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HYPOTHESIS

Integrated saliva-mediated self-cleaning and wound-healing mechanisms in animals: a hypothesis

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Abstract

Background: Animals are continuously exposed to environmental contaminants, microbial agents, ectoparasites, and minor injuries, yet many species maintain hygiene and recover from superficial wounds without external intervention.
Objective: This hypothesis manuscript proposes an integrated innate defense model in which grooming behavior, saliva-derived antimicrobial and wound-repair factors, tear antimicrobial activity, and sebaceous secretions act together to support self-cleaning and tissue repair.
Proposed mechanism: Animal saliva contains bioactive components, including lysozyme, lactoferrin, histatins, immunoglobulins, and growth factors, that may contribute to microbial control and wound healing when animals lick their skin, fur, or wounds. Tear secretions similarly contain antimicrobial proteins that protect the ocular surface and assist in debris clearance, whereas grooming behavior distributes saliva and skin lipids while mechanically removing dirt and parasites.
Hypothesis: These interacting behavioral, biochemical, and physiological pathways may be especially active during rest periods, when animals are undisturbed and able to groom. The proposed framework suggests that saliva-mediated grooming, tear antimicrobial activity, and skin secretions constitute a coordinated, evolutionarily conserved innate defense system that contributes to hygiene maintenance, infection prevention, and wound repair.
Research needs: Further comparative and mechanistic studies are needed to test this model and to explore whether saliva-derived antimicrobial and healing compounds can inform bio-inspired veterinary and biomedical therapeutic strategies.
Keywords: Animal grooming; Saliva; Wound healing; Innate immunity; Antimicrobial peptides; Tear secretions; Self-cleaning behavior.

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Introduction

Animals in natural environments are continuously exposed to dust, pathogens, parasites, and minor injuries. Despite these challenges, many animals maintain hygiene and recover from superficial wounds without external intervention (Scavizzi et al., 2022). Field and clinical observations often note that animals exposed to contaminants may appear cleaner after periods of rest, consistent with the possibility that behavioral and biochemical self-cleaning mechanisms act together over time. This observation provides the conceptual basis for evaluating natural self-cleaning and wound-healing pathways as an integrated innate defense system (Haick & Zheng, 2025).

Self-grooming is widely documented across animal species, including mammals, birds, and rodents. Cats, dogs, rodents, and livestock frequently lick or groom their fur, skin, and wounds (Tynes, 2025). Grooming can support hygiene maintenance, parasite removal, fur and skin conditioning, thermoregulation, and wound care (Hart & Hart, 2018). Biological fluids such as saliva and tear secretions also contain antimicrobial compounds and healing factors that may contribute to these processes (Mudgil, 2022; Vila et al., 2019).

Saliva is a biologically active fluid containing antimicrobial enzymes, immunological components, and growth-promoting factors (Tamai & Kiyoura, 2025). Tear fluid contains antimicrobial proteins that protect ocular surfaces from infection and help remove debris (Eshac et al., 2021). Together with grooming behavior and skin secretions, these pathways may form an integrated natural hygiene system in animals. This article therefore proposes that animals use saliva-mediated grooming, tear antimicrobial activity, and skin protective secretions to maintain hygiene and promote wound healing, particularly during rest or overnight periods.

Saliva Composition and Biological Functions in Animals

Antimicrobial Components of Animal Saliva

Animal saliva is a complex biological fluid composed of enzymes, peptides, proteins, and immune molecules. Several antimicrobial components have been identified in saliva, including lysozyme, lactoferrin, peroxidases, defensins, and immunoglobulins (Maddu, 2019). Lysozyme can damage bacterial cell walls and thereby reduce bacterial load, while lactoferrin inhibits microbial growth by binding iron, a nutrient required for microbial proliferation (Nawaz et al., 2022). Immunoglobulin A contributes to mucosal immunity by neutralizing pathogens, and antimicrobial peptides such as defensins further strengthen microbial inhibition (Zhou et al., 2025). These properties support the hypothesis that saliva can function as a local antimicrobial fluid during licking, grooming, and wound contact.

Wound-Healing Components in Saliva

In addition to antimicrobial activity, saliva contains bioactive molecules involved in wound repair. Histatin peptides, particularly histatin-1, have been shown to promote cell migration and tissue repair (Pan et al., 2021). Salivary growth-related factors may also support epithelial regeneration and angiogenesis (Yılmaz Şastım et al., 2021). Evidence from oral and mucosal wound-healing research indicates that saliva-associated factors can influence repair dynamics, although species-specific effects in animal skin wounds require direct experimental testing (Chuhuaicura et al., 2025). Animals that lick wounds may therefore receive both antimicrobial exposure and biochemical signals associated with tissue repair. The proposed causal pathways are summarized in Table 1.

Grooming Behavior as a Natural Self-Cleaning Mechanism

Self-Grooming in Animals

Self-grooming is a widespread behavior with multiple biological functions. Cats spend a substantial portion of their active time grooming, and dogs, rodents, livestock, and many other animals also engage in licking or mechanical grooming. Grooming removes dirt and debris, reduces ectoparasite burden, maintains fur and skin condition, distributes protective skin oils, and can contribute to thermoregulation. Through these mechanical and biochemical effects, grooming may reduce microbial load on the skin and fur.

Grooming During Rest and Overnight Periods

Animals commonly groom when resting, undisturbed, or preparing to sleep. Overnight or other extended rest periods may provide sufficient time for repeated grooming and redistribution of saliva and skin secretions. This pattern may help explain why animals exposed to dirt or minor superficial contamination can appear cleaner after a rest interval. During grooming, saliva is spread over the fur and skin, where it may assist in contaminant removal and local microbial suppression (Webber, 2023).

Tear Secretions and Eye-Cleaning Mechanisms

Antimicrobial Components in Tears

Tear fluid plays an essential role in ocular surface defense. Tears contain antimicrobial proteins, including lysozyme, lactoferrin, and immunoglobulins, that protect the eye from pathogens and help remove debris (Chang & Purt, 2021; Eshac et al., 2021). Continuous tear production maintains ocular moisture and flushes foreign particles from the eye surface. This system contributes to natural ocular hygiene in animals (Soimala, 2020).

Table 1: Proposed integrated biological self-cleaning mechanisms in animals.

Mechanism	Biological source	Active components	Function	Scientific significance
Saliva-mediated cleaning	Salivary glands	Histatins, lysozyme, lactoferrin	Antimicrobial and wound healing	Innate immune defense
Self-grooming behavior	Behavioral response	Mechanical cleaning + saliva	Removal of dirt and parasites	Natural hygiene maintenance
Tear antimicrobial system	Lacrimal glands	Lysozyme, immunoglobulins	Ocular surface protection	Eye-cleaning mechanism
Skin protective barrier	Sebaceous glands	Lipids and antimicrobial peptides	Skin protection	Infection prevention
Overnight grooming	Resting behavior	Combined biological mechanisms	Self-cleaning during rest	Morning cleanliness phenomenon

Morning Ocular Deposits and Natural Cleaning

Animals may show small periocular deposits after sleep. These deposits are formed from dried tear secretions mixed with debris, dust, and microbial particles. Rather than indicating an active disease process in every case, mild deposits may reflect normal tear-mediated clearance of ocular contaminants. Persistent, excessive, colored, or painful discharge, however, should be interpreted clinically rather than as routine self-cleaning. The natural debris-clearance role of tears is consistent with broader evidence linking dust exposure and ocular irritation (Hashmi et al., 2023).

Skin Secretions and Protective Barrier

Sebaceous glands in animal skin produce lipid-rich secretions that help maintain fur condition, support barrier function, and modulate the skin surface environment. These secretions contribute to microbial balance and prevent excessive dryness. When combined with grooming, sebaceous lipids and associated antimicrobial peptides may enhance natural hygiene by distributing protective material across the skin and coat (Igielska-Kalwat et al., 2025; Mosca et al., 2025).

Integrated Natural Hygiene Mechanism in Animals

The proposed model integrates three mutually reinforcing pathways: saliva-mediated grooming, tear antimicrobial activity, and skin protective secretions. Together, these pathways may support self-cleaning, wound repair, reduced infection risk, and maintenance of skin and fur health. Figure 1 maps the proposed sequence from saliva and grooming through tear antimicrobial action and skin secretions to three outcomes: reduced microbial load, wound healing, and a cleaner external appearance. This framework is consistent with broader interest in natural antimicrobial compounds and salivary biomarkers in veterinary medicine (Jadav et al., 2025; Vercelli et al., 2025).

Hypothesis

It is hypothesized that animals maintain hygiene and promote superficial wound repair through an integrated biological system involving saliva-mediated grooming, tear antimicrobial secretions, and skin protective mechanisms. These processes may collectively reduce microbial load, remove debris, support barrier maintenance, and facilitate tissue repair, particularly during rest periods. The model does not imply that licking or grooming is always clinically beneficial; excessive licking can delay healing or worsen lesions in some conditions. Rather, the hypothesis proposes that normal grooming, saliva chemistry, tear defense, and sebaceous barrier functions together represent an evolutionarily conserved innate strategy for maintaining health and reducing infection risk.

Future Research Directions

Future research should compare saliva composition across species, quantify antimicrobial activity in animal saliva, evaluate changes in microbial load before and after grooming, and document grooming patterns during rest and overnight periods. Experimental wound models could test whether saliva-derived peptides, enzymes, or growth-related molecules improve healing under controlled conditions. Studies should also distinguish adaptive grooming from excessive licking or pathological self-trauma. Such work may clarify the biological boundaries of the proposed model and support the development of bio-inspired wound-healing and antimicrobial strategies.

Conclusion

Animals possess natural behavioral, biochemical, and physiological mechanisms that may support hygiene maintenance and superficial wound repair. Saliva-mediated grooming, tear antimicrobial activity, and skin protective secretions together form a plausible integrated innate defense system. Although the hypothesis requires direct experimental validation, understanding these natural biological systems may inform veterinary hygiene, wound-care research, and the design of bio-inspired therapeutic strategies for infection control and tissue repair.

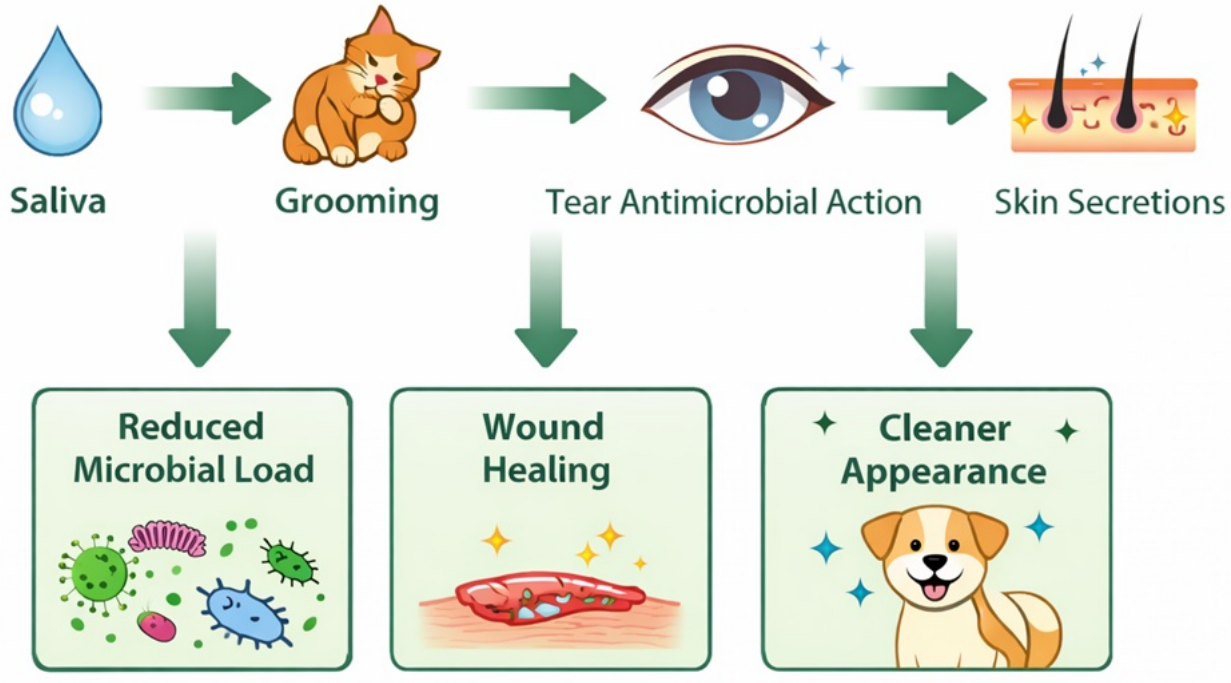

Figure 1: Proposed Natural and Self-Cleaning Mechanism in Animals

Figure 1: Proposed integrated pathway linking saliva-mediated grooming, tear antimicrobial activity, and skin protective secretions to reduced microbial load, wound healing, and a cleaner external appearance.

Declarations

Ethics Approval and Consent to Participate

Not applicable. This hypothesis manuscript did not involve live animals, human participants, or primary data requiring ethical approval.

Consent for Publication

Not applicable. The manuscript does not contain identifiable individual data.

Availability of Data and Materials

No datasets were generated or analyzed for this manuscript. All sources used to develop the hypothesis are cited in the reference list.

Competing Interests

The authors declare that there are no competing interests.

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Author Contributions

TA conceptualized the hypothesis, reviewed the literature, collected relevant material, prepared the visualization, and wrote and revised the manuscript. MA reviewed and edited the manuscript and contributed to conceptual refinement.

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