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Política editorial

La *Revista de la Facultad de Medicina Veterinaria y de Zootecnia* fue creada en 1929 por el doctor Doménico Geovine, decano de la Escuela Nacional de Medicina Veterinaria, hoy Facultad de Medicina Veterinaria y de Zootecnia. En el medio universitario y en el área pecuaria, es la revista del área de mayor antigüedad. Desde su creación su objetivo ha sido ofrecer un medio escrito de expresión para toda la comunidad académica interna y externa, en el cual exponer sus ideas, resultados de investigación, ensayos etc., en relación con el quehacer científico en el área de las Ciencias Animales y otras afines. Su filosofía ha sido tener un carácter abierto, decididamente transparente y democrático, no solo en la participación de los articulistas sino en los procedimientos internos de gestión. La Revista busca cumplir con sus objetivos de divulgar los trabajos de investigación, documentos críticos y de revisión técnico científica, permitiendo la difusión del conocimiento entre profesionales de las áreas pecuarias; siempre en la búsqueda de información pertinente y actualizada de temas relacionados con el sector y propendiendo a obtener reconocimiento en la comunidad en general, editando una revista que permita la interacción de la academia con el medio.
Periodicidad: Publicación continua (3 números por año).

Arbitraje:
Los manuscritos y propuestas de publicación serán evaluados por medio de criterios explícitos, según el tipo de material, por pares académicos externos mediante la modalidad de doble ciego con cuando menos dos evaluadores por manuscrito. La evaluación procurará identificar los aportes a la innovación científica tecnológica o pedagógica de las propuestas, frente al estado vigente de conocimiento en una disciplina; los pares académicos externos deben emitir un concepto de aprobación, modificación o reprobación y en caso de un concepto dividido será el Comité Editorial quien determine la decisión final. Así mismo, el Comité Editorial o el editor en jefe podrán recomendar o negar la publicación del manuscrito, o solicitar la corrección de forma o de fondo del mismo.
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- Pertinencia de contenido o temática: los textos deberán abordar las cuestiones que resulten relevantes de manera directa o indirecta, para la comprensión de alguna de las disciplinas y profesionales de la salud y la producción animal.
- Rigor argumental: los trabajos deberán tener un pensamiento formal coherente y lógico.
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- Claridad conceptual: correspondencia entre términos científicos o técnicos empleados en la finalidad temática.

Más allá del algoritmo: ética, descubrimiento y el futuro de la biología

La inteligencia artificial (IA) se está consolidando como una de las tecnologías más influyentes del siglo XXI, con un impacto significativo en la biología y las ciencias de la vida. Su desarrollo acelera la capacidad de analizar grandes volúmenes de datos, transforma los procesos de generación de conocimiento y plantea profundas implicaciones éticas en la investigación.

Un ejemplo emblemático es AlphaFold, cuyo modelo de *deep learning* revolucionó la predicción de la estructura tridimensional de las proteínas con una precisión cercana a la experimental, lo que ha impulsado tanto el diseño de fármacos como la ingeniería de enzimas. De manera similar, los modelos de aprendizaje automático integran datos genómicos, transcriptómicos, epigenómicos y metabolómicos, y así redefinen la clasificación de tumores, la predicción de rutas metabólicas y la personalización de terapias. Más allá de acelerar estudios científicos ya existentes, la inteligencia artificial ha comenzado a generar hipótesis novedosas, como en el desarrollo de péptidos antimicrobianos o en la exploración de posibles trayectorias evolutivas que habían escapado a la intuición humana, lo cual transforma de manera profunda la secuencia clásica de observación, hipótesis y experimento.

El potencial es aún mayor en la convergencia con la robótica aplicada a las ciencias biológicas, como el caso de los laboratorios autónomos (*self-driving labs*), que integran algoritmos y plataformas experimentales en bucles cerrados de descubrimiento. En un contexto en el que la IA propone hipótesis, los robots ejecutan ensayos y los resultados retroalimentan los modelos en un proceso repetitivo de mejoramiento continuo. Por ejemplo, este enfoque acelera los procesos de investigación en la búsqueda de catalizadores enzimáticos y en la evolución dirigida de enzimas. Es importante enfatizar que la aplicación de la IA en estas áreas del conocimiento no busca reemplazar a los científicos, sino redefinir su papel como intérpretes, críticos y guardianes éticos del proceso.

Teniendo en cuenta lo anterior, el nuevo panorama que genera la inclusión de la IA en la investigación en ciencias biológicas plantea desafíos clave. Primero, la interpretabilidad de los resultados generados es limitada, ya que los modelos de aprendizaje profundo operan como una *caja negra*, lo que dificulta explicar cómo se alcanzan determinadas predicciones. En biología, ciencia en la que la validez mecanística es esencial, se requiere avanzar hacia una IA interpretable e híbrida, que combine conocimiento biológico y estadístico. En segundo lugar, el sesgo en los resultados generados por IA es inherente a los datos de entrenamiento, lo cual se ha evidenciado en diferentes escenarios. Un ejemplo relevante se observa en la genómica humana, donde la sobrerrepresentación de poblaciones europeas restringe la precisión en grupos subrepresentados y contribuye a perpetuar inequidades en salud. El desarrollo de conjuntos de datos diversos e inclusivos debe ser una condición indispensable para generar predicciones más justas y aplicables. Por último, la transparencia y reproducibilidad de los procesos de investigación asistidos por IA se debe garantizar, ya que el uso de algoritmos cerrados y datos mal documentados puede socavar la confianza científica al

producir resultados difíciles de comprobar. En consecuencia, la publicación en código abierto, el reporte transparente de métodos y la comunicación honesta de limitaciones deben ser prácticas obligatorias.

La dimensión ética constituye un eje central en el uso de la inteligencia artificial en la investigación en ciencias biológicas. La aplicación de la IA a la biología sintética, por ejemplo, plantea riesgos de uso indebido que requieren marcos de supervisión sólidos. Paralelamente, la formación de los futuros científicos deberá incluir competencias en computación, entrenamiento en IA y, sobre todo, un juicio crítico y ético que ninguna tecnología puede suplir.

El horizonte más prometedor se encuentra en la colaboración entre algoritmos y seres humanos: los primeros aportan velocidad y capacidad de reconocimiento de patrones, mientras los segundos ofrecen creatividad, contextualización y discernimiento ético. Para materializar esta sinergia se requieren decisiones institucionales y marcos normativos que garanticen acceso equitativo, transparencia y responsabilidad. Incluso en laboratorios altamente automatizados, la orientación ética deberá permanecer bajo conducción humana.

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Beyond the algorithm: ethics, discovery, and the future of biology

Artificial intelligence (AI) is rapidly consolidating its position as one of the most influential technologies of the 21st century, with profound implications for biology and the life sciences. Its development accelerates the analysis of massive datasets, transforms knowledge-generation processes, and raises critical ethical questions in research.

A paradigmatic example is AlphaFold, whose deep learning framework revolutionized three-dimensional protein structure prediction with near-experimental accuracy, thereby advancing drug design and enzyme engineering. Similarly, machine learning models now integrate genomic, transcriptomic, epigenomic, and metabolomic datasets, redefining tumor classification, metabolic pathway prediction, and the personalization of therapies. Beyond merely accelerating existing research pipelines, AI has begun to generate novel hypotheses—such as in the design of antimicrobial peptides or the exploration of previously unanticipated evolutionary trajectories—thus reshaping the classical sequence of observation, hypothesis, and experimentation.

The potential is amplified when AI converges with robotics in the biological sciences, exemplified by autonomous laboratories ("self-driving labs"). These systems integrate algorithms and experimental platforms into closed-loop discovery cycles: AI generates hypotheses, robots execute assays, and the results iteratively refine the models. This approach has already accelerated research in areas such as the discovery of enzymatic catalysts and the directed evolution of enzymes. Importantly, the role of AI in these domains is not to replace scientists but to redefine their function as interpreters, critics, and ethical stewards of discovery.

Against this backdrop, the integration of AI into biological research introduces several key challenges. One major concern is interpretability, as deep learning models often function as "black boxes," limiting the ability to explain how predictions are generated. In biology, where mechanistic validity is critical, progress toward interpretable and hybrid AI integrating biological and statistical knowledge is essential. Another important issue is bias, since AI predictions inherently reflect the biases of their training datasets. This is evident in human genomics, where the overrepresentation of European populations limits predictive accuracy for underrepresented groups, perpetuating health inequities. Developing diverse and inclusive datasets is therefore indispensable for producing fairer and more broadly applicable predictions. Finally, transparency and reproducibility are crucial, as closed-source algorithms and poorly documented datasets risk undermining scientific trust by yielding results that are difficult to replicate. Open-source publication, transparent methodological reporting, and honest acknowledgment of limitations should become standard practice.

The ethical dimension is central to the integration of AI into biological research. Applications in synthetic biology, for example, raise risks of misuse that require robust oversight frameworks. At the same time, training the next generation of scientists must include computational literacy, AI competencies, and, above all, the cultivation of critical and ethical judgment that no technology can replace.

The most promising horizon lies in human–algorithm collaboration: algorithms contribute speed and pattern recognition, while humans provide creativity, contextual insight, and ethical discernment. Realizing this synergy requires institutional decisions and regulatory frameworks that ensure equitable access, transparency, and accountability. Even in highly automated laboratories, ethical oversight must remain under human guidance.

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Behavioral and adaptive evaluation of lactating Costeño con Cuernos and Gyrolando cows under tropical dry forest conditions (Colombia)

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ABSTRACT

Heat stress is one of the main challenges for cattle production in tropical regions, as it affects both animal welfare and productive efficiency. This study aimed to characterize the behavior of Costeño con Cuernos (CCC) and Gyrolando cattle under tropical dry forest conditions in Colombia, assessing their behavioral responses across different time periods and microclimatic conditions. The research was conducted in a silvopastoral system at the Motilonia Research Center of Agrosavia, located at an altitude of 106 m a.s.l., with a multiyear average temperature of 29.4 °C and an average relative humidity of 70%. Twelve lactating cows (six CCC and six Gyrolando) were observed from July to September 2023, and 20 behavioral variables, along with bioclimatic indicators such as the temperature–humidity index, were recorded. Data were analyzed using multiple correspondence analysis and hierarchical clustering. Results revealed two behavioral clusters: Cluster 1 (adverse climatic conditions) grouped animals that were more active during the hottest hours (12:00–14:00), with increased grazing activity and reduced resting behavior. This cluster consisted mainly of CCC cows. Cluster 2 (moderate climatic conditions) was characterized by predominant lying rumination, shaded resting, and lower overall activity, primarily involving Gyrolando cows. It is concluded that the native CCC breed exhibits more adaptive behavioral patterns under hot environmental conditions, underscoring its potential value for sustainable cattle production systems. The integration of multivariate tools and environmental monitoring allows the identification of management strategies aimed at improving animal welfare and productivity under extreme climatic conditions.

Keywords: animal welfare, adaptation, heat stress, microclimate**.**

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Evaluación comportamental y adaptativa de vacas en lactancia Costeño con Cuernos y Gyrolando bajo condiciones de bosque seco tropical (Colombia)

RESUMEN

El estrés por calor es uno de los principales desafíos para la producción bovina en regiones tropicales, afectando el bienestar animal y la eficiencia productiva. Este estudio tuvo como objetivo caracterizar el comportamiento de bovinos de las razas Costeño con Cuernos (CCC) y Gyrolando en condiciones de bosque seco tropical en Colombia, evaluando su respuesta comportamental ante diferentes rangos horarios y condiciones microclimáticas. La investigación se realizó en un sistema silvopastoril del centro de investigación Motilonia de Agrosavia a una altitud de 106 m s. n. m. con temperatura promedio multianual de 29,4 °C y humedad relativa promedio del 70%. Se observaron 12 vacas en lactancia (6 CCC y 6 Gyrolando) durante los meses de julio a septiembre de 2023, registrando 20 variables comportamentales e indicadores bioclimáticos como índice temperatura-humedad. Los datos fueron analizados mediante análisis factorial de múltiples correspondencias y clasificación jerárquica. Los resultados revelaron dos clústeres de comportamiento: clúster 1 (condiciones climáticas adversas) agrupó animales más activos durante las horas de mayor calor (12:00–14:00), con mayor pastoreo y menor descanso. Este grupo estuvo compuesto principalmente por la raza CCC. El clúster 2 (condiciones climáticas moderadas) presentó mayor rumia echado, descanso en sombra y menor actividad general, predominando la raza Gyrolando. Se concluye que la raza criolla CCC muestra actividades comportamentales más adaptativas en ambientes calurosos, lo que podría reforzar su valor en sistemas ganaderos sostenibles. La integración de herramientas multivariantes y monitoreo ambiental permite identificar estrategias de manejo orientadas al bienestar animal y la productividad bajo condiciones climáticas extremas.

Palabras clave: bienestar animal, adaptación, estrés por calor, microclima.

INTRODUCTION

The agricultural sector faces growing challenges associated with climate change, particularly in tropical regions where both the intensity and duration of heat waves are projected to increase (Masson-Delmotte *et al.*, 2019). This phenomenon threatens the sustainability of production systems, food security, and animal welfare, as it alters environmental conditions through anthropogenic activities (Bernabucci, 2019). Within this context, improving the thermal comfort of grazing animals has become a priority to ensure their health, productivity, and welfare (Islam *et al.*, 2021b).

Cattle, as homeothermic species, possess physiological, metabolic, and behavioral mechanisms that enable them to maintain body temperature within normal ranges (Giro *et al.*, 2019). However, when heat accumulation exceeds the animal's capacity for dissipation, heat stress occurs—a condition that adversely affects productive parameters such as weight gain, fertility, milk yield, and meat quality, while also

compromising animal welfare (Collier *et al.*, 2019; Summer *et al.*, 2019). Behavioral and physiological responses to heat stress include increased respiratory rate, panting, elevated body temperature, reduced feed intake, and shade-seeking behavior, among others (Islam *et al.*, 2021b). Beyond physiological impacts, the economic repercussions are substantial, with estimated losses reaching hundreds of millions of dollars annually in the global meat and dairy industries (Kim *et al.*, 2021).

In recent years, research aimed at mitigating heat stress has gained importance in response to global warming and growing concerns about animal welfare. Numerous studies have evaluated heat resilience in livestock species by integrating behavioral aspects, thermoregulatory physiology, productive performance, and climate-based indices. In addition, genomic tools have been employed to identify genes associated with thermal adaptation and to assess the genetic potential of heat-tolerant breeds. Research has also extended to natural environments that encompass diverse feeding systems, ranging from monospecific pastures to silvopastoral systems. The latter have become particularly relevant due to their ability to improve the microclimate through shade provision and thermal regulation, thereby enhancing animal comfort and productive efficiency, especially during the dry season (Ripamonti *et al.*, 2025). These advances have contributed to the development of climate change mitigation strategies aimed at optimizing productivity and animal welfare in accordance with available resources (Barragán *et al.*, 2017; Bernabucci, 2019; Brennan *et al.*, 2021; Passamonti *et al.*, 2021).

Conventional livestock production systems often prioritize high-yielding breeds, which generally exhibit lower resilience to heat stress, thereby compromising performance and threatening the sustainability of cattle production in warm climates. In contrast, locally adapted breeds such as the Costeño con Cuernos (CCC) have developed remarkable heat tolerance as a result of long-term evolution under tropical conditions. However, this adaptive capacity can be influenced by physiological, metabolic, and phenotypic traits, including coat color. Foreign breeds such as the Gyrolando, depending on their genetic composition, may display higher productivity but tend to be more sensitive to extreme temperature conditions. These differences highlight the importance of conserving, identifying, and utilizing genotypes that combine heat tolerance with desirable productive traits, ensuring functionality in heterogeneous grazing environments (Carmickle *et al.*, 2022; Negri *et al.*, 2023; Pires *et al.*, 2019).

To analyze the relationship between animal behavior, environmental variables, and grazing conditions, multivariate statistical tools such as Factorial Analysis of Mixed Data (FAMD) are employed. This exploratory technique allows the simultaneous analysis of categorical and continuous variables, facilitating the identification of patterns, relationships among observations, and homogeneous groupings within mixed datasets (Husson *et al.*, 2024). The objective of the present study was to characterize the behavioral activities of Costeño con Cuernos (CCC) and Gyrolando cattle under tropical dry forest conditions in Colombia, assessing their behavioral responses across different time intervals and microclimatic conditions.

MATERIALS AND METHODS

Study site

The study was conducted at the Motilonia Research Center of the Colombian Corporation for Agricultural Research (Agrosavia), located in the municipality of Agustín Codazzi, Cesar Department, Colombia (geographical coordinates: 10°00'08.05" N; 73°14'50.76" W). The region is classified as a tropical dry forest (Bs-T) according to the Holdridge life zone system (Holdridge, 1978) and lies at an altitude of 106 m a.s.l. The climate is characterized by a multiyear average temperature of 29.4 °C, with thermal extremes of 34.2 °C (maximum) and 22.7 °C (minimum), an average relative humidity of 70%, and an annual mean precipitation of 1580 mm. Rainfall distribution is bimodal, with peaks occurring in May (209.0 mm) and October (268.8 mm) (Zuluaga *et al.*, 2025).

Experimental design

Variables associated with heat stress and behavioral activities were evaluated in two cattle breeds under the conditions of a silvopastoral system containing scattered native tree species characteristic of the Caribbean region, including *Albizia niopoides* (Spruce ex Benth.) Burkart (Fabaceae), *Albizia saman* (Jacq.) Merr. (Fabaceae), *Cecropia peltata* (Ruiz ex Klotzsch) (Urticaceae), *Cordia alba* (Jacq.) Roem. & Schult. (Cordiaceae), *Guazuma ulmifolia* (Lam.) (Malvaceae), *Maclura tinctoria* (L.) D. Don ex Steud. (Moraceae), and *Spondias mombin* (Jacq.) (Anacardiaceae). A total of twelve (12) lactating cows—six Gyrolando and six Costeño con Cuernos (CCC)—were included, all in the mid-lactation stage (second third).

Variable measurement

Bioclimatic indices

Ambient temperature (Ta, °C) and relative humidity (RH, %) were recorded every 30 minutes using two data loggers (RHT10, Extech FLIR, Boston, Massachusetts, USA) installed 1 m above ground level in both shaded areas (under trees) and sun-exposed zones. Based on these measurements, the temperature–humidity index (THI) was calculated as an indicator of environmental heat stress level, following the equation proposed by Lemal *et al.* (2024):

$$THI = [(1.8 \times T) + 32] - \{(0.55 - 0.0055 \times RH) \times [(1.8 \times T) - 26]\}$$

Interpretation of the THI was performed according to the scale described by Yan *et al.* (2022):

- Mild stress: 68 ≤ THI < 72
- Moderate stress: 72 ≤ THI < 79
- Severe stress: 80 ≤ THI < 89
- Extreme stress: 90 ≤ THI < 99
- Lethal: ≥ 99 THI

Behavioral patterns

Behavioral observations were conducted over three consecutive days in July, August, and September 2023. A simplified ethogram previously validated for grazing systems (Barragán *et al.*, 2017; Broom D., 2021; Martin & Bateson, 2007)) was applied and adapted to the specific conditions of the tropical dry forest (table 1).

Each behavioral activity was recorded using the focal sampling technique, consisting of direct observation sessions of 5 minutes per animal, repeated every 15 minutes between 09:00 and 16:00 h (Barragán *et al.*, 2017). The observations were subsequently grouped into three time

TABLE 1. Ethogram for the evaluation of behaviors in cattle under tropical dry forest conditions

Category	Behavioral activities	Definition
Feeding	Grazing under shade	Forage consumption while standing under tree cover.
	Grazing without shade	Forage consumption while standing in areas exposed to sunlight.
	Browsing	Consumption of leaves, branches or fruits from shrubs or trees.
	Water intake	Drinking water from troughs.
	Salt intake	Ingestion of mineral salts from salt licks.
Resting and ruminating	Standing rest under shade	Animal standing still under tree cover.
	Standing rest under sun	Animal standing still, exposed to sunlight.
	Lying rest under shade	Animal lying down, inactive, under tree cover.
	Lying rest under sun	Animal lying down, inactive, exposed to sunlight.
	Lying rumination	Chewing the ruminal bolus while lying down.
	Standing rumination	Chewing the ruminal bolus while standing.
	Sleeping	Eyes closed, inactive, with evident body relaxation.
Locomotion	Walking	Movement without feeding or direct social interaction.
Social interactions	Suckling	Calf suckling milk from the mother.
	Grooming	Licking or cleaning between individuals.
	Mounting	Mounting behavior (reproductive or social).
	Aggressive behavior	Pushing, headbutting, or charging other animals.
Physiological and others	Scratching	Use of objects (trees, fences) or limbs to rub the body.
	Urinating	Excretion of urine.
	Defecating	Excretion of feces.

Source: Adapted from Barragán *et al.* (2017); Broom D (2021); Martin & Bateson (2007).

intervals (09:00–12:00, 12:00–14:00, and 14:00–16:00) for comparative analysis.

Behavioral assessment was conducted by six observers previously familiarized with the animals through their routine handling of the cattle used in this study. Each observer was assigned to specific individuals to minimize both inter- and

intra-observer variability (Moller *et al.*, 2024). An eight-day habituation period was implemented, during which the personnel entered the grazing area daily with the cattle to reduce potential biases caused by environmental disturbance. This approach is recommended for welfare and efficiency assessments in extensive production systems (Barragán *et al.*, 2017; Martin & Bateson, 2007). Data were recorded using standardized forms that included the following fields: date, animal identification number, observer, behavioral activity, observation time, and duration of the activity. Subsequently, the percentage of time and frequency of each behavioral activity were calculated relative to the total observation time.

Statistical analysis

Initially, a descriptive analysis was conducted, followed by an analysis of variance (ANOVA) to evaluate environmental variables (temperature, humidity, and THI), comparing sensor locations (sun and shade) and time intervals (09:00–12:00, 12:00–14:00, and 14:00–16:00).

Subsequently, a Factorial Analysis of Mixed Data (FAMD) was performed to reduce the dimensionality of the dataset, which included 20 behavioral variables and the supplementary variables temperature–humidity index (THI), breed (Costeño con Cuernos—CCC and Gyrolando), and time interval (09:00–12:00, 12:00–14:00, and 14:00–16:00). This technique integrates categorical and quantitative variables, facilitating the visualization of patterns and associations among observations. In addition, a Student's *t*-test was applied to compare the means of environmental variables (temperature and humidity) and THI according to sensor location (sun and shade) and time interval.

Based on the FAMD results, a hierarchical cluster analysis (HCA) was conducted to identify homogeneous groups of individuals, using Euclidean distance as the dissimilarity metric and Ward's linkage method, which optimizes cluster formation by minimizing within-group variance. The optimal number of clusters was determined using the Elbow method, which evaluates inertia (explained variability) and identifies the point where the rate of decrease becomes less pronounced. Data processing and analysis were performed using the statistical software R v4.5.1 (R Core Team, 2025), employing the *FactoMineR* package (Lê *et al.*, 2008) for FAMD execution and *factoextra* (Kassambara & Mundt, 2020) for visualization and interpretation of the results.

RESULTS

Climatic data and environmental indices

Table 2 presents the adjusted mean values of temperature, relative humidity, and temperature–humidity index (THI) according to sensor location and time interval. In sun-exposed areas, the THI averaged 89 ± 2.4 (95% CI: 85–91), corresponding to a *severe* level of heat stress. In contrast, under natural shade, the average temperature decreased, resulting in a THI of 85 ± 1.2 (95% CI: 83–87), which is classified as *moderate* heat stress.

Behavioral patterns in cattle

Figure 1 shows the distribution of behavioral activities observed in Gyrolando and Costeño con Cuernos (CCC) cows across three-time intervals (09:00–12:00, 12:00–14:00, and 14:00–16:00). Ethological variables were grouped into five

main categories—feeding, resting and rumination, locomotion, social interactions, and physiological behaviors—each encompassing specific behavioral activities (table 1).

The Factorial Analysis of Mixed Data (FAMD) reduced the dimensionality of the 23 behavioral variables, identifying multivariate patterns that explained 70.7% of the total variability across the first 13

TABLE 2. Average values of the temperature-humidity index (THI), temperature, and humidity obtained from datalogger sensors placed under sun and natural shade in scattered-tree pastures during the evaluation period

	Temperature (°C)		**Humidity (%)**		**THI**	
Location	$\bar{x}$ ± S.E.	L.L. – U.L.	$\bar{x}$ ± S.E.	L.L. – U.L.	$\bar{x}$ ± S.E.	L.L. – U.L.
Sun	39.9 ± 0.7[a]	38.4 – 41.4	43.0 ± 1.2b	40.6 – 45.3	89 ± 2.4[a]	85 – 91
Shade	33.5 ± 0.9b	31.8 – 35.3	62.5 ± 1.4[a]	59.7 – 65.2	85 ± 1.2b	83 – 87
Time range	$\bar{x}$ ± S.E.	L.L. – U.L.	$\bar{x}$ ± S.E.	L.L. – U.L.	$\bar{x}$ ± S.E.	L.L. – U.L.
9 – 12	35.9 ± 0.8[a]	34.2 – 37.6	56.7 ± 1.4[a]	54.0 – 59.4	86.7 ± 0.9[a]	84.9 – 88.4
12 – 14	37.8 ± 1.1[a]	35.7 – 40.0	49.3 ± 1.7b	45.9 – 52.7	87.7 ± 1.1[a]	85.5 – 89.9
14–16	36.4 ± 1.1[a]	34.3 – 38.5	52.1 ± 1.7ab	48.7 – 55.5	86.8 ± 1.1a	84.6 – 89.0

Adjusted mean ($\bar{x}$); standard error (S.E.); lower and upper limits of the 95% confidence interval (L.L., U.L.). Different letters within the same column and category indicate statistically significant differences ($p < 0.05$).

Source: own elaboration.

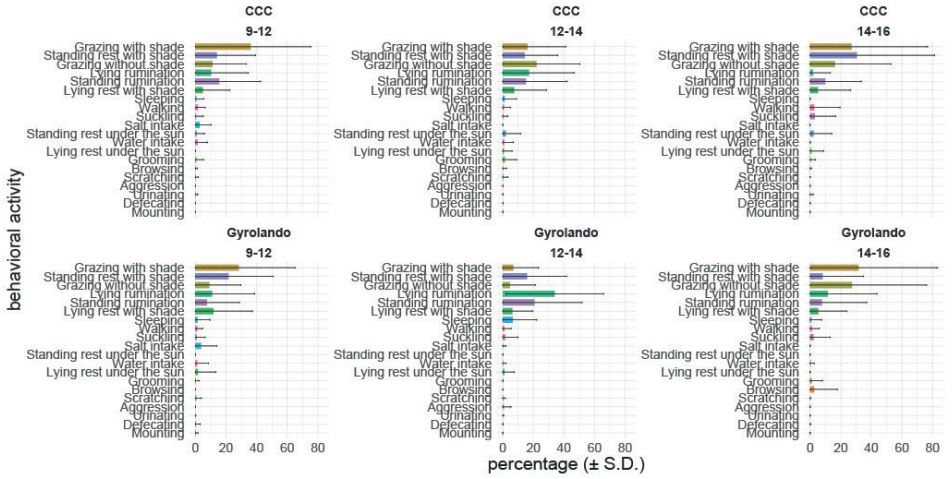

FIGURE 1. Percentage distribution of behavioral activities in lactating Costeño con Cuernos (CCC) and Gyrolando cows across three-time intervals (09:00–12:00, 12:00–14:00, and 14:00–16:00) between July and September in Agustín Codazzi, Colombia.

Source: own elaboration.

components. The hierarchical cluster analysis (HCA) based on these components grouped individuals into two distinct clusters with significant differences in activity patterns, suggesting differentiated behavioral responses influenced by environmental and physiological factors:

- **Cluster 1 (Adverse Climatic Conditions, ACC):** Comprised animals that were more active during the hottest hours, exhibiting longer grazing periods (even in unshaded areas), reduced resting time, greater salt intake, and higher THI levels.
- **Cluster 2 (Moderate Climatic Conditions, MCC):** Included animals showing energy-conserving behavioral patterns, characterized by increased shaded resting, lying rumination, and reduced activity during peak heat hours.

Figure 2 presents the Principal Component Analysis (PCA) applied to the defined clusters. A clear separation between clusters was observed, indicating that the variables included in the analysis effectively discriminated between the groups. Individuals located on the left side of the plot were associated with adverse climatic conditions (ACC), whereas those on the right corresponded to moderate climatic conditions (MCC).

Table 3 presents both the categorical and global means for the activities performed by individuals within each cluster that were statistically significant ($p < 0.01$). For the activity "grazing under shade," results indicate that animals in Cluster 1 spent more time grazing in shaded areas compared with those in Cluster 2. These results were compared with the global mean, representing the total time spent grazing under shade by all individuals (table 3). In other words, the categorical mean values illustrate behavioral differences between clusters, whereas the global mean reflects the overall average for all animals in the study.

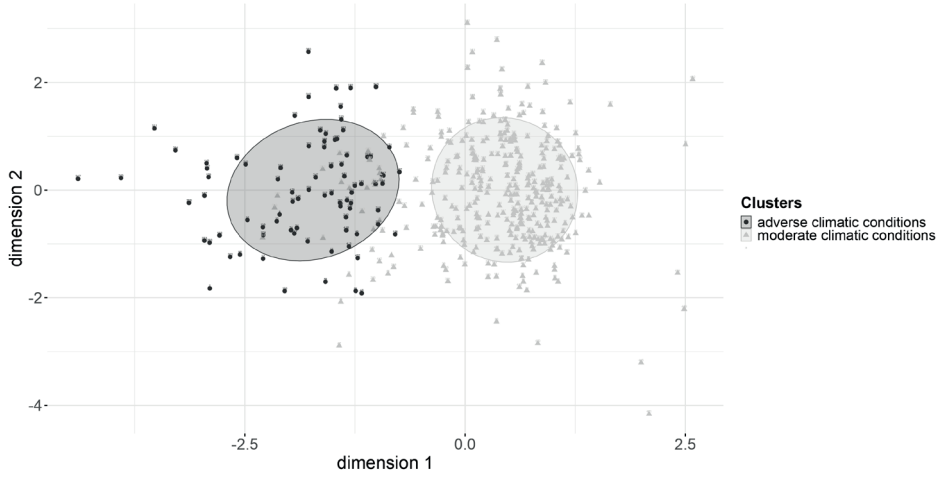

FIGURE 2. Hierarchical classification analysis of the first two dimensions according to the two defined clusters (adverse climatic conditions and moderate climatic conditions) in lactating cows of the horned coastal (CCC) and Gyrolando breeds.

Source: own elaboration.

TABLE 3. Average of the different activities performed by individuals per cluster and global mean

Behavioral activity	Category's		Overall mean
	Cluster 1 (ACC) $\bar{x}$ ± S. D.	Cluster 2 (MCC) $\bar{x}$ ± S. D.	$\bar{x}$ ± S. D.
Grazing under shade	28.53 ± 3.48	3.89 ± 1.17	21.14 ± 3.18
Grazing without shade	15.66 ± 2.74	4.91 ± 1.41	12.39 ± 2.46
Standing rest under shade	18.18 ± 2.91	8.78 ± 1.67	15.23 ± 2.63
Salt intake	1.74 ± 0.68	0.25 ± 0.21	1.28 ± 0.58
Lying rumination	2.15 ± 0.98	38.26 ± 3.42	12.75 ± 2.61
Lying rest under shade	1.72 ± 0.80	17.61 ± 2.91	6.37 ± 1.86
Sleeping	0.02 ± 0.00	5.43 ± 1.45	1.60 ± 0.82
Standing rumination	9.47 ± 2.15	18.07 ± 3.01	11.96 ± 2.46
Scratching	0.12 ± 0.12	0.67 ± 0.32	0.28 ± 0.20
Environmental index			
Temperature-humidity index	87.21 ± 1.86	84.81 ± 1.20	85.08 ± 1.70

Adverse climatic conditions (ACC); Moderate climatic conditions (MCC)*. Mean ($\bar{x}$) ± standard deviation (S.D.).

Source: own elaboration.

Table 4 presents the categorical variables most strongly associated with each cluster. The Cla/Mod metric represents the proportion of individuals within the cluster exhibiting a given characteristic, Mod/Cla indicates the percentage of individuals with that characteristic belonging to the cluster, and Global denotes the overall percentage of the population displaying the characteristic.

For instance, in Cluster 1, the Cla/Mod metric indicates that most individuals were active between 14:00 and 16:00 h, meaning that nearly all members of this cluster exhibited this characteristic. In contrast, the Mod/Cla metric shows that 39.6% of all animals active during this time period belonged to Cluster 1, suggesting that this behavior was not exclusive to that cluster but also occurred among individuals from other groups.

The detailed characterization of each cluster, based on the averages of significant behavioral activities (table 3) and the association with categorical variables (table 4), is summarized as follows:

TABLE 4. Behavioral activities of lactating cows of Costeño con Cuernos (CCC) and Gyrolando breeds, indicating for each cluster (1 and 2) the percentage of individuals within each cluster that exhibit the characteristic (Cla/Mod) and of individuals with the characteristic that belong to that cluster (Mod/Cla) by time range

Variable	Cla/Mod		Mod/Cla		Overall
	Cluster 1	Cluster 2	Cluster 1	Cluster 2	
Time range = 14–16	95,07	4,22	39,59	4,17	28,98
Breed = CCC	78,89	20,37	62,46	38,19	55,1
Time range = 12–14	75,96	22,6	46,33	32,64	42,45
Breed = Gyrolando	40,45	58,18	37,54	61,8	44,9
Time range = 9–12	34,28	65	14,08	63,19	28,57

Source: own elaboration.

Cluster 1–ACC (animals more active in the afternoon under extreme/severe THI conditions):

- Displayed a higher proportion of grazing activity, both in shaded and unshaded areas.
- Showed increased salt consumption.
- Spent less time resting and ruminating while lying down.
- Recorded shorter sleeping periods.
- This cluster was strongly associated with afternoon hours, with most individuals active between 14:00–16:00 h, followed by the 12:00–14:00 h interval.
- The Costeño con Cuernos (CCC) breed predominated in this cluster.

Cluster 2–MCC (animals more active in the morning with longer resting and rumination periods):

- Exhibited lower grazing activity, both in shaded and unshaded areas.
- Spent a higher proportion of time ruminating, both lying and standing.
- Dedicated more time to resting, particularly while lying under shade.
- Recorded longer sleep durations.
- This cluster was mainly associated with the morning period (09:00–12:00 h), when most individuals were active.
- The Gyrolando breed was more frequent in this cluster.

DISCUSSION

The results revealed significant differences in microclimatic conditions between the evaluated locations. The higher temperature and temperature–humidity index (THI) recorded in sun-exposed areas reflect the direct impact of solar radiation on the animals' immediate environment, whereas shaded areas maintained lower temperatures and higher relative humidity. This pattern aligns with findings from studies on silvopastoral systems, where tree cover contributes to thermal mitigation and microclimatic stability, thereby reducing the heat load experienced by livestock (table 2).

Regarding temporal variation, both temperature and THI increased between 12:00 and 14:00 h, coinciding with the peak of daily solar radiation. Subsequently,

these values declined between 14:00 and 16:00 h, while relative humidity exhibited an inverse pattern. This diurnal trend is characteristic of tropical dry forest ecosystems, where the combination of high temperatures and low humidity at midday intensifies heat stress in grazing cattle. As reported by Yan *et al.* (2022), the THI values observed in this study fall within the severe stress threshold, potentially compromising animal welfare. In this context, shade plays a crucial role, as evidenced by an approximate 6 °C temperature reduction compared with unshaded conditions (table 2).

These findings highlight the strong influence of time of day and shade availability on the expression of cattle behavior, consistent with previous studies reporting circadian variations in activity patterns driven by microclimatic factors (Barragán *et al.*, 2017; Giro *et al.*, 2019; Barsotti *et al.*, 2024; Pezzopane *et al.*, 2019; Ripamonti *et al.*, 2025). The presence of scattered trees within grazing areas provides shade and enhances thermal comfort (Pezzopane *et al.*, 2019), serving as an effective strategy to mitigate heat stress even when physiological indicators—such as panting or elevated respiratory rate are affected. However, full recovery to normal physiological states may require additional time, depending on subsequent environmental conditions (Veissier *et al.*, 2018).

The main findings of this study indicate that bioclimatic indicators, including THI, exceeded the thermotolerance capacity of cattle in both Cluster 1 and Cluster 2, remaining within the severe heat stress range ($80 \leq THI < 90$) (table 3). Consequently, the evaluated animals were likely exposed to significant heat stress resulting from environmental factors, which can lead to behavioral alterations, reduced feed intake, panting, decreased rumination, and weight loss, among other effects (Islam *et al.*, 2021).

In Cluster 1, THI values remained within the severe to extreme range, and grazing occurred predominantly under shaded rather than unshaded conditions. When comparing breeds, CCC cattle exhibited higher activity levels than Gyrolando cows (tables 3 and 4). Similar findings have been reported by Barsotti *et al.* (2024) and Ripamonti *et al.* (2025), who documented the positive effects of tree shade on productive performance and animal welfare, including reduced heat discomfort, lower THI values during the dry season and peak temperature hours, and extended grazing activity in silvopastoral systems.

The elevated activity observed under adverse thermal conditions likely reflects an interaction between nutritional demands, resource availability, and adaptive mechanisms to heat stress. The behavioral pattern of Cluster 1 animals showing increased grazing activity during the hottest hours (12:00–16:00 h)—indicates either enhanced heat tolerance or a behavioral drive to continue foraging and seeking water despite high thermal loads (Barragán *et al.*, 2017). This capacity to sustain grazing under stressful environmental conditions, particularly evident in the CCC breed that predominated in this cluster, holds significant implications for productivity and adaptive efficiency. As a creole or locally adapted breed, CCC cattle have evolved under tropical environments and consequently display superior thermotolerance compared with exotic breeds such as Gyrolando.

Conversely, the behavioral strategy observed in Cluster 2 characterized by reduced grazing activity and increased

resting and rumination in shaded areas during the hottest hours can be explained by thermophysiological mechanisms, since feed intake elevates internal body temperature (Islam *et al.*, 2021). Therefore, this pattern reflects an energy- and heat-conservation strategy adopted under severe heat stress conditions. The higher activity levels recorded during the cooler morning hours (09:00–12:00 h) are consistent with the natural circadian rhythm of cattle, which favors reduced activity and greater shade-seeking behavior during periods of elevated thermal load.

Rumination plays a key role in digestion and nutrient absorption and serves as a reliable behavioral indicator for detecting illness or heat stress, as its frequency typically declines under such conditions (da Silva Santos *et al.*, 2023). This trend was also evident in the present study, where animals in Cluster 2 spent approximately 38.3% of their time ruminating (Table 3). These results align with Maia *et al.* (2020), who found that Gyrolando cattle exposed to heat stress exhibited reduced dry matter intake and altered rumination behavior.

The higher proportion of Gyrolando cattle in Cluster 2 indicates that this breed spent more time resting and ruminating, particularly between 12:00 and 14:00 h (Table 4). This behavior reflects an adaptive response to thermal stress and a general tendency to reduce activity under severe climatic conditions (Barragán *et al.*, 2017). Negri *et al.* (2023) reported that breeds with a higher proportion of *Bos taurus* ancestry such as Gyrolando (7/8 H, or 87.5% Holstein) have a lower heat stress threshold and dissipate heat less efficiently than breeds adapted to hot climates. Nevertheless, within-breed variation exists, as composite genotypes such as ¼ H, ½ H, and 5/8 H (Gyr × Holstein) have demonstrated greater thermal resistance (Negri *et al.*, 2023).

When comparing breeds, CCC cattle exhibited greater tolerance to extreme heat, maintaining active behaviors such as grazing even during the hottest hours. This resilience may be attributed to genetic and morphophysiological traits typical of creole breeds, including lower metabolic heat production, protective pigmentation, and efficient heat dissipation mechanisms (Freitas Silveira *et al.*, 2021). In contrast, Gyrolando cattle, with a stronger European genetic background, markedly reduced activity during peak heat periods, favoring shaded resting and lying rumination behaviors. This pattern suggests a lower capacity for adaptation to tropical thermal environments (Maia *et al.*, 2020). Moreover, heat stress is not merely an acute condition but may exert chronic, long-term effects on cows (Becker & Stone, 2020).

Overall, these findings highlight the importance of promoting the use of heat-adapted breeds such as CCC in tropical dry forest systems, as well as ensuring continuous access to shade and fresh water during high-temperature periods—particularly for less heat-tolerant breeds such as Gyrolando. The reduction in grazing during critical hours may affect feed efficiency and productivity, underscoring the need for management strategies that optimize animal welfare and performance. Moreover, the analysis demonstrates that breed significantly influences heat tolerance, with genotypic differences reflected in preferences for shaded resting areas versus direct sun exposure.

CONCLUSIONS

The hierarchical cluster analysis identified two groups with distinct behavioral strategies in response to environmental

conditions. The Costeño con Cuernos (CCC) breed exhibited greater activity under extreme heat conditions. These results underscore the importance of implementing management strategies that enhance thermal regulation in cattle production systems, with implications for improving animal welfare, optimizing grazing schedules, and promoting the selection of animals with higher heat resilience.

CONFLICT OF INTEREST

The authors declare no conflict of interest related to this research.

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ETHICAL APPROVAL

This study did not require approval by an ethics committee, as animals were observed directly in their grazing areas without physical contact or experimental manipulation.

DECLARATION ON THE USE OF ARTIFICIAL INTELLIGENCE

The authors declare that artificial intelligence was not used in the preparation of this manuscript.

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Analysis of lamb meat consumption in La Plata, Buenos Aires, Argentina

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ABSTRACT

Argentine ovine meat enjoys a favorable reputation due to its production under extensive farming systems; however, its consumption remains low. This is particularly relevant in a global context in which the food crisis and widespread access to information have led contemporary consumers to consider not only price or traditional intrinsic attributes of foods, but also their contribution to health. Nevertheless, consumption levels remain low. The aim of this study was to characterize ovine meat consumption patterns in the city of La Plata, Argentina, during the period 2021–2022. A mixed-methods approach employing both quantitative and qualitative research techniques was used. Survey questionnaires were administered to 380 household representatives aged 18 years or older. Data were analyzed using descriptive statistics. Results showed that 62% of respondents did not consume ovine meat. Among consumers, 61% reported doing so because they liked its taste. Male predominance was observed among consumers, purchasers, and individuals responsible for cooking. Lamb was the animal category purchased by 85% of respondents. Occasional consumption (44%) and consumption at home (68%) were the most frequently reported patterns. Overall, ovine meat consumption was low. Therefore, advancing efforts to address factors associated with ovine meat consumption is relevant as input for contemporary policy discussions and for the transformation of the regional ovine sector.

Keywords: Argentina, consumer, lamb meat, marketing.

Análisis del consumo de carne ovina en La Plata, Buenos Aires, Argentina

RESUMEN

La carne ovina argentina es un producto que goza de una buena imagen por ser obtenida bajo sistemas de producción extensivos, sin embargo, su consumo es bajo, aspecto de importancia en un contexto global donde la crisis alimentaria y el acceso generalizado a la información han hecho que el consumidor actual tenga en cuenta no solo el precio o las tradicionales características intrínsecas de los alimentos, sino que también valora su contribución a la salud. Sin embargo, su consumo es bajo. El objetivo del presente

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trabajo fue describir el comportamiento del consumo de carne ovina en la localidad de La Plata, Argentina, durante el periodo comprendido entre 2021 y 2022. Para el estudio se emplearon técnicas de investigación cuantitativa y cualitativa, mediante encuestas de tipo cuestionario, a 380 representantes del grupo familiar mayores de 18 años. Los datos se analizaron por estadística descriptiva. Se observó que el 62% de la población encuestada no consumía carne ovina. De los consumidores, el 61% lo hacía por gusto. Se observó predominio masculino como consumidor, comprador y al momento de cocinar. La categoría animal adquirida por el 85% de los encuestados fue el cordero. El 44% la consumía ocasionalmente y el 68% en el hogar. El consumo de carne ovina hallado fue escaso, por ello, avanzar en el abordaje de los aspectos inherentes al consumo resulta de interés como insumo para la discusión política contemporánea y la transformación del sector ovino regional.

Palabras clave: Argentina, consumidor, carne de cordero, *marketing*.

INTRODUCTION

Argentine ovine meat enjoys a strong reputation for its quality and sustainable production. This attribute is particularly relevant within a global context characterized, on the one hand, by severe food scarcity and, on the other, by the universalization of information. These conditions have led consumers to consider not only the traditional intrinsic characteristics of food products, but also their contribution to health, the environment, and animal welfare.

Historically, sheep farming has been an important productive activity in the province of Buenos Aires, located in the Pampas region the principal agricultural–livestock zone of Argentina. However, the full meat production potential of this species has not yet been realized, nor have the agro-environmental advantages characteristic of the region been fully exploited.

Currently, small flocks oriented toward meat production for self-consumption are maintained in the province of Buenos Aires. Under these conditions, most sheep are raised with limited emphasis on efficiency, and the species is not considered a profitable economic activity. Animals are generally allocated to poor-quality fields with minimal forage availability. This has contributed to the perception of sheep as a factor in pasture degradation and a promoter of land desertification. As a result, the species has lost relevance for livestock producers, who do not incorporate it into their production plans (Moya & Lazzarini, 2013).

The province of Buenos Aires comprises 25,688,253 hectares 15% of Argentina's total surface area of which approximately 300,000 hectares (1.5%) are dedicated to ovine production. In 2023, of the 12.6 million head of sheep in Argentina, the province contributed nearly two million (Servicio Nacional de Sanidad y Calidad Agroalimentaria [SENASA], 2023). This represents 14.47% of the national stock, distributed across 22,658 establishments, positioning the region third nationwide after Chubut and Santa Cruz. These latter provinces belong to the Patagonian region, characterized by a monoculture of sheep production oriented toward high-quality fine wool for export, making Argentina one of the leading producers on the American continent (FAO, 2023). In the case of

Buenos Aires Province, it holds the largest proportion of ovine establishments in the country (25.1%), of which 60% manage up to 50 animals, 32% manage 51–250, 5% manage 251–500, and 3% manage 1,001–5,000 sheep (SENASA, 2022).

Regarding national slaughter, ovine processing has declined notably for more than a decade, with 94% of ovine meat destined for domestic consumption. Between 2009 and 2020, per-capita consumption ranged from 1.06 to 1.86 kg/year; in 2020 and 2021, annual consumption was 1.1 kg per capita (Consorcios Regionales de Experimentación Agrícola [CREA], 2021). Although emphasis is often placed on low consumption levels in Argentina, ovine meat is not a staple in most countries; rather, it is typically a specialty product consumed during festive or seasonal occasions (Goizueta & Sánchez, 2011).

It is important to highlight the role of ovine meat in regional economies, as it supports the development of strategies aimed at enhancing sectoral growth and leveraging a highly valued and necessary resource. To this end, numerous authors have characterized ovine meat consumption in various parts of the world. Mao et al. (2016) analyzed Chinese consumers and their preferences for beef and mutton, concluding that consumption patterns were determined by the relatively stronger economic conditions of southern China, whereas in northern China they were shaped by consumption habits and product availability. Additional factors such as economic considerations, religious beliefs, environmental concerns, dietary habits, and price were also shown to influence beef and lamb consumption across Chinese regions. In Latin America, Pessoa et al. (2018) and De Oliveira et al. (2024) evaluated the profile of ovine meat consumers in Brazil, where sheep and goats are traditionally and regionally important species with potential for expansion into growing urban markets. These studies examined variables such as consumption level, reasons for non-consumption, consumption frequency, purchase location, factors influencing purchasing decisions, preferred cuts, and consumption of edible offal. In Chile, Rodríguez et al. (2025) characterized consumption of *cordero de Chiloé* as a differentiated ovine meat product with geographical indication. In Argentina, studies have progressed across several provinces of the Pampas region, including Córdoba (Agüero *et al.*, 2010), central Santa Fe (Acetta et al., 2023), and Buenos Aires Province (Lagreca et al., 2009; Pastorelli et al., 2015).

In the field of consumer behavior, Boragnio (2021) theorized about the particular relationship between consumers and food, shaped through social learning and cultural heritage. In this regard, it is essential to interpret ovine meat consumption not only through descriptions of its attributes as a food product but also through the integration of diverse variables, including its intrinsic characteristics, consumer health, cultural identity, territorial dynamics, and the evolution of products and livestock producers. Such knowledge is necessary for any action aimed at expanding the productive sector through the stimulation of consumption.

Therefore, the objective of the present study was to describe ovine meat consumption in the locality of La Plata, Buenos Aires Province, Argentina, during the period 2021–2022, as input for the design of public policies and for guiding the agri-food chain.

MATERIALS AND METHODS

A mixed-methods approach, combining quantitative and qualitative research techniques, was used to study consumer behavior. The data collection instrument consisted of a questionnaire with closed and semi-open questions, administered individually and in respondents' homes. The survey was previously validated to identify potential comprehension issues. The surveyed population resulted from a random sample of informants representing their household (sampling unit), consisting of residents aged 18 years or older in the locality of La Plata, Buenos Aires Province, Argentina, during the period 2021–2022.

The variables included in the instrument were designed to characterize consumer perceptions, including reasons for consumption and non-consumption, factors guiding product choice, valued organoleptic attributes, usual purchasing channels, criteria for product selection, methods of preservation and preparation, and potential product substitutes.

The sampling frame for assessing consumption was calculated based on the total population of La Plata according to the 2019 census. The sample size was estimated using the finite population probability formula, considering a 95% confidence level, a 5% margin of error, and p and q values of 0.5. This resulted in a sample size of 380 sampling units. Descriptive statistics were used for data analysis.

For the calculation of annual per-capita ovine meat consumption, the 104 sampling units identified as consumers were considered, representing a total of 406 individuals.

RESULTS AND DISCUSSION

Of all respondents surveyed in the locality of La Plata, 68% were women and 32% were men. The most represented age group was 41–50 years. Figure 1 shows the distribution of respondents by age.

When asked whether they consumed ovine meat, 62% reported that they did

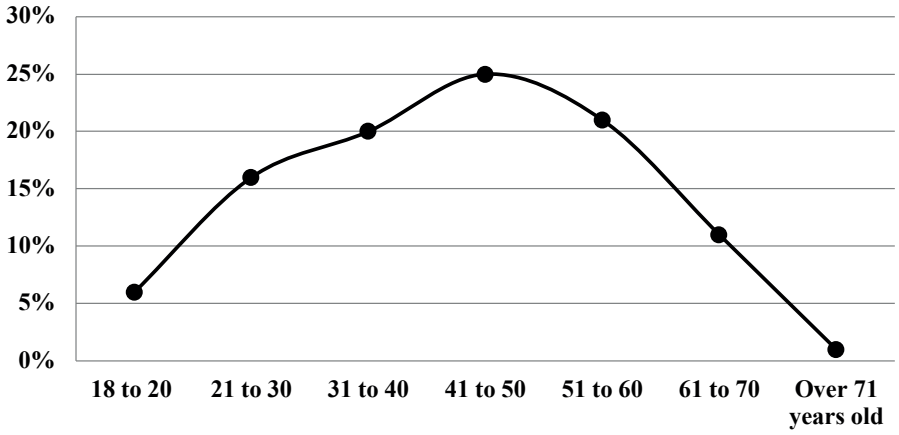

FIGURE 1. Distribution of respondents by age group (percentage).

Source: own elaboration.

not, while 38% responded affirmatively. This level of consumption was lower than that reported by Agüero (2010) in the province of Córdoba and nearly half of that recorded by Acetta (2023) in the province of Santa Fe. When consumption patterns were analyzed by sex, men were found to consume ovine meat more frequently than women (figure 2).

Regarding the reasons for non-consumption, the most relevant findings were that 49% abstained due to lack of habit consistent with observations by Agüero (2010) in Córdoba and 22% reported not consuming it because it was not readily available, among other reasons (figure 3). These two motivations coincide with the findings of Acetta (2023), who identified

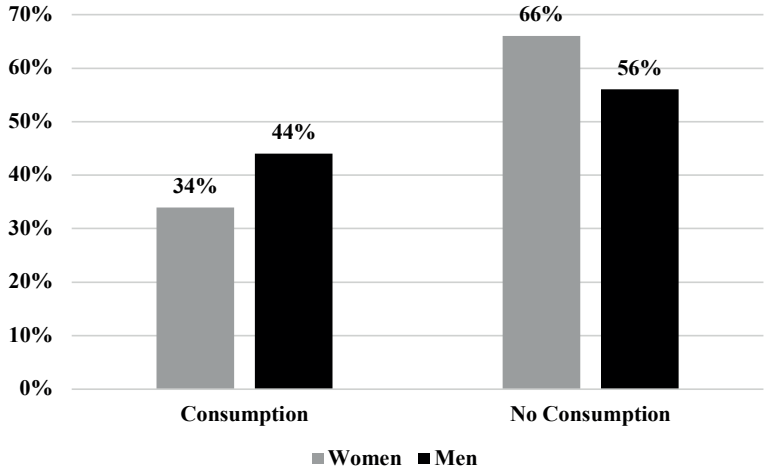

FIGURE 2. Distribution of ovine meat consumption by sex (percentage).

Source: own elaboration.

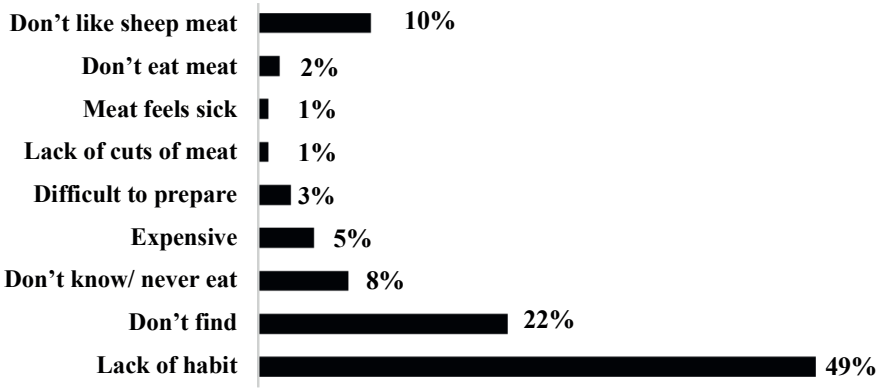

FIGURE 3. Reasons for non-consumption of ovine meat (percentage).

Source: own elaboration.

them as the principal justifications for non-consumption.

Based on the reported reasons, 13% of respondents can be classified as true non-consumers: 10% stated that they did not like ovine meat, 2% were vegetarians or vegans, and 1% reported experiencing adverse effects after consumption. In contrast, 87% did not consume ovine meat for reasons unrelated to product affinity, including lack of habit, limited availability, unfamiliarity, high cost, difficulties in preparation, or lack of appropriate cuts.

Among the motivations for consumption, 61% cited taste and 18% cited tradition (figure 4). The primary reason for consumption was therefore the pleasure associated with taste. As Bourdieu (as cited in Boragnio, 2021) notes, "tastes" include cultural capital as a structuring factor of consumption; in this sense, festive and traditional consumption reported by 20% of respondents aligns with this conceptualization. In the study conducted by Mao et al. (2016) in China, the main motivation for consumption was consumer preference for the meat, a finding that also aligns with results reported by De Oliveira et al. (2024).

Regarding purchasing behavior, men were identified as the individuals most explicitly responsible for acquiring ovine meat (32%), followed by relatives or friends (15%), women (12%), and respondents who indicated no specific purchaser (41%). Based on the types of relationships that different social groups establish with food, it is possible to infer the degree of formal or informal interaction consumers are willing to engage in to obtain this product. In this study, the variable "ovine meat producer" was included as a particular feature of the local supply chain, given that 41% of respondents purchased meat directly from producers, similar to findings reported for the province of Santa Fe by Acetta (2023). Other purchasing channels included traditional butcher shops specializing in beef (36%), butcher shops specializing in pork (8%), direct

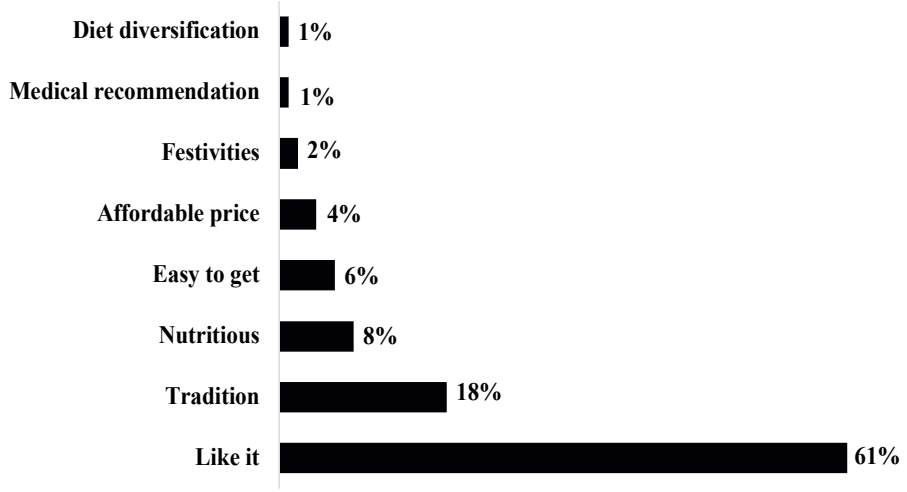

FIGURE 4. Motivations for ovine meat consumption (percentage).

Source: own elaboration.

purchases from slaughterhouses (6%), supermarkets (6%), shops specializing in poultry meat (2%), and other unspecified outlets (1%).

With respect to the animal category purchased, 85% reported buying lamb, 9% purchased castrated male sheep (*capón*), and 6% adult ewe. Regarding preferred cuts, 22% favored ribs, 15% preferred the leg or hindquarter, and 20% opted for whole lamb (figure 5). The preference for cuts such as the hindquarter differed from the findings reported by Pastorelli et al. (2015) in La Plata.

Another important factor to consider is the role of organoleptic characteristics, which serve as key dimensions influencing purchasing decisions and shaping consumer preferences. To evaluate these features, emphasis was placed on sensory attributes based on the visual appraisal of the product. Regarding the color of raw meat, 48% of consumers preferred lighter-colored meat, 30% preferred meat of intermediate coloration, 14% expressed no preference, and 8% favored darker meat. For perceived fat content, 54% described the meat as lean, 35% as fatty, 7% as very fatty, and 4% as very lean. In contrast, consumers in Brazil perceived ovine meat as fatty (Pessoa et al., 2018; De Oliveira et al., 2024), which constituted one of the main reasons for non-consumption or rejection, as fat was associated with strong flavor and odor consistent with the consumption of adult categories in that country.

Tenderness, referring to the texture of meat in the mouth, was also investigated because it is one of the attributes that most strongly influences acceptability due to its impact on the eating experience. According to Mao (2016), tenderness is a key aspect for Chinese consumers, as it determines the preferred preparation method for ovine meat. In the present study, 82% of respondents considered the meat tender, consistent with the findings of Agüero (2010), while 18% reported that it was not always tender.

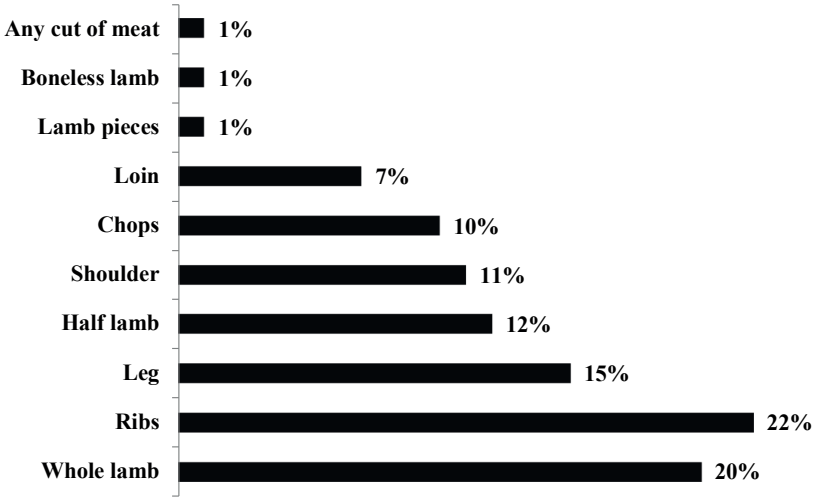

FIGURE 5. Frequency of consumption by ovine meat cuts (percentage).

Source: own elaboration.

The price that a consumer seeking gratification is willing to pay for a product depends on the credibility of the promise that the product will satisfy their expectations and on the intensity of those expectations (Bauman, 2007). For this reason, respondents were asked about their perception of the value of ovine meat relative to beef, the latter being culturally the most valued and recognized animal protein in Argentina. Of the respondents, 52% believed ovine meat should cost the same as beef, 26% were willing to pay more, and 22% would pay less. Rodríguez et al. (2025) found that 56% of consumers in Chile were willing to pay 41% more for differentiated ovine meat.

When consumers were unable to obtain ovine meat for various reasons, they were asked which meat they would choose as a substitute. Beef was the preferred alternative (35%), followed by pork (27%), chicken (15%), goat meat (5%), rabbit (1%), and no specific preference (17%). These results were similar to those reported by Lagreca et al. (2009) for the city of La Plata.

A factor that influences purchasing decisions is the interplay between commensality and food preparation, which leads consumers to plan strategies for storing and retrieving ovine meat for future use. In this regard, 60% of consumers reported not freezing ovine meat, 29% did freeze it, and 11% stated that it depended on the situation. The average storage time for frozen ovine meat was 26 days, with a minimum of 2 days and a maximum of 180 days. The most common thawing method was defrosting at room temperature (51%), followed by no specific preference (20%), microwave thawing (15%), and thawing in the refrigerator (14%).

Boragnio (2021), referring to Pierre Bourdieu's work on "tastes," notes that culinary practices, eating habits, and food strategies shaped by domestic economy and the gendered division of labor determine preparation methods in addition to cultural capital. Frequency of consumption defines opportunities for interaction between consumers and the product: 44% consumed ovine meat occasionally, 25% on festive occasions, 15% one to two times per month, 14% weekly, and 2% only when the price or product was accessible. Regarding place of consumption, the home was predominant (68%), followed by meals offered by others (16%), no preference (14.5%), and consumption exclusively in restaurants (1.5%). Similar patterns of occasional or celebration-related consumption were reported by Agüero (2010) in Córdoba and Rodríguez et al. (2025) in Chile. In contrast, Pessoa (2018) and De Oliveira (2024) documented primarily weekly and biweekly consumption frequencies in Brazil.

Considering the variables associated with the person responsible for cooking and the cooking techniques used, a strong male predominance was observed (65%), while 24% reported no preference and 11% identified women as the primary cooks. Regarding cooking methods, direct heat on a grill using embers was the most preferred (40%), followed by roasting over an open fire on a spit (23%), baking (21%), stewing (14%), and other unspecified techniques (2%). Preferences for degree of doneness indicated that 42% of respondents preferred medium-cooked meat, 35% fully cooked, 12% juicy, and 11% very well done. An important aspect that enhances the eating experience is the choice of side dishes. The preferred accompaniments were raw vegetables (36%), potatoes (31%), cooked vegetables (20%), and rice or pasta (6%).

Some respondents reported consuming ovine meat only with bread (6%), and 1% indicated that the side dish varied depending on the preparation method.

Finally, the average annual per-capita consumption calculated from the data was 1.11 kg/person/year, with a minimum of 0.125 kg/person/year and a maximum of 21.4 kg/person/year. Consumption in the locality of La Plata was similar to the national average for the same period (CREA, 2021). This may be associated with the limited or absent integration of ovine meat into daily diets, consistent with Goizueta and Sánchez (2011), who noted that ovine meat is almost always a specialty consumed on festive or seasonal occasions.

CONCLUSIONS

The characteristics of consumers, together with the practices and customs surrounding ovine meat consumption, constitute elements shared within a cultural framework whose understanding is essential for any action aimed at promoting sectoral growth through increased consumption. This underscores the importance of studies focused on a thorough understanding of demand in order to align it more effectively with supply.

Initially, it was observed that strict non-consumers are few compared with individuals who do not consume ovine meat for reasons unrelated to taste. This suggests that behind the high proportion of non-consumption lies a potential consumer base; therefore, this segment should be strategically targeted when designing promotional initiatives.

In general, consumers reported eating ovine meat because they enjoy it and due to family traditions. When relating consumption patterns to respondents' sex, men not only consumed and prepared ovine meat more frequently but were also primarily responsible for its purchase. The predominant procurement method was direct acquisition from producers, followed by purchases from traditional butcher shops specializing in beef. In the locality of La Plata, the most purchased ovine category was lamb, commonly acquired as a whole carcass, with the rib section identified as the preferred cut. Regarding perceptual evaluation of organoleptic attributes, consumers favored light-colored, lean, and tender meat, which is consistent with the preferred animal category (lamb). Most respondents purchased fresh meat for immediate or near-immediate use, whereas a smaller proportion froze the product for consumption within a month. When lamb was unavailable, it was mainly substituted with beef or pork. The predominant cooking practices involved direct heat, either on a grill or spit, typically accompanied by raw vegetables. Regional consumption was comparable to the national per-capita average and is considered very low but with potential for growth.

Ovine meat is incorporated into the culinary routine not through daily consumption owing to limited availability throughout the year or the price–yield relationshipbut rather through specific social interactions, such as festivities, end-of-year celebrations, Christmas, or Easter. This type of occasional consumption, combined with the involvement of relatives or friends in purchasing, the direct relationship established with producers supplying whole lambs, and the role of an adult host opening their home to others, highlights the ritual and symbolic value of the practice. It reflects the establishment of agreements and roles,

planning, reinforcement of bonds, and collective identity.

In contemporary societies, consumption practices and their relationship with products are fundamental for the articulation between production and social reproduction. Therefore, these aspects must be considered in current political discussions aimed at strengthening local development and enhancing territorial public–private networks. Maintaining traditional consumption, engaging younger generations and new consumer segments, and advancing productive changes that enable lamb to appear more frequently on household tables represent a multifaceted challenge one that could position the regional ovine sector as a significant productive opportunity.

CONFLICT OF INTEREST

There are no personal conflicts of interest, nor any conflicts involving other individuals, organizations, agencies, or institutions that could inappropriately influence the present article.

COMPLIANCE WITH ETHICAL STANDARDS OF EXPERIMENTATION

No animal experimentation was conducted.

FUNDING SOURCES

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DECLARATION ON THE USE OF ARTIFICIAL INTELLIGENCE

The authors declare that artificial intelligence was not used for the development of this research.

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Veterinary medicine and canine aging: general aspects of the identification and treatment of major diseases in geriatric dogs

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ABSTRACT

Life expectancy in dogs has increased due to advances in veterinary medicine, making the systematic monitoring of senior animals essential. This article presents a narrative literature review conducted between July and November 2025 using the PubMed, SciELO, and ScienceDirect databases, including publications from 2020 to 2025 that address physiological, clinical, and therapeutic aspects of geriatric dogs, with emphasis on studies from South America, North America, and Europe. The review describes criteria for age classification, physiological changes associated with aging, and the main conditions affecting this population, such as osteoarticular, renal, endocrine, cognitive, and neoplastic diseases. The literature highlights the importance of early identification of these alterations and the role of owners in adherence to care. The objective of this article is to synthesize current knowledge on the most prevalent diseases in elderly dogs and to present evidence-based measures that support adequate monitoring and management.

Keywords: dogs, treatments, aging, pathologies.

Medicina veterinária e o envelhecimento canino: aspectos gerais da identificação e tratamento das principais doenças em cães idosos

RESUMO

A expectativa de vida dos cães tem aumentado em razão dos avanços da medicina veterinária, tornando essencial o acompanhamento sistemático da saúde de animais idosos. Este artigo apresenta uma revisão narrativa de literatura conduzida entre julho e novembro de 2025 nas bases PubMed, SciELO, e ScienceDirect, incluindo publicações de 2020 a 2025 que abordam aspectos fisiológicos, clínicos e terapêuticos de cães geriátricos, com ênfase em estudos da América do Sul, América do Norte e Europa. A revisão descreve critérios de classificação etária, alterações fisiológicas associadas ao envelhecimento e as principais condições que acometem essa população, como doenças osteoarticulares, renais, endócrinas, cognitivas e neoplásicas. A literatura destaca a importância da identificação precoce dessas alterações e do papel dos tutores na adesão ao cuidado. O objetivo deste artigo é sintetizar o conhecimento atual sobre as doenças mais prevalentes em cães idosos e apresentar medidas baseadas em evidências que auxiliem no monitoramento e manejo adequados.

Palavras chave: cães; tratamentos; velhice; patologias.

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INTRODUCTION

Aging is an inevitable biological process that affects all mammalian species, including dogs, and is associated with progressive and cumulative changes that impact organ systems, behavior, and functional capacity. Over recent decades, advances in preventive, diagnostic, and therapeutic veterinary medicine have contributed significantly to the increased life expectancy of companion animals, which, in turn, has expanded the population of senior dogs and introduced new clinical challenges. With this growing demographic shift, it becomes essential to develop a comprehensive understanding of the physiological changes inherent to senescence and to recognize, at an early stage, the most frequent diseases occurring during this phase of life.

Although there is a substantial body of knowledge on veterinary geriatrics, important gaps remain regarding the standardized definition of what constitutes "old age" in dogs, the criteria used for this classification, and the differences among breeds, sizes, and individuals. Furthermore, many conditions typical of senescence such as neurological, cardiovascular, renal, osteoarticular, metabolic, behavioral, and sensory disorders exhibit slow progression and nonspecific early signs, which hinders early diagnosis and, consequently, the establishment of effective intervention strategies.

Given this context, it becomes necessary to compile and systematize updated information that may assist both veterinarians and owners in understanding this stage of life. Thus, the present study aims to deepen knowledge on canine aging by addressing the definition of the geriatric stage, the classification criteria, the main physiological changes associated with advancing age, and the most prevalent health problems in elderly dogs. Additionally, it compiles evidence on diagnostic approaches, therapeutic options, and preventive strategies, with the purpose of supporting veterinary clinical practice, guiding evidence-based decision-making, and promoting owner awareness regarding the importance of regular monitoring, specific care, and early intervention. In this way, the study seeks to contribute to the maintenance of health, welfare, and quality of life in this growing population of elderly dogs.

THE IMPORTANCE OF IDENTIFYING ABNORMALITIES

Animals of advanced age frequently develop physiological alterations resulting from the natural wear of the organism. In this context, the early identification of potential abnormalities becomes essential, as such conditions directly affect both quality of life and life expectancy. Therefore, regular veterinary monitoring is of utmost importance. Technological advances in veterinary medicine have enabled increasingly accurate diagnoses, as well as the adoption of more effective therapies. These innovations not only promote improved quality of life but also contribute to the development of therapeutic strategies capable of mitigating the effects of aging and extending the lifespan of animals, always with an emphasis on the promotion of welfare.

DEFINITION OF OLD AGE

Determining the point at which a dog can be considered elderly is influenced by several factors, among which body size and breed are particularly relevant (Montoya *et al.*, 2024). In general, large-breed dogs tend to experience aging earlier than small-breed dogs. The age range marking the onset of

canine senescence typically lies between seven and fourteen years. Specifically, small-breed dogs are considered elderly from 11 years of age, medium-breed dogs from 10 years, and large-breed dogs from 9 years, as illustrated in Supplementary Figure 1. In addition to chronological age, certain clinical and behavioral signs can assist in identifying aging. Among these are coat changes (particularly the appearance of gray hairs around the eyes and muzzle) thickening of the paw pads, tooth loss, reduced mobility, lethargy, and diminished visual and auditory capacities (Vajányi *et al.*, 2024).

NATURAL AGING AND EXPECTED CHANGES

Aging is an inevitable physiological phenomenon, and its rate and manifestations vary among individuals. While some animals develop cardiac diseases, others may present renal, respiratory, or other systemic dysfunctions (Dias-Pereira, 2022). Metabolic changes are particularly common at this stage of life, largely due to reduced cellular turnover, which compromises tissue regeneration and, consequently, the optimal functioning of organs. Among the most frequently observed changes, the following stand out:

- **Weight fluctuations:** A reduction in caloric requirements is common, accompanied by the need for a diet enriched with antioxidants, vitamins, and amino acids (Key, 2024). Body weight control becomes essential, as a decelerated metabolism may favor the development of obesity.
- **Nutritional adjustment:** It is recommended to replace the habitual diet with formulations specifically designed for senior dogs, which provide an appropriate nutrient profile for this life stage (Laflamme, 2024). The amount offered should always follow veterinary guidance.
- **Evident physical changes:** These changes include the appearance of whitish hairs around the muzzle and eyes, calluses on the elbows, fragile nails, thickening of the footpads, reduced mobility due to joint wear, and loss of lean muscle mass (Laflamme, 2024).
- **Sensory impairment:** The progressive decline of vision and hearing may hinder the animal's interaction with its environment, requiring adaptations from owners.
- **Systemic dysfunctions:** These include urinary incontinence, decreased renal and cardiac function, and increased susceptibility to the progression of periodontal diseases, such as gingivitis, periodontitis, and tartar accumulation (Olin *et al.*, 2024).

It is important to highlight that these changes do not occur uniformly. Factors such as genetic inheritance and individual predispositions directly influence the manifestation and severity of the clinical conditions observed.

ESSENTIAL CARE FOR ELDERLY DOGS

Once a dog's age has been classified, certain precautions must be taken, as many problems may arise and, if not managed appropriately, can worsen the animal's condition. Key recommendations include:

- **Weight control:** Avoid excessive weight fluctuations, which may contribute to the development of various diseases.
- **Regular physical activity:** Even with reduced stamina, it is essential to maintain a routine of walks and exercise

to prevent sedentary behavior, obesity, and joint or cardiac problems.

- **Oral hygiene:** Regular tooth brushing helps prevent tartar accumulation and periodontal disease. It is estimated that 80% of dogs over three years of age exhibit periodontal disease (Wadia, 2021).
- **Frequent check-ups:** Semiannual examinations are recommended to monitor the cardiovascular, endocrine, urinary, lymphatic, respiratory, skeletal, and nervous systems.
- **Up-to-date vaccinations:** Maintaining an updated vaccination schedule is essential for preventing infectious diseases.
- **Adapted environment:** Provide non-slip rugs, elevated feeding bowls, and avoid abrupt changes in furniture layout, especially for dogs with vision or mobility impairments.

COMMON HEALTH PROBLEMS IN ELDERLY DOGS

Although numerous diseases may emerge with advancing age, it is essential to highlight those that occur most frequently in geriatric dogs due to their clinical relevance and impact on the animal's quality of life:

- **Cognitive dysfunction:** Characterized by behavioral changes such as disorientation, disturbances in the sleep–wake cycle disturbances, reduced social interaction, and memory loss, and is often compared to Alzheimer's disease in humans (Teixeira et al., 2024).
- **Cardiac diseases:** These include conditions such as congestive heart failure and cardiac murmurs, which compromise adequate cardiovascular function and tissue perfusion (Nam et al., 2024).
- **Visual impairment:** Diseases such as cataracts and glaucoma are common in elderly dogs and may lead to progressive vision loss, potentially progressing to blindness if not properly treated (Marchini et al., 2024).
- **Periodontitis:** A severe inflammation of the periodontal tissues, frequently associated with pain, tooth mobility, tooth loss, and an increased risk of secondary systemic infections (Wallis & Holcombe, 2020).
- **Osteoarthritis:** A degenerative joint disease that causes chronic pain, joint stiffness, and limited movement, directly affecting the animal's mobility and welfare (Lampo, 2024).
- **Neoplasms:** Benign or malignant tumors are more prevalent in elderly animals and may affect various organs and systems, requiring early diagnosis and specific management (Olin *et al.,* 2024).

Preventive veterinary care and continuous monitoring are essential for the early detection and effective management of these conditions, contributing to longevity and improved quality of life in senior dogs.

DENTAL PROBLEMS

Dental calculus

Dental calculus, also referred to as tartar, consists of mineralized bacterial plaque on the tooth surface, resulting from the accumulation of food debris and inadequate oral hygiene (Cunha *et al.*, 2022). This condition may trigger a variety of clinical signs, including halitosis, tooth discoloration, gingival bleeding, intense pain, and difficulty chewing.

In more advanced stages, the accumulation of tartar may progress to gingivitis

and periodontitis, inflammatory diseases that affect the supporting structures of the teeth and significantly compromise the animal's oral health. In addition, the prolonged presence of bacteria in the oral cavity facilitates their dissemination to other regions of the body, increasing the risk of systemic infections (Cunha *et al.*, 2022).

In severe cases, surgical intervention is required for tartar removal through a procedure known as tartarectomy (Cunha *et al.*, 2022). Therefore, regular tooth brushing with products formulated specifically for veterinary use is essential for preventing these conditions and preserving oral health, particularly in elderly dogs.

Gingivitis

Gingivitis is an inflammatory condition that affects the gingiva and may, in more advanced cases, extend to the tongue and oral mucosa. This condition is frequently associated with tartar accumulation and the development of dental disorders, presenting clinically as reddened and receded gums, as well as spontaneous bleeding (Cunha *et al.*, 2022).

Upon identification of signs suggestive of gingivitis, owners are advised to seek specialized veterinary care for an accurate diagnosis and appropriate therapeutic intervention. Clinical evaluation may include the use of a periodontal probe, a procedure performed under anesthesia to assess the depth of periodontal pockets and the extent of disease progression (Gawor *et al.*, 2022).

Treatment generally involves the administration of antibiotics to eliminate the bacteria responsible for the inflammation, as well as professional dental cleaning to remove accumulated tartar (Brunius *et al.*, 2020). In more complex cases, the veterinarian may request additional diagnostic tests, such as dental radiographs, a complete blood count, a leukogram, and blood glucose testing, to evaluate the animal's systemic condition and rule out concurrent comorbidities.

Periodontitis

If gingivitis is not properly treated, it may progress to periodontitis, a more severe condition that compromises the supporting structures of the teeth in dogs (Harvey, 2018). The main clinical signs include edematous and inflamed gingiva, pain or difficulty chewing, and loss of alveolar bone support, which may ultimately lead to tooth loss (Cunha *et al.*, 2022). Inadequate oral hygiene is the primary cause of periodontitis, underscoring the importance of regular tooth brushing.

Beyond oral consequences, periodontitis can significantly affect an animal's systemic health, increasing the risk of cardiac and renal complications (Salla *et al.*, 2025). These effects result from the systemic dissemination of inflammatory mediators as well as from bacterial translocation into the bloodstream, highlighting the importance of preventive oral care and early therapeutic intervention.

Diagnosis is established through clinical evaluation using a periodontal probe and, in more advanced cases, with the aid of radiographic imaging to determine the extent of bone loss (Lee *et al.*, 2023). Treatment varies according to disease severity: mild cases require regular prophylaxis with scaling to remove tartar and prevent disease progression, whereas severe cases may necessitate surgical interventions and multiple tooth extractions, as illustrated in Supplementary Figure 2. It is important to note that, in certain cases, the damage caused may be permanent.

OCULAR PROBLEMS

Corneal degeneration

Corneal degeneration is an ophthalmic condition characterized by the accumulation of lipids within the corneal stroma the thickest layer of the cornea often associated with neovascularization, defined as the abnormal formation of blood vessels in this region (Kalwad *et al.*, 2022). This disorder may be triggered by ocular trauma or by underlying systemic conditions such as hypercholesterolemia (elevated cholesterol levels) and hypercalcemia, which may occur without overt clinical signs. The main clinical manifestations observed in affected animals include white deposits on the corneal surface, corneal opacity, photophobia (light sensitivity), partial or complete loss of visual acuity, ocular pain, and epiphora (excessive tearing) (Dubielzig & Patnaik, 2022).

Diagnosis is established through specific ophthalmic examinations aimed at identifying ulcers, corneal lesions, or preexisting diseases associated with corneal degeneration. Treatment selection depends directly on the underlying cause and may include medical therapy, management of associated systemic diseases, and, in severe cases, surgical intervention (Michalak *et al.*, 2022).

Cataract

Cataract is an ocular disorder characterized by the progressive opacification of the lens, which may lead to significant visual impairment and, in advanced cases, complete blindness. This condition results from structural alterations of the lens, which gradually becomes opaque, acquiring bluish or whitish hues. Its development may be associated with genetic predisposition, aging, metabolic disorders, or congenital abnormalities (Fischer & Meyer-Lindenberg, 2018).

In its early stages, cataract may be mistaken for nuclear sclerosis because of their similar appearance; however, distinguishing between these conditions is essential. Nuclear sclerosis is a physiological, age-related change that does not progress to significant visual loss and results from the gradual condensation of lens fibers (Oliveira *et al.*, 2021). Differentiation requires a detailed ophthalmic examination: while the ocular fundus remains visible in cases of nuclear sclerosis, lens opacification in cataract prevents fundus visualization, allowing a clear distinction between the two conditions (Oliveira *et al.*, 2021).

The most common clinical signs of cataract include photosensitivity, excessive tearing, changes in eye color, and difficulty recognizing people, objects, or familiar environments (Suresh *et al.*, 2024). Diagnosis is based on clinical evaluation of the patient, complemented by specific ophthalmic tests such as the Schirmer tear test, which measures tear production, and tonometry, which assesses intraocular pressure (Suresh *et al.*, 2024).

Glaucoma

Glaucoma is a severe ophthalmic disorder characterized by an abnormal increase in intraocular pressure, resulting from impaired drainage of the aqueous humor, leading to progressive degeneration of the optic nerve (Farkas and Pe'er, 2024). It is a rapidly progressive disease that, if not properly treated, may result in irreversible blindness.

The most common clinical signs include severe ocular pain, conjunctival hyperemia, bluish corneal opacity, and abnormal enlargement of the globe in advanced stages (Evaristo, 2020). Glaucoma may

be classified into two main categories: primary, which arises from hereditary anatomical abnormalities of the aqueous humor drainage system, and secondary, which is associated with pre-existing conditions such as advanced cataracts, uveitis, and intraocular neoplasms (Davies & Miller, 2021).

Diagnosis is established through tonometry, an examination used to measure intraocular pressure. Treatment involves the use of topical agents and specific systemic medications aimed at reducing aqueous humor production and improving its outflow. In more severe cases, surgical intervention may be indicated or, as a last resort, enucleation (removal of the globe) followed by prosthesis implantation (Evaristo, 2020).

ORTHOPEDIC DISORDERS

Orthopedic diseases encompass fractures, injuries, inflammatory processes, and other conditions affecting the locomotor system, including bones, joints, muscles, and ligaments. These disorders are particularly prevalent in elderly dogs.

Spondylosis

Spondylosis is a chronic, degenerative disorder characterized by the formation of osteophytes (bony spurs) along the vertebrae of the spinal column. This condition results primarily from the progressive degeneration of the intervertebral joints. The main clinical signs include localized pain in the affected region, lameness, and weakness of the pelvic limbs (Wadowska *et al.*, 2023).

Although the exact causes of spondylosis remain under investigation, it is believed that factors such as vertebral instability, genetic predisposition, and specific anatomical characteristics are believed to contribute to its development. Certain breeds, including Boxers, Dachshunds, Pekingese, and Basset Hounds, show a higher predisposition to the disease, particularly due to disproportionate body conformation, such as an elongated spine relative to limb length (Wadowska *et al.*, 2023). In Boxers, specifically, there is evidence that suggests a hereditary association with the condition.

Spondylosis is diagnosed through imaging examinations such as radiography, magnetic resonance imaging, and myelography, the latter being particularly useful for detecting spinal cord lesions especially in the cervical region and for determining disease severity of the condition (Harder *et al.*, 2021). Additional diagnostic tests may be indicated to rule out concurrent pathologies.

Treatment is determined according to disease stage and clinical presentation. In early phases, anti-inflammatory drugs and analgesics are commonly administered to relieve pain relief (Barbosa *et al.*, 2022). Acupuncture has demonstrated efficacy as an adjunct therapy for chronic pain management. In more advanced or refractory cases, surgical intervention may be required. Physiotherapy plays a fundamental role in rehabilitation and in maintaining the animal's quality of life, with hydrotherapy representing an effective, low-impact therapeutic option (Barbosa *et al.*, 2022).

Intervertebral Disc Disease (IVDD)

Intervertebral disc disease (IVDD) is a neurological condition that occurs when the intervertebral discs of the canine spine undergo protrusion or extrusion, leading to spinal cord compression (Garcia and Jeffrey, 2022). This alteration may result

from a progressive degenerative process related to chronic wear or may occur acutely due to the sudden extrusion of disc material. Chondrodystrophic breeds, such as Dachshunds and Beagles, are particularly predisposed to the development of this disease because of specific anatomical and genetic characteristics (De Decker *et al.*, 2020).

Clinical signs vary according to the location and severity of the lesion and may include cervical or lumbar pain, stiffness and restricted mobility, urinary incontinence, and, in more severe cases, partial or complete paralysis of the limbs with loss of neurological function (Olby *et al.*, 2020).

Diagnosis is established through a detailed neurological assessment aimed at determining the exact location of the lesion, the degree of spinal cord compression, the level of pain, and the extent of mobility loss. Imaging modalities such as radiography, computed tomography (CT), and magnetic resonance imaging (MRI) are frequently used for confirmation and therapeutic planning (Da Costa and Parent, 2021). Treatment may be conservative (medical) or surgical, depending on the severity of the condition. When there is no improvement with medical management or in cases of severe neurological impairment, surgical intervention is indicated, consisting of spinal cord decompression and removal of herniated or calcified disc material.

Arthritis

Arthritis is an inflammatory condition that affects the joints and may progress, if not properly managed, to osteoarthritis, a degenerative joint disease of irreversible nature (Yin *et al.*, 2024). This condition is primarily caused by the progressive deterioration of articular cartilage and frequently affects the vertebral column. Several factors contribute to the development of arthritis, including obesity, advanced age, and genetic predisposition. According to Forsyth *et al.* (2023), Labrador Retrievers and German Shepherds exhibit increased susceptibility to arthritis. Additionally, breed-specific characteristics and environmental conditions, such as slippery flooring, increase the risk of microtrauma to the joints.

The most common clinical signs include lameness, difficulty rising and ambulating, joint stiffness, chronic pain, reduced appetite, and decreased quality of life (Kirkby, 2023). Diagnosis is based on a thorough clinical evaluation and may be complemented by imaging modalities such as radiography, as well as laboratory tests aimed at ruling out other causes of joint pain and inflammation (Da Costa & Parent, 2021).

Treatment of arthritis relies primarily on the administration of anti-inflammatory drugs for pain and inflammation control. In more advanced cases, surgical intervention may be indicated, particularly for the removal of osteophytes bony proliferations around the joints that cause pain and restrict movement (Kirkby, 2023).

In addition to pharmacological therapy, the adoption of complementary measures is essential. Weight control is one of the main pillars of disease management, as obesity exacerbates the load on compromised joints. Physiotherapy, joint supplements, and modifications to the home environment such as the use of non-slip mats are also strongly recommended to improve the animal's comfort and mobility (Kirkby, 2023).

AUTOIMMUNE DISEASES IN DOGS

The immune system is responsible for protecting the organism against invading agents. However, when a dysfunction occurs within this system, it may begin to attack the body's own cells. In this process, the immune system sends cells to isolate and destroy these "enemy cells" but inadvertently damages healthy tissues, generating a wide range of clinical signs. This mechanism underlies autoimmune diseases, which develop and become established by exploiting failures in immune regulation.

Hemolytic anemia

Hemolytic anemia is a pathological condition characterized by the premature destruction of red blood cells by the animal's own immune system (Duclos, 2024). Erythrocytes play a fundamental role in transporting oxygen to body tissues, and their excessive destruction compromises oxygenation, potentially affecting multiple organs. Hemolytic anemia may be of primary origin (idiopathic immune-mediated) or secondary to other diseases (Duclos, 2024).

Among the secondary causes are neoplasms, systemic infections, and infestations by internal or external parasites. Endoparasitic infections involving hematophagous intestinal parasites, as well as infestations by ectoparasites such as ticks, fleas, and lice, may also trigger this condition. The most common clinical signs include hematuria, fever, lethargy, apathy, weakness, dizziness, and pale mucous membranes, particularly noticeable on the gingiva (Duclos, 2024). In severe cases, circulatory collapse may occur.

Diagnosis is established through clinical evaluation and laboratory testing, including a complete blood count, urinalysis, bone marrow examination (myelogram), and the direct Coombs test, which detects antibodies bound to the surface of red blood cells, thereby confirming the immune-mediated nature of the disease (Duclos, 2024).

Treatment depends on the underlying cause. In cases of primary hemolytic anemia, therapy typically includes corticosteroids to suppress the immune response, blood transfusions in cases of severe anemia, and, when necessary, additional immunosuppressive agents. In secondary hemolytic anemia, treatment focuses on addressing the underlying condition, such as controlling parasites, managing infections, or treating associated neoplasms (Duclos, 2024).

Pemphigus foliaceus

Pemphigus foliaceus is an autoimmune dermatopathy characterized by the production of autoantibodies targeting epidermal cells, particularly desmosomes, which are structures responsible for maintaining cohesion between skin cells (Bizikova *et al.*, 2022). This autoimmune reaction leads to separation of the epidermal layers, resulting in the formation of pustules, crusts, and ulcerative lesions.

The most common clinical signs include erythema, pain, fever, malaise, vesicles, bullae, pustules, scales, crusts, fluid-filled cysts, superficial ulcers, and open wounds (Jordan *et al.*, 2024). These manifestations typically appear initially on the face, nasal planum, ears, and distal extremities, and may later spread to other regions of the body. Diagnosis is based on biopsy of cutaneous lesions, with histopathological analysis revealing acantholysis and inflammatory infiltration (Jordan *et al.*, 2024). Cytological examination can also be useful for detecting acantholytic cells and the presence of neutrophils.

Treatment of pemphigus foliaceus involves the use of immunosuppressive drugs (Jordan *et al.*, 2024). In refractory or long-term cases, immunomodulatory agents may be added to control the autoimmune response and minimize the adverse effects associated with continuous corticosteroid therapy.

Polyarthritis

Canine polyarthritis is an inflammatory condition affecting multiple joints, resulting from an autoimmune response in which the immune system targets the synovial lining of the joints (Cruzado *et al.*, 2024). This process leads to pain, swelling, and functional impairment. The disease may have an infectious origin, caused by agents such as bacteria, viruses, fungi, or protozoa, or it may be immune-mediated (Cruzado *et al.*, 2024). Although polyarthritis is non-erosive in most cases, joint structure destruction, including cartilage and bone damage, may occur in certain situations.

The most frequent clinical signs include difficulty walking, intermittent lameness, loss of motor coordination, joint swelling, and arthralgia (Ravicini *et al.*, 2022). The joints most commonly affected are the carpus, elbow, tarsus, and stifle.

Diagnosis is based on a comprehensive clinical approach, including a thorough physical examination, specific orthopedic assessments, imaging studies such as radiography and ultrasonography, and laboratory evaluations that may reveal leukocytosis, altered inflammatory parameters, and, in some cases, abnormalities in synovial fluid samples (Ravicini *et al.*, 2022).

Treatment of primary non-erosive polyarthritis is predominantly immunosuppressive. Therapy includes the use of corticosteroids and, when necessary, additional immunomodulatory agents to control the dysregulated immune response (Ravicini *et al.*, 2022).

Degenerative diseases

Degenerative diseases in dogs have no definitive cure and show progressive evolution, worsening over time. However, with appropriate veterinary follow-up, it is possible to implement therapeutic strategies that control clinical signs, reduce discomfort, and improve the animal's quality of life. The following are some of the main degenerative disorders in dogs:

- **Osteoarthritis:** A degenerative joint disease characterized by significant pain and restricted movement, resulting from the progressive deterioration of articular structures. It may arise from previous trauma, poor anatomical conformation, or excessive joint loading, ultimately compromising the stability and functionality of the affected joints (Barbeau-Grégoire, 2022).
- **Hip dysplasia:** A congenital malformation of the hip joints, frequently associated with genetic, environmental, and nutritional factors, as well as the inappropriate use of calcium supplements during growth (Vasseur *et al.*, 2021). This condition leads to misalignment of the coxofemoral joint, causing pain, inflammation, and difficulty in ambulation.
- **Vertebral column disorders:** These may have multiple etiologies, including infections, tumors, genetic predisposition, trauma, or falls. Such alterations can result in spinal cord compression, leading to pain, loss of motor coordination, and, in more severe cases, paralysis (Harder *et al.*, 2021).
- **Degenerative myelopathy:** A progressive neurological disease characterized by degeneration of spinal cord neurons,

impairing coordination and hind limb movement. As the condition advances, affected animals may progress to paraplegia (Bouché *et al.*, 2023).

- **Cognitive Dysfunction Syndrome (CDS):** A neurodegenerative disorder analogous to Alzheimer's disease in humans (Nousiainen *et al.*, 2023). It primarily affects elderly dogs and manifests through disorientation, behavioral changes, memory loss, incontinence, and disturbances in the sleep–wake cycle.
- **Neuronal ceroid lipofuscinosis:** A rare genetic disorder that results in abnormal accumulation of lipid substances within neurons, causing progressive dementia, abrupt behavioral changes, loss of motor coordination, and seizures (Mhlanga-Mutangadura *et al.*, 2024).

TREATMENTS

In veterinary medicine, particularly in the field of geriatrics, various therapeutic approaches have been employed to address the specific needs of elderly dogs. These treatments aim to alleviate discomfort, control clinical signs, and contribute to maintaining quality of life, while also taking into account the physiological changes inherent to aging.

In general, they include interventions focused on pain control, improved mobility, support of organ functions, and stabilization of diseases commonly observed in this age group. It is also important to note that the treatments discussed at the end of this section are specific to certain geriatric pathologies and do not constitute innovative therapeutic approaches.

Stem cell therapy

Stem cell therapy has emerged as a promising alternative for the treatment of neurological sequelae and keratoconjunctivitis, while also helping to reduce the adverse effects associated with conventional treatments (Pérez-Merino *et al.*, 2020). This therapeutic approach is based on the collection of stem cells, which can be obtained from specific anatomical sites such as dental pulp, bone marrow, and abdominal adipose tissue (Oliveira & Buzinaro, 2021).

Collection is performed under anesthesia using an appropriate needle to obtain the material (Gross *et al.*, 2022). The cells then undergo a purification process, in which they are separated from other components present in the sample. Subsequently, they are stimulated to promote cellular proliferation and maintained in a nutrient solution for approximately three days.

During the practical phase of treatment, the veterinarian administers the stem cells via injections directly into the affected organs or tissues. In more complex cases, up to three applications are recommended (Gouveia *et al.*, 2023). Following administration, the animal enters a recovery period, during which the differentiated stem cells promote regeneration of damaged tissues, contributing to the restoration of function and overall health (Gouveia *et al.*, 2023).

Treatment of canine prostatic cancer

Another therapeutic approach is the management of canine prostatic cancer, which combines chemotherapy with anti-inflammatory drugs (Gibson *et al.*, 2024). Prostatic tumors express an enzyme known as cyclooxygenase-2 (COX-2). Doxorubicin ($C_{27}H_{29}NO_{11}$), the chemotherapeutic agent used, in combination with nonsteroidal anti-inflammatory drugs, inhibits this enzyme, which is directly associated with tumor proliferation.

Gene therapy

Gene therapy is employed in the treatment of various diseases through the introduction of genetic material (DNA or RNA) into the patient's cells. This procedure involves inserting a gene of interest into a vector typically a genetically modified, harmless virus which serves as a vehicle to deliver the genetic material to the target cells (Reis & Martins, 2023).

The viral vector, owing to its natural ability to infect cells, is modified so that it does not cause disease and instead assumes a therapeutic role by transferring the functional gene into the organism (Santos & Oliveira, 2022). Once internalized, the introduced gene can correct, replace, or supplement the function of defective or absent genes, promoting cellular recovery and contributing to the restoration of physiological function in the affected tissue.

This approach broadens the therapeutic possibilities in veterinary medicine, particularly for the management of genetic, oncologic, neuromuscular, and immunological disorders, and remains a promising area of research for developing more specific and long-lasting interventions (Reis & Martins, 2023).

Phacoemulsification

Cataracts in elderly dogs are also a common condition. Phacoemulsification surgery is frequently employed method to correct this problem. The procedure is performed through the cornea, creating a small incision to introduce a device that opens the lens capsule and allows access to the cataract (Kim & Lee, 2022). An ultrasound probe is then used to fragment and aspirate the lens, after which an artificial intraocular lens is implanted inside the capsule. When performed in the early stages of the disease, outcomes are generally more favorable. However, in advanced cases, some complications may arise during surgery, such as postoperative inflammation may occur, although satisfactory results can still be achieved (Kim & Lee, 2022).

FINAL CONSIDERATIONS

The evidence compiled in this review highlights the importance for both caregivers and veterinarians to understand the most prevalent health conditions in elderly dogs, as early detection of clinical alterations is crucial for more effective management. Advances in veterinary geriatrics have expanded knowledge of the specificities of canine aging, enabling the implementation of more appropriate and individualized care strategies.

Continuous monitoring and periodic consultations are fundamental strategies in the routine care of geriatric dogs. These practices allow for the early identification of clinical changes, enabling timely, evidence-based interventions. In this way, they directly contribute to maintaining quality of life, managing established diseases, and preventing the progression of multiple age-related conditions. Therefore, regular follow-up and proper guidance for caregivers is emphasized, as these elements are essential for promoting healthy and dignified aging in elderly animals.

Ongoing scientific developments in this field are expected to continue refining prevention, diagnostic, and management methods, thereby enhancing the support provided to aging dogs. Accordingly, this review aims to organize and synthesize current knowledge, support the continuing education of caregivers and professionals, encourage reflection and improvement of

clinical practice, and foster further research on canine aging.

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Dermatophytosis in cattle in the field: case report

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ABSTRACT

Bovine dermatophytosis is a zoonotic cutaneous mycosis caused by fungi of the genera *Microsporum* and *Trichophyton*, with a wide global distribution. It most frequently affects young animals and produces characteristic lesions such as circular alopecia, grayish crusts, and scaling, primarily on the head and neck. Transmission occurs through direct contact, contaminated fomites, insects, and ectoparasites. Asymptomatic animals can serve as reservoirs of the fungus, which can survive for long periods in the environment. This report aims to describe a case of dermatophytosis in a mixed-breed Nelore steer raised extensively in the semi-arid region of Pernambuco, Brazil. The animal exhibited typical lesions, and the diagnosis was confirmed by cytology of a skin scraping, in which macroconidia and spores were observed. Treatment consisted of topical glycerinated iodine and systemic Ceftiofur Hydrochloride, resulting in marked clinical improvement and complete recovery within 30 days. Early diagnosis and the combination of antifungal and antibiotic therapies are essential for controlling secondary bacterial infections. Although qPCR is a more modern diagnostic method with high sensitivity and specificity, cytology proved effective and more accessible under field conditions. Prophylactic measures, including the isolation of affected animals, disinfection of facilities, and control of animal introductions, are essential to prevent outbreaks and protect public health, given the zoonotic potential of dermatophytosis. It is concluded that the combined treatment and the preventive measures adopted were effective in the recovery of the animal and in preventing the spread of the disease. Continuous surveillance and appropriate sanitary management are fundamental for the control of dermatophytosis in cattle herds.

Keywords: scaling, epidermis, spore, zoonosis.

Dermatofitose em bovino a campo: relato de caso

RESUMO

A dermatofitose bovina é uma micose cutânea zoonótica, causada por fungos dos gêneros *Microsporum* e *Trichophyton*, com ampla distribuição mundial. Afeta animais jovens com maior frequência, provocando lesões características como alopecia circular, crostas acinzentadas e descamação, principalmente na cabeça e pescoço. A transmissão ocorre

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por contato direto, fômites contaminados, insetos e ectoparasitas. Animais assintomáticos podem atuar como reservatórios do fungo, que sobrevive por longos períodos no ambiente. Objetiva-se relatar um caso de dermatofitose em um garrote mestiço Nelore, criado extensivamente no semiárido pernambucano. O animal apresentava lesões típicas, e o diagnóstico foi confirmado por citologia de raspado cutâneo, onde se observaram macroconídios e esporos. O tratamento incluiu iodo glicerinado tópico e Cloridrato de Ceftiofur sistêmico, resultando em significativa melhora clínica e recuperação completa em 30 dias. O diagnóstico precoce e a associação de terapias antifúngicas e antibióticas, controlam infecções secundárias bacterianas. Embora a qPCR seja um método diagnóstico mais moderno, com alta sensibilidade e especificidade, a citologia provou-se eficaz e mais acessível para atendimentos a campo. A profilaxia, incluindo o isolamento de animais doentes, desinfecção de instalações e controle de entrada de novos animais, é essencial para prevenir surtos e proteger a saúde pública, considerando o potencial zoonótico da dermatofitose. Conclui-se que o tratamento combinado e as medidas profiláticas adotadas foram eficazes na recuperação do animal e prevenção de disseminação da doença. A vigilância contínua e o manejo sanitário adequado são fundamentais para o controle da dermatofitose em rebanhos bovinos.

Palavras-chave: descamação, epiderme, esporo, zoonose.

INTRODUCTION

Dermatophytosis is a contagious cutaneous mycosis of chronic course and zoonotic nature, with worldwide distribution (Burd *et al.*, 2007). Among domestic animals, cattle are among the most frequently affected, particularly in intensive production systems or in herds with sanitary deficiencies conditions that favor fungal dissemination and lead to significant economic losses due to hide devaluation, reduced weight gain, and expenses related to treatment and management. The etiologic agents are fungi of the genera *Microsporum* and *Trichophyton*, which are widely distributed in the environment and capable of infecting multiple species, including ruminants, equines, companion animals, swine, birds, wildlife, and humans.

Beyond its productive impact, dermatophytosis represents an important public health concern due to its zoonotic potential, requiring prophylactic measures and accurate diagnostic approaches to contain outbreaks and protect farm workers and animal caretakers. Young animals are more susceptible to the disease due to immunological immaturity and higher levels of close contact. The characteristic clinical sign is the appearance of alopecic areas with well-defined borders, accompanied by desquamation and grayish crust formation (Riet-Correa *et al.*, 2023). In this context, the reporting of clinical cases under field conditions, particularly in semiarid regions such as Northeastern Brazil, is relevant for understanding the epidemiological dynamics of the infection and for guiding control strategies adapted to local realities.

Asymptomatic animals serve as important reservoirs of dermatophytosis, as the fungus may be present on intact skin even in the absence of visible lesions. This condition facilitates the silent spread of infection within herds, particularly in

production systems with high animal density and inadequate sanitary management. The fungal agent penetrates and colonizes the epidermis when favorable conditions arise, such as high humidity, skin injuries, immunosuppression, or direct contact with contaminated material. These factors help explain the rapid dissemination of the disease in shared environments such as corrals and milking facilities.

The fungus also exhibits high environmental resistance, remaining viable in crusts, hair, and organic debris for more than 42 months. This prolonged environmental persistence poses a challenge for sanitary control, as new outbreaks may occur even after extended periods if strict cleaning, disinfection, and isolation measures are not implemented. Transmission occurs primarily through direct contact between infected and healthy animals but may also occur via fomites and mechanical vectors such as insects and ectoparasites, increasing the risk of infection within and between herds (Riet-Correa *et al.*, 2023; Yeruham *et al.*, 2000).

In cattle, lesions typically affect the head and neck but may spread to the trunk, limbs, and tail. Severely affected animals may exhibit weight loss and widespread crust formation across the body; when these crusts are removed, they exhibit moist and hemorrhagic areas (Riet-Correa *et al.*, 2023).

Diagnosis of dermatophytosis should follow a structured approach that integrates clinical evaluation, proper sample collection, and laboratory confirmation. Initial suspicion arises from the presence of characteristic clinical signs such as circular alopecia, grayish crusts, and desquamation. Sample collection is a critical step for diagnostic accuracy and should preferably be performed using hairs and crusts obtained from the margins of active lesions, where the concentration of viable fungal structures is highest. Although peripheral blood has been used in some studies, it is not a routine method and offers low sensitivity for diagnosing dermatophytosis, being reserved for specific cases of systemic dissemination.

Among the available laboratory tests, fungal culture on Sabouraud agar is considered the gold standard, as it enables isolation and identification of the fungal genus and species. Histopathological examination contributes to confirming fungal parasitism within tissues and aids in differentiating dermatophytosis from other dermatoses with similar presentations. When interpreted together, these methods greatly enhance diagnostic reliability. In field conditions or in veterinary laboratories with limited resources, direct cytology and potassium hydroxide (KOH) microscopy represent practical, low-cost alternatives that allow rapid and efficient screening of suspected cases (Riet-Correa *et al.*, 2023; Lima, 2019).

Histopathological examination is an important tool for confirming the diagnosis of dermatophytosis and assessing the extent of cutaneous lesions. In the analyzed samples, changes consistent with hyperplastic dermatitis and suppurative folliculitis were observed, which are typical tissue responses to fungal presence. The visualization of septate hyphae and spores within hair structures confirmed the fungal infection and enabled differentiation from other dermatopathies with similar clinical features. These laboratory findings were essential for validating the clinical diagnosis of the reported case, reinforcing the importance of combining clinical observation with

complementary diagnostic tests in veterinary practice (Riet-Correa *et al.*, 2023).

Treatment of bovine dermatophytosis should be conducted in an orderly and well-structured manner with the aim of eliminating the fungal agent, reducing the risk of transmission, and preventing recurrence. In localized and mild infections, topical therapy is generally sufficient, and crusts should be carefully removed prior to applying antifungal medications to ensure greater penetration of the product. Glycerinated iodine or povidone–iodine solutions, as well as ointments containing thiabendazole, have demonstrated clinical efficacy when applied twice daily for two to three weeks, until complete healing of the lesions.

In cases where lesions are extensive or secondary bacterial infection is present, systemic antimicrobials such as Ceftiofur Hydrochloride may be added—not to treat the fungus, but to control bacterial complications that delay cutaneous recovery. This combined approach was effective in the reported case, accelerating healing and preventing additional opportunistic infections.

Prophylaxis plays a crucial role in the control of dermatophytosis and should include the immediate isolation of affected animals; thorough disinfection of facilities, equipment, and fomites using sodium hypochlorite solutions at 0.25% or phenolic compounds (2.5–5%); and the control of insects and ectoparasites that act as mechanical vectors. Quarantine of newly introduced animals, along with improvements in ventilation and hygiene, are also essential measures to reduce the environmental persistence of the fungus and prevent new outbreaks within the herd (Avante *et al.*, 2009; Riet-Correa *et al.*, 2023).

Considering the epidemiological relevance and economic impact of bovine dermatophytosis, especially in extensive production systems located in semiarid regions, it is essential to understand how the disease manifests and is controlled under field conditions. In this context, the present study aims to report a clinical case of dermatophytosis in a bovine raised extensively in the state of Pernambuco, highlighting the diagnostic methods employed, the treatment administered, and the prophylactic measures adopted to prevent disease dissemination. This case report seeks to strengthen understanding of the infection dynamics and provide practical guidance for sanitary management and outbreak prevention in herds within the region.

CASE REPORT

A crossbred Nelore yearling, approximately one year old and weighing 210 kg, was examined. The animal originated from a herd of 30 cattle raised under extensive management in the semi-arid region of the state of Pernambuco, specifically in the municipality of Mirandiba. The main concern of the owner was the appearance of alopecic areas in several animals. Other cattle had previously displayed similar clinical signs, leading the owner to cull some of them, and one neonatal calf had died after developing myiasis in one of these lesions. Seeking a definitive solution for the new animal showing similar symptoms, the owner requested a clinical evaluation.

Physical examination revealed multiple circular, well-defined alopecic areas on the head, accompanied by desquamation and grayish crust formation (Figure 1A), findings suggestive of bovine dermatophytosis.

All other clinical parameters, including heart and respiratory rates, skin turgor, ruminal movements, temperature, and mucous membrane coloration, were within normal limits.

Cytological evaluation was performed by superficially scraping the alopecic areas. The smears were stained using a rapid Panoptic method and examined under an Olen® Basic Binocular Achromatic LED light microscope. Microscopy revealed fungal structures, including abundant thick-walled macroconidia, and in some fields, the presence of spores, crystals, and exfoliated epithelial cells was also noted (Figure 2). Based on the cytological findings combined with the clinical signs, a diagnosis of dermatophytosis was established.

For treatment, the animal was placed in isolation. Topical therapy consisted of applying glycerinated iodine to the lesions using gloves and cotton, taking care to avoid contact with mucous membranes, and continuing until the lesions were resolved. In addition, systemic therapy with Ceftiofur Hydrochloride (Cef-50) was administered intramuscularly at a dose of 0.02 mL/kg (4.2 mL) for a period of three days.

After 15 days, a follow-up visit was conducted to assess treatment progress. Some affected areas were still present; however, clear signs of regression were observed (Figure 1B). An additional three days of Ceftiofur Hydrochloride therapy were prescribed. During a subsequent visit, 30 days after the initial intervention, the animal showed marked improvement, with evident hair regrowth in the previously affected regions and weight gain (240 kg). With full clinical recovery and complete resolution of the lesions (Figure 1C), the animal was deemed fit to be reintroduced into the herd.

DISCUSSION

Bovine dermatophytosis is a highly transmissible fungal disease that predominantly affects young animals, as described by Abd-Elmegeed *et al.* (2020), and can lead

FIGURE 1. (A: Crossbred Nelore yearling, 1 year old, showing grayish crusts and alopecic areas on the lateral facial and periocular regions, as observed during the initial visit. (B: The same animal 15 days after initiation of treatment, demonstrating reduced crust formation. (C: The same animal at 30 days, at the end of treatment, with resolution of crusts and visible hair regrowth, indicating clinical improvement.

Source: own elaboration.

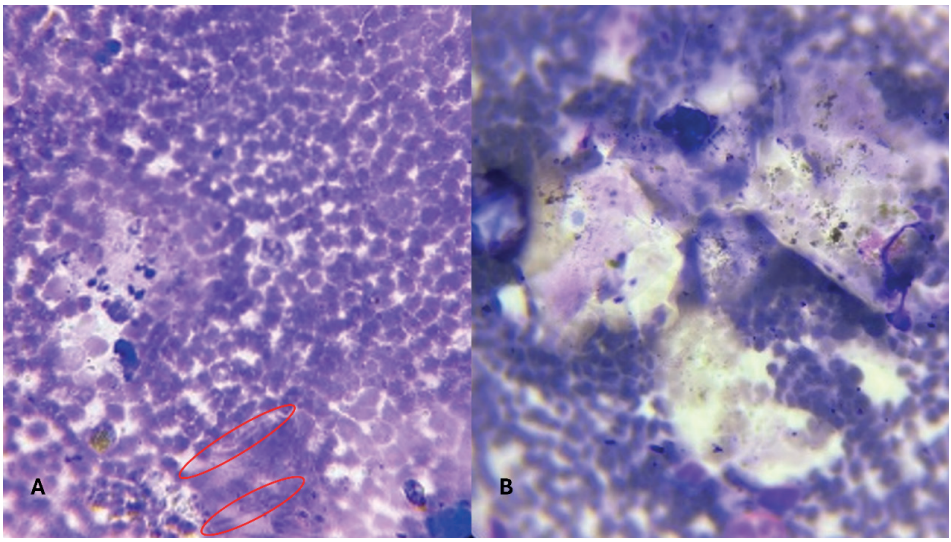

FIGURE 2. Photomicrograph of cytology from a scraped lesion area. (A: Presence of fungal hyphae (red circle). 40×, rapid Panoptic stain. (B: Presence of spores, crystals, and exfoliated epithelial cells on the smear. 40×, rapid Panoptic stain.

Source: own elaboration.

to significant economic losses in extensive production systems (Lima, 2019). Venancio *et al.* (2024) reported that dermatophytosis remains a recurrent condition in cattle in Brazil, particularly in the southern region, with frequent outbreaks recorded between 2000 and 2022. The disease, caused by dermatophyte fungi, compromises the skin of affected animals, resulting in cutaneous lesions that negatively impact on herd health and productivity.

Early diagnosis and appropriate treatment are essential to minimize the effects of the disease (Avante *et al.*, 2009). In the present case, the animal exhibited clinical signs characteristic of dermatophytosis, including alopecia, crusts, and desquamation on the head findings consistent with those reported by Lima (2019), who documented outbreaks in Paraíba in which animals developed circular, crusted, alopecic, and pruriginous lesions localized to the face and cervical region, particularly in young or recently acquired animals.

The diagnostic confirmation obtained through cytological scraping revealed the presence of fungal elements consistent with the histological alterations typically observed in dermatophytosis, such as septate and branching hyphae, as well as small spherical spores (arthroconidia) located either within the hair shaft or externally. These findings correspond to endothrix (internal) or ectothrix (external) parasitism, in addition to hyperplastic dermatitis and suppurative folliculitis (Riet-Correa *et al.*, 2023).

Diagnosis of bovine dermatophytosis has advanced considerably with the adoption of modern techniques. Traditionally, methods such as direct microscopy and

fungal culture were employed, although they present limitations related to sensitivity and turnaround time. Currently, real-time PCR (qPCR) has emerged as an effective alternative. This technique enables rapid and precise detection of dermatophyte genetic material directly from clinical samples, overcoming the constraints associated with conventional diagnostic methods (Kagowski *et al.*, 2021).

qPCR employs primers specific to dermatophytes, enhancing diagnostic specificity and reducing the time required for detection. Moreover, qPCR is capable of identifying multiple dermatophyte species within a single sample, providing a more comprehensive and detailed diagnostic assessment. The implementation of these modern molecular techniques in veterinary laboratories and specialized clinics has significantly improved the management and control of dermatophytosis in cattle herds, contributing to both animal and public health (Kagowski *et al.*, 2021). Identifying the etiologic agents is essential for selecting the most appropriate therapeutic approach (Avante *et al.*, 2009).

In the case presented, topical glycerinated iodine proved effective, supported by systemic antibiotic therapy with Ceftiofur Hydrochloride, which demonstrated an efficient combination for controlling the infection. Avante *et al.* (2009) also suggest that medications such as iodine solutions or ammoniated mercury ointments may promote satisfactory recovery.

The use of antibiotics in the treatment of fungal infections, such as dermatophytosis, may appear counterintuitive; however, there are specific reasons that justify this approach. Antibiotics, including Ceftiofur Hydrochloride, are primarily administered to manage secondary bacterial infections that may develop as a consequence of dermatophytosis. When the skin is compromised by fungal infection, it becomes more susceptible to bacterial invasion, which can exacerbate the clinical picture and delay recovery. Therefore, the use of antibiotics helps control these secondary infections, allowing antifungal therapy to act more effectively (Nobre *et al.*, 2002; Macedo, Gherardi, & Almeida, 2023).

In addition, combining topical treatments such as glycerinated iodine with systemic antibiotics may offer a more comprehensive therapeutic strategy, targeting both the fungal infection and any associated bacterial involvement. This integrated approach is essential to ensure full recovery and prevent recurrence (Nobre *et al.*, 2002; Macedo, Gherardi, & Almeida, 2023).

Isolation of the affected animal and the targeted protection of housing and handling environments are essential to prevent the spread of the fungus to other animals and to the surroundings, where the pathogen can persist for extended periods (Riet-Correa *et al.*, 2023).

Dermatophytosis in cattle, caused primarily by *Trichophyton verrucosum*, is a zoonosis of considerable importance due to its impact on both animal and human health. This fungal infection is highly contagious and can be transmitted to humans through direct contact with infected animals or contaminated materials. In humans, bovine-associated dermatophytosis predominantly affects children and adults who work closely with livestock, producing cutaneous lesions that may be challenging to manage. The prevalence of this zoonosis underscores the urgent need for rigorous preventive

measures, such as adequate hygiene and proper sanitary management, to minimize transmission. Furthermore, awareness of the associated risks and the implementation of control strategies are fundamental to safeguarding public health and reducing infection incidence (Piorunek *et al.*, 2024).

Cleaning and disinfection of facilities should be performed using commercial detergents or disinfectant solutions such as 0.25% sodium hypochlorite or phenolic disinfectants at concentrations of 2.5–5% (Avante *et al.*, 2009). In addition, prophylactic measures, including the introduction of animals only after prior health assessment and the maintenance of a clean, controlled environment, are key to preventing outbreaks of dermatophytosis (Riet-Correa *et al.*, 2023; Yeruham *et al.*, 2000).

CONCLUSION

The combination of topical treatment with glycerinated iodine and systemic therapy with Ceftiofur Hydrochloride resulted in the successful recovery of the animal affected by dermatophytosis. Prophylactic measures, including the isolation of infected animals, targeted environmental protection, and the introduction of new animals only after appropriate diagnostic evaluation, are crucial to preventing outbreaks. Proper management practices and continuous surveillance remain essential for effective disease control.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

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USE OF ARTIFICIAL INTELLIGENCE

No artificial intelligence was used for the diagnosis, treatment, or preparation of the manuscript.

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Therapeutic approach to advanced periodontal disease associated with feline chronic gingivostomatitis: case report

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ABSTRACT

Feline chronic gingivostomatitis (FCGS) is a severe inflammatory condition affecting multiple tissues of the feline oral cavity, frequently associated with advanced periodontal disease and type I tooth resorption. These disorders share common pathogenic mechanisms, particularly those involving the host's inflammatory response to bacterial plaque. This study reports the diagnostic and therapeutic management of a case of FCGS with concurrent periodontal lesions and multiple resorptions, highlighting the importance of an integrated clinical management strategy. A domestic cat presenting signs of chronic oral inflammation underwent clinical examination, laboratory evaluations (hematological, biochemical, and FIV/FeLV testing), and intraoral radiography. The images revealed lesions consistent with type I resorption, guiding the decision for selective extraction and periodontal prophylaxis. The treatment resulted in significant short-term clinical improvement. This case underscores the importance of a comprehensive diagnostic approach, emphasizing intraoral radiography for the identification of hidden alterations. Selective extraction, when properly indicated, can promote symptomatic relief and inflammation control, making postoperative follow-up essential to prevent recurrence.
Keywords: selective extraction, oral inflammation, feline dentistry, intraoral radiography.

Abordagem terapêutica de doença periodontal avançada associada a gengivoestomatite crônica felina: relato de caso

RESUMO

A gengivoestomatite crônica felina (GECF) é uma condição inflamatória severa que afeta diversos tecidos da cavidade oral dos gatos, frequentemente associada à doença periodontal avançada e à reabsorção dentária tipo 1. Essas afecções compartilham mecanismos patogênicos comuns, especialmente relacionados à resposta inflamatória do hospedeiro frente à presença de placa bacteriana. Este estudo relata a abordagem diagnóstica e terapêutica em um caso de GECF com lesões periodontais e reabsorções múltiplas, destacando a

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importância de uma conduta clínica integrada. Um gato doméstico apresentou sinais de inflamação oral crônica e foi submetido a exame clínico, avaliações laboratoriais (hematológica, bioquímica e FIV/FeLV) e radiografias intraorais. As imagens revelaram lesões compatíveis com reabsorção tipo 1, orientando a decisão por exodontia seletiva e profilaxia periodontal. O tratamento resultou em melhora clínica significativa no curto prazo. O caso reforça a importância do diagnóstico completo, com ênfase na radiografia intraoral para identificação de alterações ocultas. A exodontia seletiva, quando bem indicada, pode promover alívio sintomático e controle da inflamação, sendo essencial o acompanhamento pós-operatório para prevenir recidivas.

Palavras-chave: exodontia seletiva, inflamação oral, odontologia felina, radiografia intraoral.

INTRODUCTION

Feline oral inflammatory conditions, such as periodontal disease, chronic feline gingivostomatitis (FCGS), and tooth resorption, are highly prevalent and often coexist, sharing pathogenic mechanisms associated with the host inflammatory response and bacterial plaque (O'Neill *et al.*, 2023; Perry & Tutt, 2015; Winer *et al.*, 2016). The interrelationship among these processes complicates diagnosis and treatment, requiring a thorough understanding of their clinical particularities and overlaps.

Periodontal disease results from the interaction between subgingival plaque microorganisms and the host immune response (O'Neill *et al.*, 2023). This condition is characterized by inflammation of the periodontal tissues, triggered by microbial byproducts such as lipopolysaccharide endotoxins, organic acids, protein toxins, and chemotactic peptides (Harvey, 2022; Rossa & Kirkwood, 2012).

In cats, periodontal disease is classified as gingivitis (initial and reversible) or periodontitis (irreversible and destructive), involving the supporting tissues (Perry & Tutt, 2015; Soltero-Rivera *et al.*, 2023). The progression of periodontal disease may include periodontal pocket formation, gingival recession, tooth mobility, and furcation involvement in multi-rooted teeth (Perry & Tutt, 2015). Additionally, areas of active inflammation are often associated with tooth resorption, characterized by the loss of cementum and dentin, particularly in advanced stages (Lommer & Verstraete, 2001; Perry & Tutt, 2015). Several studies suggest that local inflammatory processes play a central role in the development of type 1 dental resorption, highlighting a significant correlation between periodontal disease and the structural deterioration of dental tissues (DuPont & DeBowes, 2002; Girard *et al.*, 2009).

In this context, FCGS is the second most common oral condition in clinical practice (Allemand *et al.*, 2013), with global prevalence rates ranging from 0.7% to 12% (Healey *et al.*, 2007; Winer *et al.*, 2016). It presents as a severe inflammatory condition affecting multiple oral tissues, primarily involving the caudal region and potentially extending to the gingival margin, glossopalatine arch, fauces, lips, and tongue (Barbosa *et al.*, 2018; Perry & Tutt, 2015; Winer *et al.*, 2016).

Retrospective studies have shown that periodontitis is frequently observed in these cases, often accompanied by alveolar bone loss in a semi-generalized or generalized pattern (Farcas *et al.*, 2014). Thus, bacterial plaque serves as a common factor in the etiopathogenesis of both periodontitis and

the exacerbated inflammatory response that characterizes FCGS, underscoring the need for an integrated management approach to these conditions.

Therefore, this case report aims not only to describe the therapeutic approach applied to a patient with advanced periodontitis, multiple dental resorptions, and chronic feline gingivostomatitis, but also to highlight the strong interrelationship among these inflammatory processes and their clinical significance. By presenting this case, we seek to contribute to the understanding of the complexity of these conditions in cats and to emphasize the importance of an integrated diagnostic and therapeutic approach, reinforcing the central role of inflammation in the progression of feline oral diseases.

CASE DESCRIPTION

Anamnesis

A 2-year-old male Persian cat weighing 4 kg was presented to the Animaniacs Veterinary Clinic in São Paulo, Brazil, for medical evaluation. According to the caregiver, the animal exhibited halitosis, marked gingival redness, and spontaneous oral bleeding. No changes in appetite or behavior were reported.

Clinical examination findings

During the general physical examination, all physiological parameters were within normal limits. However, the oral evaluation revealed severe gingivitis, characterized by marked gingival hyperemia, intense halitosis, and substantial dental calculus accumulation, necessitating a comprehensive therapeutic approach. Images illustrating the oral alterations were obtained during the surgical procedure performed under general anesthesia, which allowed better visualization of the lesions (figures 1a and 1b).

Complementary examinations

A complete blood count, liver biochemical profile (GGT, ALT), renal profile (urea, creatinine, and urinalysis), chest radiograph, Doppler echocardiogram, and electrocardiogram were performed, revealing no clinically relevant abnormalities. The animal tested negative for feline immunodeficiency virus (FIV) and feline leukemia virus (FeLV) using the SensPERT™ FeLV Ag/FIV Ab Test Kit (Dechra Veterinary Products).

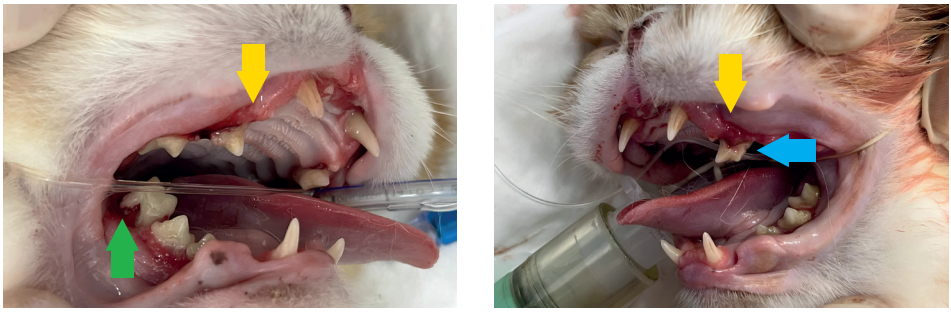

FIGURE 1. A. Right side. Grade III furcation exposure on tooth 409 (green arrow); B. Left side. Severe gingival recession on tooth 207 (blue arrow), along with hyperemia and severe gingivitis (yellow arrow).

Source: own elaboration.

A complete intraoral radiographic study was then performed under general anesthesia to identify periodontal bone alterations, even in teeth that appeared clinically intact (López-Paredes *et al.*, 2024). Parallel and bisecting techniques were employed to obtain detailed visualization of the dentition (Carvalho *et al.*, 2019; Hennet & Girard, 2005; Nepomuceno *et al.*, 2013). Dental resorption and bone lysis lesions were identified in tooth 407, absence of roots in tooth 409, and bone lysis around the left maxillary teeth and upper incisors (figures 2a and 2b).

Based on the radiographic findings and specific oral examination, a diagnosis of stage VI periodontal disease (Bread, 1989, as cited in Camargo *et al.*, 2015) was established, along with dental resorption and suspected FCGS, the latter subsequently confirmed by histopathological examination of a gingival tissue sample collected from ulcerated areas representing the most active lesions. Given this condition, a comprehensive periodontal treatment was planned, including prophylaxis of all dental arches and extractions as indicated by the radiographic findings.

Clinical conduct

Ten days after the initial consultation, the patient was referred for surgery, performed by the Amico Dentale team at the Animaniacs Clinic. Upon admission, the cat was alert but exhibited pain and discomfort during oral manipulation. Cranial symmetry was preserved, and enlargement of the submandibular lymph nodes was observed.

After sedation with acepromazine (0.02 mg/kg) and methadone (0.15 mg/kg) administered intramuscularly, venous access was established via the cephalic vein using a 22G catheter. Anesthetic induction was achieved with propofol (3 mg/kg) and ketamine (1 mg/kg), and anesthesia was maintained with inhaled isoflurane.

During the oral examination under anesthesia, severe gingivitis with generalized gingival recession and inflamed, reddened mucous membranes was observed (Loe & Silness, 1963, as cited in Camargo *et al.*, 2015), along with grade 3 dental calculus accumulation (Lascala & Moussalli, 1980, as cited in Camargo *et al.*, 2015), varying degrees of tooth mobility, oropharyngeal

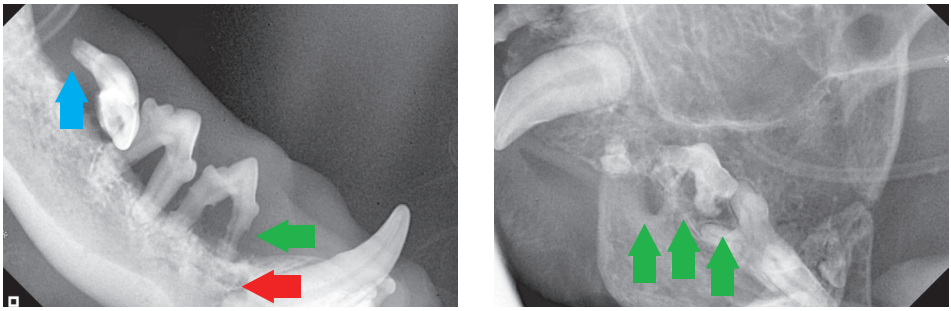

FIGURE 2. A. Bisecting technique radiograph showing a tooth resorptive lesion on tooth 407 (green arrow), absence of a dental root on tooth 409 (blue arrow), and adjacent bone lysis around tooth 407 (red arrow); B. Parallel technique radiograph revealing bone lysis adjacent to the left maxillary teeth (green arrows).

Source: own elaboration.

ulcers, and grade 3 furcation exposure on tooth 409.

Surgical procedure

The first stage of treatment consisted of a complete dental prophylaxis, involving ultrasonic scaling followed by polishing with a low-speed Robinson brush and the application of prophylactic paste to all remaining teeth. The oral cavity was then irrigated with pressurized water using a triple syringe.

Topical antisepsis was performed with 0.12% chlorhexidine, followed by local anesthetic blocks. The first regional block targeted the left mandibular nerve, using a 24-gauge needle inserted into the pterygomandibular fossa to administer 2% lidocaine (5 mg/kg) in a volume of 0.2 ml. Additional blocks were subsequently performed on the right mandibular, right maxillary, and left maxillary nerves using the same technique, drug, and dose. Local infiltrative blocks were also applied to the gingiva adjacent to the teeth designated for extraction, according to the surgeon's discretion.

Tooth extraction began with tooth 409. Gingival separation was performed using a Freer elevator (figure 3a), followed by odontosection with a bur attached to a high-speed handpiece, positioned perpendicular to the tooth axis (figure 3b). To facilitate extraction, the periodontal ligament was severed using dental elevators of various sizes inserted on the mesial and distal aspects (figure 3c). Finally, dental forceps were used to apply gentle rotational movements of up to 180° until the tooth was completely extracted (figure 3d).

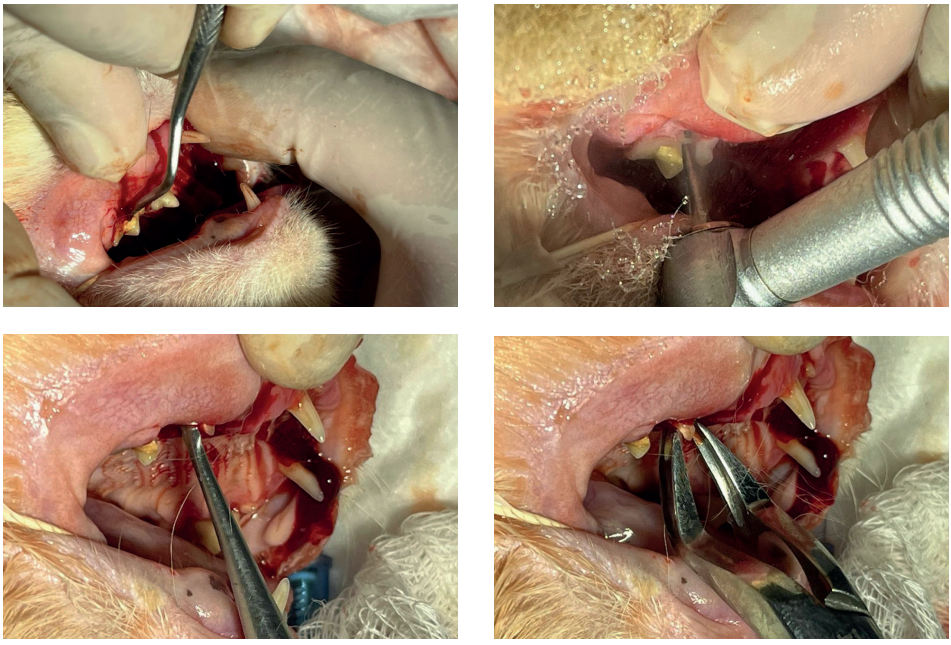

FIGURE 3. A. Gingival flap reflection; B. Odontosection performed with a dental drill; C. Periodontal ligament rupture using a dental elevator; D. Tooth extraction using dental forceps.

Source: own elaboration.

These steps were repeated for all teeth indicated for extraction, resulting in the removal of a total of 16 teeth (figure 4). At the end of the procedure, a complete postoperative radiographic evaluation of the dental arches was performed to confirm the absence of any remaining root fragments.

Subsequently, an incisional biopsy of the gingival tissue was performed for histopathological analysis. The surgical wounds were closed using mucosal flaps and sutured with 5-0 monofilament synthetic absorbable material in a combination of simple continuous and interrupted patterns (figures 5a and 5b).

During the intraoperative period, a single intravenous bolus of metronidazole (15 mg/kg) and dexamethasone (0.1 mg/kg) was administered. At the end of the surgery, inhalation anesthesia was discontinued, and the patient was transferred to the recovery area for postoperative monitoring.

Postoperatively, tramadol hydrochloride (1.5 mg/kg, twice daily for 4 days), dipyrone (25 mg/kg, once daily for 4 days), and 0.12% chlorhexidine mouthwash (four times daily for 7 days) were prescribed. In addition, prednisolone 4 mg tablets were administered, beginning with one tablet once daily on the third postoperative day, then reduced to ½ tablet once daily for an additional 7 days, followed by gradual withdrawal according to the recommendations of Hofmann-Appollo *et al.* (2010), specialists in feline medicine.

A postoperative check-up was scheduled for 4 to 7 days after surgery to allow follow-up evaluation, treatment adjustment, and specialist referral.

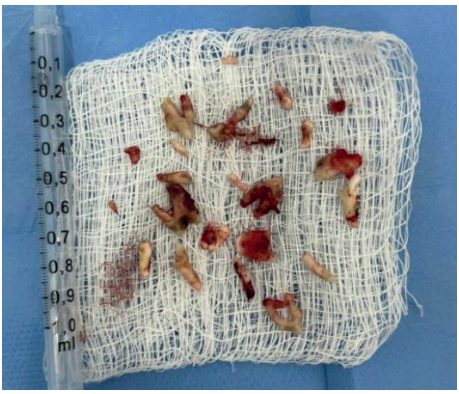

FIGURE 4. Extracted dental elements: 102, 106, 107, 108, 109, 202, 203, 206, 207, 209, 307, 308, 309, 407, 408, and 409. Source: Authors' own.

Source: own elaboration.

FIGURE 5. A. Suture in the upper right premolars; B. Suture in the upper incisors and left upper premolars.

Source: own elaboration.

DISCUSSION

FCGS can affect cats of all ages but tends to be more severe in older individuals. Certain breeds, including Abyssinians, Burmese, Persians, Siamese, and Himalayans, have a recognized genetic predisposition (Healey *et al.*, 2007). In the present case, the animal belonged to one of these breeds, underscoring the importance of clinical surveillance in predisposed populations.

The etiology of FCGS remains uncertain, although its multifactorial nature is well established, involving microorganisms, viruses, nutritional disorders, and, most importantly, immunological alterations in the host (Allemand *et al.*, 2013). The intense inflammation observed appears to be directly associated with bacterial biofilm accumulation, particularly in cats with pre-existing periodontal disease.

Periodontal disease plays a central role in feline oral inflammatory disorders and may also affect systemic health (Watanabe *et al.*, 2019). As it represents the progression of untreated gingivitis, periodontitis necessarily depends on the prior presence of gingivitis, underscoring the importance of early diagnosis and intervention (Perry & Tutt, 2015).

Given the multifactorial nature of FCGS, the diagnostic approach must be comprehensive. In this case, diagnosis was based on clinical evaluation, laboratory testing, and imaging. Radiography was essential for identifying teeth requiring extraction, and the definitive diagnosis was confirmed by histopathological examination, which revealed epithelial hyperplasia and a diffuse lymphocytic–plasmacytic inflammatory infiltrate (Barbosa *et al.*, 2018; Lee *et al.*, 2020). Testing for FIV and FeLV is crucial in the diagnostic process, as positivity is associated with a poorer prognosis. The immunosuppressive effects of these viruses are thought to contribute to the worsening of the clinical condition (Belgard *et al.*, 2010; Lee *et al.*, 2020).

Treatment of patients with FCGS must be individualized, aiming to alleviate symptoms, control secondary infections, and manage comorbidities or predisposing factors. In this case, the patient exhibited clear signs of periodontal disease associated with heavy plaque accumulation. Considering the polymicrobial nature of dental biofilm, the isolated use of antimicrobials is ineffective, as biofilm confers high resistance to antimicrobial agents and allows rapid bacterial recolonization after treatment (Palmer Jr., 2014). Therefore, the initial therapeutic intervention consisted of periodontal treatment involving tartar removal and complete dental prophylaxis. The main objective of this procedure is to eliminate plaque and dental calculus, removing local factors that perpetuate inflammation and allowing gingival tissue recovery, thereby halting disease progression (Perry & Tutt, 2015).

In general, treatment for FCGS may be clinical (medical) or surgical, with the latter currently regarded as the standard of care due to the limited effectiveness of pharmacological management in achieving long-term remission (Lee *et al.*, 2020). The therapeutic approach with the strongest evidence of efficacy is multiple tooth extraction, including all premolars and molars, with possible extension to the incisors and canines in refractory cases. This procedure results in significant improvement or complete remission in approximately 70%–80% of affected cats (Druet & Hennet, 2017; Jennings *et al.*, 2015).

In this case, selective extraction of teeth with evident lesions was performed,

preserving healthy elements such as the canines, some incisors, and the upper left fourth premolar. However, it is well established that even clinically intact teeth can act as antigenic triggers, perpetuating inflammation (Hennet *et al.*, 2011). Therefore, although the initial decision prioritized the preservation of healthy teeth, the possibility of additional extractions in the event of clinical recurrence was discussed with the owner.

Farcas *et al.* (2014) emphasize that intraoral radiography plays an essential role not only in diagnosis but also in therapeutic planning and postoperative evaluation of cats with FCGS. Its use is critical to ensure the complete extraction of affected teeth, as retained root fragments may perpetuate inflammation and compromise treatment success. Therefore, postoperative radiographs are indispensable, particularly in cases involving pre-existing dental fractures or those occurring during extraction.

In the present case, the diagnosis of dental resorption lesions was made possible precisely through intraoral radiographic examination, which revealed areas consistent with external inflammatory resorption in the premolar teeth, thereby accurately guiding the surgical approach.

Despite therapeutic advances and individualized case management, a significant limitation persists in veterinary clinical practice: the lack of patient follow-up after treatment. This discontinuity hinders the evaluation of medium- and long-term therapeutic responses and limits the accuracy of future clinical decision-making (López-Paredes *et al.*, 2024).

For this reason, it is essential to emphasize to owners the importance of continuous monitoring through regular follow-up visits, which constitute a fundamental component of clinical management and are crucial for maintaining the patient's long-term health.

CONCLUSION

This report underscores the complexity of managing FCGS associated with periodontal disease and tooth resorption, emphasizing the importance of a thorough diagnostic approach, particularly radiographic evaluation. The selective surgical strategy, tailored to the patient's specific condition and complemented by clinical monitoring, proved appropriate; however, the absence of follow-up limits long-term assessment. This case highlights the need for individualized management strategies aimed at achieving early diagnosis, controlling inflammation, and improving the quality of life of affected cats.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

SOURCES OF FUNDING

The surgical procedure was funded by the owner.

USE OF ARTIFICIAL INTELLIGENCE

The authors state that they did not use artificial intelligence in the study.

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