis in Türkiye in 2021. The dollar exchange rate, which was 2.34 TL in January 2015, became 7.38 TL as of January 2021 and 13.30 TL in December 2021.

According to the results of the study, it is seen that more than half of the participants expected to work 8 hours a day, but it is a remarkable result that those who expected to work more than 8 hours were 16-18%. The effect of the year on daily working hours expectation was found to be significant. One of the striking findings is that while the desire to work among students with low family income (below \$1600 per month) was low in 2015 (≤ 8 h), the desire to work in the same group increased in 2021. Similarly, regarding the working period, while a significant portion of the participants (76%) preferred day-time in 2015, it is observed that this selectivity of the participants decreased in 2021. In addition, both genders were more flexible in terms of working time expectations in 2021.

Monthly family income significantly affected student's monthly income expectations in both years. However, it is noteworthy that students with low-income families also have low monthly earning expectations. On the other hand, while the percentage of participants with an income expectation of 1600 USD and below was 47.7% in 2015, the percentage of the same income expectation increased to 70% in 2021. Students with high-income families have a monthly earning expectation of 1831 USD and above, regardless of the year. Gender has a highly significant effect on the monthly income expectations of students in 2021, it was not important in 2015. With the economic crisis, the monthly income expectations of female students decreased by 1601 USD. The Presidency of the Republic of Turkey Human Resources Office reported that 33.8% of newly graduated veterinarians received minimum wage in their first job (UNI-VERI, 2024). In a study conducted with veterinarians in Turkey (Balaban and Güneş, 2023), the differences in future expectations between male and female veterinarians were found to be insignificant.

Gender has a highly significant effect on the career choices of students in both years. Most of the female participants preferred companion animal clinic and

public employee while male counterparts preferred farm animal practice and companion animal clinic in 2015. In 2021, female participants' career preferences included companion animal clinic first, and academia second. In male participants' career preferences, companion animal clinic ranked first in 2021, and farm animal practice ranked second. Lofstedt (2003) attributes the decline in veterinary graduates' participation in food animal practice to the high proportion of women graduating from veterinary schools. Wise and Gonzales (2002) reported that 56% of female graduates of American veterinary colleges in 2001 preferred companion animal clinics, while 4% preferred large animal practice. Moreover, 40% of male graduates of American veterinary colleges in 2001 preferred companion animal clinics, while 13% preferred large animal practice. Moreover, Kinnison and May (2013) showed that females' percentages were significantly lower than males' in choosing farm animals and equine practice. Serpell (2005) also reported employment preferences were strongly affected by gender, mostly a significant male gender bias toward food-animal practice. Another noteworthy point is that while 21.4% of students chose farm animal practice in 2015, this rate dropped dramatically to 11.8% in 2021. In recent years, it has been observed in other countries that veterinary faculty graduates have moved away from farm animal practice (Cornish et al., 2016; Kinnison and May, 2013).

Student' hometown was significant effect on their career choices in 2015 and 2021. While the first preference of the students coming from rural/village areas is the farm animal practice (52.2%), followed by public employees (17.4%) and academia (13%) in 2015. Most of the students coming from metropolis and cities preferred working in companion animal clinics 30.8% and 23.9%, respectively. This result may be due to the previous experiences of the students coming from the village, especially their experiences with farm animals. Similarly, Kinnison and May (2013) pointed out that individuals from urban areas were likelier to choose companion animal practice, while those from rural preferred farm animal practice. Heat (2007) reported that veterinarians who grew up with animals on farms were more likely to work with cattle and sheep after graduation compared to other students from different backgrounds. Jelinski et al. (2008) reported that colleges that accept more students from rural areas produce more FAR (food animal-related) participants after graduation. Moreover, they also report that students whose parents or grandparents dealt with farm animals preferred FAR practice more. In 2021, the number of students who want to work with farm animals has generally decreased. On the other hand, most of the students coming from the rural/village areas (27.5%) still preferred this area. It is also seen that the number of students who want to work with companion animals

has increased regardless of hometown compared to 2015. Similarly, Dernas and Siméone (2019) reported that French veterinarian students' choice to work with farm animals decreases yearly. Payne et al. (2022) reported that the most common factors influencing undergraduates' attitudes toward farm animal practice work were clinical and preclinical extramural studies and working conditions (species of animal, hours, working outside, salary and variety).

Monthly family income significantly affected student career choices in 2015 while it's not in 2021. It is seen that 39.4% of the students whose monthly family income is below 685 USD preferred farm animal practice while 51.1% of students whose family income is 1601-2050 USD preferred companion animal clinics. On the other hand, students from high-income families did not prefer public employee and poultry practice in both years.

Conclusion

The findings of the study highlight the importance of gender, hometown and monthly family income considerations in shaping the career plans of veterinary students. The most striking result of the study is that, regardless of the year, students from low-income families (<1601 USD) have lower expectations of both working hours and monthly income. On the other hand, students from high-income families ($\geq$ 1601 USD) tend to work harder and earn more. There was also a clear decrease in preference for farm animal practice and an increase in companion animal practice. This decrease in farm animal practices may have negative effects on the country's future animal husbandry. To prevent this, special arrangements should be made in veterinary faculties so that students' interest in farm animal practices can be maintained. More positive farm animal clinical experiences should be provided to veterinary students.

Declaration of Competing Interest

The authors declare they have no conflicts of interest.

Author Contributions

Hulya Yalcintan: Conceptualization, Methodology, Formal analysis, Investigation Writing – original draft, Writing – review & editing. Pembe Dilara Kecici: Methodology, Formal analysis, Investigation, Writing – review & editing. Melek Özdemir: Methodology, Formal analysis, Investigation, Writing – review & editing. Bulent Ekiz: Conceptualization, Methodology, Formal analysis, Supervision, Writing – review & editing.

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Kayseri Talas'ta Gıda Çalışanlarının El Hijyen Durumlarının, Gıda Güvenliği Bilgi ve Uygulamalarının Belirlenmesi*

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Öz: Gıda işletmelerindeki çalışanların yanlış ve yetersiz uygulamaları gıda kaynaklı hastalıkların oluşmasına yol açabilmekte, ciddi ekonomik kayıplar söz konusu olabilmektedir. Bu çalışmada Kayseri Talas'ta bulunan gıda işletmelerindeki çalışanların gıda güvenliği bilgi ve uygulamalarının ve el hijyen durumlarının değerlendirilmesi amaçlanmıştır. Toplam 25 işletme 2023-2024 tarihleri arasında ziyaret edilerek gıda ile temas halinde bulunan personelin ellerinden örnekler alınmıştır. Ayrıca çalışma kapsamında işletmelerde, gıda çalışanlarının hijyen bilgileri ve tutumlarını değerlendirmek amacıyla gözlem ve anket uygulaması yapılmıştır. Ellerden alınan örneklerin mikrobiyolojik analizleri bakteriyel kültür yöntemiyle yapılmıştır. El örnekleri *Escherichia coli*, *Staphylococcus aureus*, total koliform ve *Enterobacteriaceae* açısından incelenmiştir. Çalışanlarına ait el örneklerinin %74.1'inde *Enterobacteriaceae*, %18.5'inde total koliform, %14.8'inde *E. coli* ve %40.7'sinde *S. aureus* varlığı tespit edilmiştir. Hedef değerlerin (<2.5 kob/cm²) üzerinde olan oranlar değerlendirildiğinde; örneklerin %66.6'sında *Enterobacteriaceae*, %11.1'inde koliform bakteri, %14.8'inde *E. coli*, %25.8'inde *S. aureus* sayılarının hedef değerlerin üzerinde olduğu belirlenmiştir. Ayrıca işletmelerdeki doğrama tahtaları ve bıçak yüzeylerinden de örnekler alınarak Aerob Mezofil Bakteri (AMB) açısından analiz edilmiş, bıçak örneklerinin %45.8'inde et doğrama tahtası örneklerinin ise %66.6'sında $\geq 10^3$ kob/g seviyelerinde AMB tespit edilmiştir. Yapılan anketler, gıda çalışanlarının gıda güvenliği bilgi düzeylerinin yüksek olarak değerlendirilebilecek bir düzeyde (%71.46) olduğunu ortaya koymuştur. Sonuç olarak gıda güvenliği bilgi skorlarının yüksek çıkmasına karşın, gıda çalışanlarının el örneklerindeki patojen mikroorganizma kontaminasyon yüzdelerinin yüksek olduğu belirlenmiştir. Gıda satış yerlerindeki çalışanlara sürekli ve etkin bir eğitim programının planlanması ve denetim faaliyetlerinin sıklaştırılması gerektiği kanaatine varılmıştır.

Anahtar kelimeler: El hijyeni, gıda çalışanı, gıda güvenliği, indikatör bakteri

Hand Hygiene Status, Food Safety Knowledge and Practices of Food Handlers in Kayseri, Talas

Abstract: Incorrect and inadequate practices of food handlers in food businesses can cause foodborne diseases and serious economic losses. This study aimed to evaluate the food safety knowledge and practices and hand hygiene status of food handlers in food businesses located in Kayseri Talas. A total of 25 businesses were visited between 2023-2024, and samples were taken from the hands of personnel in contact with food. In addition, observations and surveys were conducted at the point of sale to evaluate the hygiene knowledge and attitudes of food handlers. Microbiological analyses were performed by traditional methods regarding *Escherichia coli* (*E. coli*), *Staphylococcus aureus* (*S. aureus*), total coliform, and *Enterobacteriaceae*. *Enterobacteriaceae* was detected in 74.1% of the hand samples of the food handlers, total coliform in 18.5%, *E. coli* in 14.8%, and *S. aureus* in 40.7%. Regarding the contamination rates above the limit values (<2.5 cfu/cm²) were 66.6% of the samples for *Enterobacteriaceae*, 11.1% for coliform bacteria, 14.8% for *E. coli*, and 25.8% for *S. aureus* in respectively. In addition, samples were taken from the cutting board and knife surfaces in the food selling points and analyzed for Aerobic Mesophilic Bacteria (AMB). AMB was detected at levels of $\geq 10^3$ cfu/g in 45.8% of the knife samples and 66.6% of the cutting board samples. Food safety knowledge assessment surveys revealed a relatively high score (71.46%) among food handlers. As a result, despite high scores in food safety knowledge, pathogen contamination percentages in food handlers' hands were found to be high. It was concluded that continuous and effective training and control programs should be strictly implemented for workers in food selling points.

Keywords: Hand hygiene, food handlers, food safety, indicator bacteria

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Giriş

Kentleşme, sanayileşme, turizm sektörünün çeşitlenmesi ve küreselleşmedeki artış, tipik olarak dünya genelinde gıda işletmelerinin sayısında da paralel olarak artışa neden olmuştur (Abdussalam, 1984;

Getachew, 2010; Akabanda ve ark., 2017). Gıda işletme sayılarında görülen hızlı artış, gıdaların uygun-suz ortamlarda işlenmesine, gıda hazırlama ortamlarında sıklıkla yeterli düzeyde bilgi ve becerisi olmayan kişilerin çalıştırılmasına, dolayısıyla gıda güvenliği konusunda özensiz yaklaşımlara sebebiyet vermekte, bu durum da birçok ülkede giderek yaygınlaşmaktadır (WHO, 2002; 2008).

Gıda çalışanlarının gıda güvenliği açısından hijyen ve sanitasyon düzenlemelerine uyması; gıda kaynaklı hastalıkların engellenmesi veya minimize edilmesi anlamında temel bir adım olarak nitelendirilmektedir. Yapılan çeşitli çalışmalarda gıda çalışanlarının mesleki bilgi düzeyleri yüksek bulunmasına karşın birçok gıda zehirlenmesi vakalarında gıda kontaminasyonlarının gıda çalışanlarından kaynaklandığı belirtilmektedir (Ehiri ve Morris, 1996; Howes ve ark., 1996; Greig ve ark., 2007). Bu nedenle çalışan personelin bilgi düzeyi, gıda hazırlanma şekilleri ve ortamlarının genel koşulları ile ilgili farklı bölgelerde çeşitli çalışmalar yürütülmüştür (Ansari-Lari ve ark., 2010; Seaman, 2010; Martins ve ark., 2012). Yapılan bu çalışmaların tümünde işletmedeki çalışanların hangi konularda bilgi eksikliği yaşadıkları belirlenerek, eksik olan konularda verilen eğitimlerle ilgili değerlendirmeler yapılmış ve gıda üretiminin güvenli bir şekilde sürdürülebilmesi için söz konusu eğitimlerin de sürekli olarak tekrarlanması gerektiği vurgulanmıştır. 2008 yılı içerisinde Avrupa Birliği (AB) ülkelerinde 5332 kişinin gıda yoluyla zehirlendiği, bu vakalar neticesinde 45622 kişinin asgari düzeyde etkilendiği, 6230 kişinin hastanede kontrol altında bekletildiği ve 32 kişinin ise öldüğü The European Food Safety Authority (EFSA, 2010)'nin yayımladığı raporda belirtilmiştir. Söz konusu raporda gıda zehirlenmesine sebebiyet veren en önemli faktörlerin başında gıdaların uygun olmayan şekilde hazırlanması, yetersiz ısı işlemi, kontamine çığ bileşenlerin kullanılması, depolama esnasında yanlış ısı zaman parametrelerinin uygulanması ve enfekte gıda çalışanlarının sayılabileceği bildirilmektedir (Angelillo ve ark., 2000; Rippel, 2002; Yapp ve ark., 2006). Temel olarak bu etkenler çalışanların yetersiz hijyen uygulamaları ve hijyen bilinci eksikliği ile ilişkilendirilmekte ve işletmelerdeki çalışanların gıda güvenliği açısından önemli bir risk faktörü oluşturduğunu göstermektedir.

Avrupa Birliğinin 852/2004 düzenlemesinde gıda işçilerinin gıda hijyeni ve genel hijyen konularında eğitimleri yasal bir zorunluluk olarak yer almaktadır. Söz konusu regülasyonda gıda ile temas halinde bulunan çalışanların hizmet verdikleri alanlara göre eğitilerek yetkilendirilmesi gerekmektedir. Gıda çalışanlarının hijyen uygulamalarına ilişkin bilgi ve davranışlarının iyileştirilmesi gerektiği İngiltere, Polonya, Slovenya ve Türkiye'de yapılan çeşitli çalışmalarda da vurgulanmaktadır (Walker ve ark., 2003; Bas ve ark., 2006; Gomes-Neves 2007; Jevsniak ve ark., 2008).

Bu çalışmanın amacı çalışma bölgesinde yer alan

gıda işletmelerindeki gıda çalışanlarının gıda hijyen bilgi, tutum ve uygulamalarının değerlendirilerek konu hakkında temel bir veri oluşumuna katkı sağlamak, uygulamalardaki aksaklıkların giderilmesi ve gerekli önlemlerin alınması için atılacak adımların belirlenmesine öncülük etmektir.

Gereç ve Yöntem

Sunulan çalışma Erciyes Üniversitesi Klinik Araştırmalar Etik Kurulu'nun 20.12.2023 tarih ve 2023/821 karar numaralı onayı ile gerçekleştirilmiştir. 2023-2024 tarihleri arasında Kayseri Talas'ta 25 gıda satış yeri (kasap, şarküteri, market) rastgele ziyaret edilerek, çalışan elleri ve gıda temas yüzey örnekleri toplanmıştır. Toplam 27 gıda çalışan el örneği, 24 kesme tahtası yüzeyi ve 24 bıçak yüzey örneği analiz edilmiştir. El numuneleri *Enterobacteriaceae*, total koliform, *E. coli* ve *S. aureus* açısından, bıçak ve kesme tahtası yüzey numuneleri ise AMB bakımından değerlendirilmiştir.

Ellerin örneklenmesi

Gıda satışı yapan işletme çalışanlarının elleri *Enterobacteriaceae* total koliform, *E. coli* ve *S. aureus* açısından analiz edilmiştir. Gıda hazırlama süreçlerinde görev alan personelin başparmak ve işaret parmaklarının örneklenmesi amacıyla içerisinde selektif agar olan RODAC petri kapları kullanılmıştır. Personellerden alınan el örnekleri, habersizce ziyaret edilen işletmelerde, çalışanların eldivensiz ellerinden, el yıkama işlemi gerçekleştirilmeden alınmıştır. Bu işlemler mesai saatleri içerisinde, 10:00-13:00 saatleri arasında gerçekleştirilmiştir. Bu amaç doğrultusunda işaret parmağı örneklemek için *S. aureus* tespiti için kullanılan içinde Baird-Parker Agar (Oxoid CM 0275) bulunan RODAC petrileri tercih edilmiştir. Söz konusu petrilerde çevresinde beyaz halelere sahip siyah kolonilerin varlığı tipik *S. aureus* göstergesi olarak değerlendirilmiş olup ve bu kolonilerin doğruluğu koagülaz testi (Oxoid, Staphytest test kit) ile teyit edilmiştir. Çalışanların başparmaklarındaki *Enterobacteriaceae*, total koliform ve *E. coli* türlerinin belirlenmesi için de içerisinde Chromocult coliform Agar (Merck 1.10426) bulunan RODAC petrileri kullanılmıştır (Lues ve Van Tonder, 2007). 37°C sıcaklıkta 24 saat süresince petriler inkübasyona bırakılmıştır. İnkübasyon sonunda tipik somon-kırmızı renkli kolonilerin varlığı koliform grubu bakterileri, koyu mavi-mor menekşe rengindeki koloniler *E. coli*, renksiz koloniler ise *Enterobacteriaceae* olarak değerlendirilmiştir (Naratama ve ark., 2020). Koliform grubu için Moore ve Griffith (2002), *E.coli* için Legnani ve ark., (2004) tarafından kullanılan değerler bu çalışmada referans olarak alınmıştır. Çalışma kapsamında incelenmiş olan mikroorganizma türlerinin inkübasyon parametreleri Tablo 1' de sunulmuştur.

Tablo 1. Mikrobiyolojik analizlerde kullanılan besiyeri ve inkübasyon dereceleri

Mikroorganizma	İnkübasyon			
	Zaman (h)	Isı (°C)	Koloni Morfolojisi	Besiyeri
<i>Enterobacteriaceae</i>	24	35-37	Saydam (renksiz)	Chromocult Coliform Agar (Merck, 1.10426)
Toplam koliform	24	35-37	Somon-kırmızı	Chromocult Coliform Agar (Merck, 1.10426)
<i>E. coli</i>	24	35-37	Koyu mavi-mor menekşe	Chromocult Coliform Agar (Merck, 1.10426)
<i>S. aureus</i>	24-48	35-37	Beyaz haleli siyah	Baird- Parker Medium (Oxoid™)
Aerob mezofil genel canlı	48-72	31±1		Egg Yolk-Tellurite Emulsion (Oxoid™)
				Plate Count Agar (PCA, Oxoid™)

Yüzeylerin örneklenmesi

Et kesme tahtası yüzeyleri ve eti kesmek için kullanılan bıçak sapı yüzeylerini örneklemek amacıyla 15 cm² iç alana sahip steril bir çerçeve ile belirlenen alandan swaplar ile örnekler alınmıştır. Swap örnekleri Aerob Mezofil Bakteri (AMB) sayımı için kullanıldı. Steril pamuklu swaplar (T56-A, Technical Service Consultants Ltd.), içerisinde %0.05 sodyum tiyosülfat olan maksimum geri kazanım sulandırma (MRD, maximum recovery diluent OXOID CM733) ajantıyla ıslatılmış ve daha sonra et kesme tahtası yüzeyi ve bıçak yüzeyine 3'er defa farklı yönlerde sürülerek AMB sayımı için örneklemeler tamamlanmıştır. Swaplar her işlemin tamamlanma süreci sonunda MRD içeren tüpler içerisine konulmuş (Redmond ve ark., 2004; Cordoba ve ark., 1999) ve tüpler soğuk zincir altında laboratuvara ulaştırılmıştır. Steril peptonlu su kullanılarak seri dilüsyonlar hazırlanmış ve Plate Count Agar (PCA, Oxoid™) besi yerine ekimler yapılmıştır. Ekim yapılan numuneler 24-48 saat 31±1°C sıcaklıkta inkübe edilmiştir (Aulia ve ark., 2024).

Anket uygulaması

Gıda personelinin hijyen bilgi ve tutumlarını değerlendirmek amacıyla gözlem ve anket uygulaması yapılmıştır. Çalışmaya Kayseri ili Talas İlçesinde faaliyet gösteren 25 satış yeri dahil edilmiştir. Gıda satışı yapılan işletmelerde mikrobiyel kalitede etkili olabilecek tüm kriterler; işletme yapısı, gıda çalışanlarının bilgi düzeyleri ve hijyen uygulama gözlemleri olmak üzere üç ana başlık altında değerlendirilmiştir. Anket formlarının uygulanması için seçilen işletmeler ile önceden bağlantıya geçilmiş ve gerekli izinler alınmıştır. İşletmelerde mikrobiyel kaliteyle ilgili risk faktörlerini değerlendirmek amacıyla 27 soruluk anket uygulaması yapılmıştır. Mikrobiyolojik analizler için el ve yüzeylerden örnek toplama işlemi yapılırken anket uygulaması da eş zamanlı olarak gerçekleştirilmiştir. Anket sorularına verilen doğru cevap yüzdeleri belirlenmiştir. Ek olarak, işletme ortamı ve çalışanların fiziki durumlarının değerlendirilmesi için düzenlenmiş

olan kontrol listeleri ve gıda çalışanlarının demografik yapılarını tespit etmek amacıyla oluşturulan formlar anket esnasında dolduruldu. Çalışma sonucunda anket verileri ile mikrobiyolojik parametreler arasındaki ilişki değerlendirilmiştir.

İstatistiksel analiz

G-Power 3.1.9.7 programı kullanılarak örneklem büyüklüğü belirlenmiştir. Güven aralığı %95 (anlamlılık düzeyi alfa= 0.05), etki büyüklüğü d=0.8 olarak alınmış olup, 0.80'lik güç için örneklem grubu 27 kişi olarak alınmıştır. Daha sonraki işlemler için eksik ve hatalı bilgiler veri girişi sırasında belirlenmiş olup, hatalı giriş sayısının en düşük seviyede tutulması sağlanmıştır. Anket verileri doğrultusunda, mikrobiyal kalitede etkili olan risk faktörleri nitel ve nicelik bakımından gruplanıp mikrobiyolojik kalite sonuçları ile birleştirilmiş, istatistiksel dağılımları ve özet istatistiksel yapıları ortaya çıkarılmıştır. Anket verileri ve mikrobiyolojik kalite sonuçlarından hazırlanarak oluşturulan veri kütüğü üzerinde temel istatistik yöntemler ve lojistik regresyon analizi uygulanarak, risk faktörlerinin etkileri hesaplanmıştır. Verilerin betimsel analizi kapsamında, mevcut frekans yüzdeleri ve dağılımları hesaplanmıştır. Mikroorganizmaların rastlanma durumu ile hijyen algısı arasındaki ilişkiler ise bağımsız örneklem için uygulanan t-testi ile değerlendirilmiştir. Analizlerde anlamlılık düzeyi 0.05 olarak belirlenmiştir. Tüm istatistiksel işlemler SPSS 26.0 Windows paket programı kullanılarak gerçekleştirilmiştir.

Bulgular

Gıda çalışanlarına uygulanan anketler neticesinde gıda güvenliği bilgi değerlendirme skoru ortalama % 71.46 olarak ölçülmüştür (Tablo 2). Gıda personellerinin el hijyeni ile ilgili mikrobiyolojik analiz verileri Tablo 3' te, bıçak ve kesme tahtası yüzey örneklerinin mikrobiyolojik sonuçları Tablo 4'te belirtilmiştir. Kayseri Talas' ta faaliyet gösteren gıda işletme personellerinin demografik özellikleri Tablo 5'te özetlenmiş olup çalışanların işyeri ortamında gözlemlenmesi sonucunda belirlenen davranışlarına yönelik gıda

güvenliği bileşenleri de Tablo 6'da belirtilmiştir. Ayrıca, mikroorganizmaların rastlanma durumu ile hijyen algısı arasındaki anlamlı ilişkiler bulunmamıştır ($p>0.05$)

Tablo 2. Kayseri Talas'ta gıda çalışanlarının gıda güvenliği bilgisi (Çatar ve Yıldırım, 2020; Yıldırım ve ark., 2020)

	ANKET SORULARI	CEVAP %
1	Burun akıntılı veya öksüren personelin, gıda temasından uzaklaştırılması gerekmez.	85.19
2	Ellerinde yara veya kesik bulunan gıda personeli gıdaya dokunmadan önce mutlaka eldiven giymelidir.	100
3	Çiğ ürünler ile pişmiş ürünler aynı alanda karışık şekilde muhafaza edilebilir.	81.48
4	Personelin el hijyeni durumunun gıda kaynaklı hastalıklara sebep olabileceğini düşünüyorum.	96.3
5	Kesim tahtası ve bıçakların temizliği insana hastalık bulaşmasında etkili olabilir.	85.19
6	Sağlıklı gıda çalışanlarının deri, burun ve ağızlarında da mikroorganizmalar bulunur.	59.26
7	Mikroorganizma bulaşmış olan bir gıdada renk, görünüm ve tat açısından her zaman değişiklik görünür.	11.11
8	Deride bir kesik ve yaralanma olduğunda gıdaya dokunulmaması gerekir.	88.88
9	Sağlıklı yetişkinler ve risk grubu (çocuklar, hamile kadınlar, yaşlılar) gıda kaynaklı hastalıklar açısından eşit risk altındadır.	33.33
10	Çiğ hayvansal gıda (Tavuk eti, sığır eti...) ile tüketime hazır (rus salatası, patlıcan salatası, ezme...) meze tarzı gıdalar bir arada muhafaza edilebilir.	81.48
11	Buzdolabında mikroorganizma üremez.	55.55
12	Marketlerde çiğ et (sığır eti, tavuk eti, balık) tartıp hazırlayan kişilerle meze hazırlayıp tartan kişiler mümkünse farklı kişiler olmalıdır.	74.07
13	Arada sırada saçıma veya burnuma dokunmakla gıdayı kontamine edeceğimi düşünmüyorum.	70.37
14	Gıda ile bulaşabilen taşıyıcı hastalığım olup olmadığını öğrenmek için belirli periyotlarda muayene oluyorum.	92.59
15	Bakteriler gıda kaynaklı hastalıkların oluşumundaki en önemli etmendir.	92.59
16	Gıda personelinin saat, yüzük gibi takılar takması gıdalara hastalık etkeni bulaşmasında çok etkili değildir.	59.26
17	Paraya dokunduktan sonra elimi yıkamam gerektiğini düşünmüyorum.	85.19
18	Gıda personelinin elinde yüzünde yaralar olması gıda güvenliği açısından çok önemli değildir.	74.07
19	Çapraz bulaşma, mikroorganizma bulunan bir gıdadaki mikropları, satıcının ellerinden veya kesim malzemeleri vasıtasıyla diğer gıdalara bulaştırmasıdır.	81.48
20	Temizlikte kullanılan kimyasallar gıdaların bulunduğu yerden ayrı bölümlerde saklanmalıdır.	96.3
21	Dondurulan gıdalarda mikroorganizma kalmaz ölür.	55.55
22	Bir gıda çalışanı gıda üzerine öksürdüğünde veya hapşırdığında hangi tür mikroorganizma gıdalara bulaşabilir? *E. coli *Staphylococcus aureus *Salmonella *Listeria monocytogenes	18.52
23	Tuvalet ihtiyacından sonra elini yıkamayan personel, gıdaya ne tür mikroorganizmaları bulaştırabilir? *E. coli *Staphylococcus aureus *Salmonella *Listeria monocytogenes	40.74
24	Gıda zehirlenmesi açısından hangi gıda daha risklidir? *Ekmek *Çorba *Çiğ Tavuk *Peynir	92.59
25	Mikroorganizmalar hangi sıcaklıklarda hızla büyüyebilir ve çoğalabilir? *0 -4°C *5 - 65°C *72°C ve üzeri	55.55
26	Aynı koşullarda muhafaza edildiğinde hangi gıda daha çabuk bozulur? *Sığır eti *Kıyma *Yumurta *Ekmek	70.37
27	Gıda zehirlenmesinin en sık görülen belirtileri nelerdir?	92.59

Gıda güvenliği bilgi değerlendirme skoru %71.46

Tablo 3. Gıda çalışanlarının el hijyen profilleri

Mikroorganizma	N	Pozitif örnek sayısı (%)	Hedefi aşan örnek sayısı (%)
<i>Enterobacteriaceae</i> *	27	20 (74.1)	18 (66.6) ≥ 2.5 kob/cm ²
Koliform	27	5 (18.5)	3 (11.1) ≥ 2.5 kob/cm ²
<i>E. coli</i>	27	4 (14.8)	4 (14.8) ≥ 2.5 kob/cm ²
<i>S. aureus</i> *	27	11 (40.7)	7 (25.9) ≥ 2.5 kob/cm ²

N: Farklı işletmelerdeki toplam el örneği sayısı, *: Hedef değer yok

Tablo 4. Bıçak ve yüzey örneklerinin mikrobiyolojik analiz sonuçları

Örnek	Analiz Edilen Örnek Sayısı	N	AMB $\geq 10^3$ b
Bıçak	24	11	45.8
Kesme Tahtası Yüzeyi	24	16	66.6

N: pozitif örnek sayısı, b: pozitif örnek yüzdesi

Tablo 5. Kayseri Talas'ta gıda çalışanlarının demografik özellikleri

GIDA ÇALIŞANI NİTELİKLERİ	SAYI	%
CİNSİYET		
Erkek	27	100
Kadın	0	0
YAŞ		
18-25	5	18.5
26-35	8	29.6
36-45	9	33.3
46-55	1	3.7
>55	4	14.9
EĞİTİM		
İlköğretim	4	14.9
Ortaöğretim	15	55.5
Üniversite	8	29.6
DENEYİM (YIL)		
0-10	10	37
11-25	13	48.1
>25	4	14.9
POZİSYON		
Çalışan	8	29.6
İşletme Sahibi	19	70.4

Tablo 6. Gıda güvenliği bileşenleri

	GIDA GÜVENLİĞİ BİLEŞENLERİ	SAYI	%
1	Personelde takı var mı?	4	14.8
2	Çalışanlar eldiven vb. kullanmakta mı?	22	81.5
3	Çalışanlar önlük giyiyor mu?	22	81.5
4	Bone takmış mı?	2	7.4
5	Sakal, bıyık var mı?	22	81.5
6	Çalışma ortamında çeşme bulunuyor mu?	27	100
7	Elinde, yüzünde yara var mı?	1	3.7
8	Ağız, burun veya göz akıntısı var mı?	0	0
9	Havalandırma yeterli mi?	27	100
10	Kapı ve pencerede sinek, böcek vb. zararlıların girişini engelleyecek tedbirler yeterli mi?	0	0
11	Zemin ve duvar temiz mi?	24	88.9
12	Tezgâhın yakınlarında el yıkamak için çeşme lavabo var mı?	22	81.5

Tartışma ve Sonuç

The Food and Drug Administration (FDA) işletmelerde gıda hazırlamada görev alan personelin neden olduğu gıda kaynaklı hastalık vakalarının önemli bir sorun haline geldiğini belirtmektedir. Bu sorunla başa çıkmak için ciddi önlemlerin gerekliliğini vurgulayan FDA, çalışanların gıdayı kontamine etmesine neden olan faktörleri sıralamakta ve bu kontaminasyonun

önlenmesi veya minimum düzeye indirilmesi için alınabilecek önlemlerin etkinliğini değerlendirmektedir. Bu kapsamda üç temel konuya dikkat çekmektedir; i) enfeksiyon geçiren gıda personellerin gıda hazırlama ortamlarından uzaklaştırılması, ii) gıda ile temas halinde bulunan personellerin ellerindeki patojen sayılarının azaltılması iii) ellerin gıdayla temasını engellemek için bariyer kullanımı (FDA, 2019).

Bu araştırma çalışmasında, gıda işletmesindeki personellerin gıda güvenliği konusundaki sorulara doğru cevap skorunun yüksek sayılabilecek bir düzeyde (% 71.46) olduğu gözlenmiştir. Öte yandan gıda güvenliği bilgi düzeylerinin ölçülmesine yönelik yapılan bu ankete göre bazı sorulara verilen yanlış cevaplar neticesinde; hangi tür mikroorganizmaların gıdaya ne şekilde bulaşmış olabileceği, hastalık oluşumunda risk grubunda yer alan bireylerin (çocuklar, hamile kadınlar, tedavi görenler, kronik hastalığı olanlar ve yaşlılar) daha büyük risk altında olduğu ve kontamine gıdaların fiziksel açıdan herhangi bir değişikliğe uğramayabileceği konularının yeterince bilinmediği ortaya konmuştur. El örneklerinden elde edilen verilerin bilgi düzeylerindeki yüksek skor oranıyla paralellik göstermediği saptanmıştır. Benzer bir çalışmada Romanya'da gıda çalışanlarına ait hijyen bilgilerinin belirlenmesi üzerine yapılan bir araştırmada çalışanların % 63.2'sinin hijyen konusunda yeterli bilgiye sahip olduğu ve hijyen bilgisinin çalışanların eğitim düzeyi ile pozitif korelasyon gösterdiği ortaya konmuştur. Aynı zamanda söz konusu çalışma sonucunda mikrobiyolojik riskler, çapraz kontaminasyonlar ve ısı kontrolleri konusunda gıda çalışanlarının etkin bir şekilde sürekli

eğitime tabi tutulması gerektiği belirlenmiştir (Jianu ve Chiş, 2012).

Çalışmamıza katılım gösteren gıda personellerinin tamamının erkek olduğu (%100), çoğunluğunun (% 70.4) işletme sahibi olduğu, %81.5'inin 25 yaşından büyük olduğu yapılan oranlamalarla belirlenmiştir. Eğitim düzeyleri yönünden incelendiğinde; gıda çalışanlarının %70.4'ünün yalnızca zorunlu eğitimi (ilk ve ortaöğretim) tamamladığı tespit edilmiştir. Söz konusu personellerin mesleki deneyim sürelerine bakıldığında yüksek orana sahip %63'lük bölümünün 10 yıldan fazla deneyime sahip olduğu anlaşılmıştır. Malezya'nın Kuala Pilah kentinde 64 restoran çalışanı üzerinde yapılan bir araştırmada personellerin gıda hijyeni ile ilgili bilgi düzey ve uygulamalarının belirgin bir şekilde yüksek olduğu belirlenmiş, bilgi ve uygulama konularında elde edilen bu yüksek skorlar ile çalışanların eğitim düzeyleri birlikte değerlendirildiğinde pozitif bir korelasyon gözlemlendiği belirtilmiştir. Buna karşın çalışanların yüksek düzeydeki bilgilerine rağmen, çalışma ortamında personelin takı kullanımı ve gıdaların uygun şartlarda depolanması konusunda yeterli derecede duyarlılık göstermedikleri vurgulanmıştır (Abdul-Mubtalip ve ark., 2012).

Toplam aerob mezofil bakteri, *E.coli*, *Enterobacteriaceae*, koliform ve *S. aureus* hijyen uygulamalarında indikatör mikroorganizmalar olarak nitelendirilmektedir (Alves ve ark., 2021). Gıda temas yüzeylerinde ve gıdalarda total koliform ve *E. coli* varlığı, hijyen konusuna yönelik sorunların ve bağırsak kökenli kontaminasyonların olduğuna işaret etmektedir. Ortamda önemli düzeyde bağırsak kökenli patojen varlığı, total koliform ve *E.coli* sayılarının yükselmesine sebep olmaktadır (Barros ve ark., 2007). Stafilkokların sıklıkla ellerde, deri ve yüzeylerde bulunduğu bildirilmekle birlikte ana kaynak olarak burun içi gösterilmektedir (Gelatti ve ark., 2009). *S. aureus* potansiyel olarak kuru ortamlarda hayatta kalabilen dirençli bir patojen olarak rapor edilmektedir (Chaibenjawong ve Foster, 2011).

Bir gram insan dışkıında *E. coli*, *Shigella* spp. ve *Salmonella* spp. dahil 10^4 ile 10^{11} bakteriyel ajan, norovirüs ve Hepatit A virüsü de dahil olmak üzere 10^{10} 'dan fazla enfeksiyöz viral partikül bulunabilmektedir. İnsan derisinde de dışkı kontaminasyonuna sıklıkla rastlanabileceği ve temas yoluyla gıdalara çapraz kontaminasyonunun söz konusu olabileceği belirtilmektedir (Lee ve ark., 2010). Özellikle hijyen bilinci veya eğitimi olmayan gıda çalışanlarının, tüketime hazır gıdaları hazırlama esnasında bakteri veya virüsleri gıdaya ve çevresel yüzeylere aktarabileceği vurgulanmaktadır (Pickering ve ark., 2010). Yapılan bir çalışmada, gıda işçilerinin sebep olduğu salgınların %40'ının el temasından kaynaklandığı bunlardan da %14'ünün kontamine kulplara temas yoluyla ortaya çıktığı bulunmuştur (Todd ve ark., 2009). Gıda kaynaklı patojenlerin çoğunlukla ellerde ve temas yüzeylerinde uzun süre hayatta kaldığı dolayısıyla el temas yüzeylerinin (bıçak kulpları, kapı kolları vs.) de gizli bir kontaminasyon kaynağı olarak kapsamlı bir yönetim gerektirdiği belirtilmektedir. Çalışmamızda, gıda çalışanların ellerinin %74.1'inde *Enterobacteriaceae* belirlenirken *S. auerus*, *E. coli* ve total koliform grubu bakteriler örneklerin sırasıyla %40.7, %18.5 ve %14.8'inde tespit edilmiştir. Yapılan diğer bir çalışmada, gıda çalışanlarının parmaklarında yapılan örneklemede parmaklardan %32'sinde koliform varlığının limit değerlerin üzerinde bulunduğu, benzer şekilde sadece bir personelde *E. coli* varlığının mevcut limitlerin üzerinde olduğu, parmakların %44'ünün *Enterobacteriaceae* kontaminasyonuna işaret ettiği raporlanmıştır (Lues ve Van Tonder, 2007).

Toplumda mikroorganizmaların bulaşmasını engellemek için el hijyeninin sağlanması en etkili önlemdir. Enfeksiyon kontrolündeki diğer faktörler (çevresel hijyen, personel sayısı ve eğitim düzeyi) yetersiz olduğunda, enfeksiyonu azaltmak için tek başına el hijyeninin yeterli olma olasılığı düşüktür. Kültürel ve sosyal ihtiyaçların, el hijyeni farkındalığıyla sıkı bir bağlantısı olduğu ifade edilmektedir. Özellikle gelişmekte olan ülkelerde el yıkama alışkanlıklarını artırmaya yönelik daha fazla engelin bulunduğu vurgulanmaktadır. Dolayısıyla el yıkama alışkanlıklarına yönelik çalışmaların eğitim düzeyleri farklı olan ülkeler arasında farklı bir bakış açısıyla ele alınması gerektiği vurgulanmıştır (Juuma, 2005). Doğru el yıkama uygulamaları sonucunda, el kontaminasyon düzeyinin önemli derecede azaldığı, ayrıca eldiven kullanımının kontaminasyon riskini azaltabileceği kayıt altına alınmıştır (Montville ve ark., 2010). Çalışmamız kapsamında işletmenin fiziksel yapısı ve personeller ile ilgili gıda güvenliği bileşenleri konusunda yapılan incelemelerde; gıda çalışanlarının iş kıyafeti giyme, eldiven takma, iş esnasında takı kullanma gibi konularda kurallara uyduğu ancak bone takma konusunda bunun aksine sadece %7.4'lük kısmının bone taktığı görülmüştür. İşletme yönünden bakıldığında yeterli havalandırma ortamının sağlanabildiği, el yıkama

lavabolarının var olduğu (%81.5) tespit edilmiş olup buna karşın işletme içerisine sinek, böcek gibi zararlıların girişini engelleyecek şekilde hiçbir işletmede herhangi bir önlem alınmadığı da belirlenmiştir.

Bakteri transferinin sıklıkla hazırlıkların yapılması esnasında; gıda çalışanlarının ellerinden mutfak yüzeylerinin kontaminasyonu yoluyla şekillendiği belirtilmektedir (Chen ve ark., 2001). Yapılan bir çalışmada, doğal kontamine çiğ gıdaların yanlış uygulamalar sonucu gıda hazırlama esnasında temas yüzeylerini ve tüketime hazır gıdaları kontamine ettiğine işaret edilmekte, çapraz kontaminasyon vakalarının yeterince temizlenmemiş kesim tahtaları (%58) ve bıçak yüzeylerinden (%46) kaynaklandığı vurgulanmaktadır (Redmond ve ark., 2004). Güney Afrika'da yapılan bir çalışmada, yüzeylerdeki örneklerin analizi sonucunda kaşık yüzeylerinde (5.1 log kob/g) yüksek düzeyde AMB varlığı saptandığı, dilimleme tahtası yüzeylerinde koliform (4 log kob/g) tespit edildiği raporlanmıştır (Christison ve ark., 2008). Çalışmamızda kesme tahtası yüzey örneklerinin %66.6'sında ve bıçak örneklerinin %45.8'inde AMB $\geq 10^3$ kob/g düzeylerinde tespit edilmiş olması, işletmelerde temizlik uygulama prosedürlerine uyulmadığını ortaya koymaktadır.

Çalışmamız kapsamında belirlenen işletmelerdeki gıda personellerinin el örnekleri ve gıda temas yüzeyleri bazı patojen ve indikatör mikroorganizmalarla kontamine bulunmuştur. Gıda güvenliği kapsamında bilgi düzeyi değerlendirme veri analizinde yüksek skorlar elde edilmiş olsa da el ve yüzey örneklerinde tespiti yapılan patojen kontaminasyon oranları bize iyi hijyen uygulamalarının eksikliğini, personellerin hijyen uygulamalarında yetersiz olduğunu göstermektedir. Dolayısıyla yalnızca gıda güvenliği ile ilgili eğitimleri sağlamak yeterli olmadığı, uygulamalardaki başarısızlık kaynaklarının da belirlenerek çözümlenmesi gerektiği ortaya çıkmıştır. Toplum sağlığının korunması açısından kritik öneme sahip meslek gruplarından olan gıda çalışanlarının sıkı bir eğitimden geçirilerek çalışmaya başlamalarının sağlanması, eğitimlerin sürekliliğinin garanti altına alınması, gıda üretim yerlerinin sıkı ve periyodik denetimlere tabi tutulması, hijyen konusundaki yetersiz bilgi ve uygulamaların düzeltilmesi konuları bu çalışmanın dikkate alınması gereken çıktıları arasında yer almaktadır.

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Topographic and Clinical New Approaches and Correlations of Extremities in Dogs*

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Abstract: Various traumatic lesions are encountered in the extremities of dogs. For surgeons, familiarity with relevant surface landmarks is a prerequisite for the successful selection of incision sites in choosing the most suitable location for access to organs and vessels. This study aimed to reveal in detail the topographic and clinical anatomy of the extremities in dogs. In this study, the extremities of dogs were approached topographically, the layers were photographed and the anatomical structures seen in the region were named. In addition, selection sites for clinical approaches were determined and correlations of the sites with each other were examined using palpable bone points. In conclusion, this study conducted in dogs not only contributed to adding colourful and fresh operation photographs to the literature but also revealed new and simple techniques for some of the anaesthesia applied to the nerve space. Additionally, osteometric analyses using a different technique revealed a positive correlation between regions. It has been concluded that some measurements between externally palpable points on a live dog can be used to calculate other lengths.

Keywords: Clinical anatomy, dog, extremity, morphometric analysis, topographic anatomy.

Köpeklerde Ekstremitelerin Topografik ve Klinik Yeni Yaklaşımları ve Korelasyonları

Öz: Köpeklerin ekstremitelerinde çeşitli travmatik lezyonlar görülmektedir. Cerrahlar için, organlara ve damarlara erişim için en uygun lokasyonu seçerken, ilgili yüzey işaretlerine aşinalık, kesi yerlerinin başarılı bir şekilde seçilmesi için ön koşuldur. Bu çalışma, köpeklerde ekstremitelerin topografik ve klinik anatomisini ayrıntılı olarak ortaya koymayı amaçlamıştır. Bu çalışmada, köpeklerin ekstremitelerine topografik olarak yaklaşılmış, katmanlar fotoğraflanmış ve bölgede görülen anatomik yapılar isimlendirilmiştir. Ayrıca, klinik yaklaşımlar için seçim bölgeleri belirlenmiş ve bölgelerin birbirleriyle korelasyonları, elle muayene edilebilen kemik noktaları kullanılarak incelenmiştir. Sonuç olarak, köpeklerde yapılan bu çalışma, literatüre renkli ve taze operasyon fotoğrafları eklenmesine katkıda bulunmakla kalmamış, aynı zamanda sinir boşluğuna uygulanan bazı anesteziler için yeni ve basit teknikler ortaya koymuştur. Ayrıca, farklı bir teknik kullanılarak yapılan osteometrik analizler, bölgeler arasında pozitif bir korelasyon olduğunu ortaya koymuştur. Canlı bir köpekte dışarıdan elle muayene edilebilen noktalar arasındaki bazı ölçümlerin, diğer uzunlukları hesaplamak için kullanılabileceği sonucuna varılmıştır.

Anahtar kelimeler: Ekstremiteler, klinik anatomi, köpek, morfometrik analiz, topografik anatomi.

Introduction

It is a basic clinical skill to be able to detect structures under the skin by referring to the characteristics of bone prominences, which are the most palpable structures (Standing, 2012). Since the surgical approach preferred in surgical interventions on bones or joints must preserve both anatomical and functional integrity, it is important to have information about the course of large vessels and nerves in the region (Dyce et al., 2010). For surgeons, familiarity with relevant surface landmarks is a prerequisite for the successful selection of incision sites in choosing the most appropriate location for access to organs and vessels (Standing, 2012).

Various traumatic lesions are encountered in the extremities of dogs. The most common of these lesions are fracture cases (Süer and Sağlam, 2006). The skeletal system is seen as a place where most of the parameters such as shape, height, length and size are easily accessible. As a result, bones are one of the body structures used for the characterization of different animal species, including humans (Salami et al., 2011). Osteometric analyses of long bones are widely used to determine changes in the size and morphology of dogs (Alpak et al., 2004).

This study aimed to detail the topographic and clinical anatomy of the extremities in dogs, in particular the anesthesia landmarks for some nerve extensions and the correlation between bone lengths using palpable bone landmarks.

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Materials and Methods

Animals

This study was conducted with 10 dog cadavers who died at Erciyes University Veterinary Faculty Animal Hospital. There was no discrimination based on gender, race or age for the cadavers used. These cadavers were used in accordance with the ph. 2 of article 8/k, of the Erciyes University Animal Experiments Local Ethics Committee Directive.

Photography and Image Editing

SAMSUNG NX300 digital camera was used to photograph the findings. The photography process was done by photographing topographical layers from the surface to the deep. Portable Photoshop CS2 V.9.0.2 was used to name the anatomical structures.

Measurements and Statistical Analyses

The distances between palpable bone landmarks of the fore- and hind limbs were measured between each other on cadavers. These measurements were made with a digital caliper with 0-100 mm sensitivity. The conformity of the data to a normal distribution was assessed using the Shapiro-Wilk test and histogram plots. Spearman's Rho correlation coefficient was used to evaluate the statistical significance of relationships between continuous numerical variables. All analyses were conducted using R Studio (Version 2021.09.1 Build 372 – ©2009–2021 RStudio, PBC). A significance level of $P < 0.05$ was considered statistically significant. The distances between the points were named with letters. These measure

ments were shown on the skeleton and schematized (Table 1).

Table 1. Lettering and schematic representation of measurements.

	Letter	Starting Point	End Point
Forelimb	a	Cartilage scapula	Acromion
	b	Tuber olecrani	Lateral border caput radii
	c	Lateral border	Proc. styloideus lateralis
	d	caput radii	Proc. styloideus lateralis
	e	Tuberculum majus	Epicondylus lateralis
Hindlimb	f	Trochanter major	Patella
	g	Trochanter major	Tuber ischiadicum
	h	Patella	Malleolus lateralis
	j	Tuberositas tibiae	Malleolus lateralis

The use of anatomical terms in the text is based on Nomina Anatomica Veterinaria. (N.A.V., 2012)

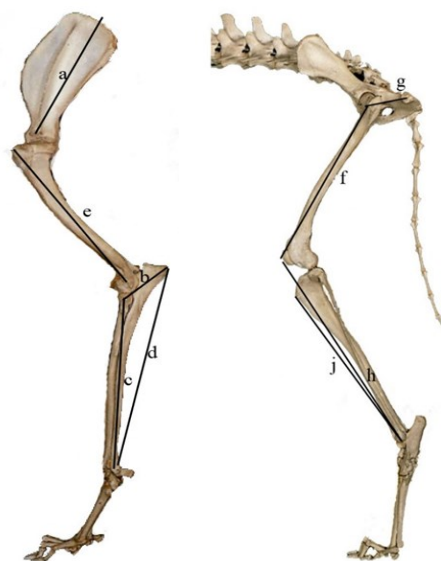
Results

For measurements, landmarks that were suitable for palpation on a living animal and that would not change depending on the animal's leg posture and flexion-extension angles of the joints were selected. Thus, the accuracy and standardization of the measurements were ensured.

The values of the measured landmarks are indicated in Table 2. According to the correlation analysis performed with the obtained values, significant correlations were found between many values (Table 3).

When Table 3 was examined, it was determined that the distance between the *trochanter major* and *tuber ischiadicum* (g) in the hind limb did not have a significant correlation with all other measurements ($P > 0.05$). In all other measurements, it was determined that there was mostly a highly significant correlation ($P < 0.01$) between the measurements of the same animal.

In this study, the selection sites for anesthesia of some of the extremity nerves in dogs that can be used practically in the clinic were examined and some methods were reported for the first time.



Tablo 2. Measurements of palpable bony landmarks

MEASUREMENTS OF PALPABLE BONY LANDMARKS (cm)													
		Proximal point	Distal point	n1	n2	n3	n4	n5	n6	n7	n8	n9	n10
Forelimb	a	Cartilago sca- pula	Acromion	13	17	16	16	16	7.4	6.2	9	9	14
	b	Tuber olecrani	Lateral border caput radii	5	6	5	5	5.5	2.3	2	5	5	5.3
	c	Lateral border caput radii	Proc. styloi- deus lateralis	15	25	17	18	18.5	8.5	8.4	14	13.7	15
	d	Tuber olecrani	Proc. styloi- deus lateralis	17	27	21	21	22.5	10	9.7	16	16.2	16
	e	Tuberculum majus	Epicondylus lateralis	14.5	22	17	19	17.5	7	6.7	9	9.3	11
Hindlimb	f	Trochanter major	Patella	16.5	22	19	21	19.5	10.6	11	14	14	18
	g	Trochanter major	Tuber ischiadi- cum	4	6	4.5	4	4	2.5	2.3	4.5	4.5	5
	h	Patella	Malleolus lateralis	21	28	23	24	25	10.4	9.7	13.7	13.6	22
	j	Tuberositas tibiae	malleolus lateralis	18	24	19	20	20	7	6.7	10.5	10.6	19

Table 3. Correlation analysis between bony landmarks.

Landmarks	a	b	c	d	e	f	g	h
b	0.877** 0.002							
c	0.979** p<0.001	0.913** 0.001						
d	0.983** p<0.001	0.917** 0.001	0.979** p<0.001					
e	0.911** 0.001	0.803** 0.009	0.900** 0.001	0.895** 0.001				
f	0.966** p<0.001	0.843** 0.004	0.962** p<0.001	0.950** p<0.001	0.929** p<0.001			
g	0.617 0.077	0.718* 0.029	0.552 0.123	0.58 0.101	0.5 0.17	0.537 0.136		
h	0.962** p<0.001	0.840** 0.005	0.967** p<0.001	0.937** p<0.001	0.917** 0.001	0.996** p<0.001	0.535 0.138	
j	0.812** 0.008	0.761* 0.017	0.812** 0.008	0.819** 0.007	0.937** p<0.001	0.807** 0.009	0.416 0.266	0.795* 0.01

**A very high level of correlation was found ($P<0.01$).

* A high level of correlation was found ($P<0.05$).

r: Correlation percentage

Nerve Blocks of the Forelimb

1. *N. suprascapularis*: In the craniolateral approach to the region of *art. humeri*, the *n. suprascapularis* was seen just below the acromion after the tendon of the *m. infraspinatus* was cut and removed. Under this nerve, the joint capsule of the *art. humeri* was detected (Figure 1). *N. suprascapularis* block can be performed just distal to the acromion.

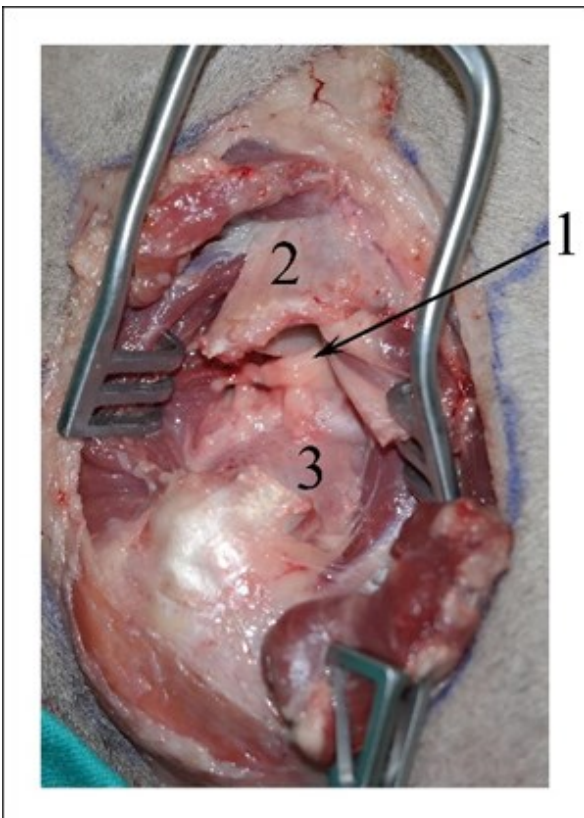


Figure 1. Appearance of the *n. suprascapularis* after the tendon of the *m. infraspinatus* is cut and removed (left front leg). 1. *N. suprascapularis*, 2. Acromion, 3. Joint capsule

2. *N. radialis*: *N. radialis*, passing from the medial to the lateral side of the leg, was exposed after the dissection of the cranial edge of the *m. triceps brachii caput laterale* in the lateral approach to the brachial region. It was determined that *n. radialis* was divided into branches at the lower $\frac{1}{4}$ of the distance between the *art. humeri* and the lateral edge of the *caput radii* (Figure 2). *N. radialis* block can be performed at the level of the lower $\frac{1}{3}$ of the distance between the *tuberculum majus* of the humerus and the *epicondylus lateralis* of the humerus.

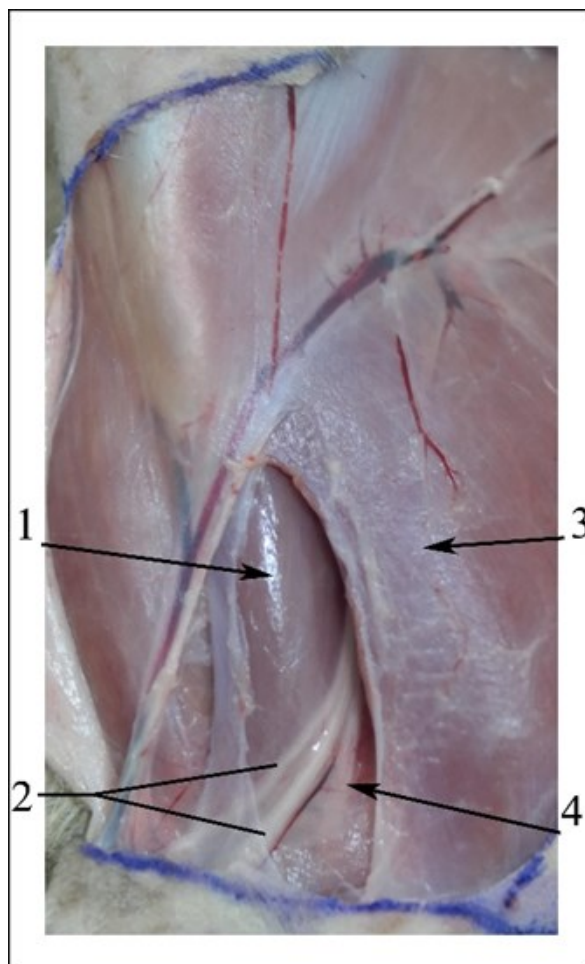


Figure 2. *N. radialis* (left front leg) after dissection of the lateral head of *m. triceps brachii*. 1. *M. brachialis*, 2. Superficial rami of *n. radialis*, 3. Lateral head of *m. triceps brachii*, 4. Profundus ramus of *n. radialis*.

3. *N. medianus*: In the region antebrachii mediale, it was observed that the *n. medianus*, passing under the muscles, descended distally from the groove between the radius and ulna together with the a. and v. *medianus*. *N. medianus* block can be performed by injection into the *sulcus radioulnaris*, which can be felt by palpation, at the level of the middle of the length of the radius (Figure 3).

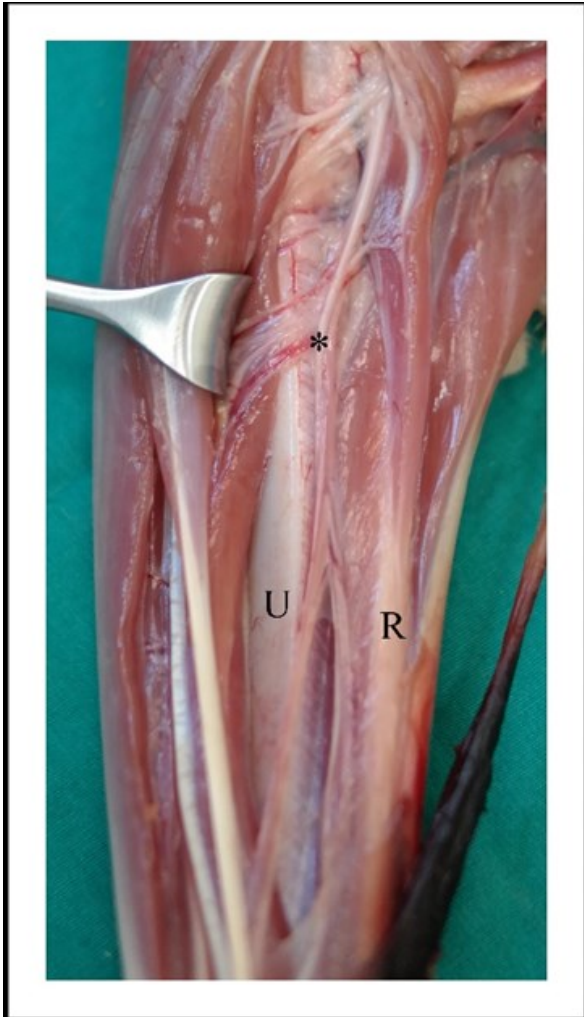


Figure 3. Regio antebrachii medialis (left front leg). U: Ulna, R: Radius, *: *a. mediana*, *n. medianus*, *v. mediana*

4. *N. ulnaris*: The block of the *n. ulnaris*, which passes close to the caudal border in the median cubital region, can be performed subcutaneously from the cranial 1/3 of the distance between the *epicondylus medialis* of the humerus and the *tuber olecrani* (Figure 4).

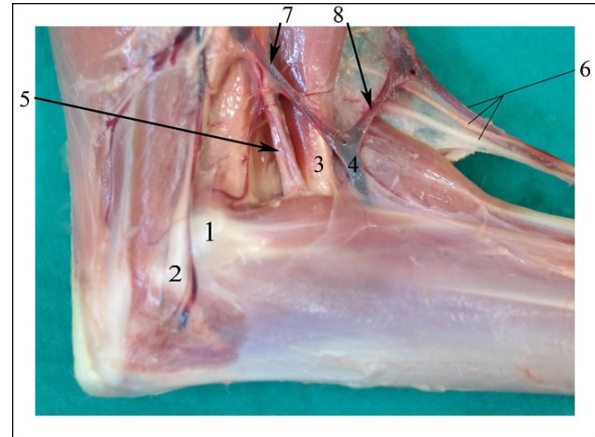


Fig. 4. Medial approach to the regio cubiti (left front leg). 1. *Epicondylus medialis*, 2. *N. ulnaris*, 3. Tendo of the *m. biceps brachii*, 4. *V. mediana*, 5. *A. mediana* and *n. medianus*, 6. Lateral-medialis ramus of the superficial ramus of the *v. cephalica-n. radialis* 7. *V. brachialis*, 8. *V. mediana cubiti*.

Nerve Blocks of the Hind Limb

1. *N. ischiadicus*: In the coxal articular region, *n. ischiadicus* was identified descending distally in a curved manner just behind the *trochanter major*. *N. ischiadicus* block can be performed through the palpable fossa just caudomedial to the *trochanter major* (Figure 5).

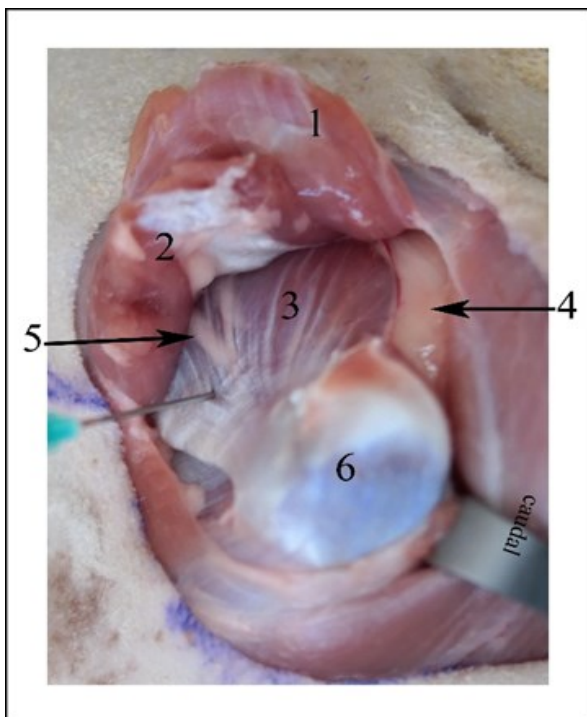


Figure 5. Regio art. coxae, lateral approach (left hindlimb). 1. *M. tensor fascia latae*, 2. *M. gluteus medius*, 3. *M. gluteus profundus*, 4. *N. ischiadicus*, 5. *N. gluteus cranialis*, 6. *Trochanter major*.

2. *N. tibialis*: *N. tibialis* block located in the regio cruris can be performed from both lateral and medial approaches. *N. tibialis* can be felt with mediolateral palpation under the skin between the *tendo calcaneus communis* and the tendons just cranial to it. *N. tibialis* block can be performed here within the middle 1/3 of the length of the tibia (Figure 6).

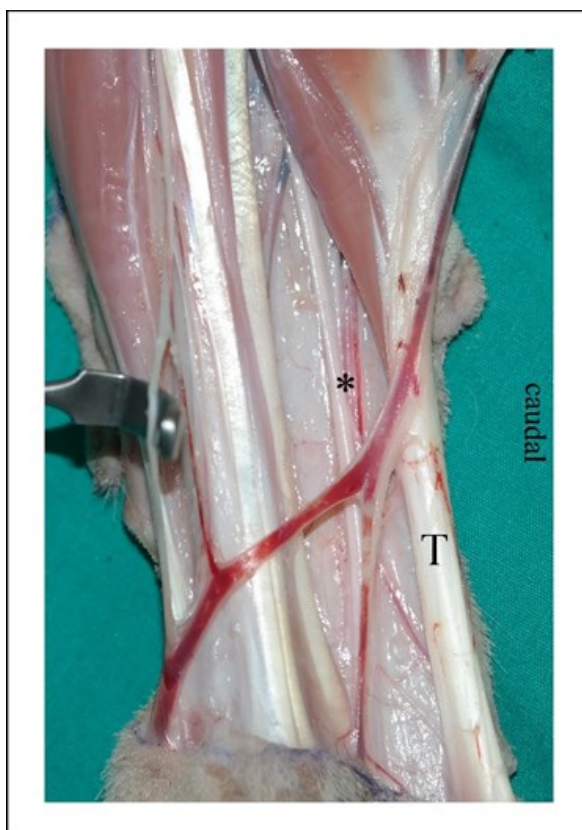


Figure 6. Lateral approach to the regio cruris (left hind leg). T: *Tendo calcaneus communis*, *: *n. tibialis* and *v. saphena medialis*, Nerve held with retractor: *n. fibularis superficialis*.

Discussion and Conclusion

As a result of the literature review, techniques including the caput, corpus and distal ends of the bones, their diameters and the ratios of substantia compacta and substantia spongiosa were used in all osteometric studies performed on bones (Berteaux and Guinard, 1995; Onar and Kahvecioğlu, 1999; Steyn and Işcan, 1999; Alpak et al., 2004; Akman et al., 2006; Taşer et al., 2009; Salami et al., 2011; Pazvant and Kahvecioğlu, 2013; Onar et al., 2015; Pazvant et al., 2015). In our study, since the extremities were approached topographically, it was not possible to reach all the measurable structures of the bones. In addition, following the main concept of the study, it was deemed appropriate to approach the bones from a topographic perspective. For this purpose, meas-

urements were made using externally palpable bone points on regions of the extremities. This method is thought to be more practical as it can also be performed on live animals. While taking the measurements, measurements were made only at the points specified in Table 1 to ensure that the extension or flexion of the joints did not affect the measurements taken. Such a measurement technique was not found in the literature searches. The fact that these measurements can be performed on live animals distinguishes our study from other morphometric studies.

In the sources reporting that the course of the *n. suprascapularis* in the scapular region passes distally to the acromion and heads upwards, the block of this nerve is not described (Çalışlar et al., 1998; Dursun, 2008; Tobias and Johnston, 2012). In this study, it was determined that the course of the nerve was the same as in the literature. In order to complete the deficiency in the literature, it was determined that the distal part of the acromion was suitable for the block of this nerve.

In the literature, there is no mention of *n. ulnaris* block located in the median cubital region (Dursun, 2008; Done et al., 2009; Evans and Lahunta, 2010). As a contribution to literature, we determined that *n. ulnaris* block can be performed at the cranial 1/3 of the distance between the *epicondylus medialis* of the humerus and the *tuber olecrani*.

In the literature, it was reported that point for *n. medianus* block is slightly behind the medial aspect of the *art. cubiti* and it can be done by taking the pulse from the *a. mediana* for nerve block (Çalışlar et al., 1998; Dursun, 2008; König and Liebich, 2014). In our study, it was determined that *n. medianus* block can also be performed from the radioulnar groove in the medial antebrachial region, which is not stated in the literature.

Dursun (2008) reported the point for *n. ulnaris* block as the middle of the ulnar groove between *m. extensor carpi ulnaris* and *m. flexor carpi ulnaris*. Contrary to literature information, it is thought that it would be more appropriate to perform *n. ulnaris* block in the upper 1/3 of the length of the ulna rather than in the middle of the ulnar groove. The reason for this is that the ulnar groove, which can be palpated more clearly in the upper 1/3, decreases in depth as it descends distally.

In an ultrasound-assisted study conducted on dogs regarding the block of the *n. ischiadicus* passing through the coxal articular region, Campoy et al. (2010) detected the nerve passing through the region with the help of a probe placed between the *tuber ischiadicum* and trochanter major and then blocked the nerve by entering it from the caudal part of the leg in the direction of the *m. semimembranosus* with a

needle. Mahler and Adogwa (2008), in a study conducted on dogs, blocked the *n. ischiadicus* by entering the needle from the middle of a line drawn between the *spina iliaca dorsalis* and the *tuber ischiadicum*; a line parallel to the median line dorsal to this line; and a perpendicular connecting these two lines, with one corner being the *tuber ischiadicum*. Different from the literature, a third and very simple method was found in our study. The palpable depression caudomedial to the trochanter major was determined as the blockage point of the *n. ischiadicus*.

According to Dursun (2008), the *n. tibialis* passing through the regio cruris anesthesia can be performed from here located in the groove between the *tendo calcaneus communis* and *m. flexor hallucis longus*. In our study, *n. tibialis* can be anaesthetized by palpating it under the skin, both laterally and medially, within the middle 1/3 of the length of the tibia, between the *tendo calcaneus communis* and the tendons in front of it. This method is considered to be both clearer in terms of description and easier to apply in dogs.

Alpak et al. (2004) determined that there was a correlation between the long bones and the cranium in their morphometric study between some measurements of the cranium and long bones in dogs. However, they did not evaluate the correlation between long bones. In our study, correlations between bones were calculated based on palpable bone points and significant positive correlations were found.

This study, which found that the distance between reference points that can be easily measured by palpation in a living animal has significant positive correlations that can be used clinically in many ways, is thought to offer a more practical method compared to other studies in the literature.

In conclusion, this study performed on the extremities of dogs has not only contributed to the addition of colorful and fresh operation photographs to the literature but also revealed new and simple techniques for some of the anesthesia applied to the nerves. In addition, it is thought that the osteometric analyses and measurement techniques used can be easily applied to live animals and will form the basis for new studies in this field. It has been concluded that some measurements between externally palpable points on a live dog can be used to calculate other lengths.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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Subclinical Mastitis in Dairy Cattle in Kayseri, Türkiye: Bacteriological Analysis and Antibiotic Susceptibilities*

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Abstract: Mastitis is a disease that causes significant economic losses in dairy farms and is caused by many microorganisms and physical trauma. In this study, it was aimed to detect subclinical mastitis (SCM) using the California Mastitis Test (CMT) and bacteriological analysis in dairy cattle and to determine the antibiotic susceptibilities of the obtained isolates. For this purpose, a total of 400 milk samples from 100 cattle were screened with CMT. The CMT-positive samples were subjected to bacteriological analysis. The samples were inoculated onto 7% sheep blood agar and incubated at 37°C for 24-96 h in aerobic/microaerobic/anaerobic atmospheres. Colonies grown were evaluated. The identification of the obtained isolates was performed by phenotypic tests, MALDI-TOF MS, and 16S rRNA gene sequencing. The susceptibilities of the isolates to nine antibiotics were determined by the disk diffusion method. The prevalence of SCM was detected as 25.75% (103/400) for the CMT results. In the bacteriological analysis, 74 (71.8%) of 103 milk samples from 60 CMT-positive animals were detected as positive, and 75 isolates were obtained. The most frequently defined bacteria were coagulase-negative *Staphylococcus* (n=25), *Staphylococcus aureus* (n=17), and *Trueperella pyogenes* (n=8). The highest antibiotic resistance among all isolates was detected to gentamicin (48%) and tetracycline (32%), while *Staphylococcus* spp. isolates were determined to be highest penicillin (45.2%) and gentamicin (38.1%). In conclusion, the current study revealed that there may be a need for dairy farms in this region to develop useful strategies for the treatment/control of SCM, considering the pathogenic bacteria and high antibiotic resistance.

Keywords: Antibiotic susceptibility testing, bacteriological analysis, MALDI-TOF MS, sequencing, subclinical mastitis

Kayseri'deki Süt Sığırlarında Subklinik Mastitis: Bakteriyolojik Analiz ve Antibiyotik Duyarlılıklar

Öz: Mastitis, süt sığırcılığı çiftliklerinde önemli ekonomik kayıplara yol açan ve birçok mikroorganizma ve fiziksel travmanın neden olduğu bir hastalıktır. Bu çalışmada, süt sığırlarında subklinik mastitisin (SKM), California Mastitis Test (CMT) ve bakteriyolojik analiz kullanılarak tespit edilmesi ve elde edilen izolatların antibiyotik duyarlılıklarının belirlenmesi amaçlandı. Bu amaçla, 100 sığırdan alınan toplam 400 süt örneği, CMT ile tarandı. CMT-pozitif örnekler bakteriyolojik analize tabi tutuldu. Örneklerden %7'lik koyun kanlı agarlara ekim yapıldı ve besiyerleri 37°C'de, 24-96 saat, aerobik/mikroaerobik/anaerobik atmosferlerde inkübe edildi. Besiyerlerinde üreyen koloniler değerlendirildi. Elde edilen izolatların tanımlanması fenotipik testler, MALDI-TOF MS ve 16S rRNA sekans analizi ile gerçekleştirildi. İzolatların dokuz antibiyotiğe duyarlılıkları, disk difüzyon yöntemi ile belirlendi. CMT sonuçlarına göre, SKM prevalansı %25.75 (103/400) olarak saptandı. Bakteriyolojik analizde, 60 CMT pozitif hayvana ait 103 süt örneğinin 74'ü (%71.8) pozitif olarak saptandı ve 75 izolat elde edildi. En sık tanımlanan bakteriler koagülaz negatif *Staphylococcus* (n=25), *Staphylococcus aureus* (n=17) ve *Trueperella pyogenes* (n=8) idi. Tüm izolatlar arasında en yüksek antibiyotik direnci gentamisin (%48) ve tetrasikline (%32) karşı tespit edilirken, *Staphylococcus* spp. izolatları arasında en yüksek penisilin (%45.2) ve gentamisine (%38.1) karşı saptandı. Sonuç olarak, bu çalışma, patojen bakteriler ve yüksek antibiyotik direnci göz önünde bulundurulduğunda, bölgedeki süt çiftliklerinin SKM'nin tedavisi/kontrolü için yararlı stratejiler geliştirmelerine ihtiyaç olabileceğini ortaya koymaktadır.

Anahtar kelimeler: Antibiyotik duyarlılık testi, bakteriyolojik analiz, dizileme, MALDI-TOF MS, subklinik mastitis

Introduction

Mastitis is defined as the inflammation of the mammary glands and causes physical and chemical alter-

ations in the gland tissue and glandular secretions (Kour et al., 2023). It is one of the most important diseases seen in dairy cattle worldwide and is also responsible for huge financial problems, such as treatment costs and losses in milk production/quality (Tommasoni et al., 2023).

Mastitis, according to symptoms, inflammation, and milk quality changes, is divided into two: clinical mas-

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titis (CM) and subclinical mastitis (SCM) (Cao et al., 2023). Clinical mastitis shows several symptoms, such as red-swollen udder, fever, and milk clots, and subdivides into peracute, acute, and subacute based on the inflammation degree (Cheng and Han, 2020). Subclinical mastitis diagnosis is more difficult according to CM, and dairy cattle with SCM might be overlooked since the animals may not present any clinical signs. In addition, SCM increases the somatic (inflammatory) cell count (SCC) in milk and leads to prolonged losses in milk performance, physiological changes, and rises in the therapy cost (Tommasoni et al., 2023; Michira et al., 2023; Cao et al., 2023). The California Mastitis Test (CMT) is a practical, inexpensive, and cow-side test that indirectly determines SCC in milk in SCM. When the SCC in milk increases, the CMT score also increases proportionally. This is associated with the probability and severity of intramammary infection (Alkan et al., 2014).

Mastitis is a disease with multi-etiological features, but many cases are of bacterial origin worldwide. A wide range of bacteria are responsible for bovine mastitis cases. The species primarily isolated in most cases of mastitis are *Staphylococcus aureus*, *Streptococcus* spp. (*Str. agalactiae*, *Str. dysgalactiae* and *Str. uberis*), *Escherichia coli*, *Klebsiella pneumoniae* and *Mycoplasma* spp. (*M. bovis*) (Kasa et al., 2020; Huma et al., 2022; Kour et al., 2023; Rifatbegović et al., 2024). On the other hand, the bacteria show differences in relative prevalence between several geographies (regions/countries). Therefore, the identification of common bacteria is important for the diagnosis of mastitis, appropriate treatment, inhibition of recurrent infections, and successful mastitis control programs (Al-Harbi et al., 2021; Rifatbegović et al., 2024).

The prevention and control programs for mastitis are generally based on antibiotic therapy. However, antimicrobial resistance (AMR) is a rising concern globally because of the extensive empirical use of antimicrobials (Cheng et al., 2019; Al-Harbi et al., 2021). In recent years, the resistance to various antimicrobials (penicillin, amoxicillin, tetracycline, amikacin, gentamicin, erythromycin, piperacillin, ceftazidime, cefquinome, tigecycline, colistin, vancomycin, etc.) has been observed to increase. Furthermore, the drug residue is another threat (Campos et al., 2022). Therefore, the performance of the antibacterial susceptibility test is important to provide the selection of the most appropriate therapy approach in mastitis cases (Cheng et al., 2019; Al-Harbi et al., 2021).

In the present study, we aimed to determine SCM using CMT and bacteriological analysis in four dairy farms and to evaluate the antibiotic susceptibilities of the recovered isolates.

Material and Methods

Milk Samples

The present study analyzed 400 milk samples from 100 dairy cattle during routine CMT screenings to diagnose SCM in 4 dairy farms (25 animals from each) in Kayseri province of Türkiye. CMT-positive milk samples were collected in sterile falcon tubes, transported under cold conditions to Erciyes University, Faculty of Veterinary Medicine, Microbiology Laboratory, and subjected to bacteriological analysis.

California Mastitis Test

The SCM was detected using the CMT and carried out in line with the method previously reported by Bastan (2013). The first two/three streams of milk were discarded, and approximately 2-3 ml of milk samples were milked from each quarter into four cups of the CMT paddle. Afterwards, an equal amount of CMT solution was added to each cup of the CMT paddle, including milk. The solution was provided to interact with the milk by mixing lightly for 15 seconds. The obtained CMT results based on gel formation were categorized as 0 and trace (negative), trace, 1 (weak positive), 2 (evident positive), and 3 (strong positive). Zero and trace of CMT scores were accepted as negative, but 1, 2, and 3 of CMT scores were evaluated as positive for SCM.

Bacteriological Analysis

Ten µL of the milk samples for bacteriological analysis were inoculated on 7% sheep blood agar (Neogen NCM2013A, USA), and the plates were incubated at 37°C in aerobic (for 24-48 h), microaerobic (for 48-72 h) and anaerobic (for 72-96 h) atmospheres. At the end of the incubation period, the colonies grown on the media were evaluated, and the pure cultures were obtained on 7% sheep blood agar.

The identification of the recovered isolates was performed by phenotypic tests, Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS), and molecular analysis. In the phenotypic identification, Gram staining, motility test, and biochemical tests were used. For MALDI-TOF MS analysis, the sample preparation of the whole cell was done as described by Dieckmann et al. (2008). In addition, Ultraflex II MALDI-TOF/TOF mass spectrometer (Bruker Daltonics, USA) equipped with an all-solid-state SmartBeam™ laser (Nd: YAG laser), operated at 100 Hz in the positive linear mode (100 ns, 25 kV, and 2.2-20 kDa) under the control of the Flex Control software version 3.0 (Bruker Daltonics), was used to determine all mass spectra. According to the manufacturer's specified criteria, the score results of ≥2.00, 1.70-1.99, and <1.70 were assigned as the correct species, low consistency, and no consistency, respectively (Sogawa et al., 2011).

The molecular analysis (16S rRNA gene sequencing) was performed for the identification of the isolates not identified via MALDI-TOF MS. DNA extraction from the recovered isolates was carried out with the classical single-cell lysis buffer (SCLB) protocol (Olah et al., 2006). The universal 27F and 1492R primers were used for amplification and sequence analysis of a near-complete (1465 bp) portion of the 16S rRNA gene region (Lane, 1991). The obtained chromatograms as a result of sequence analysis were evaluated using Finch TV (version V1.4) and aligned. It was identified in the BLAST (Basic Local Alignment Search Tool) rRNA/ITS database of the National Center for Biotechnology Information (NCBI) and deposited in the National Institutes of Health (NIH) GenBank the 16S rRNA gene sequence results.

Results

The Results of CMT

The 103 udder lobes belonging to 60 dairy cattle were found to be positive for SCM. The prevalence of SCM was detected to be 25.75% (103/400). According to CMT results, there are no significant differences between the rates of mastitis in farms ($P=0.365$) (Table 1).

The Bacteriological Analysis Results

The rate of 71.8% of milk samples (74/103) belonging to 52 dairy cattle (52/60) were found to be positive. There are no significant differences between the rates of mastitis in farms in the bacteriological analysis results ($P=0.344$) (Table 1).

Table 1. The detailed results of the California Mastitis Test and the bacteriological analysis

Dairy Farm	CMT		Bacteriological analysis	
	No. of dairy cattle screening	Positive result n (%)	No. of milk samples taken	Positive result n (%)
A	25	13 (52)	23	15 (65.2)
B	25	17 (68)	32	23 (71.8)
C	25	18 (72)	26	22 (84.6)
D	25	12 (48)	22	14 (58.3)
Total	100	60 (60)	103	74 (71.8)
	$P=0.365$		$P=0.344$	

n (%): Number (percentage) of CMT-positive dairy cattle, and number (percentage) of positive milk samples (in the result of bacteriological analysis)

Antibiotic Susceptibility Testing

The susceptibilities to ampicillin (AM, 10 µg), amoxicillin/clavulanic acid (AMC, 30 µg), cefotaxime (CTX, 30 µg), ciprofloxacin (CIP, 10 µg), erythromycin (E, 15 µg), gentamicin (CN, 10 µg), penicillin (P, 10 µg), tetracycline (TE, 30 µg) and trimethoprim/sulfamethoxazole (SXT, 25µg) (Bioanalyse, Türkiye) of the isolates were determined by the disk diffusion method (Bauer et al., 1966). *E. coli* ATCC 25922 was used as the standard control strain. The results were interpreted according to the breakpoints specified in the European Committee on Antimicrobial Susceptibility Testing (EUCAST, 2025) guidelines.

Statistical Analysis

The SCM prevalence was calculated according to CMT results in milk samples collected within the scope of the study. Prevalence data were represented by n (%). The chi-square test was used to analyze the statistical significance of differences in mastitis diagnosis according to the farms where milk samples were collected for CMT and the bacteriological analysis and the significance level was determined as $P < 0.05$. Statistical analyses were performed with the SPSS 30.01 package program.

A total of 75 isolates (2 isolates from one milk sample) were obtained (Table 2). As a result of phenotypic tests, 61 and 14 of the 75 isolates were defined as Gram-positive and Gram-negative bacteria. Six isolates were positive in the motility test. In addition, 17, 58, and 4 of the isolates were coagulase-positive, catalase-positive, and oxidase-positive, respectively. In the MALDI-TOF MS analysis, two and 66 of 75 isolates were identified at the genus level (*Psychrobacter* sp.) and the species level, respectively, but the remaining 7 isolates were not identified at the genus/species level. 16S rRNA gene sequencing was performed to identify 9 isolates (including two isolates identified at the genus level by MALDI-TOF MS). Five and 4 isolates were identified at the genus level (3 *Staphylococcus* sp. and 2 *Acinetobacter* sp.) and the species level (2 *Psychrobacter pulmonis*, 1 *Staphylococcus borealis* and 1 *Streptococcus pluranimalium*), respectively. The data of the 16S rRNA gene sequence of 9 isolates were deposited in GenBank under accession numbers from PQ870726 to PQ870734.

The most frequently identified genera at the genus level within 75 isolates were *Staphylococcus* (42/75),

Trueperella (8/75), *Escherichia* (5/75), and *Aerococcus* (5/75). The most identified *Staphylococcus* species at the species level were *S. aureus* (n=17), *S. haemolyticus* (n=13), *S. epidermidis* (n=4) and *S. chromogenes* (n=4), while the other most frequently identified species were *Trueperella pyogenes* (n=8), *Escherichia coli* (n=5), and *Aerococcus viridans* (n=5). In addition, two isolates recovered from one milk sample were defined as *T. pyogenes* and *S. aureus*. The distribution of the bacteria is presented in Table 2.

20%, 16%, and 8% of 25 coagulase-negative *Staphylococcus* (CNS) isolates were found to be resistant to P, AM, SXT, CN, CTX, and E, respectively. The CN, SXT, and TE resistance rate of 8 *T. pyogenes* isolates was 62.5%. While the highest antibiotic resistance in 5 *E. coli* isolates was observed to CN (60%), AM (40%), and AMC (40%), the resistance in 5 *A. viridans* isolates was determined to CIP (100%) and CN (80%). In addition, *T. pyogenes* and *S. aureus* isolates recovered from one udder lobe were detected to be resistant to CN but susceptible to AM,

Table 2. The distribution of the recovered bacteria from milk samples

Genus	Species	No. of the isolates (n)	Percentage (%)	GenBank Accession Number
Staphylococcus	<i>S. aureus</i>	17	23	-
	<i>S. haemolyticus</i>	13	17.3	-
	<i>S. chromogenes</i>	4	5.3	-
	<i>S. epidermidis</i>	4	5.3	-
	CNS	1	1.3	PQ870733
	<i>Staphylococcus</i> sp.	3	4	PQ870727 PQ870730 PQ870731
Trueperella	<i>T. pyogenes</i>	8	10.7	-
Escherichia	<i>E. coli</i>	5	6.7	-
Aerococcus	<i>A. viridans</i>	5	6.7	-
Acinetobacter	<i>A. baumannii</i>	1	1.3	-
	<i>A. johnsonii</i>	1	1.3	-
	<i>Acinetobacter</i> sp.	2	2.7	PQ870728 PQ870732
Streptococcus	<i>S. agalactiae</i>	1	1.3	-
	<i>S. uberis</i>	1	1.3	-
	<i>S. pluranimalium</i>	1	1.3	PQ870726
Psychrobacter	<i>P. pulmonis</i>	2	2.7	PQ870729 PQ870734
Corynebacterium	<i>C. pseudotuberculosis</i>	1	1.3	
Arcanobacterium	<i>A. pluranimalium</i>	1	1.3	
Lactococcus	<i>L. lactis</i>	1	1.3	
Pasteurella	<i>P. multocida</i>	1	1.3	
Pseudomonas	<i>P. aeruginosa</i>	1	1.3	
Klebsiella	<i>K. oxytoca</i>	1	1.3	

n: No. of the isolates, %: Percentage of the isolates, **CNS**: Coagulase-negative *Staphylococcus*.

The Results of the Antibiotic Susceptibility Testing

In the test, 48%, 32%, 30.6%, 26.7%, 22.7%, 17.6%, 14.7%, 9.3%, and 5.3% of the isolates were found to be resistant to CN, TE, P, AM, SXT, E, CIP, CTX, and AMC, respectively. The antibiotic resistance in 42 *Staphylococcus* spp. isolates was mostly detected to P (45.2%), CN (38.1%), and AM (35.7%). Of the 17 *S. aureus* isolates, 70.6%, 64.7%, 17.6%, 17.6%, 11.8%, 5.9%, and 5.9% were resistant to TE, CN, P, AM, E, AMC, and SXT, respectively. 64%, 48%, 24%,

AMC, CIP, CTX, and P. The detailed antibiotic susceptibility test results belonging to all isolates (n=75) are given in Table 3.

Table 3. The results of antibiotic susceptibility testing of the isolates obtained from milk samples

Isolates	Antibiotic															
	AM				AMC				CIP				CN			
	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S
<i>S. aureus</i>	3 (17.6)*	14 (82.4)	1 (5.9)	16 (94.1)	-	17 (100)	-	17 (100)	-	6 (35.3)	11 (64.7)	6 (35.3)	-	17 (100)	2 (11.8)	15 (88.2)
<i>CNS</i>	12 (48)	13 (52)	-	25 (100)	-	25 (100)	-	25 (100)	-	20 (80)	5 (20)	20 (80)	4 (16)	21 (84)	2 (8)	23 (92)
<i>T. pyogenes</i>	-	8 (100)	-	8 (100)	2 (25)	6 (75)	-	8 (100)	-	3 (37.5)	5 (62.5)	3 (37.5)	-	8 (100)	4 (50)	4 (50)
<i>E. coli</i>	2 (40)	3 (60)	2 (40)	3 (60)	1 (20)	4 (80)	-	5 (100)	-	2 (40)	3 (60)	2 (40)	-	5 (100)	ND	ND
<i>A. viridans</i>	-	5 (100)	-	5 (100)	5 (100)	-	-	5 (100)	-	4 (80)	4 (80)	1 (20)	-	5 (100)	-	5 (100)
<i>Acinetobacter</i> spp.	-	4 (100)	-	4 (100)	1 (25)	3 (75)	-	3 (75)	-	2 (50)	2 (50)	2 (50)	1 (25)	3 (75)	2 (50)	2 (50)
<i>Streptococcus</i> spp.	1 (33.3)	2 (66.7)	-	3 (100)	-	3 (100)	-	3 (100)	-	3 (100)	3 (100)	-	1 (33.3)	2 (66.7)	1 (33.3)	2 (66.7)
<i>P. pulmonis</i>	-	2 (100)	-	2 (100)	-	2 (100)	-	2 (100)	-	1 (50)	1 (50)	1 (50)	-	2 (100)	1 (50)	1 (50)
<i>C. pseudotuberculosis</i>	-	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)	1 (100)	-	-	1 (100)	-	1 (100)
<i>A. pluranimalium</i>	-	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)	1 (100)	-	-	1 (100)	-	1 (100)
<i>L. lactis</i>	-	1 (100)	-	1 (100)	1 (100)	-	-	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)
<i>P. multocida</i>	-	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)
<i>P. aeruginosa</i>	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)	1 (100)	-	1 (100)	1 (100)	-	1 (100)	-
<i>K. oxytoca</i>	1 (100)	-	-	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)	-	1 (100)
Total (n=75)	20 (26.7)	55 (73.3)	4 (5.3)	71 (94.7)	11 (14.7)	64 (85.3)	7 (9.3)	68 (90.7)	12 (17.6)	39 (52)	36 (48)	19 (30.6)	17 (22.7)	52 (69.3)	24 (32)	51 (68)

*n (%): No. of the isolates (%), CNS: Coagulase-negative Staphylococcus, ND: Not Determined, R: Resistant, I: Intermediate, S: Susceptible, AM: Ampicillin, AMC: Amoxicillin/clavulanic acid, CIP: Ciprofloxacin, CN: Gentamicin, CTX: Cefotaxime, E: Erythromycin, P: Penicillin, SXT: Trimethoprim/sulfamethoxazole, TE: Tetracycline.

Discussion and Conclusion

Mastitis, one of the leading diseases affecting milk capacity in dairy cattle, causes significant economic losses in dairy cattle farms in Türkiye and around the world (Tel et al., 2009; Tommasoni et al., 2023). CMT is an inexpensive, practical, and reliable test used to detect SCM cases in dairy cattle. The bacteriological analysis is performed to detect and identify bacteria that lead to SCM. As a result of the analysis, many bacteria, primarily *Staphylococcus* spp. are obtained in SCM cases (Tel et al., 2009). In the current study, 75 isolates were obtained as a result of bacteriological analysis of the milk samples from dairy cattle detected SCM after screening with CMT, and the most frequently identified species were *S. aureus* (23%), *S. haemolyticus* (17.3%), and *T. pyogenes* (10.7%). In the studies conducted in Türkiye, Tel et al. (2009) detected the most *S. aureus* (32.5%), CNS (27.5%), and *Streptococcus* spp. (8.9%) in the result of bacteriological analysis of 332 milk samples from cattle with SCM. Buyukcangaz et al. (2012) reported that the highest rates of *S. aureus* (31.45%), CNS (23.88%), and *Streptococcus* spp. (26.36%) were isolated and identified from 480 milk samples. Alkan et al. (2014) defined frequently *S. aureus* (20/34) and *Bacillus* spp. (7/34) in 109 CMT-positive/negative milk samples. Ozavcı et al. (2017) noted that it was mostly identified *Aeromonas hydrophila* (17.24%), *Corynebacterium* spp. (13.79%), *Lactobacillus* spp. (12.06%), *E. coli* (10.34%), *Shigella* sp. (10.34%), CNS (10.34%), and *S. aureus* (4.59%) from 238 milk samples. Kenar et al. (2019) obtained *E. coli* (13/61), *S. epidermidis* (8/61), *S. haemolyticus* (5/61), and *S. aureus* (4/61) as the most dominant species from 61 milk samples. Kahya Demirbilek (2020) detected the most frequent *Streptococcus* spp. (28.5%), *S. aureus* (23.1%), CNS (11.5%), and *E. coli* (11.5%) from 394 milk samples. Kurt and Eski (2021) analyzed 103 milk samples and determined that *E. coli* (19.9%), *S. aureus* (13.7%), and *Mycoplasma bovis* (8.2%) were the dominant species. Delikanlı Kiyak et al. (2024) reported that it was identified *E. coli* (26.10%), *S. aureus* (21.29%), *Str. agalactiae* (20.08%), and *S. epidermidis* (12.05%) in the analysis of the milk samples. In the studies conducted worldwide, Barreiro et al. (2010) noted that it was obtained 33 isolates from milk samples from cattle with SCM, and 42.4%, 30.3%, and 27.3% of them were identified as *S. aureus*, *Str. agalactiae* and CNS, respectively. Persson et al. (2011) reported that the most common species identified in 583 milk samples were *S. aureus* (19%), CNS (16%), and *Str. dysgalactiae* (9%). Dieser et al. (2014) detected mostly CNS (52.1%) and *S. aureus* (21.3%) in 1201 milk samples. Abed et al. (2021) defined the most frequently *E. coli* (49.8%), *S. aureus* (44.9%), *Streptococcus* spp. (44.1%) and non-aureus staphylococci (37.1%) in 488 milk samples. Al-Harbi et al. (2021) announced that it was identified com-

monly non-aureus staphylococci (10%), *Str. uberis* (7%), and *S. aureus* (5%) in milk samples. Chung et al. (2021) determined by a majority of CNS (44.7%), *Bacillus* spp. (30.3%), and *S. aureus* (20.45%) in 132 milk samples. Huma et al. (2022) identified the most *S. aureus* (34.45%), *E. coli* (21.36%), and CNS (13.54%) in 235 milk samples. Michira et al. (2023) declared that it was defined frequently CNS (40.1%), *S. aureus* (15.8%), and *Micrococcus* spp. (10.4%) in milk samples. Cao et al. (2023) noted that the most common isolates from 208 milk samples were *K. pneumoniae* (15.35%), *E. coli* (13.70%), and *P. aeruginosa* (12.33%). Rifatbegović et al. (2024) obtained the highest *S. aureus* (17.1%), CNS (17.1%), *Str. uberis* (12.2%), *Streptococcus* spp. (12.2%), and *T. pyogenes* (9.8%) from 111 milk samples. In the majority of the studies mentioned above, *S. aureus* and non-aureus staphylococci were the most commonly identified bacteria in dairy cattle with SCM, which is consistent with our study's results. It is thought that minor differences in the distribution of the most frequently identified species may be due to geography, nutrition, farm management, hygienic conditions, milking practices, and isolation/identification methods (Kasa et al., 2020).

Antibiotic treatment is an important therapy for the prevention and control of mastitis cases. On the other hand, the extensive empirical use of antibiotics is known to be the primary cause of AMR (Abed et al., 2021). There are many studies on determining the antibiotics to be used in the treatment of SCM cases, and the antibiotic resistance profiles show differences in these studies. The resistance rates of *S. aureus* isolates recovered from dairy cattle with SCM in Türkiye to AM, AMC, CIP, CN, CTX, E, P, SXT, and TE ranged between 10.5%-77.3%, 10%-66.5%, 0%-50%, 0%-59.5%, 2.9%-25%, 0%-63%, 0%-75.8%, 3.6%-12.6%, and 17.9%-23.3%, respectively (Tel et al., 2009; Ozavcı et al., 2017; Gulmez Saglam et al., 2018; Kenar et al., 2019; Kahya Demirbilek, 2020; Gokdag and Ciftci, 2021; Tavsanlı and Cibik, 2022). It is observed that the resistance rates of *S. aureus* isolates worldwide to AM, AMC, CIP, CN, CTX, E, P, SXT, and TE varied between 45.7%-96%, 0%-78%, 0%-16%, 0%-32.1%, 0%-46%, 0%-44.6%, 4%-92.7%, 0%-26%, and 0%-18.6%, respectively (Persson et al., 2011; Xu et al., 2015; Ren et al., 2020; Abed et al., 2021; Al-Harbi et al., 2021; Chung et al., 2021; Michira et al., 2023; Silva et al., 2023; Rodríguez et al., 2023; Haq et al., 2024). In our study, it is detected that 70.6%, 64.7%, 17.6%, 17.6%, 11.8%, 5.9%, and 5.9% of the 17 *S. aureus* isolates were resistant to TE, CN, P, AM, E, AMC, and SXT, respectively (Table 3). TE and CN resistance rates in *S. aureus* isolates are higher than the antibiotic resistance rates mentioned above.

Of the CNS or non-aureus staphylococci isolates obtained from dairy cattle with SCM in Türkiye, the

resistance rates against AM, AMC, CIP, CN, CTX, E, P, SXT, and TE were found to vary between 8.5%-58%, 8.6%-89%, 0%-56%, 0%-66.2%, 2.9%-47.4%, 5.6%-46.8%, 11.4%-55.3%, 2.8%-6.4%, and 0%-40.4%, respectively (Tel et al., 2009; Buyukcangaz et al., 2012; Ozavcı et al., 2017; Gulmez Saglam et al., 2018; Kenar et al., 2019; Kahya Demirbilek, 2020; Gokdag and Ciftci, 2021). It was determined that the resistance rates of CNS or non-aureus staphylococci isolates worldwide to AM, AMC, CIP, CN, CTX, E, P, SXT, and TE ranged between 27%-90%, 0%-76%, 0%-12%, 0%-18%, 0%-42%, 2%-49%, 12%-86.8%, 0%-16.1%, and 1%-39.5%, respectively (Botrel et al., 2010; Persson et al., 2011; Xu et al., 2015; Phophi et al., 2019; Abed et al., 2021; Al-Harbi et al., 2021; Chung et al., 2021; Michira et al., 2023; Rodríguez et al., 2023). In the present study, it determined that 64%, 48%, 24%, 20%, 16%, and 8% of 25 CNS isolates were resistant to P, AM, SXT, CN, CTX, and E, respectively (Table 3). The resistance rate of SXT in CNS isolates was detected to be higher than those mentioned above. It is thought that these differences in antibiotic resistance profiles of both *S. aureus* and CNS isolates in our study may be related to geographic location, climate, population characteristics, nutrition, hygienic conditions, study design, the number of isolates, etc. (Haq et al., 2024).

In conclusion, the subclinical mastitis rate in dairy cattle in Kayseri province of Türkiye, for the CMT results was detected to be 25.75%, and 71.8% positivity (74/103) was detected as a result of bacteriological analysis. The most commonly identified genus and species among the recovered 75 isolates were *Staphylococcus* (56%) and *S. aureus* (22.7%), respectively. The gentamicin (48%) and tetracycline (32%) resistance were detected at a high rate in the 75 isolates analyzed according to the antibiotic susceptibility testing results. Due to antibiotic resistance, it is thought that it may be appropriate to take various precautions to prevent the emergence/spread of the resistance in dairy cattle farms in the region. In addition, the present study showed that there may be a need for dairy farms in this region to develop useful strategies for the treatment/control of SCM, according to the recovered bacteria from SCM cases and antibiotic resistance profiles.

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contributing to the statistical analyses of our findings.

Competing Interest

The authors declare that they have no conflict of interest.

Ethical Statement

Ethics committee approval is not required within the scope of this study.

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Slaughter and Carcass Traits of Male Kids Called as Manavlı Goat *

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Abstract: The study was planned to determine the slaughter and carcass characteristics of the kids of Manavlı goats raised only/purely under breeder conditions in Denizli province. A total of 12 male kids at live weight of 34-36 kg at five months of age were slaughtered. In the study, hot dressing percentage based on pre-slaughter liveweight was 41.37%. While the cross-sectional area of the M. longissimus dorsi (MLD) was found to be 12.46 cm², the back fat thickness fat value was determined to be 0.74 mm. In the study, the carcass length, rump circumference, rump width, chest circumference, and chest width were 75.15 cm, 54.80 cm, 18.52 cm, 71 cm, and 18.91 cm, respectively. Additionally, the percentages of valuable carcass parts, such as the shoulder, ribs, and long leg, were determined to be 20.75%, 26.09%, and 31.97%, respectively. The study is the first research to examine the slaughter and carcass characteristics of male kids of Manavlı goats, which are a native genetic resource raised under local breeder condition and not yet sufficiently defined. It was thought that obtained results from this study will be a database for the following studies.

Keywords: Carcass, kid, Manavlı, slaughtering

Manavlı Olarak Adlandırılan Keçilerin Erkek Oğlaklarının Kesim ve Karkas Özellikleri

Öz: Bu çalışma Denizli ilinde halk elinde saf olarak yetiştirilen, Manavlı keçilerinin erkek oğlaklarının kesim ve karkas özelliklerini belirlemek için yapılmıştır. Çalışmada 34-36 kg arasında kesim öncesi canlı ağırlığa ulaşan 5 aylık yaştaki 12 erkek oğlak kesime sevk edilmiştir. Çalışmada kesim öncesi canlı ağırlığa göre hesaplanan sıcak karkas randımanı değeri %41.37 olarak belirlenmiştir. Yine, M. longissimus dorsi (MLD) alanı 12.46 cm² olarak bulunurken; kabuk yağı kalınlığı ise 0.74 mm olarak belirlenmiştir. Karkas ölçülerinden karkas uzunluğu, sağrı çevresi, sağrı genişliği, göğüs çevresi ve göğüs genişliği değerlerinin sırasıyla 75.15 cm, 54.80 cm, 18.52 cm, 71 cm ve 18.91 cm olduğu görülmüştür. İlave olarak çalışma kapsamında ön kol, kaburga ve uzun but gibi önemli karkas parçalarının yüzde oranları sırasıyla %20.75, %26.09 ve %31.97 olarak belirlenmiştir. Çalışma halk elinde yetiştirilen ve henüz yeterince tanımlanmamış yerli bir gen kaynağı olan Manavlı olarak adlandırılan keçilerinin erkek oğlaklarının kesim ve karkas özelliklerine ilişkin ilk araştırma niteliğindedir. Çalışma sonuçlarının ileride yapılacak araştırmalar bir veri tabanı oluşturacağı düşünülmektedir.

Anahtar kelimeler: Karkas, kesim, Manavlı, oğlak

Introduction

The selection of animals for farming is influenced not only by factors such as regional conditions but also by the type of product intended to be obtained and targeted. In this regard, farming activities can be carried out based on the desired products, such as meat, milk, or mohair (Ceyhan et al., 2015).

Goat farming, which is primarily preferred by those living in rural areas, can utilize the natural resources

in its surrounding geography more efficiently compared to other types of livestock farming, with relatively lower costs. Furthermore, the ability of goats to produce products by utilizing feed resources that are not sufficiently exploited by other livestock species increases the significance of goat farming (Çelik and Olfaz, 2017). Goat farming is practiced not only for milk production but also for meat yields. It has been noted that goat meat is less watery and leaner compared to sheep carcasses, which could be important factors in consumer preferences (Webb et al., 2005).

In Türkiye, sheep and goat breeding, especially goat breeding, is carried out in small and irregularly structured family enterprises. Goat farming, which holds a privileged position within small livestock farming, is mainly practiced in forested and border regions (Dellal and Erkuş, 2000). The total number of farm

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animals in Türkiye has surpassed 70 million, with goats constituting approximately 15% of this figure. The Mediterranean, Southeastern Anatolia, and Aegean regions are the primary geographical areas for goat populations (TUIK, 2024).

The fact that the Turkish Hair goats, which have such a large population in different geographical regions, possess various types and varieties, requires the identification of their distinct characteristics. Additionally, it should be considered that, previously referred to collectively as Turkish Hair goats, there may be animals with different structural characteristics in terms of both morphological and physiological breed traits. Although there has been a significant increase in studies aimed at identifying all possible varieties and the potential emergence of new breeds from native goat genetic resources in Türkiye, it can still be said that there are not enough. For this purpose, the Manavlı goat genotype, which has never been previously introduced to the scientific community, is believed to have been raised for many years in certain areas of Western Anatolia. This genotype, named after the Manavlı Nomads, is claimed to have high birth weight, rapid growth capacity, and a large body structure (Akbaş et al., 2023). The purpose of this study was to detect slaughter and carcass traits of Manavlı male kids raised under breeder conditions.

Material and Methods

Animals and Data Collection

In order to reveal the fattening, slaughter and carcass characteristics, single male kids were purchased from the breeders in Denizli province (latitude 39°20' and 40°30' N, longitude 26°30' and 28°30' E) that were born in March, 2024. Male single kids, were numbered with ear tags, were kept with their mothers at morning and night until the suckling period ended (approximately 75-90 days of age) under breeder conditions. No different management procedure was applied to the flocks during the experimental periods of the study. In the study, among 60 male kids, whose live weight values were determined at 30-day intervals from birth to 5 months of age, a total of 12 male kids that first reached a pre-slaughter live weight of 34-36 kg were transported to a commercial slaughterhouse in the province of Burdur without causing unnecessary distress on them by ensuring the welfare conditions. On the day of slaughter, their pre-slaughter live weights were recorded after they were deprived of food (for 12 h) but allowed free access to water. After the preslaughter live weights of kids were detected, slaughter characteristics such as skin, feet, head and red organs (lungs and trachea, liver, heart, spleen) were recorded using a scale with 50-g precision. Then the hot carcass weights were detected. The hot carcasses were chilled for 24 h at 4°C and re-weighed. Hot and cold carcass dressing

percentages were calculated based on live weight before the slaughter. Additionally, chilling lost value was determined between the differences of hot and cold carcass weights. Some of carcass measurements such as the carcass length, the rump circumference, rump width, chest circumference and chest width were carried out by using a measuring stick and measuring tape. Then carcasses were split into two equal part. The left side was separated into five joints as described by Colomer-Rocher et al. (1987) (Figure 1), they were weighed. Percentages of the valuable carcass parts were calculated based on cold carcass weight.

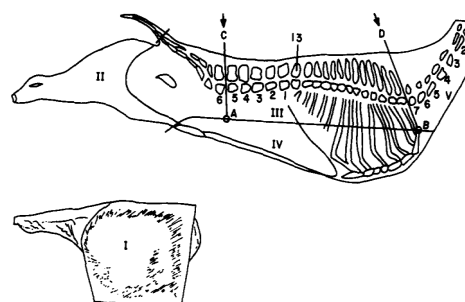


Figure 1. Scheme for jointing the left side of a goat carcass

I: Shoulder, II: Long leg, III: Ribs, IV: Flank, V: Neck

A digital plot was used in order to detect the fat thickness. Additionally, the M. Longissimus dorsi (MLD) area was detected by using drawing software as stated by Akbaş (2013). A digital caliper with a sensitivity of 0.01 mm, an accuracy of ± 0.01 mm (< 100 mm) and a repeatability of 0.01 mm. was also used in order to determine the backfat thickness.

The study was approved by the Burdur Mehmet Akif Ersoy University Local Ethics Committee on Animal Experiments (29.03.2023, resolution number: 1036).

Minitab (2019) statistical software packaged was used for examining the data. An intense descriptive statistical analysis was applied on the data with the means and standart errors of means. The coefficient of variances was presented to indicate the reliability of the data in the study. Additionally, Pearson correlation coefficients were calculated to determine the relationship between some of the slaughter and carcass characteristics examined from the data obtained in the study.

Results

Slaughter and carcass characteristics of Manavlı male kids and relations between some of them were presented in Tables 1-4. The average preslaughter weights of Manavlı male kids were found to be 35.22 kg. The hot carcass weight was determined to be

14.57 kg, with a dressing percentage of 41.37%. In the study, the average cold carcass weight was found to be 14.34 kg, with a chilling loss of 1.58%, and a cold dressing percentage of 40.72%. Additionally, the M. longissimus dorsi (MLD) area was found to be 12.46 cm², and the back fat thickness was determined to be 0.74 mm. The study also showed that the carcass length, rump circumference, rump width, chest circumference, and chest width were 75.15 cm, 54.80 cm, 18.52 cm, 71 cm, and 18.91 cm, respectively.

Phenotypic correlation coefficients (r) between some carcass traits were presented in Table 3. High positive correlations were calculated between the relevant feature ($P < 0.05-0.001$). While the highest positive correlation coefficient (0.922) was between slaughter weight and M. Longissimus dorsi area, a relatively low correlation coefficient (0.645) was determined between back fat thickness and cold carcass weight compared to other characteristics.

Table 1. Certain slaughter and carcass characteristics of Manavlı male kids ($\bar{x} \pm S_{\bar{x}}$)

Traits	Values	CV%
Slaughter weight (kg)	35.22±1.45	7.49
Hot carcass weight (kg)	14.57±0.68	9.61
Dressing percentage, %	41.37±0.25	8.25
Head weight (g)	2029.06±19.57	7.40
4 Feet weight (g)	1203.44±21.23	9.17
Skin weight (g)	2687.92±20.29	9.13
Lungs and trachea weight (g)	521.10±19.45	8.12
Heart weight (g)	146.05±4.29	10.16
Liver weight (g)	688.06±10.05	8.15
Spleen weight (g)	70.02±0.45	9.25
Full stomach weight (g)	4529.30±51.01	10.11
Full intestine weight (g)	2492.44±23.79	9.48
Internal fat weight (g)	159.51±3.25	9.17

$\bar{x}$: Mean $S_{\bar{x}}$: Standart error of mean CV: Coefficient of variance

Table 2. Certain cold carcass characteristics of Manavlı male kids ($\bar{x} \pm S_{\bar{x}}$)

Traits	Vaues	CV%
Cold carcass weight (kg)	14.34±0.50	9.49
Chilling loss (%)	1.58±0.07	7.23
Dressing percentage, %	40.72±0.38	8.05
Left half of carcass weight (kg)	7.29±0.31	9.07
Shoulder weight (g)	1513.03±43.11	9.22
Flank weight (g)	695.13±25.39	9.56
Neck weight (g)	786.05±43.27	8.19
Ribs weight (g)	1946.28±54.11	10.31
Sirloin weight (g)	1510.63±26.06	9.75
Loin weight (g)	436.11±38.01	9.78
Long leg weight (g)	2331.19±72.05	8.39
Back fat thickness (mm)	0.74±0.07	9.40
M. Longissimus dorsi area (cm ²)	12.46±0.47	8.24
Carcass length (cm)	75.15±0.90	8.03
Rump circumference (cm)	54.80±0.63	9.15
Rump width (cm)	18.52±0.47	8.79
Chest circumference (cm)	71.00±0.81	9.18
Chest width (cm)	18.91±0.70	9.27

$\bar{x}$: Mean $S_{\bar{x}}$: Standart error of mean CV: Coefficient of variance

Table 3. Phenotypic correlation coefficients (r) between some carcass traits

Traits	Slaughter weight (kg)	MLD area (cm ²)	Back fat thickness (mm)	Hot carcass weight (kg)
MLD area (cm ²)	0.922***			
Back fat thickness (mm)	0.856**	0.654*		
Hot carcass weight (kg)	0.830**	0.757*	0.719*	
Cold carcass weight (kg)	0.820**	0.790**	0.645*	0.987***

*, $P < 0.05$, **, $P < 0.01$, ***, $P < 0.001$ MLD: *Musculus Longissimus dorsi*

When examining Table 4, which presents the proportions of certain slaughtering characteristics in male kids of the Manavlı goat, the percentages of the head, legs, skin, lungs and trachea, full stomach, full intestines, and omental and mesenteric fat were found to be 5.76%, 3.41%, 7.62%, 1.48%, 12.85%, 7.02%, and 0.45%, respectively. Additionally, the percentage proportions of valuable carcass parts, such as the shoulder, ribs, and long leg, were determined to be 20.75%, 26.69%, and 31.97%, respectively.

Studies on determining the meat production of sheep and goat farming are generally based on the principles of assessing the growth characteristics of the offspring, establishing suitable feeding models, and subsequently determining the carcass characteristics of the animals. The dressing percentage value, which is influenced by numerous factors related to the animal and its care and nutrition generally increases with the rise in pre-slaughter live weight (Warmington and Kirton, 1990).

Table 4. Percentages of the valuable parts and slaughtering characteristics in Manavlı male kids ($\bar{x} \pm S_{\bar{x}}$)

Traits	Values	CV%
Percentages (%) relative to cold carcass weight		
Shoulder	20.75±0.44	8.41
Flank	9.54±0.16	7.27
Neck	10.78±0.11	8.13
Ribs	26.69±0.62	9.74
Sirloin	20.71±0.16	9.19
Loin	5.98±0.04	9.27
Long Leg	31.97±0.41	7.39
Percentages (%) relative to slaughter weight		
Head	5.76±0.11	9.85
4 Feet	3.41±0.12	10.01
Skin	7.62±0.23	9.46
Lungs and Trachea	1.48±0.07	9.17
Heart	0.42±0.03	8.70
Liver	1.96±0.04	8.64
Spleen	0.20±0.02	9.37
Full stomach	12.85±0.25	8.86
Full intestine	7.02±0.11	9.10
Internal Fat	0.45±0.06	8.40

$\bar{x}$: Mean $S_{\bar{x}}$: Standard error of mean CV: Coefficient of variance

Discussion and Conclusion

The coefficient of variation, which is one of the most appropriate prevalence measures for comparing data series with different means in terms of variation, is below 10 percent, indicating that the data are very homogeneous (Tekin, 2010). In the study, lots of coefficient of variance (%91.66, 44/48) values for slaughter and carcass traits presented in tables were under %10. This situation shows that the data presented are quite homogeneous, based on the slaughtering and data collection procedures carried out under controlled conditions.

In the study, hot and cold dressing percentage values were detected as 41.37% and 40.72%, respectively. These values are higher than those reported by Gökdağ (2013) for Alpine x Hair goat (F1), Saanen x Hair goat (F1) crosses, and male Turkish Hair goat kids; however, they are compatible with the values stated by Oral Toplu et al. (2010) for male Turkish Hair goat kids under breeder conditions. Although there are studies (Koyuncu et al., 2007; Atay et al., 2011; Yılmaz et al., 2010) reporting relatively higher values than those detected for male Turkish Hair goat kids, Akbaş and Saatçı (2016) and Elmaz et al.

(2017) reported higher yield values for male Honamlı goat kids. It is stated that dressing percentages in goats can vary between 35% and 53% due to the influence of various factors (Warmington and Kirton, 1990). The relatively low percentages observed in this study, which are affected by breeder conditions, suggest that positive differences and higher values could be achieved in the aforementioned values for the Manavlı goat through studies conducted under more controlled conditions, where the animals' fattening performance is also considered, using different experimental designs.

Since the hot, cold carcass weights and MLD area which are economically important, they were tried to be estimated like the growth characteristics. So, slaughter weight is one of the main factor for hot and cold carcass weights and MLD cross sectional area. In the study, strong positive correlations were determined between pre-slaughter live weight and both hot and cold carcass weights, with correlation coefficients of 0.830 and 0.820, respectively. Similarly, Stanford et al. (1995), in their study on Alpine goats using ultrasound to assess certain carcass traits, and Rahman (2007), who investigated Bengal goats divided into three different groups, reported a correlation coefficient of 0.85 between live weight and hot carcass weight. In the present study, high and positive phenotypic correlation coefficient (0.922) were defined between slaughter weight and MLD area. It is known that there is a relationship between MLD and the amount of quality meat in the carcass. MLD is affected by factors such as cross-sectional area, genotype, applied fattening method, and slaughter live weight (Daşkiran et al., 2010).

As subcutaneous fat increases, the amount of water lost by evaporation from the carcass surface decreases, thus reducing chilling loss (Dhanda et al., 2003). The back fat thickness value (0.74 mm), which is one of the important criteria determining the fatness levels of the carcasses, was higher than Koşum et al. (2003), Yılmaz et al. (2010), and Özcan et al. (2010), reports. Contry to this, Gül (2004) and Koyuncu et al. (2007) reported higher values than the current study. The higher back fack thickness might be associated with the fact that the lower chilling loses for Manavlı kids.

In the study, MLD area value were defined as 12.46 cm² for Manavlı male kids. It is relatively in parallel with the values reported by Akbaş and Saatçı (2016) for Honamlı x Hair goat crossbred kids. However, it is higher than the values reported by Aktaş et al. (2015) for Honamlı breed kids. Furthermore, it is higher than the values reported by Akman et al. (1991) and Erol (2015) for Ankara goat kids with pre-slaughter live weights around 30-31 kg. Therefore, it was thought that the differences on MLD value was associated with slaughter live weight of kids.

Carcass measurements can be influenced by factors such as breed, gender, slaughter age, live weight at slaughter, and feeding conditions (Erol, 2015). When the carcass measurements in this study are generally examined, various researchers (Cameron et al., 2001; Dhanda et al., 2003; Koşum et al., 2003; Gökdağ, 2013) reported higher values than the current study. They are generally consistent with the values reported by Akbaş and Saatçı (2016) and Elmaz et al. (2017) for male Honamlı goat kids. Variation in the values reported on carcass measurements within the literature is likely attributable to differences in rates of growth, slaughter age and slaughter weight and also feeding system.

When considering the percentages of significant carcass parts for consumption, the determined values for the shoulder (20.75%), ribs (26.69%), and long leg (31.97%) were found to be lower than the values reported by Akbaş and Saatçı (2016) and Aktaş et al. (2015) for the long leg percentage in Honamlı male kids. Additionally, Koşum et al. (2003), Pena et al. (2007), Bonvillani et al. (2010), and Daşkiran et al. (2010) reported higher values than these values. However, they were in parallel with the values reported by Kor et al. (2011) and Atay et al. (2011). These differences among the studies may be due to slaughter weight and rearing conditions.

The value for the percentage of the head (5.76%) determined in this study is relatively lower compared to the values reported by Atay et al. (2011). It is reported that as the pre-slaughter live weight of the kids increases, the head ratio in the carcass will decrease relatively (Erol, 2015). Therefore, it is thought that the differences observed for the values specified in the study may be due to different pre-slaughter live weights. Additionally, the skin percentage (7.62%) is consistent with the values reported by Koyuncu et al. (2007) for Turkish Hair goats at various slaughter weights, as well as by Özcan et al. (2010) for Saanen, Gökçeada, and Maltız kids. However, it is lower than the values reported by Akbaş and Saatçı (2016) and Elmaz (2017) for Honamlı kids, and by Erol (2015) for Ankara goat kids. Especially the differences between skin percentages might be associated with the less intense and less long hair production of Manavlı kids.

In the study, it has been observed that the average slaughter weight values of male Manavlı goat kids are higher than those of many local goat breeds, particularly the Turkish Hair goat for the 150th day of age. Furthermore, in terms of carcass measurements, positive differences were found in Manavlı goat kids compared to the reports on Turkish Hair goats in the literature. This study is important because it is the first to reveal the potential of Manavlı goat kids, a native genetic resource that is raised under local breeder condution and has not yet been

sufficiently studied from a scientific perspective, in terms of their carcass characteristics. It is believed that the results obtained from this study could make a positive contribution to biodiversity and the production spectrum.

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Evaluation of Serum Neopterin and Procalcitonin Levels in Dogs with Ascariasis

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Abstract: Ascariasis is a commonly encountered parasitic infection in dogs that can lead to gastrointestinal damage and systemic inflammatory responses. However, studies evaluating the role of inflammatory biomarkers in the diagnosis of ascariasis remain limited. The aim of this study was to evaluate the association between ascariasis and the levels of inflammatory biomarkers, specifically serum neopterin and procalcitonin, in dogs. The study included 15 puppies aged between 1 and 6 months, diagnosed with ascariasis, and 10 clinically healthy control dogs. All animals were of different breeds and included both males and females. A single blood sample was collected from both infected and healthy animals. The samples were centrifuged at 3000 rpm for 10 minutes to separate the serum. The analysis revealed that serum neopterin (5.06 ± 0.50 nmol/L) and procalcitonin (68.47 ± 2.86 pg/mL) levels in the infected dogs were significantly higher ($P < 0.05$) than those observed in healthy controls (neopterin: 3.67 ± 0.26 nmol/L; procalcitonin: 57.42 ± 3.91 pg/mL). The study concludes that gastrointestinal damage caused by ascariasis is associated with increased serum levels of neopterin and procalcitonin. These biomarkers may have clinical value in supporting the differential diagnosis of parasitic infections associated with inflammatory responses in dogs, and they may contribute to the early detection and monitoring of disease severity. Further studies with larger sample sizes and a broader panel of inflammatory markers are warranted to validate these findings and to better elucidate the role of neopterin and procalcitonin in the immunopathogenesis of canine ascariasis.

Keywords: Ascarid, dog, neopterin, procalcitonin

Askariasisli Köpeklerde Serum Neopterin ve Prokalsitonin Düzeylerinin Değerlendirilmesi

Öz: Askariasis, köpeklerde yaygın olarak görülen paraziter bir enfeksiyondur ve gastrointestinal hasara ile sistemik inflammatuar yanıtlara yol açabilir. Ancak, askariasis tanısında inflammatuar biyobelirteçlerin rolünü değerlendiren çalışmalar sınırlıdır. Bu çalışmanın amacı, köpeklerde askariasis ile inflammatuar biyobelirteç düzeyleri özellikle serum neopterin ve prokalsitonin arasındaki ilişkiyi değerlendirmektir. Çalışmaya, askariasis tanısı konulan 1 ila 6 aylık yaş aralığında 15 yavru köpek ile klinik olarak sağlıklı 10 kontrol köpeği dahil edilmiştir. Tüm hayvanlar farklı ırklardan olup hem erkek hem de dişi hayvanlar çalışmaya dahil edilmiştir. Hem enfekte hem de sağlıklı hayvanlardan tek seferlik kan örnekleri alınmıştır. Serum örnekleri elde etmek amacıyla kan örnekleri 3000 devirde 10 dakika santrifüj edilmiştir. Gerçekleştirilen analizler sonucunda, hastalıklı köpeklerdeki neopterin (5.06 ± 0.50 nmol/L) ve prokalsitonin (68.47 ± 2.86 pg/mL) seviyelerinin, sağlıklı köpeklerde belirlenen neopterin (3.67 ± 0.26 nmol/L) ve prokalsitonin (57.42 ± 3.91 pg/mL) seviyelerine kıyasla istatistiksel olarak anlamlı düzeyde yüksek olduğu ($P < 0.05$) tespit edilmiştir. Çalışma, askariasisin neden olduğu gastrointestinal hasarın artmış serum neopterin ve prokalsitonin düzeyleri ile ilişkili olduğunu ortaya koymaktadır. Bu biyobelirteçler, özellikle köpeklerde inflammatuar yanıtla ilişkili paraziter enfeksiyonların ayırıcı tanısında klinik olarak destekleyici tanı değeri taşıyabilir ve hastalığın erken tespiti ile şiddetinin izlenmesine katkı sağlayabilir. Bu bulguların doğrulanması ve neopterin ile prokalsitoninin köpeklerde askariasisin immünopatogenezindeki rolünün daha iyi aydınlatılması için daha geniş örneklem büyüklüklerine ve daha kapsamlı bir inflammatuar belirteç paneline sahip çalışmalara ihtiyaç vardır.

Anahtar kelimeler: Askarid, köpek, neopterin, prokalsitonin

Introduction

Ascariasis is one of the most prevalent zoonotic parasitic diseases worldwide (Macpherson, 2013). The causative agents of this disease, which is commonly observed in dogs, are *Toxocara canis* and *Toxascaris leonina*. These gastrointestinal nematodes are highly

resistant to disinfectants and can survive for months or even years both inside the host and in the external environment under suitable conditions (McTier et al., 2000; Tınar et al; 2006; Macpherson, 2013; Sezer et al., 2024). The transmission routes of the disease vary depending on the species. While *T. leonina* is transmitted solely through oral ingestion (Parsons, 1987; Rostami et al., 2020), *T. canis* can infect hosts through oral, galactogenic, and transplacental routes (Robertson and Thompson, 2002; Romasanta et al.,

2004; Rostami et al., 2020). Infected puppies play a crucial role in disease transmission by shedding millions of eggs into the environment through their feces (Schnieder et al., 2011; ESCCAP, 2024). These parasites induce various hematological, biochemical, and pathological alterations in the host (Cansız, 2015). Given their persistence in the environment and the high egg-shedding capacity of infected puppies, understanding the epidemiology and transmission dynamics of *T. canis* and *T. leonina* is essential for effective control and prevention strategies.

Ascariasis is more commonly observed in dogs aged 0-6 months (Overgaauw and Knapen, 2013). Studies have shown that the disease does not exhibit breed predisposition or gender differences (Gingrich et al., 2010). The clinical signs can vary depending on the age of the infected animal, the intensity, location, and developmental stage of the parasite. However, the disease is primarily characterized by gastrointestinal symptoms such as enteritis, vomiting, growth retardation, abdominal distension (bloating), constipation, and mechanical obstruction in the intestines (Epe, 2009; Atasoy et al., 2015; Corda et al., 2019).

Neopterin (Np), a pteridine derivative, was first identified in bee larvae in 1963 and subsequently isolated from human urine by Sakurai and Goto in 1967. Synthesized predominantly by monocytes, macrophages, and T lymphocytes upon stimulation by interferon-gamma (IFN- γ), Np serves as a sensitive marker of cellular immune activation. Although other cell types such as renal epithelial cells, fibroblasts, and vascular smooth muscle cells can also produce Np in response to stimuli involving guanosine triphosphate (GTP), its release during immunological processes primarily reflects IFN- γ -mediated activation of mononuclear phagocytes, particularly during infectious diseases, oxidative stress, and systemic immune responses (Berdowska and Zwirska-Korczala, 2001; Miao et al., 2018; Ünüvar and Aslanhan, 2019; Akyüz, 2020; Akyüz et al., 2022). The secretion of Np typically precedes the peak proliferation of T lymphocytes and the emergence of specific antibody responses, making it a valuable early indicator of Type 1 T helper (Th1)-type immune activity. Elevated serum Np levels have been associated with various pathological conditions, including infections, malignancies, autoimmune disorders, and organ transplant rejection (Eisenhut, 2013). In particular, parasitic diseases such as toxocariasis have been shown to trigger significant increases in circulating Np, likely reflecting the activation of IFN- γ -responsive macrophages during tissue invasion by migrating larvae (Kozłowska-Murawska and Obuchowicz, 2008; Batı et al., 2023). Supporting this interpretation, Başbuğ et al. (2020) reported markedly elevated Np concentrations in animals with systemic inflammatory response syndrome (SIRS), reinforcing its potential as a biomarker of early and robust immune system activation.

Procalcitonin (Pct) is a small peptide, weighing 13

kDa and consisting of 116 amino acids, produced by the parafollicular cells of the thyroid gland (Matur et al., 2021). However, it can also be synthesized by extrathyroidal organs such as the pancreas, liver, spleen, adrenal glands, lungs, kidneys, brain, spinal cord, testes, stomach, small intestines, colon, abdominal adipose tissue, and white blood cells (Müller et al., 2000). The release of procalcitonin is regulated by proinflammatory cytokines and may vary depending on the severity of inflammation (Gürbüz and Ulutaş, 2017). Yılmaz et al. (2008) reported an increase in serum Pct levels in dogs following endotoxin administration. Similarly Dözen (2018) reported elevated plasma Pct levels in dogs with acute diarrhea compared to the control group.

Materials and Methods

This study was conducted with the approval of the Kafkas University Animal Experiments Local Ethics Committee (decision dated 25.10.2022, number KAÜ-HADYK/2022-173) to ensure compliance with ethical standards. Additionally, blood samples were obtained following the recommended "standard sample collection procedure," ensuring that animals were neither stressed nor harmed in any way. All procedures involving animals complied with institutional guidelines and national regulations on animal welfare.

Animal Material

The material of this study consisted of dogs aged 1-6 months, of different breeds and sexes, brought to the Internal Medicine Department of the Faculty of Veterinary Medicine at Kafkas University. The study groups included 15 dogs diagnosed with ascariasis (Group I), which were examined through physical examination, and 10 healthy dogs (Group II) without any signs of illness.

Clinical Examination

After determining that the relevant pathogens were negative using the rapid test kit (CPV/CCV/Giardia Ag Rapid Test Kit, Anigen, South Korea), fecal samples were collected from the dogs suspected of ascariasis for examination purposes. The collected samples were placed on a slide, diluted with 1-2 drops of physiological saline, and homogenized. A coverslip was then applied, and microscopic examination was performed (Yılmaz et al., 2017). For animals with a definitive diagnosis, pyrantel pamoate was administered at a dose of 10 mg/kg for treatment.

Blood Sample Collection

Blood samples were collected in a single draw from the *V. cephalica antebrachii* using an appropriate holder and a sterile holder needle (Vacuette®, Greiner Bio-One GmbH, Austria) into serum tubes and EDTA blood tubes (BD Vacutainer®, BD, UK). To obtain serum, the blood samples were centrifuged at 3000 rpm for 10 minutes (Hettich Rotina 380R®,

Hettich, Germany). The serum samples to be used for ELISA measurements were stored at -20°C until the analysis was performed.

Complete Blood Count Analyzes

For CBC, blood samples were collected in EDTA tubes, and the following values were recorded using a VG-MS4e® analyzer (Melet Schloesing, France): total leukocyte count (WBC $\times 10^3/\mu\text{L}$), erythrocyte count (RBC $\times 10^6/\mu\text{L}$), hematocrit percentage (HCT %) and hemoglobin concentration (HGB g/dL).

Neopterin and Procalcitonin Analyzes

Serum Pct and Np concentrations were determined using dog-specific commercial ELISA kits (Canine Neopterin ELISA Kit®, Canine Procalcitonin ELISA Kit®, BT Lab, Shanghai Korain Biotech Co, China). The ELISA tests were performed according to the manufacturer's instructions, and optical densities were measured at a wavelength of 450 nm using an ELISA microplate reader (Epoch®, Biotek, USA). Neopterin and procalcitonin values were calculated through regression analysis.

Table 1. Mean and standard error values of the vital signs of dogs in the ascariasis and control groups.

Vital Parameters	Patient Group (n=15)	Control Group (n=10)	P Value
Pulse Rate (per minute)	113.46 $\pm$ 4.84	108.60 $\pm$ 3.15	P>0.05
Respiratory Rate (per minute)	30.40 $\pm$ 1.79	29.60 $\pm$ 1.07	P>0.05
Body Temperature (°C)	38.46 $\pm$ 0.18	38.16 $\pm$ 0.07	P>0.05

Table 1. Mean and standard error values of the vital signs of dogs in the ascariasis and control groups.

Statistical Analysis

The sample size was determined based on an effect size of 1.67 reported in a previous study by Atasoy et al. (2015), with a statistical power of 95% and a significance level of 5%. An a priori power analysis was conducted using G*Power® software (Version 3.1.9.4, Franz Faul, Universität Kiel, Germany) for a one-tailed independent samples t-test. The analysis indicated that a minimum total sample size of 18 subjects (9 per group) would be sufficient to detect a statistically significant difference between the groups. The normality of the data was assessed using the Shapiro-Wilk test. Since the distributions of procalcitonin,

opterin and pulse values did not follow a normal distribution, group comparisons for these parameters were conducted using the Mann-Whitney U test. All statistical analyses were performed using SPSS software (Version 20.0, IBM Corp., Armonk, NY, USA). A significance level of $P < 0.05$ was considered statistically significant. All parameter values are presented as mean $\pm$ standard error of the mean (SEM).

Results

In the clinical examinations of the dogs included in the study, diarrhea, vomiting, abdominal distension and tension, anorexia, coat condition deterioration, halitosis were observed. Dehydration was assessed based on sunken eyes and reduced skin elasticity, while anemia was suspected in animals exhibiting pale or whitish mucous membranes. Clinical examinations were performed on the dogs in the patient group before treatment, and their body temperature, respiratory rate per minute, and heart rate per minute were statistically evaluated (Table 1).

The vital signs of dogs with ascariasis were compared with the control group, and it was determined that the obtained results were not statistically significant ($P > 0.05$).

Hematological assessments revealed no statistically significant difference in white blood cell (WBC) counts between the patient and control groups ($P > 0.05$). In contrast, red blood cell (RBC) count, hematocrit (HCT), and hemoglobin (HGB) levels were significantly lower in dogs with ascariasis compared to healthy controls ($P < 0.001$) (Table 2).

Table 2. Mean and standard error values of hematologic parameters in dogs with ascariasis and the control group

Vital Parameters	Patient Group (n=15)	Control Group (n=10)	P Value
WBC ($\times 10^3/\mu\text{L}$)	4.21 $\pm$ 1.12	6.42 $\pm$ 0.55	P>0.05
RBC ($\times 10^6/\mu\text{L}$)	4.91 $\pm$ 0.51	9.59 $\pm$ 0.16	P<0.001
HCT (%)	31.19 $\pm$ 2.07	63.85 $\pm$ 1.44	P<0.001
HGB (g/dL)	10.71 $\pm$ 0.80	15.19 $\pm$ 0.37	P<0.001

Statistical difference between patient and control groups ($P < 0.05$)

temperature, and respiratory rate values were normal within the groups, comparisons were performed using the independent samples t-test. In contrast, as ne-

Serum Np and Pct levels were examined in dogs with ascariasis and in the control group. The analyses revealed that the Np and Pct levels in the affected group were significantly higher compared to the control group ($P<0.05$). The results are presented in Table 3.

anemia (McCown and Specht, 2011). In *Toxocara canis* infections, internal hemorrhages caused by larval migration through the liver and intestinal mucosa further exacerbate this condition by significantly reducing RBC counts (Schnieder et al., 2011). Cansız (2015) also reported a marked decline in RBC

Table 3. Mean and standard error values of neopterin and procalcitonin in dogs with ascariasis and the control group

Biomarkers	Patient Group (n=15)	Control Group (n=10)	P Value
Neopterin (nmol/L)	5.06±0.50	3.67±0.26	$P<0.05$
Procalcitonin (ng/L)	68.47±2.86	57.42±3.91	$P<0.05$

Statistical difference between patient and control groups ($P<0.05$)

Discussion and Conclusion

Studies on ascariasis in dogs have reported that the disease does not show breed predisposition and is most commonly observed in dogs aged 0-6 months (Gingrich et al., 2010; Overgaauw and Knapen, 2013). In accordance with the literature, our study group consisted of dogs aged 0–6 months, representing different breeds and both sexes.

In dogs with ascariasis, gastrointestinal symptoms such as vomiting, growth retardation, abdominal distension, constipation, and, in severe cases, intestinal obstruction may be observed (Epe, 2009; Atasoy et al., 2015). Clinical examinations of the dogs included in our study revealed diarrhea, vomiting, growth retardation, abdominal distension and tension, anemia, anorexia, deterioration of coat quality, halitosis, and dehydration. These clinical findings are consistent with previous reports describing systemic effects and gastrointestinal manifestations of ascariasis in dogs (Altuğ et al., 2007; Cansız, 2015; Corda et al., 2019). Specifically, halitosis and coat condition deterioration have also been noted in naturally infected puppies (Corda et al., 2019), and signs such as dehydration, anorexia, and anemia have been previously reported in association with parasitic gastrointestinal infections (Altuğ et al., 2007; Cansız, 2015).

Cansız (2015) reported that body temperature, pulse, and respiratory rates might not show statistically significant differences in cases of ascariasis. This variability was attributed to individual differences among infected animals, as these parameters could increase in some animals, decrease in others, or remain within normal limits, resulting in an overall average that falls within the reference range. Similarly, in the current study, vital parameters such as body temperature, pulse rate, and respiratory rate did not differ significantly between infected dogs and healthy controls, confirming that ascariasis may present without clear alterations in these clinical parameters.

Iron deficiency is a well-documented complication of intestinal parasitic infections in young animals, frequently resulting in decreased serum iron, transferrin saturation, HGB, and HCT levels, and ultimately leading to the development of microcytic-hypochromic

levels in cases of severe infestation. Similarly, Altuğ et al. (2007) observed statistically significant decreases in HCT and HGB levels in dogs with ascariasis and suggested that these findings might be attributed to iron deficiency secondary to malabsorption. In the present study, consistent with previous findings, statistically significant reductions in RBC, HCT, and HGB levels were identified in puppies with ascariasis ($P<0.001$). These hematological changes are likely associated with mucosal damage in the gastrointestinal tract, chronic blood loss, and malabsorption.

The use of more reliable biomarkers for evaluating the prognosis and diagnosis of diseases has been increasingly adopted in both human and veterinary medicine. Biomarkers are fundamental molecules that fluctuate under physiological and pathological conditions, playing a crucial role in disease assessment (De Looer et al., 2013; Köse and Maden, 2013). The objective of this study was to investigate serum neopterin and procalcitonin levels in dogs with ascariasis and to evaluate the diagnostic significance of these biomarkers in the disease.

In the present study, serum Np levels were found to be significantly elevated in dogs naturally infected with *Toxocara canis* compared to healthy controls. This finding supports the hypothesis that *T. canis* infection elicits a strong cellular immune response, likely driven by immunopathological processes associated with the larval migratory phase. As larvae migrate through hepatic and gastrointestinal tissues, they induce mechanical damage and trigger local inflammation, hemorrhage, and cytokine release, particularly interferon-gamma (IFN- γ), which is a key inducer of neopterin synthesis. The elevated Np levels observed in our study are therefore consistent with IFN- γ -mediated activation of mononuclear phagocytes in response to larval tissue invasion.

Previous studies have demonstrated that *T. canis* infection is characterized by marked eosinophilic and monocytic infiltration, especially during the tissue-migratory phase (Salem et al., 2015). Given that Np secretion typically precedes peak T lymphocyte proliferation and antibody production, it serves as an early marker of Th1-type immune activation during parasit-

ic infections. Our findings align with earlier reports of elevated Np levels in other parasitic diseases (Kozłowska-Murawska and Obuchowicz, 2008; Batı et al., 2023), supporting the notion that Np can function as a valuable biomarker of early and active immune responses during helminthic infections.

Additionally, the significantly higher Np concentrations found in infected dogs mirror findings in animals with systemic inflammatory response syndrome (Başbuğ et al., 2020), reinforcing the link between tissue damage, immune activation, and Np elevation. Taken together, these results suggest that serum Np may serve not only as a marker of general immune activation but also as a specific indicator of immunopathological changes occurring during larval migration in canine ascariasis.

Procalcitonin is an acute-phase reactant that increases particularly in response to bacterial sepsis and systemic infections. This increase has been attributed to the host immune system's response to endotoxins and proinflammatory cytokines, including interleukin-6 (IL-6), interleukin-1 β (IL-1 β), and tumor necrosis factor-alpha (TNF- α), which stimulate PCT synthesis in various extrathyroidal tissues such as the lungs, liver, and leukocytes (Panico and Nysten, 2013; Duru, 2014; Hacımustafaoğlu, 2017). These studies highlight that PCT levels correlate with the severity of infection and inflammatory burden, and may exceed other conventional markers such as C-reactive protein in both sensitivity and prognostic value. Consequently, it has been reported that Pct levels rise significantly in severe infection cases (Balci et al., 2003; Köse et al., 2013; Dözen, 2018).

Ascarids are significant parasitic pathogens that cause enteritis in dogs (Willard, 2013). These parasites typically reside in the small intestine and induce a variety of pathophysiological effects. The inflammatory response, mediated by lymphocytes, plasma cells, and phagocytic cells within the intestinal layers, leads to lymphocytic infiltration accompanied by degenerative changes in the mucosal glands and the smooth muscle layer of the intestinal wall. This inflammatory process results in villus atrophy, hyperplasia, and shedding of intestinal epithelial cells (Majeed Alnassiri, 2023). The destructive effects within the gastrointestinal tract facilitate the translocation of pathogenic microorganisms and their toxins from the gut flora into the systemic circulation, thereby predisposing the host to sepsis (Singer et al., 2016). Sepsis is one of the primary triggers for procalcitonin (Pct) release. During this process, Pct production occurs not only from monocytes but also from parenchymal tissues such as the lungs, liver, and intestines (Goggs et al., 2018). In the present study, consistent with the aforementioned literature, it is considered that intestinal damage caused by ascarid infestation promotes secondary bacterial invasion, leading to sepsis, which in turn results in increased serum Pct concentrations.

Our study has several limitations. First, the limited sample size reduces the statistical power and generalizability of the findings. Second, key proinflammatory cytokines such as IL-6, IL-1 β , and TNF- α —which are essential for evaluating systemic inflammation and immune response—were not measured. The absence of these markers limits the interpretation of elevated Pct and Np levels and prevents definitive conclusions about the presence of inflammation or activation of the immune system in dogs with ascariasis. Although Np is known to be secreted by activated macrophages during Th1-type immune responses, the lack of complementary cytokine data hampers a clear understanding of the immune profile in these animals. These limitations will be addressed in future studies to achieve more accurate and meaningful results.

In conclusion, this study demonstrated that serum neopterin and procalcitonin levels are elevated in dogs with ascariasis, suggesting that these biomarkers may have potential diagnostic utility for the disease. The findings support the role of immune response and inflammatory processes in the pathogenesis of ascariasis, as previously reported in studies demonstrating hematological, immunological, and inflammatory alterations in parasitic infections such as toxocariasis (Altuğ et al., 2007; Başbuğ et al., 2020; Sezer et al., 2024). These results highlight the need for further research to comprehensively evaluate the diagnostic and prognostic value of these biomarkers in parasitic diseases of veterinary importance.

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Türkiye’de Koyun ve Keçilerde *Haemonchus contortus* (*H. contortus*) Kaynaklı Üretim Kayıplarının Monte Carlo Simülasyon Modeliyle Tahmin Edilmesi

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Öz: Bu çalışmanın amacı, Türkiye’de koyun ve keçilerde *H. contortus* kaynaklı üretim kayıplarının Monte Carlo simülasyon modeliyle tahmin edilmesidir. Bu amaçla daha önce yayımlanmış çalışmalardan elde edilen prevalans verileri göz önüne alınmış ve 2025 yılındaki güncel fiyatlarla üretim kayıpları hesaplanmıştır. Koyun ve keçilerde *H. contortus* kaynaklı üretim kayıplarını tahmin etmek için Monte Carlo simülasyon yöntemi kullanılmıştır. Koyun ve keçilerde *H. contortus*’un prevalans değeri sırasıyla %29.5 ve %34.8 olarak hesaplanmıştır. Mevcut çalışmada hastalığın maliyetinin hesaplanmasında üretim kayıpları (et, süt, sakatat ve yün/tiftik) dikkate alınmıştır. Çalışma bulgularına göre, *H. contortus* kaynaklı hayvan başına kayıp koyunlarda 215.47 TL (5.67 \$), keçilerde 209.47 TL (5.51 \$) olarak tahmin edilmiştir. Enfekte hayvan başına kayıp koyunlarda 705.35 TL (18.56 \$) ve keçilerde 538.20 TL (14.16 \$) hesaplanmıştır. *H. contortus*’un ulusal düzeyde koyun ve keçilerde meydana getirdiği yıllık toplam kayıp miktarı 6.60 milyar TL (173.7 milyon \$) bulunmuştur. Sonuç olarak, Türkiye’de koyun ve keçilerde *H. contortus*’un oldukça yaygın görüldüğü, ciddi ekonomik kayıplara neden olduğu hesaplanmıştır. Paraziter hastalıklara karşı üreticilerin bilinçlendirilmesi ile birlikte hem üretici hem de karar vericiler tarafından kontrol/eradikasyon stratejilerinin oluşturulması gerekmektedir. Böylece hayvan hastalıkları azaltılıp, hayvan refahı artırılırken, küçükbaş hayvancılığın da ekonomik sürdürülebilirliği sağlanabilir.

Anahtar kelimeler: Ekonomik kayıp, *Haemonchus contortus*, keçi, koyun, üretim

Estimation of Production Losses due to *Haemonchus contortus* (*H. contortus*) in Sheep and Goats in Türkiye using Monte Carlo Simulation Model

Abstract: This study aimed to estimate the production losses caused by *H. contortus* in sheep and goats in Türkiye using a Monte Carlo simulation model. For this purpose, previously published prevalence values were considered, and production losses were calculated with current prices in 2025 year. Monte Carlo simulation model was used to estimate the production cost due to *H. contortus* in sheep and goats. The prevalence of *H. contortus* was calculated as 29.5% in sheep and 34.8% in goats. In production cost calculations, meat losses, milk losses, offal losses and wool/mohair losses were considered. As a result, the average loss per animal due to *H. contortus* was estimated at 215.47 TL (\$ 5.67) for sheep and 209.47 TL (\$ 5.51) for goats. The loss per infected animal was calculated at 705.35 TL (\$ 18.56) for sheep and 538.20 TL (\$ 14.16) for goats. The total annual national economic loss caused by *H. contortus* in sheep and goats was found to be 6.60 billion TL (173.7 million \$). In conclusion, *H. contortus* is highly prevalent among sheep and goats in Türkiye and causes substantial economic losses. Raising awareness among livestock producers and developing control/eradication strategies by both producers and policymakers are necessary. In this way, animal diseases can be reduced, animal welfare can be improved, and the economic sustainability of small ruminant farming can be ensured.

Keywords: Economic loss, goat, *Haemonchus contortus*, production, sheep

Giriş

Türkiye’de küçükbaş hayvancılık, ülkenin sahip olduğu geniş mera alanları sayesinde et, süt, yün ve tiftik gibi değerli hayvansal ürünlerin üretiminde önemli bir yere sahiptir (Semerci ve Çelik, 2016). Bu hayvancılık alt sektörü kırsal nüfus için önemli bir geçim kaynağı olmakla birlikte, verimliliği birçok faktör tarafından sınırlandırmaktadır. Bu faktörlerden biri de

paraziter enfeksiyonlardır. Hayvanlarda yaygın olarak görülen paraziter hastalıklar, hayvan refahını düşürmenin yanında işletmelerde önemli ekonomik kayıplara yol açarak kârlı ve sürdürülebilir hayvancılığın önünde önemli bir engel oluşturmaktadır (Adduci ve ark., 2022). Geviş getiren hayvanların gastrointestinal nematodu (GIN) olan *H. contortus*’un Türkiye genelinde özellikle meraya dayalı beslenen koyun ve keçilerde yaygın olarak görüldüğü farklı çalışmalarla ortaya konulmuştur (Önder ve ark., 2016; Şahin ve ark., 2021). Bu çalışmalar incelendiğinde Türkiye’de hastalık

prevalansının koyunlarda %8-54 aralığında (ortalama %30), keçilerde ise biraz daha yüksek %12-70 aralığında (ortalama %35) olduğu anlaşılmaktadır. Yurt dışında yapılan çalışmalarda (Tony, 2007; Abosse ve ark., 2022) da koyunlara göre keçilerde prevalansın daha yüksek olduğu bildirilmiştir.

Hemonkozis hastalığına neden olan *H. contortus*'un prevalansı Endonezya'da %89.4 (Widiarso ve ark., 2018); Togo'da %82 (Bonfoh ve ark., 1995); Ruanda'da %75.7 (Mushonga ve ark., 2018); Çin'de %72 (Wei ve ark., 2025); İsviçre'de %77, İtalya'da %73, İrlanda'da %4 (Rinaldi ve ark., 2015); Etiyopya %71 (Mengist ve ark., 2014); Gambia'da %67 (Fritsche ve ark., 1993); Pakistan'da %56-61 (Chaudary ve ark., 2007); Benin Cumhuriyeti'nde %55.6 (Attindehou ve ark., 2012); Bulgaristan'da %33 (Zurliiski ve Rusev, 1990); Kamerun'da %31 (Ngambia Funkeu ve ark., 2000) bildirilmiştir.

Halk arasında "berber direği kurdu" veya "tel kurdu" olarak da bilinen *H. contortus*, oldukça patojenik bir parazit olup, abomasuma yerleşir ve kan emerek beslenir. İştahsızlık, anemi, ishal, gelişme geriliği, fertilité bozuklukları, et, süt, yün kaybı yanında tedavi edilmezse ölümlere kadar varan kayıplara neden olabilir (Önder ve ark., 2016). İlave olarak bu enfeksiyonun neden olduğu kronik enerji ve protein kaybı nedeniyle hayvanlarda yün/tiftik kalitesi ile veriminin azaldığı bilinmektedir. Ayrıca küçük ruminantlarda görülen *H. contortus* enfeksiyonu etkin şekilde kontrol altına alınmadığında, hayvan refahındaki azalma, verim kayıpları ve artan mortalite oranları, sadece işletmelerin kârını değil, aynı zamanda ulusal düzeyde kırmızı et ve süt üretimini de tehdit eder hâle gelebilir (Adduci ve ark., 2022). Bu durum, ulusal gıda arz güvenliğini olumsuz etkileyerek ülkenin (özellikle kırmızı et ithalat rakamlarının yükselmesi sonucu) dışa bağımlılığını artırabilir.

Türkiye'de hayvanlarda bazı parazitler hastalıklara bağlı kayıp hesaplamaları/tahminleri yapılmış olsa da (Demir ve ark., 2014; Sarıözkan ve Küçükoflaz, 2022), bu alanda literatüre katkı sağlamak için *H. contortus* enfeksiyonuna bağlı kayıpların da Monte Carlo simülasyon modeli ile hesaplanmasının gerekli olduğu düşünülmektedir. Bu düşünceden hareketle mevcut çalışmada, kullanılan Monte Carlo simülasyonu belirsizlikleri/varyasyonları dikkate alarak stokastik (olasılıklı) yaklaşım içeren daha hassas ve gerçekçi kayıp tahmini yapılmasına olanak sunmaktadır. Böylece yapılan bu kayıp tahminleri, üretici ve sektör paydaşlarına, mevcut parazit enfeksiyonuna karşı uygulanabilecek kontrol stratejilerinin oluşturulması için yol gösterici nitelik taşımakta ve kaynak tahsisinde önceliklerin belirlenmesinde karar desteği sağlamaktadır.

Bu bilgiler ışığında, mevcut çalışmada Türkiye'de koyun ve keçilerde *H. contortus*'a bağlı oluşan üretim kayıplarının simülasyon yoluyla tahmin edilmesi amaçlanmıştır.

Materyal ve Metod

Hayvan hastalıklarının işletme düzeyinde oluşturduğu maliyet genel olarak aşağıdaki formülle hesaplanır (Sarıözkan ve Yalçın, 2011; Küçükoflaz ve Sarıözkan, 2023);

Hastalık maliyeti=Kayıplar+Kontrol harcamaları

Burada hastalık kaynaklı kayıplar; canlı ağırlık, süt, yün/tiftik, sakatat (abomasum) ve varsa ölümler nedeniyle oluşan kayıplar olarak özetlenebilir. Kontrol harcamaları ise hastalık için yapılan aşı/ilâç gibi koruyucu önlemleri kapsamaktadır. Türkiye şartlarında hastalık kaynaklı ölüm oranları ve koruyucu hekimlik uygulamaları resmi düzeyde ve saha çalışmasına dayalı olarak bilinmediğinden hesaplamalarda dikkate alınamamıştır. Dolayısıyla mevcut çalışmada hastalığın maliyeti olarak üretim kayıpları (et, süt, sakatat ve yün/tiftik) hesaplanmıştır. Hastalık kaynaklı kayıplar; i) hayvan başına, ii) enfekte hayvan başına ve iii) toplam ulusal kayıplar şeklinde 3 düzeyde hesaplanmıştır (1 ABD \$ = 38 TL; 15.04.2025). Yapılan bazı çalışmalarda enfekte hayvanlarda protein ve yağ oranı gibi süt kalitesinin değiştiği (Rinaldi ve ark., 2007), bazılarında ise değişmediği (Hoste ve Chartier, 1993) yönünde bulguların olması, bu konuda netliğin oluşmadığını gösterdiğinden, mevcut çalışmada süt kalitesi ile ilgili bir çalışma/hesaplama yapılmamıştır.

Hayvan sağlığı ekonomisi perspektifinden hastalık kaynaklı kayıpların tahmininde statik, dinamik, deterministik, stokastik, optimizasyon ve simülasyon modelleri mevcuttur. Özellikle mevcut çalışmada olduğu gibi farklı olasılıkların ve belirsizliklerin/varyasyonların olduğu durumlarda dinamik-stokastik simülasyon modelleri uygulanmaktadır. Nitekim bu çalışmada da mevsimlere, illere/bölgelere ve hayvan türüne göre (koyun-keçi) farklı prevalanslar bildirildiği için *H. contortus*'un kayıp miktarının tahmininde stokastik yaklaşım olan Monte Carlo simülasyonu tercih edilmiştir. Çalışmada belirsizlik içeren parametreler için stokastik modelleme tercih edilmiş ve bu bağlamda ilgili değişkenlerin minimum, mod ve maksimum değerlerine dayalı olarak triangular (üçgen) dağılım kullanılmıştır. Özellikle prevalans oranı, et, süt ve yün/tiftik kaybı gibi parametreler triangular (üçgen) dağılım ile modellenmiştir. Hayvan sayıları, ürün (et, süt, yapağı/tiftik vb.) fiyatları, üretim verileri gibi sabit ve resmi/güvenilir kaynaklardan elde edilen değişkenler deterministik (sabit) değerler olarak modele dahil edilmiştir. Model, Python 3.13 programlama dili kullanılarak geliştirilmiş ve her bir senaryo için 10000 iterasyon uygulanmıştır. Araştırmada beklenen (ortalama) kayıpların yanında simülasyon yardımıyla iyimser (en düşük) ve kötümser (en yüksek) senaryoların gerçekleşmesi halinde oluşacak toplam kayıp miktarları da hesaplanmıştır.

Türkiye'de koyun ve keçilerde *H. contortus* kaynaklı üretim kayıplarının hesaplanmasında kullanılan teknik ve ekonomik göstergeler Tablo 1'de

sunulmuştur.

Tablo 1. Türkiye’de koyun ve keçilerde *H. contortus* kaynaklı üretim kayıplarının hesaplanmasındaki kullanılan teknik ve finansal göstergeler

Göstergeler	Değer	Kaynak/Açıklama
1. Teknik göstergeler		
Toplam koyun sayısı (baş)	42060470	TÜİK, 2023
Sağılan koyun sayısı	19836985	TÜİK, 2023
Kesilen koyun sayısı	25437813	TÜİK, 2023
Koyun prevalans (%)	29.5	*
Ortalama karkas ağırlığı (kg/baş)	22	
Karkas ağırlığında azalma (kg)	1.3	Albers ve ark., 1989; Mwangi ve ark., 2023
Ortalama süt verimi (kg/yıl)	77	
Süt veriminde azalma (kg)	3.85	Hoste ve Chartier, 1993
Toplam keçi sayısı (baş)	10302940	
Sağılan keçi sayısı	5471086	
Kesilen keçi sayısı	6753478	
Keçi prevalans (%)	34.8	**
Ortalama karkas ağırlığı (kg/baş)	19	
Karkas ağırlığında azalma (kg)	1.1	Albers ve ark., 1989; Mwangi ve ark., 2023
Ortalama süt verimi (kg/yıl)	105	
Süt veriminde azalma (kg)	5.25	Hoste ve Chartier, 1993
Yün/tiftik veriminde azalma (kg)	0.1	Waller ve ark., 2006
2. Finansal göstergeler		
Koyun eti fiyatı (TL/kg)	400	UKON, 2025
Keçi eti fiyatı (TL/kg)	350	UKON, 2025
Koyun sütü fiyatı (TL/kg)	35	DKKYB, 2025
Keçi sütü fiyatı (TL/kg)	25	DKKYB, 2025
Sakatat fiyatı (TL/adet)	50	DKKYB, 2025
Yün fiyatı (TL/kg)	15	DKKYB, 2025
Tiftik fiyatı (TL/kg)	10	DKKYB, 2025

1 \$ = 38 TL (15.04.2025); * Vural ve ark., 1975; Zeybek, 1980; Celep, 1987; Vuruşaner, 1995; Güçlü ve ark., 1996; Umur, 1997; Öncel, 2000; Tınar ve ark., 2005; Umur ve Yukarı, 2005; Cengiz ve Değer, 2009; Önder ve ark., 2016.

** Umur, 1991; Akkaya, 1992; Cantoray ve ark., 1992; Cetindag ve, Biyikliglu, 1997; Dilgin, 1999; Tınar ve ark., 2005; Altaş ve ark., 2009.

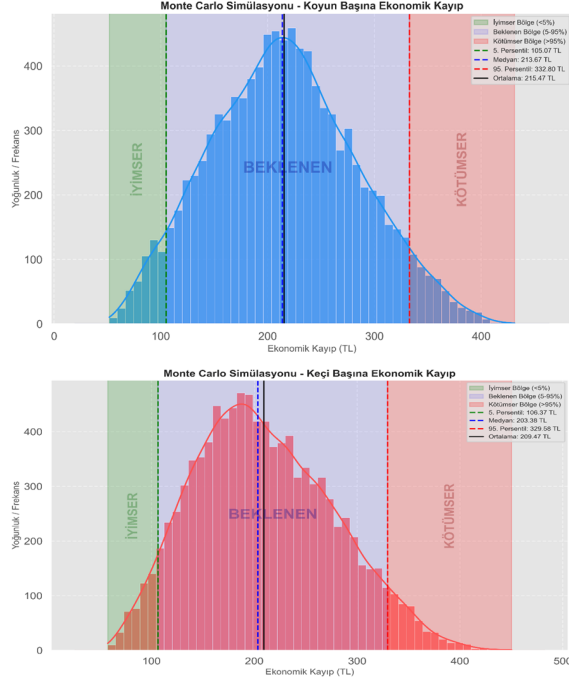
Türkiye’de koyun ve keçilerde *H. contortus* kaynaklı üretim kayıplarının hesaplanmasında kullanılan yöntemler Tablo 2’de verilmiştir.

Tablo 2. Üretim kayıplarının hesabında kullanılan yöntemler

Kayıp kalemi	Hesaplama yöntemleri
Et kaybı	Kesilen koyun/keçi sayısı × koyun/keçi prevalans oranı × karkas ağırlığında azalma × koyun/keçi eti fiyatı
Süt kaybı	Sağılan koyun/keçi sayısı × koyun/keçi prevalans × süt veriminde azalma × koyun/keçi sütü fiyatı
Sakatat kaybı	Kesilen koyun/keçi sayısı × koyun/keçi prevalans × sakatat fiyatı
Yün/tiftik kaybı	Sağılan koyun/keçi sayısı × koyun/keçi prevalans × yün/tiftik azalma × yün/tiftik fiyatı

Bulgular

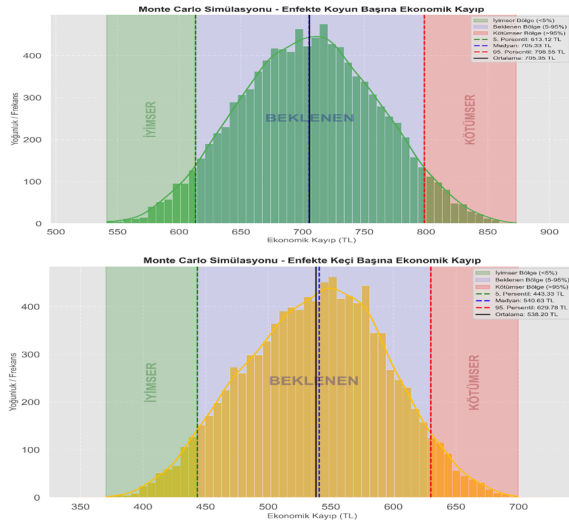
Türkiye’de koyun ve keçilerde *H. contortus* kaynaklı hayvan başına üretim kayıpları Şekil 1’de sunulmuştur.



Şekil 1. Hayvan başına üretim kayıpları

H. contortus kaynaklı hayvan başına kayıplar koyun ve keçilerde sırasıyla ortalama 215.47 TL (5.67 \$; % 95 CI, 105.07-332.80 TL) ve 209.47 TL (5.51 \$; %95 CI, 106.37-329.58 TL) olarak hesaplanmıştır (Şekil 1).

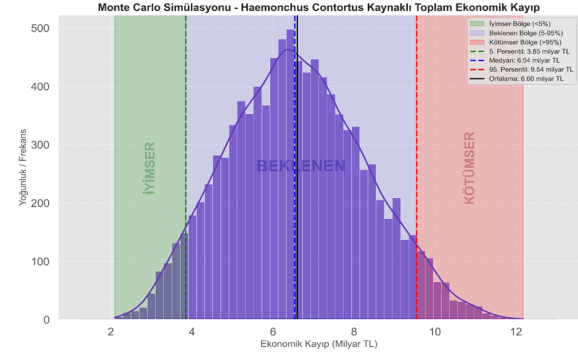
Enfekte hayvan başına üretim kaybı Şekil 2’de verilmiştir.



Şekil 2. Enfekte hayvan başına kayıplar

Enfekte hayvan başına kayıplar incelendiğinde, koyunlarda ortalama 705.35 TL (18.56 \$; %95 CI, 613.12-798.55 TL), keçilerde ise ortalama 538.20 TL (14.16 \$; %95 CI, 443.33-629.78 TL) kayıp hesaplanmıştır (Şekil 2).

Türkiye’de ulusal düzeyde koyun ve keçilerde *H. contortus* kaynaklı toplam üretim kayıpları Şekil 3’te sunulmuştur.



Şekil 3. Koyun ve keçilerde *H. contortus* kaynaklı toplam üretim kayıpları

Türkiye’de koyun ve keçilerde *H. contortus* kaynaklı yıllık toplam ekonomik kayıp 6.60 milyar TL (173.7 milyon \$; %95 CI, 3.85-9.54 milyar TL) olarak hesaplanmıştır (Şekil 3). *H. contortus* kaynaklı toplam üretim kayıplarının koyun ve keçilerde dağılımı sırasıyla 5.25 milyar \$ ve 1.35 milyar \$ olarak hesaplanmıştır. Üretim kayıpları içerisinde ise en yüksek payı %69.2-76.8 ile et kayıpları oluşturmıştır. Bunu sırasıyla süt (%15.6-20.8), sakatat (%7.4-9.8) ve yün/tiftik (%0.2) kayıpları takip etmiştir.

Tartışma ve Sonuç

Türkiye, geniş mera alanlarından dolayı uzun yıllardır küçükbaş hayvancılığın yaygın olarak yapıldığı ülkelerden biridir (Günlü ve Mat, 2021). Ancak küçükbaş hayvan yetiştiricileri, meraya dayalı beslenme sonucunda gastrointestinal nematod (GIN) olan ve kendilerini ciddi ekonomik kayıplara uğratan *H. contortus* enfeksiyonları ile karşılaşmaktadır. Hastalık, özellikle gelişmekte olan ülkelerde hayvan sağlığı hizmetlerinin sınırlı olması nedeniyle büyük tehdit oluşturmaktadır. Bu parazitin neden olduğu canlı ağırlık kaybı, düşük süt ve yapağı/tiftik verimi, tedavi ve kontrol maliyetleri ile artan ölüm oranları, küçükbaş hayvancılıkta ciddi ekonomik kayıplara yol açmakta, üreticilerin kârlılığını doğrudan etkilemektedir (Terrill ve ark., 2012). Ayrıca *H. contortus*, yerleştiği doku itibarıyla yöresel yemek olarak yapılan Şirdan için kullanılan abomasumun atılması neticesinde hammadde temininde zorluğa da neden olmaktadır.

Mevcut çalışmada enfekte koyunlarda meydana gelen kayıp miktarı (705.35 TL), kasaplık bir koyunun ticari değerinin ($22 \times 400 = 8800$ TL) %8’ine, keçilerde %8.1’ine ulaşmaktadır. Benzer şekilde,

Sackett ve ark. (2006) Avustralya'da koyunlarda GIN ticari değerini %8.7'si kadar kayıp oluşturduğunu bildirmiştir. Koyun ve keçilerde *H. contortus*'a bağlı meydana gelen toplam ekonomik kayıp miktarı 6.60 milyar TL (173.7 milyon \$) olarak hesaplanmıştır. Toplam kaybın %79.5'i koyun, geri kalan %20.5'i keçi kaynaklı oluşmaktadır. Hesaplanan toplam kayıp miktarı, 89.4 milyar \$ olan Türkiye'nin toplam yıllık tarımsal üretim değerinin 0.2'sine ve 32.7 milyar \$ olan hayvansal üretim değerinin ise yaklaşık 0.5'ine denk gelmektedir (FAO, 2025). Farklı ülkelerde de *H. contortus* kaynaklı kayıp hesaplamaları yapılmış olup, Pakistan-Faisalabad'da koyun ve keçi kaynaklı yıllık 112000 \$ üretim kaybı hesaplanmıştır (Iqbal ve ark., 1993). Yine Pakistan'da hastalık kaynaklı ölümlere bağlı olarak 3.2 milyon \$ kayıp olduğu bildirilmiştir (Qamar ve ark., 2011). Avustralya'da koyunlarda yıllık kayıp miktarı 369 milyon \$ olarak bildirilmiştir (Sackett ve ark., 2006). Türkiye'de *H. contortus* kaynaklı ekonomik kayıpların yüksek çıkmasında koyun ve keçi varlığının çokluğu, ekstansif üretim yapısının ağır basması, prevalansın yüksekliği, parazit ve ilaç kullanımı hakkında yetiştirici bilinç düzeyinin düşüklüğü, yıllardır süregelen antiparaziter ilaçlara karşı direnç gelişimi etkili olabilir (Bauri ve ark., 2015; Oliveira Santos ve ark., 2019).

Daha önce yapılan çalışmalarda (Rinaldi ve ark., 2007) mide-bağırsak nematodlarına karşı uygulanan doğru ve uygun dozda antelmintik tedavisinin oldukça başarılı sonuçlar verdiği belirlenmiştir. Adduci ve ark. (2022) tarafından yapılan çalışmada mRNA tabanlı aşılmasının kullanılmasının gerektiği bildirilmiştir. Güney Amerika'da bitkisel temelli antiparaziterler (Papaya, A. indica gibi) kullanılarak parazit yükü azaltılmıştır (Bauri ve ark., 2015). Avustralya'da ise parazit direncini izleyen sürveyans sistemleri ile kontrol stratejileri etkin biçimde uygulanmaya çalışılmıştır (Terrill ve ark., 2012). Türkiye'de de bu şekilde yapılacak yerel koşullara uygun mücadele programları ile hastalık prevalansının ve kayıp oranlarının azaltılabileceği düşünülmektedir. Aksi takdirde *H. contortus*'un neden olduğu üretim kayıpları yalnızca doğrudan et, süt ve diğer hayvansal ürünlerin azalmasıyla sınırlı kalmayıp, üretim maliyetlerinin artmasına, pazar arzının azalmasına neden olabilir. Özellikle küçük ölçekli üreticiler açısından maliyetlerin artması, gelirin azalması üretimden çekilme gibi sonuçlar doğurabilir. Bu durumda, aynı zamanda hayvansal üretimde dalgalanmaya yol açarak gıda güvencesini tehdit edebilir.

Sonuç olarak, Türkiye'de hayvansal üretim içerisinde koyun-keçi yetiştiriciliği önemli bir yer tutmaktadır. Şöyle ki, toplam kırmızı et üretiminin yaklaşık %30'u ve süt üretiminin %7'si koyun-keçilerden sağlanmaktadır (FAO, 2025). Bu oranlar Türkiye'de koyun-keçi yetiştiriciliğinin vazgeçilmez ve iyi bir alternatif üretim alanı olduğunu göstermektedir. Dolayısıyla *H. contortus* enfeksiyonları gibi parazitler hastalıklar nedeniyle oluşan kayıpları azaltabilmek ve hayvansal üretimde sürdürülebilirliği sağlayabilmek

için, gerek işletme gerekse ulusal düzeyde ciddi kontrol ve eradikasyon programları (sürü yönetiminde hijyenin artırılması, direnç gelişimini izleyen sürveyans çalışmalarının yapılması ve biyolojik, bitkisel, genetik direnç vb alternatif mücadele yöntemlerinin araştırılması gibi) oluşturmak gerekmektedir. Özellikle üreticilerin hastalık kaynaklı kayıp miktarının büyüklüğü konusunda bilgilendirilmeleri, Bakanlık yetkililerinin de parazitler hastalıklar hakkında bilinç/farkındalık oluşturacak eğitim-yayım faaliyetlerine öncelik vermeleri ve politika geliştirmeleri kayıpların azaltılmasında fayda sağlayacaktır. Böylelikle hem hayvan sağlığı korunabilir hem de küçükbaş hayvancılığın sürdürülebilirliği güvence altına alınabilir.

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Yazım Kuralları

1. Erciyes Üniversitesi Veteriner Fakültesi Dergisi'nde veteriner bilimlerini ilgilendiren alanlarda orijinal araştırmalar, olgu sunumları, araştırma notları, kısa bildiri, derleme ve editöre mektup yayımlanır.
2. Dergide yayımlanacak yayınlar için resmi dil Türkçe'dir. İngilizce yazılmış eserler de yayımlanabilir. **İngilizce hazırlanmış makalelerin yayımlanmasına öncelik verilir.**
3. Yayınlar A4 tipi formatta, çift aralık, Arial, 10 punto ve iki yana yaslı olarak yazılmalıdır. Her kenardan 2.5 cm boşluk bırakılarak, sayfaların sağ altına numara verilmelidir. Resimler, şekiller ve kaynaklar dâhil orijinal makaleler ve derlemeler 14, olgu sunumları, araştırma notu ve kısa bildiriler 7 sayfayı geçmemelidir.
4. Yazılar, ercvet@gmail.com adresine gönderilmelidir. Yazışmalar için, makale kapak sayfasında, sorumlu yazarın yazar adı, unvanı, ORCID numarası ve E-posta adresi yazılmalıdır.
5. Daha önce kongrelerde tebliğ edilmiş ve özeti yayımlanmış çalışmalar, bu durum kapak sayfasında belirtilmek üzere kabul edilir.
6. Araştırma herhangi bir kuruluş tarafından desteklenmiş ise kapak sayfasında dipnot olarak belirtilir.
7. Kapak sayfasında Türkçe makale başlığı (koyu ve ilk harfleri büyük), İngilizce başlık (ilk harfler büyük), kısa başlık (40 karakteri geçmemeli ve ilk kelimenin ilk harfi büyük, diğerleri küçük olarak yazılmalıdır), yazar adları (unvansız), çalıştıkları kuruma ait bilgiler (soyadı üstüne numara konulup dipnot olarak) verilmelidir.
8. Türkçe ve İngilizce özetlerin bir sonraki sayfaya yazılması gerekir. Bu sayfa, paragrafsız olarak Türkçe ve İngilizce özetleri (en fazla 250 kelime) içermelidir. Anahtar kelimeler özetlerin altına alfabetik olarak (virgülle ayrılmış şekilde) yazılmalıdır. Yalnızca ilk anahtar kelime büyük harfle başlanmalıdır. **Türkçe Bilmeyen yazarlar için Türkçe özet ve anahtar kelimeler yazma zorunluluğu bulunmamaktadır.**
9. Araştırma makalesi; Kapak Sayfası - Özet (Türkçe ve İngilizce) - Anahtar kelimeler (Türkçe ve İngilizce), Giriş, Gereç ve Yöntem, Bulgular, Tartışma ve Sonuç, Teşekkür, Kaynaklar, Tablo ve Şekiller, Sorumlu yazar (Correspondence Author) bölümlerini içerecek şekilde düzenlenmelidir. Metin içindeki tüm başlıklar koyu yazılmalıdır. Metin içinde paragraf girintisi yapılmamalı, devamlı satır numarası verilmelidir.
10. Derlemeler, orijinal olması, en son yenilikleri içermesi, yazarların konu ile doğrudan ilişkili **en az 3 adet** çalışmalarının olması ve bunların derleme içinde kullanılması durumunda yayınlanmak üzere kabul edilebilecektir. Derlemeler kapak sayfası, Özet (Türkçe ve İngilizce), Anahtar kelimeler (Türkçe ve İngilizce), Giriş, konunun kendine ait alt başlıkları, Sonuç, Kaynaklar, Tablo ve Şekiller ve Sorumlu yazar (Correspondence) bölümlerini içerecek şekilde düzenlenmelidir.
11. Olgu Sunumları, Özet (Türkçe ve İngilizce), Anahtar kelimeler (Türkçe ve İngilizce), Giriş, Olgu(lar), Tartışma ve Sonuç, Kaynaklar, Tablo ve Şekiller ve Sorumlu yazar bölümlerini içermelidir.
12. Etik kurul onayı gerektiren çalışmalarda Etik Kurul onayı alınan kurumun adı ve onay numarası, çalışmanın Gereç ve Yöntem kısmında belirtilmelidir.
13. Tablo ve şekillerin metinde geçeceği yer, altı ve üstü çizgili olarak belirtilmelidir.
14. Öndalık ifadelerde nokta kullanılmalıdır.
15. Tür isimleri ve anatomik terimler gibi Latince ifadeler *italik* karakterle yazılmalıdır. Tüm ölçü birimleri SI (*Système Internationale*)'e göre verilmelidir.
16. Tablolar kaynaklar kısmından sonra, her bir tablo ayrı sayfada olacak şekilde verilmelidir. Tablo başlıklarının yalnızca ilk harfleri büyük olmalıdır. Tablo başlıkları tablonun üzerinde bulunmalı ve **Tablo 1.** şeklinde numaralandırılmalıdır. Tablolarda iç ve yan kılavuz çizgiler kullanılmamalıdır. Tanımlayıcı bilgi ve açıklamalar tabloların altına yerleştirilmelidir.
17. Her resim, grafik ve çizim; şekil olarak kabul edilip **Şekil 1.** gibi yazılmalı, her biri ayrı sayfada olacak şekilde verilmelidir. Tanımlayıcı bilgi ve açıklamalar şekil ismi ile birlikte şeklin altına yerleştirilmelidir. Resimler 300dpi çözünürlükte olmalıdır.
18. Kaynaklar metin içinde cümle sonunda belirtilmelidir. Yazar soy isimleri ve tarihi yazı içinde her kaynağa ait yayın yılı yazar isminden hemen sonra parantez içinde belirtilmelidir. Kaynak iki isimli ise isimler belirtilmeli (örn; Kaldhane ve Nayak, 2008). Kaynakta yazar sayısı ikiden fazla ise sorumlu yazar "ve ark." şeklinde belirtilmelidir (örn, Kaldhane ve ark., 2008). Eğer kaynak cümlelerin başında kullanılıyorsa yazar isimlerinden sonra parantez içinde yayın yılı belirtilmelidir.
19. Kaynaklar yazılırken alfabetik sıraya konulmalı, kaynaklar bölümünde 0.5 cm içeri doğru asılı halde yazılmalıdır. Noktalama işaretlerine örneklerde gösterildiği şekilde dikkat edilmelidir. Dergi kısaltmaları *Index Medicus* ile uyum içerisinde olmalıdır. **Orijinal araştırma makaleleri, derlemeler ve olgu sunumları sırasıyla 30, 45 ve 15'ten fazla kaynak içermemelidir.**
Kaynaklar;
19.1. Kaynak süreli yayın ise;
Örnek: Kaldhane P, Nayak R, Lynne AM, Dvaid DE, McDermott PF. Characterisation of *Salmonella enterica* serovar Heidelberg from Turkey-associated sources. Appl Environ Microbiol 2008; 74(16): 5038-46.
19.2. Kaynak editörlü kitaptan bir bölüm ise;
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Örnek: Fleiss JL. Statistical Methods for Rates and Proportions. Second Edition. New York: John Wiley and Sons, 1981; p.103.
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19.7. Kaynak internette bulunan bir web sitesi ise;
Örnek: TÜİK. Hayvancılık İstatistikleri. <http://www.tuik.gov.tr/hayvancilik.app/hayvancilik.zul>; Accessed Date: 14.03.2010.
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