Boric Acid ("Boric Water") and Canine Ocular Hygiene: A Critical Evidence-Based Review of Safety, Misuse, and Physiological Implications

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Running Title

Boric Acid Use in Canine Eye Care

Abstract

Boric acid solutions, commonly referred to as “boric water,” are frequently recommended in pet-care communities as a home remedy for cleaning dogs’ eyes and reducing tear staining, particularly in light-coated breeds. Despite widespread use, scientific evaluation of this practice remains limited. This review examines the chemical properties of boric acid, characteristics of canine tear film physiology, toxicological evidence related to borate compounds, and principles of ophthalmic formulation safety. Available literature indicates that boric acid functions as a chemical buffering agent rather than an inert cleansing substance, and toxicological assessments demonstrate its potential to cause ocular irritation under certain conditions. Additionally, ocular compatibility depends on complete formulation composition rather than individual ingredients alone. No peer-reviewed veterinary ophthalmology studies were identified that support routine or repeated use of boric acid solutions for periocular hygiene in dogs. Tear staining is typically associated with porphyrin pigments and underlying physiological factors rather than surface contamination, meaning cosmetic removal does not address causation. Based on current evidence, routine use of boric acid near canine eyes cannot be considered evidence-based practice. Safer alternatives formulated specifically for veterinary ophthalmic use are available and should be preferred.

Introduction

The use of informal or traditional remedies in companion animal care remains widespread despite increasing access to scientific information. Among these practices, boric acid solutions—commonly referred to as “boric water”—are frequently recommended in grooming communities, online pet forums, and anecdotal care guides as a cleansing agent for dogs’ periocular regions and as a cosmetic treatment for tear staining. Such recommendations are often justified by referencing historical human medicinal use, creating a perception that boric acid is inherently mild or physiologically neutral.

However, extrapolation from human applications to canine ocular care raises important scientific concerns. Ocular tissues are highly specialized structures with strict physiological tolerances, and even minor variations in chemical composition, buffering systems, or concentration may influence epithelial integrity, tear-film stability, and ocular surface health. Furthermore, companion animal physiology differs significantly from that of humans, making direct assumptions of cross-species safety unreliable.

Despite the persistence of recommendations promoting boric acid use in dogs, there is limited evaluation of this practice within veterinary ophthalmic literature. The purpose of this review is therefore to examine available chemical, physiological, and toxicological evidence in order to determine whether routine periocular use of boric acid solutions in dogs can be considered scientifically justified or evidence-based.

Chemical Nature of Boric Acid

Boric acid (H_3BO_3) is a weak Lewis acid derived from boron that is widely used in pharmaceutical, industrial, and cosmetic formulations as a buffering, stabilizing, or antimicrobial agent.[1,2] Unlike strong acids that donate protons readily, boric acid functions primarily as a Lewis acid by accepting hydroxyl ions, thereby influencing solution chemistry through complex formation rather than classical proton dissociation.[1] Its dissociation constant (pKa ≈ 9.0–9.24) indicates that borate buffer systems stabilize solutions within an alkaline range rather than neutral pH.[1,2] This property explains its frequent use in ophthalmic preparations, where borate buffers may help maintain tonicity and chemical stability when properly formulated and tested for ophthalmic compatibility.[2]

Importantly, boric acid is not used in ophthalmic products as a cleansing or therapeutic agent in itself; rather, it serves a supportive formulation role. The biological safety of borate-containing solutions therefore depends on multiple factors beyond the presence of boric acid alone, including concentration, buffering partners, osmolarity, sterility, preservatives, and duration of tissue exposure. Even minor variations in these parameters may significantly alter tissue compatibility, particularly in sensitive structures such as the ocular surface.

Commercial ophthalmic solutions intended for human use that contain borates are carefully engineered to maintain low concentrations and physiological compatibility, often limiting borate content to small fractions of a percent and restricting use to brief exposure.[3,4] Such formulations undergo controlled testing to confirm tolerability. By contrast, improvised or non-ophthalmic boric acid solutions lack these safeguards and may differ substantially in chemical behaviour. Because boric acid participates in equilibrium reactions dependent on

environmental conditions, dilution, storage, or mixing with other substances can unpredictably alter solution properties.

For these reasons, evaluating boric acid solely by its name or historical reputation is scientifically insufficient; its biological effect is determined not by identity alone but by formulation context. Understanding this distinction is essential when assessing whether boric acid solutions can be considered appropriate for routine use near sensitive tissues such as the canine periocular region.

Canine Ocular Physiology

The canine ocular surface is a highly specialized biological system designed to maintain transparency, lubrication, immune defence, and optical integrity. Its stability depends on precise interactions among the corneal epithelium, conjunctival tissues, lacrimal secretions, and tear-film structure. Even minor chemical disturbances can disrupt this balance and lead to irritation, inflammation, or epithelial compromise. For this reason, topical substances applied near the eye must be compatible not only with general tissue physiology but also with the unique biochemical characteristics of the ocular surface.

The tear film in dogs is a multilayered structure consisting of a superficial lipid layer, a middle aqueous layer, and a deep mucin layer. Each layer performs distinct physiological functions: the lipid layer reduces evaporation, the aqueous layer provides nutrients and antimicrobial components, and the mucin layer stabilizes tear adherence to the corneal surface. Disruption of any layer can alter tear distribution and ocular surface protection. Because the tear film is chemically dynamic, exposure to exogenous substances may influence osmolarity, protein stability, epithelial permeability, and local immune responses.

Comparative studies demonstrate that canine tear film pH differs from that of humans. In one veterinary investigation measuring tear pH across species, dogs exhibited a mean tear pH of approximately 8.05 ± 0.26[5], indicating a naturally alkaline ocular environment. This finding highlights an important limitation of extrapolating safety assumptions from human ophthalmic products to dogs. A formulation compatible with human tear chemistry may not be physiologically equivalent in canine eyes, particularly if buffering systems shift local conditions outside species-specific tolerance ranges.

Beyond pH, ocular tolerance depends on factors such as osmolarity, preservative type, ionic composition, and exposure duration. Research on ophthalmic solutions demonstrates that different buffering agents—even when adjusted to similar pH values—can exert different biological effects on corneal epithelial cells, influencing cell viability, wound healing, and inflammatory signalling. Thus, compatibility cannot be predicted solely from a product's labelled pH; the chemical identity of its buffering system and excipients is equally important.

Breed-related anatomical variation further complicates assumptions about safety. Many breeds prone to visible tear staining, including brachycephalic and toy breeds, possess shallow orbits, narrowed nasolacrimal ducts, or periocular hair that increases mechanical irritation. These structural characteristics can predispose individuals to tear overflow or ocular surface sensitivity, meaning that repeated exposure to unsuitable topical substances may exacerbate rather than alleviate periocular conditions.

Taken together, current understanding of canine ocular physiology indicates that the eye is not a passive surface but a tightly regulated microenvironment. Substances applied near it must be specifically designed for ocular compatibility in the target species. Any evaluation of topical solutions—including those containing boric acid—must therefore consider species-specific tear chemistry, epithelial sensitivity, and formulation-dependent effects rather than relying on generalized assumptions of safety.

Toxicology and Irritation Potential of Borate Compounds

Although boric acid is commonly described as “mild,” toxicological literature demonstrates that borates are biologically active substances capable of producing tissue responses under certain conditions.[6],[7] The safety profile of boric acid is highly dependent on concentration, formulation, and duration of exposure. In regulatory toxicology assessments, boric acid and related borate compounds have demonstrated ocular irritation potential in animal models when applied directly to ocular tissues.[6],[7] These findings do not imply severe toxicity at all concentrations; however, they confirm that borates are not physiologically inert.

Regulatory bodies and cosmetic safety review panels have documented irritation responses associated with borate exposure, including conjunctival redness, corneal effects, and transient inflammatory changes under specific test conditions.[6],[7] Such evaluations are designed to identify hazard potential rather than clinical dosing thresholds, yet they establish that borate compounds can interact with ocular tissues in a measurable manner. The degree of irritation depends on factors such as concentration, solution buffering, osmolarity, and exposure time.

Importantly, ophthalmic tolerance is not determined solely by pH. Research examining ocular buffer systems has demonstrated that different buffering agents—even when adjusted to identical pH levels—can exert varying effects on epithelial cell viability and wound healing.[8] Buffer chemistry may influence cellular osmotic balance, membrane integrity, and inflammatory signalling pathways. Consequently, the assumption that a solution is safe simply because it is “pH balanced” does not reflect current understanding of ocular surface biology.

In human ophthalmology, borate-containing solutions are carefully formulated and tested as complete products rather than as isolated ingredients. Compatibility assessments evaluate the

entire formulation, including preservatives, stabilizers, and excipients. The safety observed in these controlled products cannot automatically be extended to improvised mixtures or non-ophthalmic boric acid preparations. Differences in dilution methods, storage conditions, sterility, and buffering composition may alter biological response.

Furthermore, the ocular surface is particularly susceptible to cumulative micro-irritation. Even mild, repeated exposure to suboptimal solutions may disrupt tear-film stability, increase epithelial permeability, or provoke low-grade inflammatory responses. In breeds predisposed to tear overflow or periocular sensitivity, repeated chemical exposure intended for cosmetic lightening may paradoxically worsen tear production or periocular skin changes.

Taken together, toxicological data and ocular surface research indicate that borate compounds possess measurable irritation potential and must be evaluated within the context of full formulation design and species-specific tolerance. The characterization of boric acid as universally “safe” for routine canine eye cleaning is therefore not supported by toxicological principles.

Evidence Gap in Veterinary Literature

Despite the widespread informal recommendation of boric acid solutions for canine periocular cleaning, a review of available veterinary literature reveals a notable absence of controlled clinical evidence supporting this practice. Searches of veterinary ophthalmology publications, clinical trial databases, and peer-reviewed journals do not identify randomized controlled trials, longitudinal safety assessments, or dose–response studies evaluating the routine use of boric acid solutions for tear-stain management in dogs.

The lack of published data is significant. In evidence-based medicine, routine recommendations for repeated topical application near sensitive tissues typically require documentation of safety, tolerability, and efficacy within the target species. Such studies commonly assess epithelial integrity, tear-film stability, inflammatory markers, and long-term tolerance. No such veterinary studies appear to have been conducted for boric acid solutions used specifically for cosmetic tear-stain removal in dogs.

It is important to distinguish between historical human use and species-specific veterinary validation. Certain human ophthalmic products containing borate buffers have undergone compatibility testing as complete formulations. However, these data cannot be directly extrapolated to canine patients without species-specific evaluation. Differences in tear chemistry, ocular anatomy, grooming behaviour, and frequency of exposure introduce variables that may alter biological response.

Additionally, anecdotal reports of cosmetic improvement do not constitute evidence of safety. Cosmetic lightening of hair discoloration does not confirm absence of subclinical irritation or

cumulative tissue effects. In the absence of formal safety data, the burden of proof remains unmet.

Within veterinary medicine, the principle of prudence generally favours the use of products specifically formulated and tested for animal ophthalmic use when available. When evidence supporting a practice is lacking, and safer validated alternatives exist, routine recommendation becomes difficult to justify under evidence-based standards.

The persistence of boric acid use in canine eye care therefore reflects tradition and anecdote rather than documented veterinary clinical research. Until controlled species-specific studies establish safety and efficacy, routine periocular use of boric acid solutions in dogs cannot be considered supported by veterinary evidence.

Tear Staining Mechanisms and Cosmetic Misinterpretation

Periocular tear staining in dogs is a common concern among owners and groomers, particularly in light-coated breeds where discoloration is more visible. Contrary to popular belief, these stains are not caused by dirt or poor hygiene but are primarily associated with porphyrins—iron-containing pigment molecules that are naturally present in tears and saliva.[9] Porphyrins originate from haemoglobin metabolism and are excreted in small quantities through bodily secretions.[9] When tears accumulate on surrounding hair, exposure to air and light oxidizes these pigments, producing the characteristic reddish-brown discoloration observed beneath the eyes.[9] The visibility and persistence of staining are influenced by multiple physiological and anatomical factors rather than surface contamination. Tear overflow (epiphora) may result from narrow or obstructed nasolacrimal ducts, eyelid conformation, hair contact with the ocular surface, mild irritation, or increased tear production.[10] In many cases, staining represents a secondary cosmetic effect of underlying tear flow rather than a primary dermatological or hygienic problem. Consequently, approaches that focus solely on removing pigment from the hair shaft do not address the biological source of the discoloration.

Chemical agents that lighten staining may create the impression of improvement by altering pigment appearance without modifying tear production or ocular physiology. Such approaches may therefore mask clinical indicators rather than resolve underlying causes. In addition, repeated application of topical substances near the eye—particularly those not specifically formulated for ophthalmic use—may influence local tissue conditions, potentially affecting tear-film stability or periocular skin integrity. While mild cosmetic improvement may be observed in some cases, this does not constitute evidence of therapeutic benefit.

Understanding the biological basis of tear staining is essential for distinguishing between cosmetic management and medical treatment. Evidence-based care focuses on identifying underlying physiological contributors, such as anatomical variation or mild irritation, rather than relying solely on topical agents intended to remove visible discoloration. From a scientific perspective, treatments should therefore be evaluated according to their effect on ocular health rather than their ability to alter hair pigmentation.

Why the Recommendation Persists

The continued recommendation of boric acid solutions for canine eye cleaning illustrates how informal practices can persist in companion animal care despite limited scientific validation. Several factors likely contribute to the longevity of this advice.

First, boric acid has a long historical association with human medicinal use, particularly in older ophthalmic and dermatological preparations. This history contributes to a perception of mildness and familiarity. When a substance is sold in pharmacies and labelled for ophthalmic or antiseptic use in humans, it is often assumed to be broadly safe. However, historical use does not necessarily reflect contemporary evidence-based standards, nor does it confirm cross-species compatibility.

Second, anecdotal reinforcement plays a powerful role. Cosmetic lightening of tear stains following topical application may be interpreted as proof of safety and efficacy. However, visible improvement in hair discoloration does not provide information about epithelial tolerance, tear-film stability, or long-term ocular health. In the absence of clinical monitoring, subtle irritation or cumulative effects may go unnoticed. Anecdotal reports therefore reinforce perceived effectiveness without addressing physiological impact.

Third, the distinction between buffering agents and therapeutic agents is often unclear outside pharmaceutical formulation science. Boric acid functions primarily as a chemical buffer in ophthalmic products, yet it may be perceived as a cleansing or soothing ingredient. This misunderstanding can lead to the assumption that any solution containing boric acid is inherently appropriate for ocular hygiene, regardless of formulation context.

Finally, the absence of strong regulatory guidance specific to cosmetic periocular practices in companion animals creates space for informal advice to circulate unchallenged. In areas where practices are considered cosmetic rather than medical, scientific scrutiny may be limited, allowing tradition and convenience to shape recommendations.

Understanding these factors does not imply negligence or intentional misinformation; rather, it highlights how well-intentioned advice can persist without systematic evaluation. From a scientific perspective, however, routine practices should ideally be supported by species-specific evidence, particularly when involving repeated exposure near sensitive tissues such as the ocular surface.

Evidence-Based Alternatives for Canine Periocular Hygiene

When addressing periocular hygiene and tear staining in dogs, evidence-based practice favours approaches that prioritize ocular surface compatibility and underlying cause assessment. Rather than focusing solely on cosmetic pigment removal, management strategies should emphasize tear-film preservation, tissue safety, and identification of physiological contributors to epiphora.

Sterile isotonic saline (0.9% sodium chloride solution) represents the most physiologically neutral option for routine external cleaning of the periocular region.[11] Because isotonic saline closely approximates the osmolarity of natural tears and does not rely on active buffering agents or preservatives, it minimizes the risk of chemical irritation when applied externally with sterile gauze.[11] Importantly, such use should remain limited to gentle cleansing of surrounding hair and should avoid direct ocular instillation unless medically indicated.

Veterinary-formulated ophthalmic cleansers provide an additional option. These products are specifically designed for animal use and typically undergo compatibility testing as complete formulations. They may include ingredients intended to support tear-film stability or mild cleansing while maintaining appropriate osmolarity and sterility standards. When selecting such products, preference should be given to those clearly labelled for veterinary ophthalmic application rather than general antiseptic or cosmetic use.

In cases of persistent tear staining, evaluation of contributing factors is essential. Anatomical features such as narrowed nasolacrimal ducts, eyelid conformation, or periocular hair contact may influence tear overflow.[10]

Mild chronic irritation, environmental allergens, or dietary factors may also play roles.[10]

Addressing these contributors may reduce staining more effectively than repeated application of topical cosmetic agents.

Professional guidance is particularly important when additional clinical signs are present, including redness, squinting, discharge changes, or signs of discomfort. In such situations, veterinary assessment is warranted to exclude infection, obstruction, or inflammatory conditions.[10] Cosmetic management should not replace medical evaluation when symptoms extend beyond discoloration alone.

In summary, periocular care strategies should prioritize species-specific compatibility, minimal chemical exposure, and attention to underlying physiology. When safer alternatives exist and lack of supporting evidence remains for certain practices, conservative and validated approaches align more closely with principles of ocular health and responsible animal care.

Discussion

The evaluation of boric acid solutions for canine periocular use highlights a broader issue in companion animal care: the persistence of widely accepted practices that have not undergone systematic scientific validation. The evidence reviewed indicates that boric acid is a chemically active buffering agent whose biological effects depend on formulation parameters, concentration, and exposure conditions. Although it has recognized roles within carefully designed pharmaceutical products, its safety profile cannot be assumed outside controlled formulations. This distinction is particularly important when considering application near the ocular surface, where tissue tolerance thresholds are narrow and cumulative effects may occur. Current understanding of ocular physiology demonstrates that compatibility is determined not solely by pH but by the interaction of multiple physicochemical factors, including osmolarity, buffer composition, preservative systems, and exposure frequency. Research showing variable cellular responses to different buffering agents underscores that solutions with similar pH values may nonetheless differ substantially in biological effect.[8] Therefore, the common rationale that a substance is safe because it is "pH balanced" does not reflect contemporary knowledge of ocular surface biology.

The absence of controlled veterinary studies evaluating boric acid for routine tear-stain management represents a significant evidentiary gap. In clinical science, absence of evidence does not equate to evidence of harm; however, it also does not constitute evidence of safety. When repeated application near sensitive tissues is proposed, the standard of justification typically requires species-specific safety data. Without such data, recommendations remain speculative rather than evidence-based.

The popularity of boric acid for cosmetic tear-stain reduction appears to arise from a convergence of historical precedent, anecdotal reinforcement, and misinterpretation of pharmaceutical terminology. These influences illustrate how informal knowledge transmission can shape care practices independently of scientific evaluation. Recognizing these dynamics is essential for improving science communication within animal care communities, where well-intentioned advice may spread rapidly in the absence of accessible evidence-based guidance.

Importantly, the goal of evidence-based assessment is not to discredit traditional practices indiscriminately but to evaluate them using consistent scientific standards. Where validated alternatives exist that are specifically designed for ocular compatibility, prioritizing such options aligns with principles of preventive care and risk minimization. This approach is particularly relevant for routine grooming practices performed frequently over long periods.

Taken together, the available data suggest that routine use of non-ophthalmic boric acid solutions near canine eyes cannot currently be justified on scientific grounds. The issue is therefore not one of proven toxicity but of insufficient evidence to support safety, efficacy, or necessity. In clinical and preventive contexts, practices lacking such evidence warrant careful reconsideration, especially when safer validated alternatives are available.

Conclusion

Boric acid solutions, commonly referred to as “boric water,” are widely recommended in informal companion animal care contexts for cleaning dogs’ periocular regions and reducing tear staining. However, evaluation of available chemical, physiological, and toxicological evidence indicates that such recommendations are not supported by species-specific scientific data. Boric acid is a chemically active buffering compound whose biological effects depend on formulation, concentration, and exposure conditions, and it cannot be considered inherently inert when applied near sensitive tissues such as the ocular surface.

Current knowledge of canine ocular physiology demonstrates that compatibility of topical solutions depends on multiple factors beyond pH, including buffer composition, osmolarity, and excipient interactions. Toxicological findings confirm that borate compounds possess measurable irritation potential under certain conditions, and no controlled veterinary studies have established the safety or efficacy of routine boric acid use for tear-stain management in dogs. In the absence of such evidence, anecdotal reports and historical precedent cannot substitute for systematic evaluation.

Importantly, tear staining is primarily a physiological phenomenon related to porphyrin pigments and underlying anatomical or functional factors rather than a surface contaminant requiring chemical removal. Cosmetic lightening of discoloration therefore does not constitute therapeutic benefit and may obscure underlying causes.

From an evidence-based perspective, routine use of non-ophthalmic boric acid solutions for canine periocular care cannot presently be considered justified. When validated alternatives formulated specifically for ocular compatibility are available, preference for these approaches

aligns with principles of preventive care, risk minimization, and responsible animal management. Further controlled studies would be required to establish safety parameters before boric acid solutions could be recommended for routine use in this context.

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