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Comparative Analysis of Chemical and Bioorganic Disinfectants in Hospital Settings: Focus on Citriferine and Filiferine, Application in Neonatal Units

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Abstract

Introduction: Healthcare-associated infections (HAIs) are one of the main challenges for health systems, especially in low- and middle-income countries, where the incidence can reach up to 15% of hospitalized patients. Hospital cleaning and disinfection are essential measures to improve the quality of care and environmental protection, being especially crucial in hospitals with limited resources. However, traditional products present notable disadvantages, motivating the analysis of bioorganic alternatives such as Citriferine and Filiferin. Moreover, recent studies have highlighted the importance of evaluating the compatibility of these products with commonly used medical materials to avoid damage that could affect their functionality. In this context, an integrated approach considering both short- and long-term efficacy and safety is a priority. **Objective:** To evaluate the efficacy, safety, and environmental relevance of Citriferine and Filiferine in comparison to conventional disinfectants, with an emphasis on their application in neonatal units. **Methods:** A systematic review was conducted using PubMed (98 entries), EMBASE (54), LILACS (45), and gray literature, totaling 197 records. After applying inclusion criteria (controlled trials, observational studies with clear clinical or microbiological outcomes, peer review) and exclusion criteria (absence of control group, insufficient data, low quality), 27 studies (18 clinical, 4 *in vitro*, 5 environmental), and 4 hospital reports were selected for final analysis. The risk of bias was assessed using validated tools, and pilot and *in vitro* studies were contextualized regarding their limitations. Detailed analyses of Filiferina's microbiological efficacy and toxicological profile previously published were included to ensure methodological integrity of the selection [1]. **Results:** Both bioorganic alternatives showed antimicrobial efficacy equivalent to chemical disinfectants (MIC 1:1000 - 1:2000) and

100% compliance with asepsis protocols with negative cultures in neonatology, monitored through formal audits. The cost per gallon of active Citriferine/Filiferine solution at 5% is $4.39 USD, eight times lower than 2% glutaraldehyde, which is highly relevant for hospitals with limited resources. Hospital pilot reports and recent reviews ruled out toxic outcomes and highlighted advantages in tolerability, biodegradability, and material compatibility. The product also demonstrates prolonged chemical and biological stability. Its biodegradability reduces environmental impact compared to traditional agents, reaffirming its role in sustainable hospital policies [2]. **Conclusions:** Citriferine and Filiferine represent reliable and cost-effective alternatives for hospital disinfection, enabling resource optimization and reducing toxicological and environmental risks.

Keywords

Healthcare-Associated Infections, Bioorganic Disinfectants, Filiferine, Citriferine, Neonatal Units, Hospital Quality, Cost Control

1. Introduction

HAIs remain a complex challenge in public health, especially among vulnerable populations and in resource-limited regions, where their incidence can reach 15% of hospitalized patients [3]. Hospital cleaning and disinfection are key actions to reduce nosocomial transmission, improve clinical outcomes, and protect both the environment and available resources [4]. These strategies are even more relevant in lower-budget hospitals, where optimizing expenditures and adopting effective, sustainable measures are fundamental.

Effective infection control requires minimizing exposure to resistant pathogens and ensuring a safe environment, with low environmental impact and risk to staff [5]. Traditionally, chemical disinfectants have been the standard, but their association with toxicity, high cost, waste generation, and risks of bacterial resistance have prompted the search for bioorganic alternatives [6]-[9].

Disinfectant compatibility with medical materials, such as catheters and life-support devices, is key to maintaining equipment integrity and preventing contamination spread; in this regard, bioorganics like Citriferina and Filiferina have shown advantages over harsh chemicals [10] [11].

Citriferine and Filiferine, natural products derived from citrus fruits and lilies, respectively, have shown antimicrobial activity comparable to traditional compounds, with the additional advantages of improved safety and sustainability [6]. Transitioning to these disinfectants requires support from clinical trials, clear economic metrics, and ongoing monitoring of efficacy, tolerability, and environmental viability.

2. Methodology

A structured narrative review was designed, supported by systematic searches in

PubMed (98 records), EMBASE (54), LILACS (45), and relevant gray literature until July 2025. After review of titles and abstracts, 52 articles and 6 institutional reports were analyzed in full text. Inclusion criteria were controlled studies, data on efficacy, toxicity, environmental impact, and peer review. Exclusion criteria included absence of control, insufficient information, lack of methodological rigor, and unpublished studies. In total, 27 articles (18 clinical, 4 experimental or *in vitro*, 5 environmental), and 4 regional hospital reports formed the analysis [5] [6] [12].

Risk of bias was evaluated using CONSORT and PRISMA tools. Evidence was catalogued by level, recognizing that pilot and *in vitro* studies should be confirmed in multicenter settings.

3. Results

3.1. Efficacy, Safety, and Quality Control

Both bioorganic alternatives demonstrated MIC values comparable to conventional agents in key hospital bacteria (1:1000 - 1:2000), with pathogen destruction in minutes [5] [12]. Regional hospitals reported 100% protocol compliance and absence of pathogens post-disinfection, confirmed by process auditing and negative cultures [5] [6]. The risk of bias in clinical studies was low; in pilot and *in vitro* studies, the main limitation was sample size, offset by strict controls and microbiological validation. The inherent variability in bioorganic extracts was addressed through analytical control and batch-wise efficacy tests [13].

Efficacy was also assessed using standard hospital cleanliness methods such as ATP bioluminescence, showing significant improvement after bioorganic implementation [14] [15].

3.2. Stability and Clinical Application

Filiferine and Citriferine retain efficacy for up to 24 hours post-dilution, with progressive biodegradability limiting environmental and bioaccumulation risks [16]. Compared to glutaraldehyde, they showed lower dermal and ocular toxicity, good compatibility with medical materials, and no adverse event reports [5] [6] [17].

Reduced toxicity is reflected in lower occupational dermatitis incidence, especially in neonatal units where prolonged disinfectant exposure is frequent [12] [18].

3.3. Cost, Management, Yield, and Economic Relevance

A gallon of 2% glutaraldehyde costs $37.85 USD, requires activation, and is only usable for 30 days after opening [19]. Filiferine or Citriferine costs $4.39 USD per gallon at 50%. When diluted to 5%, 20 gallons of ready-to-use solution are obtained, with a real cost of $4.39 per gallon (or $0.0116 per liter), 8 times less than glutaraldehyde [16]. This difference is a strategic advantage in resource-limited hospitals, maximizing infection prevention within tight budgets. The cost per patient-day is substantially reduced, enabling full coverage of critical areas without increased toxicological or environmental risks.

3.4. Efficacy in the Presence of Organic Matter and Dilution Tables

Filiferine and Citriferine retain activity even in the presence of blood, plasma, and excreta, showing higher values than conventional compounds [20]. Standard dilution tables have been validated in both field and laboratory studies [15].

Pilot clinical studies have confirmed the safe and effective applicability of these disinfectants in pediatrics and neonatology [18].

4. Discussion

The evidence supports the gradual implementation of bioorganic disinfectants Citriferine and Filiferine in hospitals in Latin America and other regions facing similar challenges. Reduced cost, high yield, low toxicity, and easy implementation contrast with the risks and environmental burden of traditional chemical products. Robust quality control and staff training are critical to ensuring a safe and effective transition.

Pilot studies support the transition, but it is essential to replicate findings in multicenter trials and conduct further environmental audits. Recent guidelines recommend integrating sustainability metrics (cost per liter or patient-day, waste reduction, local toxicological profile) in future regulatory directives [21] [22].

5. Limitations and Recommendations

The main limitation is that part of the evidence comes from hospital pilots and *in vitro* studies, so extensive validation and longitudinal follow-up are needed [1]. Regulated multicenter research and environmental audits are recommended, along with the creation of open databases for international comparison of experiences and outcomes.

6. Conclusions

1) Citriferine and Filiferine are effective, safe, and economical alternatives to chemical disinfectants, suitable for resource-limited hospital environments.
2) They reduce expenses by up to 8 times compared to glutaraldehyde without sacrificing quality or environmental sustainability.
3) They require monitoring and quality control, but their adoption will foster progress toward safer and more ecologically responsible hospitals.
4) Implementation must be accompanied by training programs, indicator measurement, and institutional audits.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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