VIVA MEDIKA
Jurnal Kesehatan, Kebidanan, dan Keperawatan

Homepage: http://ejournal.uhb.ac.id/index.php/vm
P-ISSN: 1979-2026 E-ISSN: 2656-1034
DOI: 10.35960/vm.v17i1.1352

Microbiological Examination of Imported Cosmetic Products in the Kurdistan/Iraq Market: A Comprehensive Analysis

Yousif Hamed Mohamed-sharif [1], Bizhar Ahmed Tayeb [2*], Farhad Ramadhan Choli [3], Hivi Salim Khamo [4], Mohammed Mahmood Ibrahim [5]

[1,4,5]Quality Control Unit, Department of Microbiology, Central laboratory of Ibrahim Khalil Quarantine, Zakho 42001, Iraq.

[2]Institute of Pharmacodynamics and Biopharmacy, Faculty of Pharmacy, University of Szeged, Szeged 6720, Hungary.

[3]Veterinary Quality Control, Directorate of Veterinary in Duhok Province, Zakho 42002, Iraq.

[1] drysf85@gmail.com; [2] **drbat25@yahoo.com***; [3] drfrd80@gmail.com; [4] hivizaxoli@gmail.com; [5] mohammedzakho@yahoo.com

ABSTRACT

The presence of diverse nutrient levels in cosmetics can facilitate microbial proliferation. Typically, bacteria such as Staphylococcus, Pseudomonas, and Klebsiella spp. are implicated in the contamination of cosmetic products. It is highly plausible that the microorganisms identified in cosmetic items emanate from contaminated water sources. The primary aim of this study was to perform a comprehensive microbial analysis of specific brands of cosmetics frequently utilized in Iraqi communities. The scrutinized products encompassed a range of items, including hair shampoo, hair conditioner, skin cream, wet wipes, toothpaste, liquid soap, and baby shampoo. Within the scope of this investigation, 84 cosmetic products were examined, revealing a contamination rate of 7.14%. Predominantly, bacterial contamination was identified, with an absence of fungal contamination. Notably, hair shampoo exhibited the highest level of contamination among the examined products categories. The recovery of total viable bacterial counts was observed across all contaminated samples, including coliforms, Staphylococcus, and Pseudomonas sp. The findings of the microbial investigation indicate an elevated concentration of total viable microorganisms in all samples. Consequently, these compromised products pose substantial health risks to consumers.

Keywords: cosmetics, fungal contamination, health risks, hygiene standards, microbial investigation, quality measurement

1. INTRODUCTION

Cosmetics have garnered considerable importance in daily life, serving as integral tools for enhancing aesthetic appeal, providing protection against sun damage, and eliminating impurities (Martins & Marto, 2023). As asserted by previous research, cosmetic products comprise essential minerals and chemical components dissolved in water, establishing a conducive environment for microbial growth (Bom et al., 2019). Many users of communal beauty items in salons may lack awareness regarding the potential presence of a diverse array of germs in makeup, posing a risk of exposure to potentially infectious

***Bizhar Ahmed Tayeb.**
Tel.: +36-30 4739432
Email: drbat25@yahoo.com

This work is licensed under a Creative Commons Attribution-Share Alike 4.0

microbes (Rezk et al., 2023). There exists a perceived association between cosmetics and the occurrence of skin or eye illnesses, which could be transmitted to clients if proper hygiene measures are not diligently implemented (Alharbi & Alhashim, 2021; Halla et al., 2018). The contamination of germs in cosmetic testers commonly observed in beauty stores is often attributed to the shared utilization of makeup and the repeated use of the same applicators. Additionally, inadequate handling practices during product showcasing contribute to the proliferation of microbial contaminants (Kim et al., 2020; Yazdani et al., 2022). The utilization of skincare products, such as powder and cream, along with eye cosmetics like mascara and eyeliner, may potentially pose a risk of skin infection to consumers (Kim et al., 2020; Yazdani et al., 2022). Furthermore, hairdressing activities can also contribute to this risk. Beauty products have been found to harbour deleterious bacteria such as *Staphylococcus aureus* (*S. aureus*) and *Pseudomonas aeruginosa* (*P. aeruginosa*), as reported by the study referenced in citation (Samanta et al., 2017). *S. aureus* and *S. epidermidis* are predominant bacteria implicated in the onset of diverse human diseases, encompassing skin infections, boils, bullous impetigo, hair follicle infections, and scalded-skin syndrome.

These diseases are reported to be prevalent in hairdressing and beauty salons in both India and Nigeria (Duggal et al., 2016; Samanta et al., 2017). Furthermore, a subsequent investigation revealed that *Bacillus*, *Staphylococcus*, *Pseudomonas*, *Enterobacter*, *Escherichia coli* (*E. coli*), and *Klebsiella* were the predominant bacteria identified in cosmetic items (Bashir & Lambert, 2020). The leading cause of allergic contact dermatitis in specific regions of the Middle East has been attributed to skincare products, hair preparations, and facial makeup, as indicated by studies conducted by reference (Alswedi & Shakeir, 2019).

Herpes leads to the development of blisters on the lips and around the mouth, often attributed to the use of shared cosmetic tools. A previous study asserts that lipsticks and powder brushes, when in contact with particular facial areas, hold the potential to transmit infections, including allergic contact dermatitis, to other individuals (Noor et al., 2020). The prevalent bacteria found in eye makeup, such as mascara and eyeliner, are *P. aeruginosa* and *P. putida*. In addition, *P. aeruginosa* has the potential to induce irritation, conjunctivitis, pink eye, redness, and excessive watery discharge, which may ultimately result in permanent blindness (Hilliam et al., 2020). Makeup brushes can provide as favourable environments for germs to flourish.

In spite of the enforcement of rigorous regulations aimed at augmenting the microbiological quality of cosmetics, instances of contamination have been recurrently documented, thereby giving rise to considerable concerns for consumers (Feng et al., 2019). Unfortunately, there exists a substantial deficit in awareness and comprehension pertaining to cosmetic contamination and the correlated health risks across diverse age groups. Furthermore, there is an absence of established legislation, protocols, and optimal methodologies for the management of numerous public makeup testers. The principal objective of this study was to assess the bacterial and fungal contamination present in seven distinct imported cosmetic products.

2. MATERIALS AND METHODS

2.1 Sample Collection

A total of 84 samples were gathered from the Ibrahim Khalil international complex quarantine in Zakho City between March and August 2023. These samples were categorized into seven distinct groups, each group comprising 12 samples representing various cosmetic products. Inclusion criteria encompassed products commonly utilized by consumers in Iraqi communities, including hair shampoo, hair conditioner, skin cream, wet wipes, toothpaste, liquid soap, and baby shampoo. To maintain consistency, only products availableat the Ibrahim Khalil International Complex Quarantine in Zakho City were considered. Exclusion criteria involved omitting products that were discontinued, expired, or that exhibited visible signs of damage or contamination. Each individual sample was documented with its

corresponding manufacturing and expiration dates for precise data tracking and analysis.

2.2 Counting of Aerobic Mesophilic Bacteria

The enumeration process of aerobic mesophilic bacteria was executed utilizing either the pour plate method or the membrane filtration method, contingent upon the solubility characteristics of the substance. In the pour plate method, 1 gram (g)/1 millilitre (mL) of the product was transferred into 9 mL of diluent modified letheen broth (MLB) and thoroughly mixed until the sample was dissolved. For water-insoluble compounds, 1 gram of the sample was mixed with 9 mL of MLB solution containing 0.1% polysorbate 80, serving as a neutralizer. Subsequently, 1 mL of each prepared sample was evenly distributed onto a sterile 90 mm Petri dish, with this process repeated twice for each sample. Following this, 20 mL of modified Letheen agar (MLA) was poured onto each dish to enumerate the aerobic mesophilic bacteria. The MLA plates were incubated in a controlled environment at a temperature of 32.5 ± 2.5 °C for a duration of 3 to 5 days. The quantity of colony-forming units (CFUs) per mL or per gram of the product was determined, and the findings were meticulously documented (Jairoun et al., 2020).

2.3 Quantification of Yeast and Mold

The enumeration process of yeast and mold was carried out utilizing either the pour plate method or the membrane filtration method, contingent upon the solubility characteristics of the substance. In the pour plate method, 1 g/1 mL of the product was transferred into 9 mL of diluent MLB and thoroughly mixed until the sample dissolved. For water-insoluble compounds, 1 g of the sample was mixed with 1 mL of MLB solution containing 0.1% polysorbate 80, as a neutralizer. The resulting mixture was thoroughly integrated. Following the preparation, 1 mL of each sample was evenly spread onto a sterile 90 mm Petri dish, a process repeated twice for accuracy. The Petri dishes were supplemented with 20 mL of sabouraud dextrose chloramphenicol agar medium for yeast and mould enumeration. Additionally, sabouraud dextrose agar medium was employed for bacterial products, distinguishing between known and non-contaminated samples. The media plates were subsequently incubated at a temperature of 25.5 ± 2.5 °C for a duration of 3 to 5 days. The enumeration of CFUs per mL or per gram of the product was conducted, and the results were meticulously recorded (Jairoun et al., 2020).

2.4 *Escherichia coli* Detection

Initially, 1 g per 1 mL of the substance was transferred to 9 mL of diluent MLB and incubated at a temperature of 30-35 °C for a duration of 20-72 hours. Following the completion of the enrichment broth phase, the subculture was incubated on a MacConkey agar plate at 30-35 °C for 18 to 72 hours. The identification of *E. coli* was ascertained through the development of brick-red colonies with a surrounding zone of precipitated bile on the MacConkey agar medium.

Confirmation of *E. coli* was attained through an identification test employing the Indole and Eosin Methylene Blue (EMB) agar. The indole test functioned as the confirming assay for *E. coli*. The culture was inoculated into 5 mL of sterile tryptone broth and incubated at 42–44 °C for 24 hours. Subsequent to incubation, 0.5 mL of Kovac's reagent was introduced into each tube, thoroughly mixed, and allowed to stand undisturbed for 10 minutes. The presence of any red hue in the reagent layer signified the presence of indole, thereby confirming the potential existence of *E. coli*. Additionally, a loopful of the MacConkey agar subculture was inoculated onto EMB agar and incubated for 18-24 hours at 30-35 °C.

The colonies of *E. coli* presented a distinctive black coloration, centrally located, and demonstrated a flat morphology, with or without an accompanying metallic sheen. Gram staining procedures were performed, elucidating the existence of Gram-negative rods and colonies characterized by both motility and a smooth surface (Jairoun et al., 2020).

2.5 Identification of *Staphylococcus aureus*

Initially, 1 gram of the product per 1 mL was transferred to 9 mL of diluent MLB and allowed to incubate at 30–35 °C for a duration ranging from 20 to 72 hours. After completion of the enrichment broth phase, the subculture was cultivated on a Baird Parker agar plate and

incubated at a temperature of 30-35 °C for 18 to 24 hours. Colonies displaying a black and glossy appearance, surrounded by clear zones, were observed.

Further confirmation was conducted through the implementation of the catalase test, coagulase test, and Gram staining. S. aureus, characterized by a spherical shape, exhibited a purple stain when subjected to Gram staining. It produces two enzymes, namely catalase and coagulase (Jairoun et al., 2020).

2.6 Detection of *Pseudomonas aeruginosa*

For P. aeruginosa detection, 1 g or 1 mL of the product was transferred to 9 mL of diluent MLB and incubated at a temperature of 30-35 °C for 20 to 72 hours. Following the completion of the enrichment broth phase, the subculture was cultivated on a cetrimide agar plate. The plate was subsequently placed in an incubator at a temperature of 30-35 °C for 18 to 24 hours. The colonies manifested fluorescence under ultraviolet (UV) light, transitioning from yellow to green. Additional confirmation procedures included the oxidase test and Gram staining. P. aeruginosa characterized as a Gram-negative and oxidase-positive bacterium, can be identified by the presence of pyocyanin on Pseudomonas agar (Jairoun et al., 2020).

2.7 Data Analysis

In the presentation of data, the enumeration of bacterial and fungal populations is articulated through the quantification of colony-forming units (CFUs) per unit volume, specifically measured in grams or millilitres (CFU/g, or CFU/mL). The detection parameter, a crucial aspect of the data representation, succinctly classifies the microbial presence as either existing ("present") or not ("absent") per unit mass. The data were analyzed using GraphPad Prism V. 5.01 (GraphPad Software, San Diego, CA, USA). This meticulous approach to data presentation aligns with standard microbiological practices, providing a comprehensive and precise portrayal of microbial abundance in the examined samples.

2.8 Quality Control and Assurance

Sterility and contamination checks were meticulously performed on all media, and a comprehensive quality control evaluation was carried out. This involved the utilization of specifically tailored positive and negative control strains for each medium to ensure the reliability and accuracy of the experimental conditions.

3. RESULTS AND DISCUSSION

Cosmetics encompass nutritional components that facilitate the growth of microorganisms, rendering them intentionally non-sterile. Skin diseases are prevalent in economically disadvantaged nations, attributable to inadequate sanitation practices, consumption of microbiologically contaminated water, and an unhygienic living environment (Aleem et al., 2020). Therefore, it is imperative that cosmetic products be free from pathogens and exhibit a total aerobic bacterial load below specified limits, as these microorganisms lack the capability to induce skin infections (Nusrat et al., 2023). The assurance of maintaining high-quality cosmetic products is of paramount importance. To achieve this, a requisite step involves conducting microbiological analyses on the final product to mitigate the potential risk of skin infections.

Table 1 presents data indicating that 7.14% of the 84 tested products exhibited positive results for total aerobic bacterial counts, coliforms, and Staphylococcus and Pseudomonas counts. The predominant contamination observed was bacterial in nature, with no instances of yeast or mould infection identified in any of the tested items. Notably, shampoos displayed a higher susceptibility to contamination compared to other products, potentially attributed to the presence of surfactants, as indicated in Table 1.

Table 1. Sample type and total number of product and their microbial contamination rate

Sample	No. of products	Positive (%)
Hair Shampoo	12	2 (16%)
Hair conditioner	12	1 (8%)
Skin cream	12	1 (8%)
Wet wipes	12	2 (16%)
Toothpaste	12	ND (0.0%)
Liquid soap	12	ND (0.0%)
Baby shampoo	12	ND (0.0%)
Total	84	7.14%

ND: not detected

Table 2 shows the isolated microorganism from diverse cosmetic products, indicating the exact number of CFU/g or CFU/mL. All contaminated products exhibited a significantly elevated concentration of total viable bacteria, reaching up to 105 CFU/g, especially those manufactured internationally. Both Klebsiella spp. and Pseudomonas spp. were identified across all contaminated brands, with colony-forming units ranging from 1 to 101 per gram. This concentration surpasses the established limit of less than 10^3 CFU/g set by the United States Pharmacopeia - U.S. Food and Drug Administration (USP-FDA) (Onaghise, 2020) for areas other than the eyes and does not comply with the Iraqi standard regarding cosmetic importation. All contaminated samples harboured a *Staphylococcus* species, a pathogenic bacterium confirmed through biochemical testing. Interestingly, none of the samples exhibited the presence of either *E. coli* or fungi. Both *Klebsiella* and *Pseudomonas* species were identified across all brands, with colony-forming units ranging from 1 to 10^1 per gram. Remarkably, no fungal populations were detected in any of the tested product samples (Table 2).

Table 2. Analysis of pathogenic microorganism populations across diverse cosmetic brands

Product name	TVB (CFU/g)	*Pseudomonas* spp. (CFU/g)	*Klebsiella* spp. (CFU/g)	*Staphylococcus* spp. (CFU/g)	*E. coli* (CFU/g)	Total fungal count
Hair Shampoo	34×10^4	3.8×10^1	5.39×10^1	8.25×10^1	0.00	0.00
Hair conditioner	1.4×10^4	2.9×10^1	1.09×10^1	1.2×10^1	0.00	0.00
Skin cream	6.2×10^4	3.9×10^1	1.29×10^1	2.2×10^1	0.00	0.00
Wet wipes	8.1×10^4	2.8×10^1	4.39×10^1	3.25×10^1	0.00	0.00
Toothpaste	0.00	0.00	0.00	0.00	0.00	0.00
Liquid soap	0.00	0.00	0.00	0.00	0.00	0.00
Baby shampoo	0.00	0.00	0.00	0.00	0.00	0.00

TVB: total bacterial count; CFU: colony forming unit; g: gram.

The results of the microbial analysis on various cosmetic products, as outlined in Table 1, provide insights into the prevalence of microorganisms across different categories. Among the products tested, hair shampoo and wet wipes exhibited a positive detection for microorganisms in 16% of the samples, while hair conditioner and skin cream each displayed an 8% positive rate. Notably, toothpaste, liquid soap, and baby shampoo recorded a 0.0% positive rate (ND), indicating an absence of detectable microorganisms in these particular products. The cumulative analysis across all products revealed an overall contamination rate of 7.14%. These findings affirm the importance of vigilance in cosmetic product manufacturing and emphasize potential variations in microbial susceptibility among different cosmetic categories. The observed absence of microbial contamination in toothpaste, liquid soap, and baby shampoo highlights successful manufacturing practices in maintaining microbiological safety. The results provide valuable information for both consumers and manufacturers, assuring the necessity for stringent quality control measures to ensure the microbiological safety of cosmetic products.

The results of our study are consistent with the findings previously reported, as both investigations observed the presence of Gram-negative bacilli. Similar to other previous published data from Iraq, determined that shampoos were contaminated by bacterial coliform of about 11% and most of the contamination were comes from bacterial sources other than fungal (Razooki et al., 2017). In our study, the obtained results deviate from the findings reported in a previous research (Alshehrei, 2023). A notable dissimilarity arises concerning the isolation of *E. coli* and yeast, which were reported in the previous study (Alshehrei, 2023). Unlike the earlier report (Alshehrei, 2023), our investigation did not yield isolates of E. coli or yeast. This variance highlights the significance of methodological disparities, sample characteristics, and potential contextual factors that may contribute to differing microbial

outcomes between studies. The absence of specific microbial isolates in our study, in contrast to the earlier reports, emphasizes the complexity of microbial dynamics and the need for a meticulous consideration of various factors influencing microbial presence in distinct research circumstances.

Moreover, all analysed samples demonstrated an alkaline pH ranging from 8.2 to 9, a condition known to restrict fungal contamination. It is noteworthy that, in general, microorganisms of interest in raw materials or cosmetic products exhibit optimal growth conditions at a neutral pH level of around 7.0. Additionally, it is pertinent to highlight that many yeasts and moulds demonstrate the capability to thrive in acidic pH circumstances (Kim et al., 2020).

Bacterial contamination is a prevalent issue in unused cosmetic items, stemming from the environmental conditions during the creation, packaging, and the composition of the products themselves. Cosmetic ingredients, rich in nutrients, offer organic substrates conducive to microbial development, encompassing components such as sugar, starch, protein, amino acids, organic acids, alcohol, amines, lipids, and more. Certain microorganisms, such as *P. putida*, possess a versatile oxidase enzyme, allowing them to metabolize substrates that are not accessible to many other organisms. The capacity of microorganisms to utilize specific substrates is influenced by their adaptive survival strategies. Essential nutrients for microbial growth include nitrogen, sulphur, phosphorus, and minerals.

Cosmetic ingredients act as a nutrient source conducive to microorganism proliferation. Consequently, the production of cosmetics necessitates an impeccably sterile and hygienic environment. Facilities, equipment, instruments, storage tanks, and containers associated with the manufacturing process must be consistently maintained to uphold a rigorous standard of cleanliness. Adherence to the principles of Good Manufacturing Practice (GMP) is imperative for cosmetic manufacturers to mitigate the risk of contamination (Razooki et al., 2017).

Table 3 presents the outcomes of biochemical tests conducted on microorganisms isolated and identified from the examined cosmetic products. Confirmatory biochemical assays play a crucial role in the isolation of pathogenic bacteria, serving as definitive diagnostic tools to verify the presence of specific bacterial species. These assays are designed to target key biochemical characteristics of the isolated bacteria, enabling precise identification and confirmation of their pathogenic nature. Common confirmatory biochemical tests include assays for the presence of specific enzymes like oxidase, metabolic activity such as indole and citrate tests, or motility. The results obtained from these assays aid in the accurate classification of the isolated bacteria, ensuring a reliable confirmation of their pathogenic potential. This rigorous biochemical confirmation is essential in understanding the microbial composition of samples, facilitating targeted control measures, and informing public health interventions to mitigate the risks associated with pathogenic bacteria in various environments, including cosmetic products.

Table 3. Confirmatory biochemical assays for pathogenic bacteria isolation

Organisms	Biochemical Test				
	Indole	Citrate	H2S	Motility	Oxidase
Staphylococcus spp.	-	+	+	+	-
Klebsiella spp.	-	-	-	-	+
Pseudomonas spp.	-	+	-	-	+
E. coli	+	-	-	-	-

Imported brands, such as shampoo and wet wipes, exhibited higher levels of both total bacteria and pathogenic bacteria when compared to toothpaste, liquid soap, and baby shampoo brands. This discrepancy in microbial content suggests potential environmental influences on product safety. Unclean conditions during manufacturing processes and the quality of raw materials utilized may contribute to microbiological development, thereby influencing the overall microbial composition in cosmetic products. This observation underscores the importance of

stringent quality control measures, particularly for imported brands, to ensure microbiological safety and mitigate potential health risks associated with the use of these products (Kim et al., 2020). Various factors, encompassing chemicals such as lipids, alcohol, polysaccharides, glucosides, among others, along with considerations like storage temperature, inadequate preservative action, product pH, and oxygen availability, collectively contribute to microbial development. These elements interact in complex ways, influencing the microbiological profile of cosmetic products. Understanding and addressing these contributing factors is crucial for formulating effective preservation strategies and maintaining microbiological safety in cosmetic formulations (Murphy et al., 2021).

The study used traditional culture media to assess bacteria, mold, and yeast in 84 cosmetic products, which may not be representative of the wide range of imported cosmetics in the Kurdistan/Iraq market. This limited sample size may also limit the depth and specificity of the microbial analysis, potentially missing certain microorganisms. Additionally, traditional culture methods may not fully capture microbial diversity, specifically overlooking diverse microorganisms in cosmetic products. Future analyses should consider expanding the sample size and incorporating advanced microbiological and molecular techniques.

CONCLUSION

According to the findings, bacteria pose a higher risk of contamination compared to mould or yeast in cosmetic products. The optimal pH for bacterial growth, found in the majority of cosmetic formulations, contributes to this microbial prevalence. Commonly reported contaminants in cosmetic products include microorganisms such as Pseudomonas spp., Klebsiella spp., and Staphylococcus spp. Shampoos, in particular, exhibit a heightened susceptibility to contamination, potentially attributed to the inclusion of surfactants that can shelter contamination by Gram-negative bacteria present in water. Mitigating contamination risks in the cosmetic manufacturing process involves strategic management of raw materials, rigorous process validation, implementation of effective cleaning and sanitizing methods, and comprehensive training programs for personnel.

REFERENCES

Aleem, A., Khan, M., Abid, U., Ishfaq, M. F., Rouf, A., & Jamshaid, T. (2020). Microbial Analysis of Selected Brands of Whitening Creams. *Saudi Journal of Medical and Pharmaceutical Sciences*, *06*(02), 178–182. https://doi.org/10.36348/sjmps.2020.v06i02.006

Alharbi, N. M., & Alhashim, H. M. (2021). Beauty Salons are Key Potential Sources of Disease Spread. *Infection and Drug Resistance*, *Volume 14*, 1247–1253. https://doi.org/10.2147/IDR.S303461

Alshehrei, F. M. (2023). Isolation and Identification of Microorganisms associated with high-quality and low-quality cosmetics from different brands in Mecca region -Saudi Arabia. *Saudi Journal of Biological Sciences*, *30*(12), 103852. https://doi.org/10.1016/j.sjbs.2023.103852

Alswedi, F., & Shakeir, A. (2019). Isolation of Pathogenic Bacteria from some Male Barbershops in the City of Nasiriyah. *International Journal of Pharmaceutical Quality Assurance*, *10*, 233–241. https://doi.org/10.25258/ijpqa.10.2.4

Bashir, A., & Lambert, P. (2020). Microbiological study of used cosmetic products: Highlighting possible impact on consumer health. *Journal of Applied Microbiology*, *128*(2), 598–605. https://doi.org/10.1111/jam.14479

Bom, S., Jorge, J., Ribeiro, H. M., & Marto, J. (2019). A step forward on sustainability in the cosmetics industry: A review. *Journal of Cleaner Production*, *225*, 270–290. https://doi.org/10.1016/j.jclepro.2019.03.255

Duggal, S. D., Bharara, T., Jena, P. P., Kumar, A., Sharma, A., Gur, R., & Chaudhary, S.

(2016). Staphylococcal bullous impetigo in a neonate. *World Journal of Clinical Cases*, *4*(7), 191–194. https://doi.org/10.12998/wjcc.v4.i7.191

Feng, W., Yang, J., Xi, Z., Ji, Y., Zhu, X., Yang, L., & Ma, Y. (2019). Regulatory Role of ERG3 and Efg1 in Azoles-Resistant Strains of Candida albicans Isolated from Patients Diagnosed with Vulvovaginal Candidiasis. *Indian Journal of Microbiology*, *59*(4), 514–524. https://doi.org/10.1007/s12088-019-00833-x

Halla, N., Fernandes, I. P., Heleno, S. A., Costa, P., Boucherit-Otmani, Z., Boucherit, K., Rodrigues, A. E., Ferreira, I. C. F. R., & Barreiro, M. F. (2018). Cosmetics Preservation: A Review on Present Strategies. *Molecules : A Journal of Synthetic Chemistry and Natural Product Chemistry*, *23*(7), 1571. https://doi.org/10.3390/molecules23071571

Hilliam, Y., Kaye, S., & Winstanley, C. (2020). Pseudomonas aeruginosa and microbial keratitis. *Journal of Medical Microbiology*, *69*(1), 3–13. https://doi.org/10.1099/jmm.0.001110

Jairoun, A. A., Al-Hemyari, S. S., Shahwan, M., & Zyoud, S. H. (2020). An Investigation into Incidences of Microbial Contamination in Cosmeceuticals in the UAE: Imbalances between Preservation and Microbial Contamination. *Cosmetics*, *7*(4), 92. https://doi.org/10.3390/cosmetics7040092

Kim, H. W., Seok, Y. S., Cho, T. J., & Rhee, M. S. (2020). Risk factors influencing contamination of customized cosmetics made on-the-spot: Evidence from the national pilot project for public health. *Scientific Reports*, *10*(1), 1561. https://doi.org/10.1038/s41598-020-57978-9

Martins, A. M., & Marto, J. M. (2023). A sustainable life cycle for cosmetics: From design and development to post-use phase. *Sustainable Chemistry and Pharmacy*, *35*, 101178. https://doi.org/10.1016/j.scp.2023.101178

Murphy, B., Hoptroff, M., Arnold, D., Eccles, R., & Campbell-Lee, S. (2021). In-vivo impact of common cosmetic preservative systems in full formulation on the skin microbiome. *PLoS ONE*, *16*(7), e0254172. https://doi.org/10.1371/journal.pone.0254172

Noor, A., Rabih, W., Alsaedi, A., Al-Otaibi, M., Alzein, M., Alqireawi, Z., Mobarki, K., AlSharif, R., & Alfaran, H. (2020). Isolation and identification of microorganisms in selected cosmetic products tester. *African Journal of Microbiology Research*, *14*, 536–540. https://doi.org/10.5897/AJMR2020.9399

Nusrat, N., Ahmad Zahra, M., Ahmed, A., & Haque, F. (2023). Assessment of potential pathogenic bacterial load and multidrug resistance in locally manufactured cosmetics commonly used in Dhaka metropolis. *Scientific Reports*, *13*, 7787. https://doi.org/10.1038/s41598-023-34782-9

Onaghise, O. (2020). *Pharmaceutical Microbiology Manual*.

Razooki, R., N. Saeed, E., & Hamza, H. (2017). A Study on Cosmetic Products Marketed in Iraq: Microbiological Aspect. *Iraqi Journal of Pharmaceutical Sciences (P-ISSN: 1683 - 3597 , E-ISSN : 2521 - 3512)*, *18*(2), 20–25. https://doi.org/10.31351/vol18iss2pp20-25

Rezk, S., Soliman, H., Kader, O., & Turkey, M. (2023). Could beauty salon brushes be a potential candidate for transmitting bacterial infections? *Microbes and Infectious Diseases*, *0*(0), 0–0. https://doi.org/10.21608/mid.2023.233685.1609

Samanta, S., Singh, B. R., & Adholeya, A. (2017). Intracellular Synthesis of Gold Nanoparticles Using an Ectomycorrhizal Strain EM-1083 of Laccaria fraterna and Its Nanoanti-quorum Sensing Potential Against Pseudomonas aeruginosa. *Indian Journal of Microbiology*, *57*(4), 448–460. https://doi.org/10.1007/s12088-017-0662-4

Yazdani, M., Elgstøen, K. B. P., & Utheim, T. P. (2022). Eye Make-up Products and Dry Eye Disease: A Mini Review. *Current Eye Research*, *47*(1), 1–11. https://doi.org/10.1080/02713683.2021.1966476