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Magnesium Hydroxide for Axillary Odor Control: An Evidence-Mapping Review of Experimental Deodorant Formulations, Antimicrobial Activity, and the Topical Use of Oral Milk of Magnesia

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Abstract

Background: Magnesium hydroxide has attracted interest as an ingredient in aluminum-free axillary deodorants because of its alkaline properties, availability, and potential effects on odor-associated microorganisms. In addition to purpose-designed cosmetic formulations, commercially available oral magnesium hydroxide suspensions, commonly known as milk of magnesia, are reportedly applied directly to the axillae for odor control. However, the experimental evidence supporting these applications remains fragmented, and laboratory antimicrobial findings have not been adequately distinguished from clinically demonstrated deodorant efficacy.

Objective: To critically map experimental evidence concerning magnesium hydroxide-containing deodorants, evaluate microbiological and physicochemical findings, and examine the scientific rationale and evidence gaps associated with the topical repurposing of oral milk of magnesia.

Methods: An exploratory evidence-mapping review was conducted using five full-text experimental investigations from Brazil, Malaysia, and India, supplemented by relevant scientific and documentary literature. Studies were classified according to whether magnesium hydroxide was directly investigated or whether they provided indirect methodological evidence concerning alternative deodorants. Formulation composition, antimicrobial outcomes, physicochemical characteristics, clinical measurements, and methodological limitations were narratively synthesized.

Results: Three studies directly investigated magnesium hydroxide-containing formulations, whereas two evaluated alternative deodorants without magnesium hydroxide. A Brazilian study reported a 7-mm bacterial inhibition zone for a multicomponent magnesium hydroxide deodorant, compared with 15 mm for a vancomycin control. Another Brazilian investigation demonstrated formulation feasibility, with a final pH of approximately 6.0, but did not establish clinical odor reduction. A Malaysian study reported weaker antibacterial activity for magnesium hydroxide than for the essential oils tested. An Indian investigation involving nine participants demonstrated a 65.0% reduction in mean axillary bacterial counts after four hours, although its formulation did not contain isolated magnesium hydroxide. None of the five studies established the clinical efficacy or long-term dermatological safety of oral milk of magnesia applied to the axillae.

Conclusions: Magnesium hydroxide is a feasible ingredient for experimental deodorant formulations, but its independent clinical effectiveness remains unproven. The topical repurposing of oral milk of magnesia represents a relevant, insufficiently investigated practice. Controlled clinical studies are required to establish odor reduction, duration of action, comparative efficacy, microbiological effects, and repeated-use safety.

Keywords: Magnesium hydroxide, Milk of magnesia, Axillary malodor, Deodorants, Antimicrobial activity

1. Introduction

Axillary malodor is a common physiological phenomenon that may affect personal comfort, interpersonal relationships, and quality of life. Although freshly secreted sweat is generally minimally odorous, characteristic axillary odors arise through complex interactions between skin secretions and resident microorganisms. Bacterial metabolism transforms initially odorless precursors into volatile compounds, including short-chain fatty acids and sulfur-containing substances, making the composition and metabolic activity of the axillary microbiota central determinants of body odor [1, 2]. This biological relationship explains

why many deodorant strategies seek to modify bacterial activity or interfere with the formation and persistence of odor-associated compounds rather than simply suppressing perspiration.

Deodorants and antiperspirants represent distinct, although frequently combined, approaches to axillary odor management. Deodorants aim to prevent, reduce, neutralize, or mask unpleasant odors through antimicrobial ingredients, fragrances, odor absorbers, or other functional compounds, whereas antiperspirants primarily reduce perspiration through aluminum-containing salts that temporarily obstruct sweat ducts [3]. Consumer interest in alternatives to conventional products has encouraged the development of mineral-based preparations, botanical extracts, essential-oil formulations, and products marketed as aluminum-free or natural. Nevertheless, these descriptions do not independently establish superior efficacy or safety, and both conventional and alternative products require appropriate evaluation of their physicochemical properties, microbiological effects, dermatological tolerability, and clinical performance.

Magnesium hydroxide [$Mg(OH)_2$] is a sparingly soluble inorganic compound traditionally used in oral antacid and laxative preparations. Its alkaline properties, relatively simple chemical composition, and compatibility with suspension-based formulations have stimulated interest in cosmetic applications, particularly in axillary deodorants. Experimental preparations containing magnesium hydroxide have been investigated in Brazil and Malaysia, frequently in combination with essential oils, sodium bicarbonate, zinc ricinoleate, or other functional ingredients [4–6]. Although these investigations provide preliminary information about formulation development and antimicrobial activity, their heterogeneous methods and multicomponent compositions make it difficult to determine whether magnesium hydroxide itself is responsible for the reported effects.

Beyond purpose-designed cosmetic formulations, an additional practice of scientific interest involves the direct topical application of commercially available oral magnesium hydroxide suspensions, commonly known as milk of magnesia, as alternatives to conventional deodorants. In Brazil, Phillips' Milk of Magnesia is a familiar example of an oral preparation containing magnesium hydroxide, and its application to the axillae has been described informally as a method of controlling body odor. This practice differs from the use of specially developed cosmetic formulations because it involves repurposing an existing pharmaceutical product for an indication outside its approved labeling, potentially without the additional antimicrobial or fragrance ingredients incorporated into experimental deodorants. However, anecdotal accounts of satisfactory odor control cannot establish clinical effectiveness, and the prevalence of this practice has not been adequately quantified.

The available experimental literature is heterogeneous and includes investigations of magnesium hydroxide-containing formulations, physicochemical stability, antibacterial activity, and consumer acceptance. Additional studies involving herbal or traditional deodorants have employed microbiological techniques that may inform the design of future magnesium hydroxide investigations, although their findings cannot be used as direct evidence of magnesium hydroxide efficacy [7, 8]. A critical synthesis is therefore necessary to distinguish experimental observations from clinically meaningful outcomes, identify the methodological limitations of the existing literature, and clarify the relevance of oral milk of magnesia as a potential topical deodorant. The present review aimed to map experimental investigations of magnesium hydroxide-containing axillary deodorants, evaluate their microbiological and physicochemical findings, examine indirect methodological evidence from alternative deodorant studies, and discuss priorities for future clinical research.

2. Materials and Methods

2.1. Review Design and Research Questions

This study was conducted as an exploratory evidence-mapping review, informed by established scoping-review principles and the PRISMA extension for scoping reviews [9]. Its purpose was to characterize the available experimental evidence, distinguish direct from indirect findings, and identify research gaps rather than estimate a pooled clinical treatment effect. The review addressed whether magnesium hydroxide had been experimentally investigated in axillary deodorant formulations, whether the available investigations demonstrated antimicrobial activity or clinically meaningful odor reduction, and whether repeated topical use had been adequately evaluated for dermatological safety. A further question concerned the applicability of findings from experimental cosmetic preparations to commercially available oral magnesium hydroxide suspensions used directly on axillary skin.

2.2. Evidence Identification and Eligibility

The evidence synthesis was based on five original experimental investigations for which full texts were available for examination, comprising three studies involving magnesium hydroxide-containing deodorant formulations and two investigations of herbal or traditional deodorants that provided indirect methodological evidence. Relevant background publications were used to contextualize the microbiology of axillary odor, the mechanisms of conventional deodorants, skin physiology, and evidence-mapping methodology. Original studies were classified as directly relevant when magnesium hydroxide was explicitly incorporated into a tested deodorant formulation or evaluated as an individual ingredient. Investigations without magnesium hydroxide were retained only when their experimental methods were relevant to deodorant evaluation and were not used to support magnesium hydroxide-specific efficacy claims. Academic dissertations were eligible when they reported original formulation development or experimental findings, whereas patents and secondary reviews were excluded from the primary experimental evidence synthesis.

The identification process was exploratory and did not involve a fully documented, reproducible search and screening of all potentially relevant records across bibliographic databases. Consequently, the review should not be interpreted as an exhaustive systematic review, and no comprehensive study-identification count or PRISMA flow diagram is reported. This distinction was maintained throughout the analysis to avoid implying a level of search completeness that could not be independently verified.

2.3. Data Extraction and Evidence Synthesis

The full texts were examined for publication details, country, experimental design, formulation ingredients, magnesium hydroxide concentration, sample size, microorganisms

investigated, assay methods, physicochemical characteristics, efficacy outcomes, statistical analyses, and safety findings. Antimicrobial outcomes were distinguished from clinical deodorant efficacy because laboratory inhibition zones and reductions in bacterial counts do not directly measure perceived axillary odor. Where percentage changes were not explicitly provided, descriptive reductions were calculated from the published group means without interpreting them as individual treatment responses or controlled estimates of effectiveness.

A structured narrative synthesis was performed because the studies differed substantially in active ingredients, formulation systems, biological samples, experimental methods, and outcome measures, making quantitative pooling inappropriate. The evidence was organized into direct magnesium hydroxide investigations, indirect methodological evidence from alternative deodorants, and research gaps concerning the topical use of oral milk of magnesia. Formal pooled risk-of-bias estimates were not generated; instead, methodological limitations were assessed qualitatively, including small sample sizes, absence of concurrent controls, incomplete microbial identification, multicomponent formulations, lack of blinded odor assessments, short follow-up, and inadequate evaluation of repeated-use dermatological safety. The principal study characteristics, formulations, quantitative findings, and limitations are presented in Tables 1–4.

Table 1: Characteristics of the experimental studies included in the evidence-mapping review

Study	Country	Design and sample	$Mg(OH)_2$	Main outcomes
Fiorese *et al*., 2023 [4]	Brazil	Experimental formulation; questionnaire n=100; axillary samples from two individuals	Yes	Consumer preferences and preliminary bacterial inhibition
Silva, 2025 [5]	Brazil	Undergraduate experimental formulation study; three prototypes	Yes	pH, appearance, texture, odor, physical stability
Yusoff and Kassim, 2026 [6]	Malaysia	Laboratory investigation of individual ingredients and ten formulations	Yes	Antibacterial activity, biochemical assays, physicochemical properties and stability
Prakruthi *et al*., 2025 [7]	India	Single-arm before-and-after microbiological investigation; n=9	No	Axillary bacterial counts at baseline, 2 h and 4 h
Debnath *et al*., 2011 [8]	India	Laboratory formulation study; three herbal sticks	No	Antibacterial activity and physical stability

The two investigations without magnesium hydroxide provide indirect methodological evidence only.

Table 2: Composition and physicochemical characteristics of the investigated formulations

Study	Principal ingredients	Reported concentration or composition	Physicochemical findings
Fiorese *et al*. [4]	$Mg(OH)_2$, tea tree oil, sodium bicarbonate, fragrance and other excipients	2.565 g $Mg(OH)_2$ per nominal 30-g preparation (~8.55% w/w); tea tree oil 1.5%; fragrance 1%; sodium bicarbonate 0.5%	Spray and cream preparations described
Silva [5]	Magnesium hydroxide suspension, essential oils, water or moisturizing cream base	Different proportions of magnesium hydroxide suspension in three prototypes	Final selected cream pH approximately 6.0; homogeneous appearance
Yusoff and Kassim [6]	$Mg(OH)_2$, zinc ricinoleate, shea butter, capric triglyceride, beeswax, tapioca starch, essential oils and vitamin E	Ten formulations developed through mixture-design methodology	pH 7.53–9.33; 14-day stability investigation
Prakruthi *et al*. [7]	Adhatoda vasica, conch shell-derived material, emulsifying wax and essential oil	Single topical application of 0.5 mL	Roll-on preparation
Debnath *et al*. [8]	Clove oil, beeswax, cocoa butter, coconut oil, castor oil, lavender oil and rosemary oil	Three herbal formulations	Reported pH approximately 8–9.5; two-week stability evaluation

The proportion of a magnesium hydroxide suspension in a finished product is not equivalent to the concentration of pure magnesium hydroxide.

Table 3: Quantitative experimental findings and interpretation

Study	Outcome	Quantitative findings	Interpretation
Fiorese *et al*. [4]	Agar diffusion	Deodorant: 7 mm; vancomycin: 15 mm	Preliminary antibacterial inhibition
Fiorese *et al*. [4]	Questionnaire	22% reported previous deodorant-associated allergy; 94% expressed interest in an affordable alternative	Consumer perceptions
Silva [5]	Final formulation pH	Approximately 6.0	Formulation characterization
Yusoff and Kassim [6]	Antibacterial screening	Overall range across tested bioactives: approximately 14.5–28.3 mm	Essential oils more active than mineral ingredients
Yusoff and Kassim [6]	Protein-denaturation assay	$Mg(OH)_2$: 79.1% inhibition at 0.2 mg/mL	Laboratory biochemical outcome
Yusoff and Kassim [6]	DPPH assay	$Mg(OH)_2$: 74.5% reported activity at 0.5 mg/mL	Laboratory assay outcome
Yusoff and Kassim [6]	Formulation pH	7.53–9.33	Alkaline formulations
Prakruthi *et al*. [7]	Baseline bacterial count	6,188.89 ± 4,088.53	Reference measurement
Prakruthi *et al*. [7]	Bacterial count at 2 h	2,557.78 ± 2,021.27; calculated reduction 58.7%; p=0.049	Not significant after Bonferroni adjustment
Prakruthi *et al*. [7]	Bacterial count at 4 h	2,166.67 ± 1,161.90; calculated reduction 65.0%; p=0.002	Significant within-group reduction
Prakruthi *et al*. [7]	Overall comparison	Friedman p=0.034	Difference across measurement times
Debnath *et al*. [8]	S. aureus inhibition	20, 21 and 22 mm	Herbal formulation activity
Debnath *et al*. [8]	E. coli inhibition	20, 20 and 24 mm	Laboratory antibacterial activity
Debnath *et al*. [8]	B. subtilis inhibition	18, 20 and 24 mm	Laboratory antibacterial activity

The percentage reductions in Prakruthi *et al*. were calculated from published group means and do not represent controlled treatment effects.

Table 4: Methodological limitations and applicability to oral milk of magnesia

Study	Main limitations	Applicability to oral milk of magnesia
Fiorese *et al.* [4]	Two biological sample donors; preliminary microbiology; multicomponent formulations; no standardized odor assessment	Relevant ingredient, but results cannot be extrapolated to oral suspension alone
Silva [5]	Formulation development; limited analytical characterization; no clinical efficacy trial	Supports formulation feasibility, not clinical effectiveness
Yusoff and Kassim [6]	Laboratory surrogate outcomes; multicomponent products; short stability assessment	Supports ingredient research, not clinical use of oral milk of magnesia
Prakruthi *et al.* [7]	Nine participants; no parallel control; no standardized odor assessment; no $Mg(OH)_2$	Indirect methodological evidence
Debnath *et al.* [8]	Laboratory tests of herbal formulations; no human efficacy study; no $Mg(OH)_2$	Indirect methodological evidence

3. Results

3.1. Characteristics of the Evidence Base

Five experimental investigations originating from Brazil, Malaysia, and India were examined [4–8]. Three studies directly investigated magnesium hydroxide-containing deodorant formulations, whereas two evaluated alternative deodorants without magnesium hydroxide and were retained as indirect evidence relevant to experimental methods. The directly relevant investigations primarily addressed formulation development, antibacterial activity, physicochemical properties, and short-term stability, while the indirect studies examined microbiological responses to herbal or traditional preparations. None of the five investigations provided a randomized controlled clinical evaluation of isolated magnesium hydroxide for axillary odor reduction, and none established the efficacy or long-term dermatological safety of commercially available oral milk of magnesia applied directly to the axillae. The characteristics of the evidence base are summarized in Table 1.

3.2. Magnesium Hydroxide-Based Deodorant Formulations in Brazil

Fiorese *et al.* [4] investigated a magnesium hydroxide-based deodorant in a Brazilian experimental study combining formulation development, microbiological testing, and a questionnaire administered to 100 students. The formulation contained 2.565 g of magnesium hydroxide in a nominal 30-g preparation, corresponding to approximately 8.55% by mass, together with tea tree essential oil, fragrance, sodium bicarbonate, and other excipients depending on the formulation. The investigators described spray and cream preparations and explored participants' preferences regarding deodorant products. In the questionnaire, 61% of respondents reported using aerosol deodorants, 19% roll-on products, and 20% other formulations; previous deodorant-associated allergy was reported by 22%, while 94% expressed interest in an affordable alternative. These findings provide information about consumer perceptions and preferences but do not constitute clinical evidence of deodorant effectiveness or dermatological safety.

The microbiological component of Fiorese *et al.* [4] involved axillary samples from two individuals and an agar diffusion experiment in which the experimental deodorant produced a 7-mm inhibition zone, compared with a 15-mm zone for the vancomycin positive control. The authors characterized the antimicrobial result as indicative rather than confirmatory, an important qualification given the limited biological sampling and the preliminary nature of the assay. Furthermore, because the tested formulation contained tea tree oil and sodium bicarbonate in addition to magnesium hydroxide, the observed inhibition cannot be attributed specifically to the mineral ingredient. The limited identification of the tested microorganisms and the absence of standardized clinical odor assessment further restrict the interpretation of these findings. Silva [5] investigated the development of magnesium hydroxide-containing deodorant formulations at the State University of Goiás, Brazil, describing three prototypes that incorporated magnesium hydroxide suspension, essential oils, and different vehicle systems, including a moisturizing cream base. The investigation focused on manufacturing feasibility, organoleptic characteristics, appearance, texture, pH, and physical stability rather than microbiological or clinical efficacy. The selected cream formulation exhibited a reported pH of approximately 6.0, homogeneous appearance, characteristic peppermint odor, and satisfactory physical stability during the observation period. These findings support the feasibility of preparing a cosmetically acceptable magnesium hydroxide-containing product, although they do not demonstrate antibacterial effectiveness or clinically meaningful odor reduction. An additional analytical limitation is that pH was assessed using indicator paper rather than a calibrated instrumental method, reducing the precision of the reported measurement.

3.3. Magnesium Hydroxide and Natural Deodorant Ingredients in Malaysia

Yusoff and Kassim [6] developed and evaluated natural deodorant formulations incorporating mineral and plant-derived ingredients, including magnesium hydroxide, zinc ricinoleate, tea tree essential oil, rose essential oil, and kaffir lime essential oil. Antibacterial activity was investigated against Staphylococcus aureus using agar diffusion assays, while additional experiments assessed antioxidant activity, inhibition of protein denaturation, and physicochemical stability. The essential oils produced greater bacterial inhibition than the mineral ingredients, with tea tree essential oil showing the strongest activity, followed by rose and kaffir lime essential oils, whereas magnesium hydroxide and zinc ricinoleate produced smaller inhibition zones. Across the evaluated bioactive ingredients, inhibition-zone diameters ranged from approximately 14.5 ± 0.29 to 28.3 ± 0.33 mm; however, this overall range should not be interpreted as the specific antibacterial effect of magnesium hydroxide.

In the same investigation, magnesium hydroxide demonstrated 79.1% inhibition in a bovine serum albumin protein-denaturation assay at 0.2 mg/mL and 74.5% activity in the reported DPPH assay at 0.5 mg/mL [6]. Although these laboratory findings suggest measurable responses in the experimental systems, they do not establish anti-inflammatory effects in human skin, clinical antioxidant benefits, or deodorant efficacy. Ten formulations were developed through a mixture-design approach, with reported

pH values ranging from 7.53 to 9.33, and short-term stability was assessed at different temperatures over 14 days. The study therefore provides useful comparative information about candidate ingredients and formulation behavior, but its laboratory outcomes and brief stability assessment cannot establish long-term skin compatibility or clinically meaningful axillary odor control.

3.4. Indirect Evidence from Ayurvedic Deodorant Research

Prakruthi *et al.* [7] evaluated an Ayurvedic roll-on deodorant based on Gatra Dourgandhyanashana Lepa, containing Adhatoda vasica and conch shell-derived material, in nine participants aged 18–40 years. Following a single 0.5-mL application, axillary bacterial counts were measured before treatment and after two and four hours. Mean bacterial counts decreased from 6,188.89 ± 4,088.53 at baseline to 2,557.78 ± 2,021.27 after two hours and 2,166.67 ± 1,161.90 after four hours, corresponding to descriptive reductions of approximately 58.7% and 65.0%, respectively, when calculated from the published group means. The Friedman test demonstrated an overall difference across the three time points ($p = 0.034$), while pairwise comparisons indicated that the baseline-to-two-hour change did not meet the Bonferroni-adjusted significance threshold of 0.025 ($p = 0.049$), whereas the baseline-to-four-hour comparison remained statistically significant ($p = 0.002$).

These findings indicate a measurable within-group reduction in bacterial counts following application of the investigated preparation, but several limitations restrict their interpretation [7]. The study included only nine participants, lacked a concurrent untreated or placebo control group, and did not report standardized clinical odor scores. Consequently, changes in bacterial counts cannot be interpreted as proof of clinically meaningful deodorant effectiveness, and the absence of a parallel control prevents confident attribution of the observed changes to the formulation. Moreover, the preparation did not contain isolated magnesium hydroxide, making the investigation relevant to microbiological assessment methods rather than to magnesium hydroxide-specific efficacy.

3.5. Indirect Evidence from Herbal Deodorant Sticks

Debnath *et al.* [8] developed three herbal deodorant-stick formulations containing clove oil, lavender oil, rosemary oil, beeswax, cocoa butter, coconut oil, castor oil, and other excipients. The investigators evaluated physical characteristics, pH, softening point, disintegration time, stability, and antibacterial activity against Staphylococcus aureus, Escherichia coli, and Bacillus subtilis. Agar diffusion assays demonstrated inhibition zones that varied according to the bacterial species and formulation, while short-term stability was assessed over two weeks under different storage conditions. Although the investigation illustrates laboratory approaches that may be adapted to future studies of mineral-based deodorants, the formulations did not contain magnesium hydroxide and no direct clinical assessment of axillary odor was performed. Its contribution to the present review is therefore methodological rather than confirmatory.

3.6. Evidence Concerning Oral Milk of Magnesia Applied to the Axillae

No controlled clinical investigation among the five included studies directly evaluated a commercially available oral milk of magnesia suspension as an isolated axillary deodorant. This absence is particularly relevant because experimental cosmetic preparations frequently incorporate multiple functional ingredients, whereas oral magnesium hydroxide suspensions differ in formulation, excipients, intended route of administration, and approved indications. Although the use of milk of magnesia for axillary odor control has been described informally, the available studies cannot determine whether this practice produces clinically meaningful odor reduction, how long any benefit persists, or whether repeated application is dermatologically safe. These questions remain unresolved and represent an important opportunity for future clinical investigation.

3.7. Overall Interpretation of Efficacy and Safety Findings

Taken together, the experimental findings support the feasibility of incorporating magnesium hydroxide into topical deodorant formulations and provide preliminary evidence of antibacterial activity under selected laboratory conditions. However, the independent contribution of magnesium hydroxide remains uncertain because the directly relevant investigations frequently used multicomponent preparations and relied on surrogate outcomes rather than standardized clinical odor measurements. None of the included studies demonstrated clinical equivalence or superiority to conventional deodorants, and none provided adequate longitudinal safety data concerning daily axillary application of oral magnesium hydroxide suspensions. The principal evidence gaps therefore concern controlled odor assessment, ingredient-specific efficacy, duration of action, repeated-use dermatological tolerability, and the effects of magnesium hydroxide on the axillary microbiome.

4. Discussion

4.1. Principal Findings and Interpretation

The present review demonstrates that magnesium hydroxide has attracted experimental interest as an ingredient in alternative axillary deodorants, although the available evidence remains insufficient to establish its independent clinical effectiveness against malodor. The three directly relevant investigations provide complementary but incomplete information: Fiorese *et al.* [4] reported preliminary antimicrobial activity in a multicomponent formulation, Silva [5] demonstrated the feasibility of developing magnesium hydroxide-containing preparations with acceptable physical characteristics, and Yusoff and Kassim [6] compared the laboratory activity of magnesium hydroxide with that of other candidate deodorant ingredients. However, none of these investigations directly measured clinically meaningful odor reduction attributable to magnesium hydroxide alone, and their results cannot establish the effectiveness of commercially available oral magnesium hydroxide suspensions when applied to axillary skin. This distinction is essential because a substance may inhibit bacterial growth *in vitro* without necessarily reducing the production or perception of malodorous compounds under real-life conditions. Conversely, an ingredient may potentially reduce odor through physicochemical mechanisms without producing substantial changes in total bacterial counts. The available findings therefore justify further investigation but do not establish magnesium hydroxide as a clinically validated replacement for conventional deodorants.

4.2. Axillary Microbiology and the Mechanisms of Malodor Formation

The microbiological origins of axillary malodor have been extensively investigated, with particular attention to the capacity of resident microorganisms to transform odorless sweat-derived precursors into volatile compounds. Certain Corynebacterium and Staphylococcus species participate in pathways responsible for the generation of characteristic axillary odors, including volatile sulfur-containing molecules and short-chain fatty acids [1, 2]. These processes depend not only on the number of microorganisms present but also on their metabolic capabilities, enzymatic activity, substrate availability, and interactions within the local microbial community. Consequently, total viable bacterial counts represent an incomplete surrogate for deodorant effectiveness, since a formulation may reduce overall bacterial abundance while having limited effects on the organisms or biochemical pathways primarily responsible for odor production.

The experimental studies included in this review illustrate this methodological limitation. Fiorese *et al*. [4] investigated inhibition of microorganisms obtained from axillary samples but did not adequately establish the identity or odor-producing capacity of the inhibited organisms, whereas Yusoff and Kassim [6] evaluated antibacterial activity against S. aureus, a clinically relevant bacterium that does not necessarily represent the complete odor-producing axillary community. Although such assays are useful for preliminary screening, they cannot reproduce the complexity of the human axillary environment or determine whether bacterial inhibition translates into a perceptible reduction in malodor. Future investigations should therefore incorporate microorganisms specifically associated with axillary odor and, where feasible, quantify odor-related metabolites alongside standardized sensory assessments. This combined approach would provide a more biologically relevant evaluation of the mechanisms through which magnesium hydroxide might influence axillary odor.

4.3. Potential Mechanisms of Magnesium Hydroxide

Magnesium hydroxide is a sparingly soluble alkaline compound whose physicochemical properties may influence the local environment of axillary skin. Potential mechanisms of deodorant action include interactions with acidic odor-associated compounds, modification of local pH, and indirect effects on microbial metabolism. However, these mechanisms remain incompletely established in experimental systems that specifically reproduce the conditions of human axillary skin. In particular, the hypothesis that alkalinization might reduce malodor requires careful investigation because changes in pH may influence microbial communities in different directions, depending on the organisms involved and the surrounding skin environment. The mere presence of an alkaline ingredient does not establish that odor-producing bacteria will be selectively inhibited or that clinically relevant odor reduction will occur.

This consideration is especially important because healthy skin generally maintains a mildly acidic surface environment that contributes to epidermal barrier function and microbial homeostasis [10]. Increasing skin pH may alter microbial ecology and barrier-related processes, making it necessary to distinguish a potential deodorant effect from unintended changes in skin physiology. Yusoff and Kassim [6] reported formulation pH values ranging from 7.53 to 9.33, whereas Silva [5] described a final cream formulation with a pH of approximately 6.0. These findings illustrate how the pH of a finished product depends on the complete formulation rather than on magnesium hydroxide alone. Although the reported physicochemical characteristics may be useful during product development, they do not establish long-term dermatological compatibility. Future mechanistic studies should therefore evaluate the relationship between magnesium hydroxide concentration, formulation pH, microbial activity, odor-associated metabolites, and skin tolerability under conditions representative of repeated axillary use.

4.4. Antimicrobial Activity Versus Clinical Deodorant Efficacy

A major limitation of the available evidence is the predominance of laboratory endpoints rather than direct clinical assessments of deodorant performance. In Fiorese *et al*. [4], the magnesium hydroxide-containing preparation produced a 7-mm inhibition zone, compared with a 15-mm zone for the vancomycin positive control. Although this observation suggests preliminary antibacterial activity, inhibition-zone diameters depend on several factors, including the diffusion characteristics of the tested substances, formulation viscosity, ingredient concentration, microbial susceptibility, and experimental conditions. The smaller inhibition zone cannot be converted into a percentage of clinical deodorant effectiveness, nor can it be used to determine how long a preparation might control axillary odor during normal daily activities. Furthermore, the formulation contained tea tree oil and sodium bicarbonate, preventing attribution of the observed activity to magnesium hydroxide alone.

The findings of Yusoff and Kassim [6] reinforce the importance of separating ingredient-specific effects from those of complete formulations. In their experimental system, essential oils demonstrated stronger antibacterial activity than magnesium hydroxide, suggesting that botanical ingredients may contribute substantially to the antimicrobial performance of multicomponent deodorants. Nevertheless, weaker antibacterial activity in an agar diffusion assay does not necessarily exclude a deodorant effect through non-bactericidal mechanisms, particularly if an ingredient modifies the physicochemical environment or interacts with odor-associated compounds. The appropriate next step is therefore not simply to repeat antibacterial screening but to investigate whether magnesium hydroxide independently produces measurable odor reduction in humans. Such investigations should include standardized sensory outcomes and, when technically feasible, analytical measurements of volatile compounds associated with axillary malodor.

4.5. Repurposing Oral Milk of Magnesia as an Axillary Deodorant

An important practical consideration is the topical application of commercially available oral magnesium hydroxide suspensions as alternatives to conventional axillary deodorants. Milk of magnesia is traditionally marketed as an oral antacid and laxative, and Phillips' Milk of Magnesia represents a familiar example in Brazil. The original preparation is marketed as an oral suspension containing approximately 80 mg/mL of magnesium hydroxide, equivalent to 8% weight per volume [11]. Although developed

for gastrointestinal administration, such preparations have also been described informally as products applied directly to the axillae for odor control. This practice is scientifically relevant because it involves the repurposing of a widely available pharmaceutical preparation for an indication outside its approved labeling, potentially offering an accessible approach to odor management that differs from the use of purpose-designed cosmetic products.

The reported topical use of milk of magnesia should not, however, be confused with evidence of established clinical effectiveness. Anecdotal accounts may suggest perceived benefits, but they cannot determine the magnitude, reproducibility, or duration of odor reduction, nor can they establish how frequently the practice occurs in the general population. Moreover, commercially available oral suspensions should not be regarded as chemically equivalent to isolated magnesium hydroxide because they may contain preservatives, flavoring agents, or other excipients, depending on the manufacturer and product version. These components may influence physicochemical behavior, skin tolerability, and potentially antimicrobial activity, making it inappropriate to extrapolate findings from one commercial preparation to all products marketed as milk of magnesia. The fact that a pharmaceutical suspension is suitable for oral administration also does not establish its safety during repeated topical exposure, particularly in a region characterized by moisture, friction, occlusion, and frequent hair removal.

A further distinction concerns the interpretation of magnesium hydroxide concentrations. Fiorese *et al.* [4] used 2.565 g of magnesium hydroxide in a nominal 30-g deodorant preparation, corresponding to approximately 8.55% by mass, whereas Phillips' Milk of Magnesia is marketed as an oral suspension containing approximately 8% weight per volume [11]. Although these numerical values appear similar, they are expressed using different denominators and refer to different formulation systems. They therefore cannot be interpreted as equivalent topical doses, and their apparent similarity does not demonstrate comparable antimicrobial activity, clinical effectiveness, or skin compatibility. This distinction is particularly important when considering the development of future studies that compare an oral pharmaceutical suspension with a specially formulated cosmetic deodorant.

A controlled clinical investigation specifically evaluating commercially available oral milk of magnesia would address an important gap in the literature. Such a study should determine whether the preparation reduces axillary odor compared with an appropriate vehicle or untreated control, whether any effect persists during normal daily activities, and whether repeated application produces irritation or changes in skin physiology. Ideally, it should also compare the performance of the oral suspension with that of a purpose-designed magnesium hydroxide formulation to establish whether excipients and vehicle characteristics influence effectiveness or tolerability. The clinical relevance of this research extends beyond cosmetic innovation because it could clarify whether an inexpensive and accessible pharmaceutical preparation has a scientifically demonstrable role in axillary odor management or whether its perceived benefits remain primarily anecdotal.

4.6. Comparison with Conventional Deodorants and Antiperspirants

Conventional deodorants and antiperspirants address axillary odor through different but potentially complementary mechanisms. Deodorants may reduce malodor through antimicrobial activity, fragrance masking, odor adsorption, or interference with the formation of odor-associated compounds, whereas antiperspirants act primarily by reducing the delivery of sweat to the skin surface [3]. Magnesium hydroxide-containing preparations may represent an alternative for individuals who prefer products without aluminum-based antiperspirant ingredients, but the absence of aluminum should not be interpreted as evidence that a preparation is necessarily safer, more effective, or better tolerated. The distinction between avoiding a particular ingredient and demonstrating clinical superiority is fundamental to evidence-based cosmetic evaluation, particularly when consumer perceptions may be influenced by concerns about the long-term safety of conventional products.

Although questions concerning aluminum-containing antiperspirants have contributed to interest in alternative formulations, claims of systemic harm from normal use require careful evaluation of exposure, absorption, toxicology, and epidemiological evidence. A human isotope-tracer investigation reported very low dermal absorption of aluminum from an antiperspirant formulation [12], illustrating why safety comparisons should be grounded in measured evidence rather than presumed toxicity. This observation does not exclude the possibility of local irritation or other adverse reactions in susceptible individuals, but it reinforces the need for balanced interpretation. None of the investigations included in the present review established that magnesium hydroxide is clinically superior to conventional deodorants or antiperspirants, and future comparative studies should therefore evaluate effectiveness, tolerability, acceptability, and cost without presupposing the superiority of either product category.

4.7. Lessons from Herbal and Traditional Deodorant Investigations

The Indian investigations included in this review provide useful methodological perspectives for future studies of magnesium hydroxide, although they do not constitute direct evidence of its efficacy. Prakruthi *et al.* [7] demonstrated that bacterial counts could be measured before and after the application of an alternative deodorant, reporting a statistically significant within-group reduction after four hours. However, the small sample size, absence of a concurrent control group, and lack of standardized odor scoring limit the clinical interpretation of the findings. Debnath *et al.* [8], in turn, demonstrated the use of agar diffusion assays and short-term physicochemical stability testing during the development of herbal deodorant sticks. Together, these investigations illustrate relatively accessible experimental methods that could be incorporated into future mineral-based deodorant research, particularly in settings with limited laboratory resources. Nevertheless, because neither study evaluated isolated magnesium hydroxide, their findings should remain clearly separated from conclusions

concerning the efficacy or safety of magnesium hydroxide-containing preparations.

4.8. Dermatological Safety and Repeated Topical Exposure

The dermatological safety of repeated magnesium hydroxide application remains insufficiently investigated, particularly when the product used is an oral pharmaceutical suspension rather than a formulation specifically developed and evaluated for cutaneous use. Although magnesium hydroxide has an established history of oral administration, safety through one route of exposure cannot automatically establish safety through another. The axillary region presents specific dermatological considerations, including moisture, friction, occlusion, hair removal, and potential interactions with other personal care products. Repeated exposure to alkaline preparations may influence the skin surface environment and potentially affect barrier function or microbial homeostasis [10], while additional ingredients in commercial suspensions or cosmetic formulations may contribute to irritation or sensitization.

The available experimental studies do not provide sufficient longitudinal information to establish the frequency of contact dermatitis, pruritus, erythema, burning sensations, or other adverse reactions during prolonged use. Moreover, the short-term physicochemical stability reported in formulation studies should not be confused with clinical tolerability, since a product may remain physically homogeneous while producing undesirable effects on the skin. Future investigations should therefore incorporate structured adverse-event monitoring, standardized dermatological examinations, and, where feasible, objective measures of skin barrier function. These assessments would be particularly valuable in repeated-use studies involving oral milk of magnesia, for which the approved indication does not encompass routine axillary application.

4.9. Patents and Technological Development

Patent literature provides additional evidence of technological interest in magnesium hydroxide-containing deodorant systems, including mineral-based formulations and combinations with other functional ingredients. However, patent claims are not equivalent to independently replicated clinical findings, and their primary purpose is to establish intellectual property rights rather than demonstrate clinical effectiveness according to the standards used in controlled medical research. Although patent documents may contain laboratory observations or formulation descriptions, such information should be interpreted separately from peer-reviewed experimental evidence. For this reason, patents were not included in the primary evidence tables or used to support clinical efficacy conclusions. Their relevance is principally technological, indicating that magnesium hydroxide has been considered a candidate ingredient for commercial deodorant development.

4.10. Clinical Research Priorities

The most immediate research priority is a controlled trial evaluating magnesium hydroxide independently of other potentially active ingredients. A randomized, assessor-blinded, split-axilla design could provide an efficient initial framework in which one axilla receives a standardized magnesium hydroxide preparation and the contralateral axilla receives a suitable comparator. A separate investigation could evaluate a commercially available oral milk of magnesia suspension as the intervention of interest, allowing researchers to distinguish the effects of the pharmaceutical product from those of a specially developed cosmetic formulation. The primary outcome should be the difference in axillary odor intensity assessed by trained, blinded evaluators using a predefined standardized scale, while secondary outcomes could include participant-reported odor control, duration of effectiveness, skin irritation, changes in skin pH, bacterial counts, and concentrations of selected odor-associated volatile compounds.

Future investigations should also distinguish reductions in perceived odor from changes in sweat production because magnesium hydroxide is not established as an antiperspirant. Studies designed to examine the mechanism of action should evaluate whether any observed benefit is associated with bacterial inhibition, changes in microbial metabolism, physicochemical interactions with odor-associated compounds, or combinations of these effects. Longer-term follow-up would be necessary to determine repeated-use tolerability and the stability of any observed benefits, while comparative studies could assess whether magnesium hydroxide-based preparations offer practical advantages in acceptability, cost, or convenience. A proposed framework for these investigations is presented in Table 5.

Table 5: Proposed clinical research framework for topical oral milk of magnesia

Research objective	Proposed method	Principal outcome
Establish deodorant efficacy	Randomized, assessor-blinded controlled trial	Standardized axillary odor-intensity score
Determine duration of action	Repeated assessments over a defined period	Duration of clinically meaningful odor reduction
Isolate the effect of $Mg(OH)_2$	Compare $Mg(OH)_2$, matched vehicle and active comparator	Between-group differences in odor reduction
Investigate antimicrobial mechanisms	Axillary microbiological sampling	Changes in microbial abundance and activity
Investigate odor-related chemistry	Analysis of volatile odor-associated compounds	Changes in odorant concentrations
Assess skin compatibility	Prospective dermatological examination	Irritation, erythema, pruritus and barrier-related outcomes
Evaluate repeated-use tolerability	Longitudinal follow-up	Incidence of adverse skin reactions
Compare acceptability	Participant-reported outcomes	Satisfaction, convenience and willingness to continue use

4.11. Strengths and Limitations

A principal strength of this review is its critical examination of original experimental publications rather than reliance solely on secondary summaries. The inclusion of Brazilian academic research alongside studies from Malaysia and India broadens the discussion beyond commonly cited commercial cosmetic investigations and allows the evidence to be classified according to its direct or indirect relevance to magnesium hydroxide. The review also distinguishes laboratory antimicrobial findings from clinical deodorant efficacy and explicitly addresses the repurposing of oral milk of magnesia, a practice that deserves scientific investigation but has not been adequately evaluated in the included studies. These distinctions are important because they reduce the risk of overstating the conclusions that can legitimately be drawn from preliminary experimental findings.

Several limitations must nevertheless be acknowledged. First, the review was based on a defined set of five accessible experimental studies rather than a fully exhaustive and reproducible systematic search, meaning that additional relevant investigations may not have been identified. Second, the available evidence was heterogeneous and predominantly preclinical, with substantial differences in formulations, microorganisms, methods, and outcomes. Third, the directly relevant investigations frequently employed multicomponent preparations, making it difficult to isolate the effects of magnesium hydroxide. Fourth, standardized clinical odor outcomes were largely absent, preventing meaningful estimation of deodorant effectiveness. Finally, evidence concerning the direct topical application of oral milk of magnesia remains insufficient for conclusions regarding clinical effectiveness, duration of action, or long-term dermatological safety. These limitations preclude quantitative synthesis and require cautious interpretation of the findings.

5. Conclusions

Magnesium hydroxide has been incorporated into experimental axillary deodorant formulations, with preliminary findings supporting formulation feasibility and limited antimicrobial activity under selected laboratory conditions. However, the available investigations do not establish the independent clinical effectiveness of magnesium hydroxide in reducing axillary malodor, particularly because most experimental preparations contain additional ingredients and rely on surrogate microbiological or physicochemical outcomes rather than standardized clinical odor assessments. The topical application of commercially available oral milk of magnesia, including products such as Phillips' Milk of Magnesia, represents an interesting but insufficiently investigated practice for which controlled evidence of effectiveness, duration of action, and long-term dermatological safety remains unavailable. Future randomized studies should evaluate isolated magnesium hydroxide and oral magnesium hydroxide suspensions using appropriate comparators, validated odor measurements, microbiological outcomes, and systematic assessments of skin tolerability. The current evidence supports continued investigation but does not justify definitive claims of clinical superiority, equivalence, or established long-term safety.

6. Declarations

Ethics Approval and Consent to Participate

Not applicable. This review analyzed previously published investigations and did not involve recruitment of participants or collection of new biological samples.

Consent for Publication

Not applicable.

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No external funding was received specifically for the preparation of this manuscript.

Competing Interests

The authors' declarations of competing interests should be confirmed before submission.

Data Availability

All experimental findings discussed in this review were extracted from the cited publications. No new individual participant dataset was generated.

Use of Artificial Intelligence

The manuscript was initially developed from scientific material organized in Portuguese and subsequently prepared in English with assistance from ChatGPT for drafting, language refinement, and organization of the evidence. The authors remain responsible for scientific accuracy, interpretation, reference verification, and final approval.

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