Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(3), 611-619 | ISSN:2251-6727

Microbial Intruders: Unveiling the Impact of Bacterial and Fungal Contamination in Cosmetics on Skin Health

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(Received: 04 February 2024 Revised: 11 March 2024 Accepted: 08 April 2024)

KEYWORDS

Aspergillus, Candida, Pseudomonas aeruginosa, Enterobacter gergoviae, Klebsiella oxytoca, Serratia marcescens, Contamination, Cosmetics, Microbial Testing, Skin health

ABSTRACT:

Abstract: This abstract explores the pervasive issue of microbial contamination in cosmetics and its potential impact on skin health. Fungi and bacteria can proliferate in cosmetic formulations, posing a risk to consumers. The presence of these contaminants may lead to adverse reactions, ranging from mild irritations to severe dermatological conditions. Several factors contribute to microbial contamination in cosmetics, including inadequate preservative systems, improper manufacturing processes, and unsuitable storage conditions. Case studies highlight instances where contaminated cosmetics have caused skin reactions, underscoring the need for stringent quality control measures within the cosmetics industry. Pseudomonas aeruginosa, Enterobacter gergoviae, Klebsiella oxytoca, Serratia marcescens are few bacterial contaminants in the cosmetics. Examining the specific examples of fungal contaminants, this abstract discusses the potential harm caused by Aspergillus flavus, which can produce mycotoxins like aflatoxins, known for their carcinogenic properties. Candida species, on the other hand, may contribute to persistent skin infections, affecting individuals with compromised immune systems. The abstract concludes by emphasizing the importance of implementing robust quality assurance protocols, including microbial testing, to ensure the safety of cosmetic products. Increased awareness among consumers, manufacturers, and regulatory bodies is crucial for minimizing the risks associated with fungal contamination in cosmetics and safeguarding skin health.

Introduction:

The cosmetic industry has witnessed unprecedented growth over the years, with an extensive array of products promising to enhance beauty and well-being. Amid this flourishing market, concerns have emerged regarding the potential risks associated with microbial contamination in cosmetics and its repercussions on skin health. Fungi, ubiquitous microorganisms thriving in diverse environments, have found an unwitting habitat in cosmetic formulations, posing a latent menace that demands scientific scrutiny. Cosmetic products, ranging from lotions and creams to powders and makeup, serve as ideal breeding grounds for various fungi due to their moisture-rich and nutrient-laden compositions. Fungal contaminants such as yeasts and molds, though often invisible to the naked eye, can proliferate within these formulations, triggering a cascade of adverse effects when applied to the skin. Despite

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JCHR (2024) 14(3), 611-619 | ISSN:2251-6727

the meticulous quality control measures implemented by cosmetic manufacturers, the dynamic nature of fungal populations and their adaptability pose challenges in ensuring absolute product safety.

This review endeavors to delve into the intricate relationship between fungal contamination in cosmetics and its impact on skin health. Beyond the aesthetic allure of cosmetics, the potential health hazards arising from fungal exposure necessitate a comprehensive examination. The skin, the body's largest organ and a vital barrier against external threats, becomes the frontline battleground where these unseen adversaries interact with human physiology. In this paper, we will explore the diverse fungal and bacterial species that commonly infiltrate cosmetic products, examining their mechanisms of colonization and survival. Furthermore, the adverse effects of fungal contamination on the skin will be dissected, encompassing a spectrum of dermatological concerns such as irritations, allergic reactions, and more severe complications. By shedding light on the intricate interplay between cosmetics, fungal contaminants, and skin health, this review aims to contribute to a more nuanced understanding of the potential risks consumers face in their pursuit of beauty and self-care. Ultimately, this knowledge could inform regulatory measures, industry practices, and consumer awareness to safeguard skin health in the realm of cosmetic usage.[21,22,23]

Review of Literature

The study of Lundov M.D et al (2009) delved into the intricate balance between contamination and preservation of cosmetics, examining legislation, usage, infections, and contact allergy. The authors explored the risk of microbial contamination, with a focus on specific microorganisms such as *Staphylococcus aureus* and *Pseudomonas aeruginosa*, commonly found in contaminated cosmetics. They underscored the concentration-dependent development of contact allergy, particularly to preservatives like parabens, formaldehyde, formaldehyde releasers, and methylchloroisothiazolinone/ methylisothiazolinone. The regulatory frameworks in the EU and the USA were discussed, emphasizing safety evaluations by expert committees and the challenges of achieving effective preservation without overusing preservatives. Specific fungal and bacterial genera, including *Pseudomonas* and *Staphylococcus*, associated with contaminated cosmetics were reported.[1] The findings of study of Fatimah M. Alshehrei et al (2023) revealed that lip gloss and lipstick in low-quality brands showed the highest bacterial isolates such as *Staphylococcus aureus, Staphylococcus epidermidis, Escherichia coli, Streptococcus pneumonia, Bacillus subtilis and Pseudomonas aeruginosa* and fungal isolated such as *Aspergillus fumigatus, Aspergillus niger, Penicillium citrinum, Rhizopus arrhizus.* Preservatives play a crucial role in preventing microbial contamination in cosmetics. The presence of preservatives in cosmetic products ensures that the products remain free from harmful microorganisms, thus safeguarding consumer health. The study emphasized the importance of a good preservative system in cosmetics to maintain microbiological safety.[2] The study of Dadashi L et al (2016)., investigated bacterial and fungal contamination in shared cosmetics in women's beauty salons. All examined cosmetics were contaminated with bacteria (100%), with powders and eyeliners having the highest fungal contamination. Dominant species included *Streptococcus, Pseudomonas, Bacillus, and Staphylococcus. Candida, Rhodotorula,* and *Penicillium* were among the isolated fungi.[3]

In the study conducted by Ammar Abdulrahman Jairouner et al (2020)., an analysis of 100 cosmetics and personal care products revealed varying levels of microbial contamination, with 39% being body care preparations, 8% eye care, 21% face and neck care, 21% hair and scalp care, and 11% oral hygiene products. Country-wise, the products were manufactured in China (9%), EU (15%), India (14%), Korea (8%), the Middle East (10%), the United Arab Emirates (32%), and the United States (12%). Although not statistically significant, body and hair care preparations showed higher microbial contamination rates. Specifically, aerobic mesophilic bacteria contamination was more prevalent in body and hair care products, while yeast and mold contamination were higher in oral hygiene and body care items. Out of the 100 samples, 19% exhibited some microbiological risk, with 15% showing contamination with aerobic mesophilic bacteria. Notably, talcum powder, toothpaste, hair gel, body care preparations, facial/neck

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care products, and henna products displayed varying contamination levels. Additionally, 13% of the samples had yeast and mold contamination, including talcum powder, oral hygiene products, eyebrow gel, hair gel, body care preparations, facial moisturizer, and henna products. Microbiological contamination in cosmetic/personal care products can stem from various factors, such as the conditions of raw material growth, storage, transportation, and manufacturing environments. The study emphasized the importance of adhering to high manufacturing standards, analyzing raw materials for contamination, and implementing controls in susceptible areas. Talcum powder, exposed frequently to air, stood out as one of the most contaminated products, while cosmetic creams with rich textures were prone to yeast, mold, and aerobic mesophilic bacterial contamination. Fortunately, the study revealed no contamination from *Pseudomonas aeruginosa, Candida albicans, Staphylococcus aureus, or Escherichia coli*. This contrasts with European studies, where Gram-negative bacteria, especially *Pseudomonas aeruginosa* and *Enterobacter gergoviae,* were identified as major contaminants. The robust regulatory provisions in the UAE were credited for the relatively low levels of microbiological contamination in products sold there. Examining the global landscape, products from India, the Middle East, and the USA exhibited higher microbial contamination levels. Improving preservative systems and employing non-invasive packaging were suggested as essential measures to prevent microbial contaminants. The study underscored the importance of these findings for consumer safety and the need for ongoing efforts to enhance product safety in the cosmetics and personal care industry.[4]

In the study of Abdulwahab, A. et al (2022)., the prevalence of cosmetics usage was explored, focusing on organoleptic properties, microbial load, and heavy metal impurities of common topical cosmetic products. Participants were found to use at least 5 products daily and these products, in contact with various skin areas, could potentially transmit pathogenic organisms. The skin's defensive mechanisms protect against external matter, and while complete sterility is not essential for cosmetics, there is a threshold limit for microorganisms that the skin can handle. The European Scientific Committee on Consumer Safety (SCCS) and the US FDA set limits for microbial counts in cosmetics, especially for products used around the eyes, on injured skin, and on vulnerable populations. Results indicated that certain baby products exceeded SCCS limits, posing a risk to infants with weak immune systems. Makeup powder, hair cream, and hair oil serum also surpassed limits, with microbial loads exceeding recommended levels. Microbial contamination was observed in 14 samples, with *S. aureus* prevalent in 12. *S. aureus,* a normal skin microorganism, can act as an opportunistic pathogen causing various skin infections. Eczema, acne, and other skin issues may result from contaminated product usage. Additionally, the presence of *S. aureus* in eye products can lead to severe eye infections. *Bacillus* species were found in 10 tested products, including makeup powder. *Bacillus cereus,* a subdivision known for causing skin infections, can lead to serious eye infections, particularly in cosmetics used around the eyes. Even with prompt investigation upon product opening, contamination persisted in some products, highlighting the importance of efficient preservation mechanisms against post-opening contaminants.[5]

In the study Edlira Neza et al (2016)., the risks associated with recalled cosmetic products were categorized into two main groups: chemical and microbiological. Chemical risks predominated, accounting for 87.47% of the recalls. Notably, 62 cosmetic products were found to be contaminated with various microorganisms during this period. The most prevalent among them was the pathogenic *Pseudomonas aeruginosa,* making up 35.48% of the cases. Other microorganisms identified included mesophilic aerobic microorganisms, *Burkholderia cepacia, Klebsiella oxytoca, Serratia marcescens, Enterobacter gergoviae, Enterobacter cloacae, Staphylococcus aureus, Achromabacter xylosoxidans, Rhizobium radiobacter, Candida albicans, Pantoea agglomerans, Citrobacter freundii, Pseudomonas putida, Enterococcus faecium, and Klebsiella pneumoniae.* The contaminated cosmetic products encompassed a range of types, including skin lightening products, eye creams, eye makeup products, children's shampoos, skin care products, baby creams, baby balms, and toothpastes. Notably, Germany accounted

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for 41.67% of the notifications, with a total of 14 different countries reporting recalled products. Within the microbiological contaminants, *Pseudomonas aeruginosa* was present in 21 cosmetic products (33.87%), posing a significant risk due to its association with infectious diseases affecting the eyes. *Burkholderia cepacia*, identified in five products, is an opportunistic pathogen known to cause infections, particularly in immuno-compromised populations. *Staphylococcus aureus* was found in two products, and *Enterobacter gergoviae,* resistant to parabens, was present in eye creams and children's cosmetic products. *Serratia marcescens,* previously considered non-pathogenic, was linked to severe infections, including cases of infant mortality due to contaminated baby shampoo. Additionally, *Klebsiella pneumoniae* was found in two products, a shampoo/shower gel and an herbal tooth powder, with known pathogenic effects. Molds and yeasts were identified in two products, one of which, a makeup set, was associated with potential skin irritation, inflammation, respiratory infection, or vision loss. *Candida albicans* was isolated in a shea butter product from Germany. *Rhizobium radiobacter*, usually of low virulence, was found in an eye contour cream product. Another significant category of recalls involved over-preserved cosmetic products, with 24 products containing preservatives such as methylisothiazolinone, methyldibromo glutaronitrile, triclosan, and benzalkonium chloride in concentrations exceeding European Regulation 1223/2009 limits. Fifteen products containing methyldibromo glutaronitrile were recalled due to increasing rates of contact allergy. Seven products from the Russian Federation exceeded the approved concentration limit for methylisothiazolinone, a sensitizing agent. Additionally, one product with benzalkonium chloride at a concentration 10 times higher than allowed raised concerns regarding skin and eye irritation. Furthermore, 32 cosmetic products were recalled due to formaldehyde concentrations (0.3%–25%) exceeding authorized limits, all of which were hair treatment products. In the European Union, formaldehyde is not authorized as an active ingredient in hair straightening products, and its use is restricted in other cosmetic products according to Cosmetics Regulation 1223–2009 Annex V.[6]

The study by Michalek, I.M et al (2019) investigated the prevalence of microbiologically contaminated cosmetic products in Europe between 2005 and 2018, utilizing data from the European Union Rapid Information System for dangerous non-food products (Rapex). A total of 104 reports were analyzed, revealing that 20 of these cases involved products intended for children. The majority of contaminated products (65.38%) originated from Rapex member states. Gram-negative bacteria, notably *Pseudomonas* spp. (35.58%) and *Enterobacter* spp. (11.54%), were identified as the primary contaminants, highlighting the risk posed by rod-shaped bacteria in cosmetic items. The findings underscored the importance of addressing microbial contamination to ensure consumer safety, particularly for vulnerable populations such as immunocompromised individuals.[7] In the study of Bashir, A. and Lambert, P. et al (2020)., microbial contamination within five categories of used cosmetic products (lipstick, lip gloss, eyeliners, mascaras, and beauty blenders) were analysed, methods involved the analysis of donated products through microbial culture and identification. Results revealed that 79–90% of all used products harbored bacterial contamination, with bacterial loads ranging between 10^2 and 10^3 CFU per ml. Notably, beauty blenders exhibited an average load exceeding 10^6 CFU per ml. Pathogenic organisms, including *Staphylococcus aureus, Escherichia coli, Citrobacter freundii,* were detected. *Enterobacteriaceae* and fungi were pervasive in all product types, with beauty blenders showing particularly high prevalence (26.58% and 56.96%, respectively). A striking observation was that 93% of beauty blenders had not been cleaned, and 64% had been dropped on the floor yet continued to be used.[8] Sandhya Khunger et al (2023)., reported that skin microflora in various individuals varied, and sharing products increased contamination risks. Long-term cosmetic use and sharing were discouraged. Personalized beauty kits and salon inspections were recommended. Contact dermatitis, more common in women, prompted the need for interdisciplinary teams.[9]

Microbial contamination in cosmetics, altered product features and posed potential health risks. Examining cosmetics from beauty salons revealed bacteria (9.2%) and fungi (90.8%) contamination. Notably, eye cosmetics

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contained *Bacillus* spp., *Staphylococcus* spp., *Escherichia coli, Salmonella, Klebsiella,* and *Citrobacter*. Microorganisms such as *Streptococcus* spp., *Pseudomonas* spp., *Acinetobacter, Bacillus, Escherichia coli, Salmonella, Klebsiella, Citrobacter, Penicillium, Rhodotorula,* and *Candida* were identified. Previous findings highlighted prevalent bacteria in both skin and eye cosmetics, including *Streptococcus, Pseudomonas, Acinetobacter, Bacillus,* and *Staphylococcus*. Fungi diversity was notable in skin powders, with *Penicillium, Rhodotorula,* and *Candida* being common.[10]

The study by Cho T. J. et al., provides valuable insights into the safety management of customized cosmetics made on-the-spot, revealing significant risk factors that can affect their safety. The analysis of 120 samples highlighted the prevalence of microbial contamination, with notable findings including the impact of transfer processes on cross-contamination and the importance of heat treatment in reducing microbial counts. Moreover, the study shed light on the microbial stability of customized cosmetics during storage, indicating the need for continuous monitoring and management of potential contaminants. Several bacteria and fungi of concern were identified, including *Staphylococcus epidermidis, Bacillus cereus, Bacillus circulans,* and *Aspergillus versicolor,* among others. These microorganisms, while some are commonly found in nature or on human skin, pose potential risks of skin infections or other health issues when present in cosmetics. The study underscores the importance of rigorous quality control measures, including monitoring raw materials, production processes, environmental sanitation, and personal hygiene, to mitigate these risks effectively. Furthermore, the absence of heavy metals in the tested samples alleviates concerns regarding chemical safety, although ongoing monitoring and regulatory oversight remain crucial. Recommendations for improving safety management include implementing stricter hygiene practices, providing comprehensive information on customized cosmetic ingredients, and exploring preservative systems to ensure microbial stability over time. Overall, the findings underscore the importance of adopting a preventative approach to safety management in the production and sale of customized cosmetics. By addressing identified risk factors and implementing robust quality control measures, stakeholders can enhance consumer confidence and mitigate potential health hazards associated with these products.[11]

The study by Orús P et al., sheds light on the adaptive mechanisms of *Enterobacter gergoviae, Pseudomonas putida,* and *Burkholderia cepacia* in response to recurrent contamination in cosmetic products containing preservatives. While diminished susceptibility to formaldehyde-donors was observed in isolates, resistance to other commonly used preservatives in the cosmetics industry remained unchanged. However, alarming trends emerged regarding increased resistance to various antibiotics, including β-lactams, quinolones, rifampicin, and tetracycline, compared to the wild-type strains. Evaluation of outer membrane protein modifications and efflux mechanism activities highlighted key factors contributing to this resistance. The findings underscore the potential risks associated with the development of antibiotic-resistant microorganisms due to selective pressure from preservatives in cosmetic formulations. This phenomenon poses a significant threat to public health by potentially facilitating the emergence and spread of bacterial resistance in the environment. Nonetheless, it is essential to acknowledge the crucial role of disinfection and preservation in maintaining the microbiological quality and safety of cosmetic products. Further research is warranted to explore strategies for mitigating cross-resistance while ensuring consumer safety and product efficacy in the cosmetics industry.[12]

The study by Nuzhath Fatima et al., provides valuable Insights into the microbial contamination of cosmetics, focusing on both branded and non-branded products available in the Jazan region of Saudi Arabia. It highlights the presence of bacterial contaminants in all cosmetic samples, with non-branded cosmetics exhibiting a significantly higher bacterial load compared to branded ones. Moreover, the identification of various bacterial species, including opportunistic pathogens, underscores the potential health risks associated with the use of contaminated cosmetics. One notable finding is the presence of antibiotic-resistant strains, particularly in branded cosmetics, suggesting a possible correlation

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between preservative use and the development of resistance. This raises concerns about the efficacy of preservative systems in controlling post-production contamination, warranting further investigation through microbial challenge tests. Overall, the study emphasizes the importance of using high-quality cosmetics to mitigate the risk of infections and allergies associated with microbial contamination. It underscores the need for stringent quality control measures and microbial testing in the cosmetic industry to ensure product safety and efficacy.[13]

Noor A. I. et al., in their study investigated the microbial contamination of shared cosmetic testers in beauty shops in Saudi Arabia, shedding light on potential health risks associated with their inappropriate usage. The findings reveal a concerning level of contamination, with over 70% of samples harboring bacteria, predominantly *Staphylococcus epidermidis,* and about 27% contaminated with *Candida albicans* and *Propionibacterium acnes.* Notably, bacterial contamination exceeds fungal contamination, indicating the need for heightened awareness and preventive measures.[14] Ibegbulam-Njoku PN et al. conducted a comprehensive assessment of the microbial quality of twenty different cosmetic products manufactured and sold in Aba, Abia state, Nigeria. The findings revealed concerning levels of bacterial and yeast contamination in the products, with predominant isolates including *Pseudomonas aeruginosa* and *Staphylococcus aureus.* Notably, only a minority of the products passed the preservative effectiveness test, indicating potential health hazards for consumers. The research underscores the importance of stringent quality management systems in cosmetics production, emphasizing the need for quality raw materials, proper formulation, hygienic manufacturing processes, and validated preservative systems. Failure to adhere to these standards can lead to microbial contamination, jeopardizing consumer safety. The study's findings highlight the necessity for regulatory agencies like NAFDAC and SON to enforce Good Manufacturing Practices (GMP) and provide regular training to industry personnel. Implementing and upholding these regulations are crucial steps toward improving the overall quality and safety of cosmetic products in Nigeria.[15] The study by Das K. K et al., assessed the microbial contamination in commonly used cosmetic samples across six categories: soap, shampoo, lotion, face wash, cream, and petroleum products. Among the 20 brands studied, the majority exhibited high levels of bacterial contamination ranging from 10^3 to 10^5 cfu/g, with fungal species proliferating up to 10^3 cfu/g. *Staphylococcus, Pseudomonas,* and *Bacillus* species were prevalent within the range of 10^1 to 10^3 cfu/g, while *actinomycetes* were absent. Notably, Escherichia coli was absent from all samples, but *Klebsiella* species were present up to 10^1 cfu/g. These findings underscored significant public health risks associated with skin diseases among users, emphasizing the need for proper guidelines to maintain good microbiological quality in topically used healthcare products.[16]

In a comprehensive study assessing the microbial contents of 150 cosmetic samples, including eye shadows, mascaras, and face creams, significant differences in contamination levels were observed among the categories. Mascaras exhibited higher contamination rates compared to eye shadows, with over 75% of eye shadows containing fewer than 100 cfu/g of aerobic bacteria, while 63% of mascaras fell into the same category. Notably, viable bacteria were absent in 61% of eye shadows and 48% of mascaras. However, a small percentage of both eye shadows (4%) and mascaras (15%) were heavily contaminated, containing more than 10^4 cfu/g of bacteria. Face creams were found to be more heavily contaminated than eye shadows and mascaras, with over 70% of creams containing more than 100 cfu/g of bacteria. Additionally, qualitative tests revealed that none of the eye shadows were contaminated with hazardous microorganisms, while specific brands of mascara exhibited isolates of *Pseudomonas aeruginosa, Citrobacter freundii,* and *Klebsiella pneumonia.* Furthermore, certain brands of face creams showed exceptionally high contamination levels, with over 85% of samples containing more than 10^3 cfu/g of fungi and at least 10^4 cfu/g of bacteria. Gram-positive cocci were more prevalent than Gram-negative bacteria, with *Staphylococcus epidermis* and *Micrococcus* species being the most commonly isolated. Among Gram-negative bacteria, *Enterobacter agglomerans, Citrobacter freundii,* and *Escherichia coli* were identified in isolated cases.[17]

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Farahnaaz Feroz et al., evaluated the microbiological quality of various commercially available baby cosmetics, such as body lotion, body wash, baby shampoo, and baby oil, from popular brands in Dhaka city. Four brands were subjected to bacteriological and mycological screening. Results showed that Brand 1 products exhibited aerobic bacterial counts exceeding acceptable limits, with all samples containing *Klebsiella* spp. and some containing *Pseudomonas* spp. and *E. coli*. In contrast, Brands 2, 3, and 4 met quality standards, with no presence of *Staphylococcus* spp. or *Bacillus* spp. This is concerning, particularly for Brand 1, given its reputation and prior contamination issues reported in the media. Considering the susceptibility of babies to infections due to their weaker immune systems, it's imperative that baby products remain free from microorganisms to prevent skin diseases such as acne, eczema, and dyschromia. Bangladesh's higher incidence of skin diseases due to overpopulation and hygiene knowledge gaps further underscores the importance of ensuring cosmetic quality.[18]

R Razooki et al., examined the microbial contamination of various cosmetic products, including shampoo, hand and body lotion, facial cleanser, and liquid soaps. Out of 60 products analyzed, 26.4% were found to be contaminated, predominantly by bacteria with no fungal contamination detected. Shampoo showed the highest level of contamination. Viable bacteria were not recovered from most samples of bath soaps, facial cleanser, hand and body lotion, and shampoo. However, coliforms were found in one shampoo sample, and isolates of *Shigella* and *Pseudomonas aeruginosa* were detected in two shampoo samples. The findings highlight the potential health risks associated with microbial contamination in cosmetic products, particularly in shampoo formulations.[19] The study aimed to assess the microbiological quality of various cosmetic powders sold in the Jos metropolis, focusing on the presence of *Staphylococcus aureus, Clostridium tetani, Pseudomonas aeruginosa,* and *Candida albicans*. A total of 60 samples, comprising 20 from each of three different brands, were analyzed. The mean aerobic plate counts ranged from 1.6×10^4 to 4.5×10^5 cfu/g, while the mean yeast and mould counts ranged from 1.1×10^4 to 2.7×10^4 cfu/g. Fifty percent of the samples were contaminated with *Staphylococcus aureus,* 20% with *Clostridium tetani,* and 7% with *Candida albicans. Bacillus* spp. were isolated from 7% of the samples, while *Pseudomonas aeruginosa* was not detected. The identified moulds included *Aspergillus niger, Aspergillus fumigatus, Penicillium spp., Rhizopus oligosporus,* and *Fusarium* spp. These findings underscore the potential microbial risks associated with cosmetic powders and highlight the importance of stringent quality control measures in their production and distribution.

Conclusion

The presence of bacterial and fungal contamination in cosmetics presents a significant concern for skin health. Despite the cosmetic industry's efforts to maintain product safety through quality control measures, microbial intruders continue to pose risks to consumers. Studies have highlighted the prevalence of various pathogenic microorganisms, including *Staphylococcus aureus, Pseudomonas aeruginosa,* and *Candida albicans*, in contaminated cosmetics. These contaminants can lead to a range of adverse effects on the skin, from irritations and allergic reactions to more severe infections. The findings underscore the importance of stringent regulatory oversight, adherence to quality manufacturing practices, and ongoing research to mitigate microbial contamination in cosmetics effectively. Consumers should also be educated about the risks associated with contaminated products and encouraged to prioritize the use of high-quality, properly preserved cosmetics to safeguard their skin health. Ultimately, addressing microbial intruders in cosmetics requires a collaborative effort among industry stakeholders, regulatory agencies, healthcare professionals, and consumers. By raising awareness, implementing best practices, and continuously monitoring product safety, we can minimize the impact of bacterial and fungal contamination on skin health and promote safer cosmetic usage.

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