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MICROBIAL RISKS IN SOAP PRODUCTS: CHALLENGES AND PUBLIC HEALTH IMPLICATIONS

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Abstract : The current understanding of pathogen contamination in both bar soap and liquid soaps is examined in this review in a variety of settings. Although soap plays an important role in maintaining hygiene, it can also become an important source of microbial contamination in the future. In addition to analyzing the pathogens found in contaminated soaps, this article also examines the factors contributing to contamination and the health consequences.

Key words: Soap, Pathogen, Contamination, Microbes, Hygiene

1.INTRODUCTION

Soaps are essential tools in maintaining hygiene or cleanliness and preventing disease transmission among population. However, research has shown that these products can themselves become reservoirs for potentially harmful microorganisms. This phenomenon presents a particular concern in healthcare settings, where vulnerable populations may be exposed to contaminated soap products (Langley, 2022).

1.1 Types of Microbial Contamination

The following microbial categories have been reported by predominantly reported in soap products, primarily due to contamination during manufacturing, storage, or use (Lucassen et al, 2023; Blanc et al, 2016; Buffet-Bataillon et al, 2009; Cantón et al, 2002 ; Cheng & Chen, 1994; Lanini, et al, 2011; Pakkulnan et al, 2019; Weiser et al, 2019; WHO, 2022; Zapka et al, 2011).

1.1.1 Bacterial Contamination

The most commonly isolated bacteria from contaminated soap products are Gram-negative bacteria that include:

- *E.coli*
- *Klebsiella* spp. (*K.oxytoca, K.pneumoniae*)
- *Enterobacter clocae*
- *Pseudomonas* spp. (*P. aeruginosa, P. putida, P. luteola*)
- *Serratia marcescens*
- *Burkholderia cepacia*
- *Pluralibacter gergoviae*
- *Pasturella testudinis*
- *Acinetobacter calcoaceticus*
- *Flavobacterium odoratum*

These organisms are particularly problematic due to their ability to form biofilms and their intrinsic resistance to many preservatives.

Further, some Gram-positive bacteria have been reported on soap products that include:

- *Staphylococcus* spp. (*S. epidermidis, S. aureus, S. simulans, S. hemolyticus* etc.)
- *Corynebacterium* spp.
- *Nocardia* spp.
- *Eubacterium* spp.
- *Propionibacterium acnes*
- *Bacillus* spp.
- *Micrococcus* spp.
- *Peptococcus* sp.
- *Streptomyces* spp.

1.1.2 Fungal Contamination

While less common than bacterial contamination, fungal species have been isolated from soap products, including:

- *Candida* spp. (*C.parapsilosis, C. albicans*)
- *Aspergillus* spp. (*A. niger, A.candidus*) and various environmental molds

1.2 Risk and impact of some selected microorganisms: The major microbial contaminants (bacteria, fungi) found in soap products that can pose health hazard due to their disease causing ability in humans are summarized below as:

(a) *Pseudomonas aeruginosa* is particularly problematic because it can survive in minimal nutrients and form biofilms. It is often found in liquid soaps and can cause serious infections, especially in healthcare settings (Thi et al, 2020).

(b) *Burkholderia cepacia* is concerning because it is naturally resistant to many preservatives and can grow in low-nutrient environments and can cause pneumonia especially in immuno-compromised person(Tavares et al, 2020).

(c) *Klebsiella pneumoniae* and *Enterobacter* species are frequently isolated from liquid soap, particularly in bulk dispensers due to improper storage can cause respiratory and urinary tract infections (Paczosa et al, 2016).

(d) *Escherichia coli* can contaminate soap through improper hygiene practices during production. It can cause gastrointestinal illnesses if transferred from hands to food or can cause urinary tract infections (Navab-Daneshmand et al, 2018).

(e) *Serratia marcescens* is notable for its pink/red pigment and is often found in soap dispensers and can cause respiratory and urinary tract infections, osteomyelitis, endocarditis, septicemia (bloodstream infections), wound infections, eye infections, and meningitis (Zivkovic et al, 2023).

(f) *Staphylococcus* spp. (including *Staphylococcus aureus*) is frequently associated with skin infections, may cause abscesses, boils, or more severe infections in compromised individuals (Stulberg et al,2022).

(g) *Enterobacter spp. is found in liquid soaps due to inadequate preservation, can cause Opportunistic infections in hospital settings (Denissen et al, 2022).*

(h) Molds such as *Aspergillus* species are common environmental contaminants that can grow in soap. *Penicillium* species have also been isolated from contaminated soap products.These fungi can produce mycotoxins and cause lung infections, and also cause allergic reactions in individuals with weakened immune systems(Pfliegler et al, 2020).

(g) Yeast such as *Candida* species is a member of yeast category of fungi, especially *C. parapsilosis* and *C. albicans*, can survive in soap products. They can cause sepsis, wound and tissue infections or exacerbate skin conditions.These are particularly concerning in healthcare settings where immunocompromised patients are present.(R and Rafiq, 2023).

Some opportunistic pathogens like *Acinetobacter* species are environmental organisms that may not be pathogenic but indicate poor product integrity. Occasionally, atypical mycobacteria in specific settings has been reported. (LeChevallier et al, 2024).

1.3 Factors that contributes growth of contaminants

(a) Capacity to form biofilms (Liu et al, 2023)

(b) Cannot be controlled by normal preservatives (Amit et al, 2017)

(c) Can live in low-nutrition environment(Hennig et al, 2018)

(d) Can exist in environments with varying pH levels (Razmi et al, 2023).

(e) Soap components that can be utilized as food (Donald et al, 2018).

1.4 Implications and Prevention of contaminants

The key implications of soap contamination and the essential prevention strategies are given below (Chirani et al, 2019, Schaffner et al, 2018).

1.4.1 Implications of soap contamination

(i) Healthcare settings impact

(a)Patient safety risk: Contaminated soap can lead to healthcare-associated infections (HAIs)
(b)Vulnerable population: Particularly dangerous for immunocompromised patients, surgical patients, and newborns in NICUs
(c)Economic burden: Increased healthcare costs due to extended hospital stays and additional treatments
(d)Legal liability: Healthcare facilities may face litigation if contamination leads to patient harm

(ii) Community impact

(a)Public health risk: Contaminated soap in public facilities can expose large populations.
(b)Reduced hygiene efficacy: Contaminated products may fail to clean effectively.
(c)Cross-contamination: Can spread pathogens between users, especially in shared facilities.
(d)Trust issues: Can erode public confidence in hygiene products.

1.4.2 Prevention strategies

(i) Product design and manufacturing

(a)Use of effective preservative systems that maintain stability
(b)Implementation of sealed, single-use packaging when possible
(c)Regular stability testing during product development
(d)Quality control measures throughout manufacturing

(ii) Storage and handling

(a)Maintain proper temperature control (usually room temperature)
(b)Avoid exposure to direct sunlight
(c)Store in dry conditions to prevent external moisture
(d)Follow first-in-first-out (FIFO) inventory management

(iii) Dispenser management

(a)Regular cleaning and sanitization of soap dispensers
(b)Complete emptying and cleaning before refilling
(c)Avoid "topping off" partially empty dispensers
(d)Regular maintenance checks for proper functioning

(iv) Institutional practices

(a)Staff training on proper handling procedures
(b)Regular monitoring and testing protocols
(c)Clear documentation of cleaning and maintenance
(d)Established response protocols for contamination incidents

(f) Regulatory compliance

(a)Following GMP (Good Manufacturing Practices)
(b)Regular quality assurance testing
(c)Proper labeling including expiration dates
(d)Maintaining batch traceability

1.5 Conclusion

Dispensers used for liquid soaps in public facilities are more exposed to contamination. Cleaning and drying the refillable dispensers help prevent microbial exposure. Though soap has the purpose of cleansing, adulterated soap becomes a pathogen carrier due to contaminated products, hence it paradoxically contributes to the problem. Monitoring manufacturing procedures and good storage can greatly minimize risks and prevent soap from turning out to be ineffective and even a source of illness.

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