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Detection of Bacterial and fungal contamination in shared cosmetic products used in some beauty women's salons in Benghazi

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الكشف عن التلوث البكتيري والفطري في منتجات التجميل المشتركة المستخدمة في بعض صالونات التجميل النسائية في مدينة بنغازي

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Abstract

This study aims to identify the microbial contamination of in-use skin and eye cosmetics available as public makeup kits in beauty salons. A total of 120 samples were included in this cross-sectional study, collected from 15 randomly selected beauty salons across different regions of Benghazi between July and December 2024. Samples were transported to the laboratory under sterile conditions and examined to identify bacterial and fungal species.

The results revealed that all tested cosmetics were contaminated, with bacteria found in 76.4% of samples and fungi/yeast in 23.5%. *Staphylococcus epidermidis*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Bacillus subtilis*, and *Candida* were the dominant species isolated. The highest rate of microbial contamination was found in skin products (50%), while the lowest was in eye products (26.5%). Regarding fungal contamination, cream-based products showed the highest rate (70.8%), followed by mascara (20.8%), lip gloss (16.6%), and brushes (11.5%).

The findings indicate that shared cosmetic products in beauty salons are heavily contaminated with various microorganisms. Therefore, it is strongly recommended to avoid sharing cosmetic tools and products, refrain from using public makeup in salons, and ensure that products are stored in dry, appropriate conditions.

Keywords: Contamination, Cosmetic products, Beauty salons, Benghazi.

الملخص

تهدف هذه الدراسة إلى تحديد التلوث الميكروبي لمستحضرات تجميل البشرة والعيون المستخدمة حالياً، والتي تتوفر كأطقم مكياج عامة للسيدات في صالونات التجميل. اشتملت هذه الدراسة المقطعية على 120 عينة من مستحضرات تجميل البشرة والعيون، تم جمعها من 15 صالون تجميل اختيرت عشوائياً من مناطق مختلفة بمدينة بنغازي في الفترة ما بين يوليو وديسمبر 2024. نُقلت العينات إلى المختبر تحت ظروف تعقيم كاملة، ثم فُحصت لتحديد الأنواع البكتيرية والفطرية الموجودة بها.

أظهرت النتائج أن جميع مستحضرات التجميل المستخدمة كانت ملوثة، حيث بلغت نسبة التلوث البكتيري 76.4%، بينما بلغت نسبة التلوث بالفطريات والخمائر حوالي 23.5%. كانت الأنواع السائدة المعزولة من المستحضرات هي: البكتيريا العنقودية البشرية(*Staphylococcus epidermidis*) ، الزائفة الزنجارية(*Pseudomonas aeruginosa*) ، المكورات العنقودية الذهبية(*Staphylococcus aureus*) ، العصوية الرقيقة(*Bacillus subtilis*) ، وفطريات الكانديدا (*Candida*). سُجلت أعلى معدلات التلوث الميكروبي في منتجات البشرة (50%)، بينما كانت النسبة الأدنى في منتجات تجميل العيون (26.5%). وفيما يتعلق بالتلوث الفطري، كانت المنتجات ذات القوام الكريمي هي الأكثر تلوثاً بنسبة (70.8%)، تليها الماسكارا بنسبة (20.8%)، ثم ملمع الشفاه بنسبة (16.6%)، وأخيراً الفرش بنسبة (11.5%).

خلصت النتائج إلى أن جميع عينات مستحضرات التجميل المختبرة والمستخدمة بشكل مشترك في صالونات التجميل كانت ملوثة تقريباً بالبكتيريا والفطريات. بناءً على ذلك، توصي الدراسة بتجنب مشاركة الأدوات ومستحضرات التجميل بين السيدات، والامتناع عن استخدام المكياج العام في الصالونات، وضرورة حفظ المنتجات المستخدمة في أماكن جافة.

الكلمات المفتاحية :التلوث، مستحضرات التجميل، صالونات التجميل، بنغازي.

1. Introduction

Beauty salons, while intended for aesthetic enhancement, often serve as reservoirs for various infections, including skin and eye diseases. This risk is primarily driven by inadequate hygiene standards, a lack of preventative measures, and insufficient regulatory oversight, which imposes significant psychological and financial burdens on affected individuals. Factors contributing to this issue include the absence of proper sterilization equipment, the misuse of chemical products, and the prevalence of counterfeit brands manufactured under substandard conditions (1).

Cosmetics have become essential in daily life, with consumption increasing annually (1). Most cosmetic formulations contain ingredients that provide a favorable environment for microbial growth. Contamination can occur during the manufacturing process due to non-sterile factory environments (2), contaminated raw materials, or the use of non-sterile water (3). Once in use, cosmetics can act as vectors for microorganisms, potentially leading to infections such as conjunctivitis or more severe health complications through direct or indirect exposure (4). The susceptibility of these products to microbial proliferation is attributed to the high moisture content in certain formulations (such as creams) and the presence of minerals and organic/inorganic compounds that support microbial life (5, 6). Furthermore, salon tools such as tweezers, sponges, and brushes can facilitate the transmission of pathogens (7). Therefore, investigating the growth and transmission patterns of infectious agents in beauty products is crucial for developing effective protocols to prevent such diseases (8).

2. Materials and Methods

2.1 Aim of the Study

This study aims to evaluate the microbial contamination of cosmetic products used in selected beauty salons in Benghazi, Libya. Fifteen salons were randomly selected from various districts to ensure a representative sample of cosmetic products used in professional beauty environments.

2.2 Sample Collection

The study was conducted in Benghazi over a six-month period, from July 2024 to December 2024. A total of 120 swab samples were collected from 15 beauty salons. Samples were obtained directly from in-use products, including lipsticks, mascaras, foundation creams, eyeliners, face powders, moisturizers, brushes, and makeup removers. All samples were collected following standardized scientific protocols to ensure sterile conditions during transport and processing.

2.3 Laboratory Analysis

The samples were inoculated onto Blood Agar, MacConkey Agar, and Sabouraud Dextrose Agar (SDA) media and incubated at 37°C for 24–48 hours. Following incubation, the isolates were identified using morphological characteristics and a series of biochemical tests, including Coagulase, Catalase, Oxidase, and Germ Tube tests. For definitive species identification, API (Analytical Profile Index) test kits were utilized.

3. Results

A total of 120 microbial samples were collected from various cosmetic products across 15 beauty salons in Benghazi, Libya. The sampled items included mascara, blush, lipstick, eyeliner, compact powder, foundation cream, eyeshadow, and applicator brushes.
Microbiological culture analysis revealed that 102 samples (85%) exhibited positive microbial growth, while only 18 samples (15%) showed no evidence of microbial contamination.

Table 1 Collected samples according to bacterial growth**.**

Bacterial growth	Number of cases	Percentage%
growth	102	85%
Non-growth	18	15%
Total	120	100%

Table 1 illustrates the percentages of microbial growth and non-growth. Out of the 120 cosmetic products tested, 102 samples (85%) exhibited positive microbial growth, while 18 samples (15%) showed no growth.

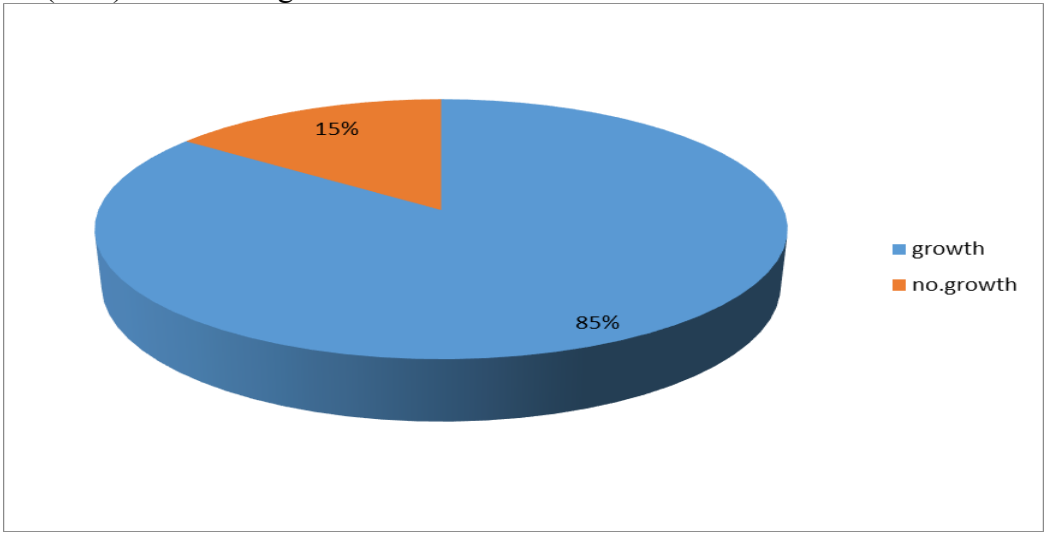

Figure 1: Collected samples according to bacterial growth.

Table 2 Cosmetics samples products with microbial contamination.

Isolated microorganisms	Number of isolates	Percentages %
Staphylococcus epidermidis	36	35.3%
Candida albicans	24	23.5%
Staphylococcus Aureus	18	17.6%
Pseudomonas aeruginosa	16	15.7%
Bacillus subtilis	8	7.8%
Total	102	99.9%

Table 2 presents the distribution and percentages of microbial species isolated from the contaminated cosmetic products. The most prevalent microorganism was Staphylococcus epidermidis with 36 isolates (35.3%), followed by Candida albicans with 24 isolates (23.5%). Other isolated species included Staphylococcus aureus at 18 isolates (17.6%), Pseudomonas aeruginosa at 16 isolates (15.7%), and Bacillus subtilis at 8 isolates (7.8%).

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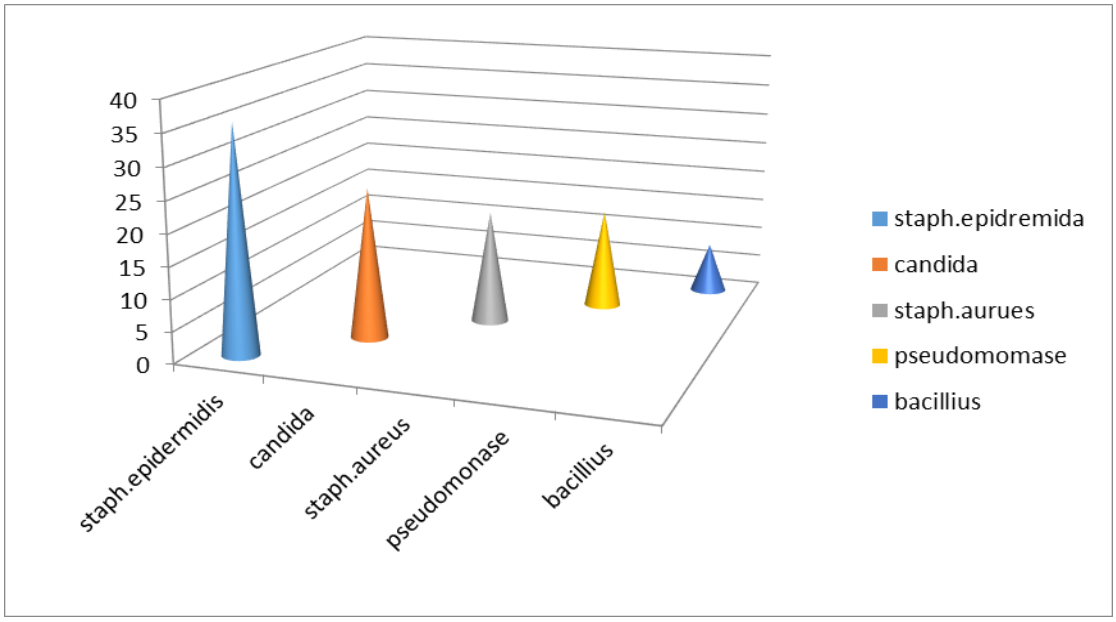

Figure 2: Cosmetics sample products with microbial contamination**.**

Table 3 Percentage of isolated bacteria and fungi.

Microorganism Type	Number of Isolates	Percentage (%)
Bacteria	78	76.47%
Fungi	24	23.53%
Total	**102**	**100%**

Table 3 illustrates the distribution of isolated microorganisms categorized by type. Bacterial isolates constituted the majority of the recovered microorganisms, accounting for 78 cases (76.47%). In contrast, fungal isolates represented a significantly smaller proportion, with 24 cases (23.53%).

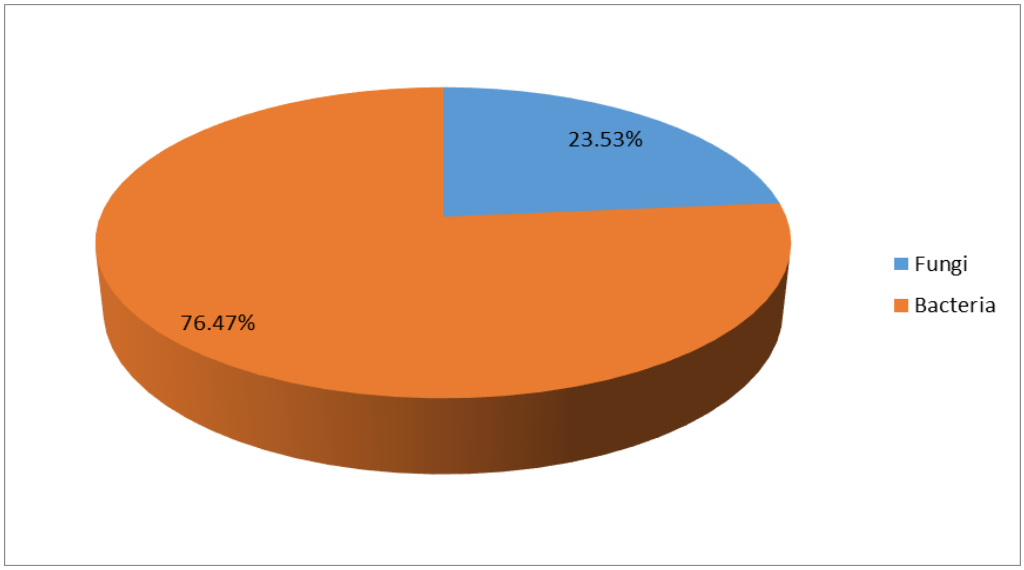

Figure 3: Percentage of isolated bacteria and fungi.

Table 4: Frequency of Contaminants in Cosmetic Products by Microorganism Type

Product Type	Isolated Microorganisms	Count	Microbial Classification
Brush	*Staphylococcus epidermidis*	9	Gram-positive cocci
	Staphylococcus aureus	4	Gram-positive cocci
Blenders	*Candida albicans*	7	Yeast (fungal pathogen)
Compact Powder	*Staphylococcus epidermidis*	4	Gram-positive cocci
	Bacillus subtilis	5	Gram-positive bacilli
Concealer	*Staphylococcus epidermidis*	3	Gram-positive cocci
	Pseudomonas aeruginosa	1	Gram-negative bacilli
Eyeliner	*Staphylococcus epidermidis*	2	Gram-positive cocci
	Staphylococcus aureus	4	Gram-positive cocci
	Pseudomonas aeruginosa	2	Gram-negative bacilli
Eyeshadow	*Staphylococcus aureus*	2	Gram-positive cocci
	Pseudomonas aeruginosa	4	Gram-negative bacilli
	Staphylococcus epidermidis	4	Gram-positive cocci
Foundation	*Bacillus subtilis*	2	Gram-positive bacilli*
	Staphylococcus epidermidis	3	Gram-positive cocci
Highlighter	*Bacillus subtilis*	1	Gram-positive bacilli
	Staphylococcus epidermidis	2	Gram-positive cocci
Hand Cream	*Candida albicans*	4	Yeast (fungal pathogen)
	Pseudomonas aeruginosa	1	Gram-negative bacilli
	Staphylococcus epidermidis	1	Gram-positive cocci
Lipstick	*Candida albicans*	3	Yeast (fungal pathogen)
	Pseudomonas aeruginosa	3	Gram-negative bacilli
	Staphylococcus epidermidis	3	Gram-positive cocci
	Staphylococcus aureus	6	Gram-positive cocci
Lip-gloss	*Candida albicans*	4	Yeast (fungal pathogen)
	Staphylococcus epidermidis	3	Gram-positive cocci
Mascara	*Candida albicans*	5	Yeast (fungal pathogen)
	Staphylococcus aureus	2	Gram-positive cocci
	Pseudomonas aeruginosa	5	Gram-negative bacilli
	Staphylococcus epidermidis	1	Gram-positive cocci
Makeup Remover	*Candida albicans*	1	Yeast (fungal pathogen)
	Staphylococcus epidermidis	1	Gram-positive cocci

Table 4 details the frequency of contaminants in cosmetic products according to the type of microorganism and product. The data indicate that *Staphylococcus epidermidis* and *Staphylococcus aureus* were the most frequently isolated bacteria, reflecting the predominance of skin-associated contaminants in cosmetic products. The presence of *Pseudomonas aeruginosa* and *Candida albicans* highlights significant potential health risks, particularly for users with compromised skin barriers. These findings emphasize the necessity for strict hygienic manufacturing protocols and proper storage practices to minimize microbial contamination in cosmetics.

Table 5 illustrates the prevalence of bacterial and fungal contamination across cosmetic tools and products categorized by their area of use[11]. Skin cosmetic products showed the highest levels of contamination, accounting for 50% of both total bacterial and fungal isolates[2]. Eye cosmetic products followed with 33.3% of bacterial isolates and 20.8% of fungal isolates[3]. Cosmetic tools represented the lowest proportion of bacterial contamination at 16.7%, though they harbored 29.2% of the fungal isolates[4].

Table 5: Prevalence of Bacterial and Fungal Contamination in Cosmetic Tools and Products Used for the Face, Eyes, and Hands

Product and Tool Category	Bacteria (n=78)	Fungi (n=24)
Cosmetic tools	13 (16.7%)	7 (29.2%)
Eye cosmetic products	26 (33.3%)	5 (20.8%)
Skin cosmetic products	39 (50.0%)	12 (50.0%)

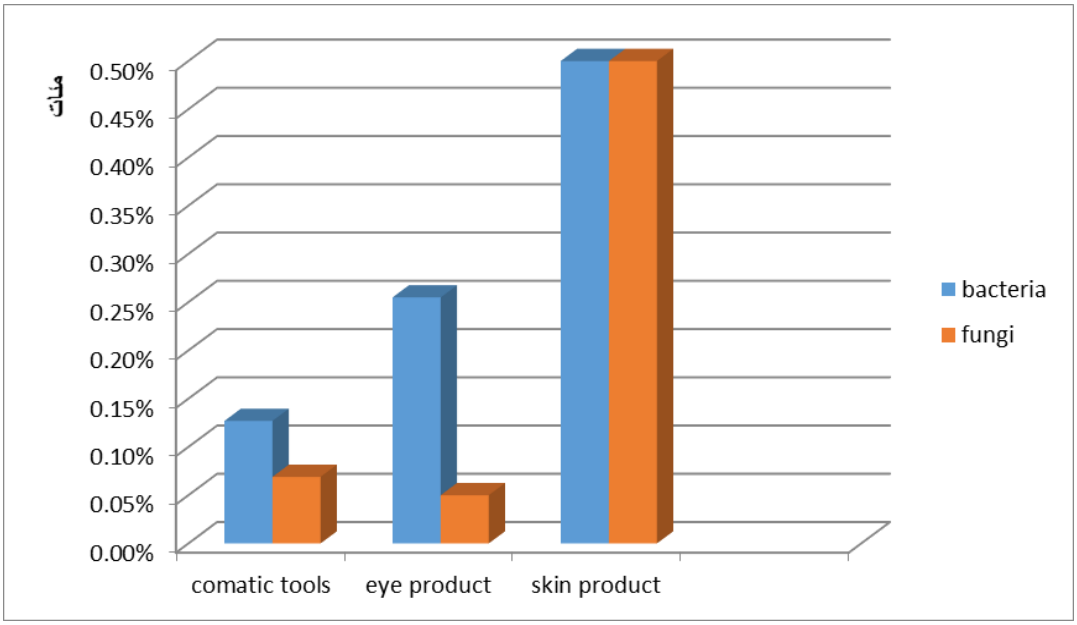

Figure 4: Prevalence of Bacterial and Fungal Contamination in Cosmetic Tools and Products Used for the Face, Eyes, and Hands.

Table 6 presents a comparison of microbial contamination between cream-based and dry cosmetic products. The data reveal that cream-based products were more susceptible to both bacterial and fungal growth, with 43 bacterial and 17 fungal isolates recovered. In contrast, dry cosmetic products yielded 22 bacterial isolates and no fungal growth.

Table 6: Distribution of Bacterial and Fungal Contamination by Product Formulation.

Cosmetic Products	Bacteria	Fungi
Cream-Based Cosmetic Products	43	17
Dry Cosmetic Products	22	0

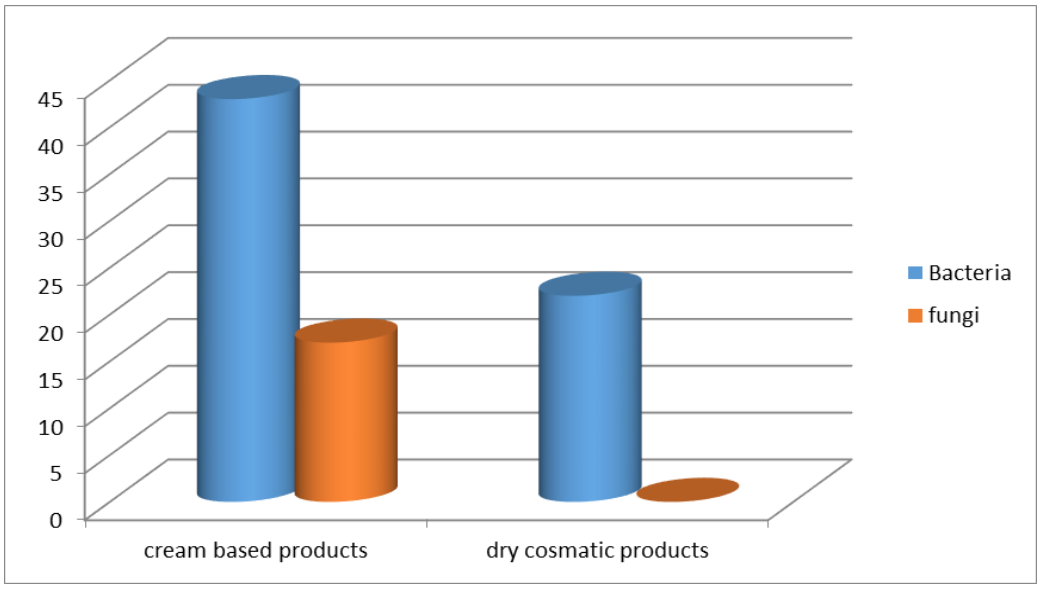

Figure 5: Percentage of Bacterial and Fungal Contamination in Dry and Cream-Based Cosmetics.

4. Discussion

In the present study, the highest rate of contamination (76.47%) was attributed to bacteria, particularly Gram-positive species. This high prevalence is partly related to human skin flora; while specific microflora may be commensal to one individual, they can become pathogenic when transferred to another. The most prevalent bacterial isolate was *S. aureus* (17.6%), a significant Gram-positive pathogen. Despite the presence of saprophytic molds—which often exhibit greater resistance to cosmetic preservatives—the opportunistic yeast *C. albicans* (23.5%) was the most frequent fungal isolate. These findings confirm that cosmetic tools in salons act as effective media for the proliferation of pathogenic microbes [9].

Previous research has consistently reported microbial contamination in both new and partially used cosmetics. For instance, a 2017 study in Iran found that 19.2% of cosmetic products were contaminated with *Candida* [10]. In Brazil, *S. aureus*, *Aspergillus*, and *Cladosporium* were identified as the primary contaminants in lipsticks [11]. Other studies in Brazil [12] and Iran [13] also identified *S. aureus* as the most frequently isolated microorganism. Conversely, separate studies in Iran conducted in 2010 [14] and 2012 [15] reported *P. aeruginosa* as the predominant strain in lotions and beauty creams. Variations in microbial profiles across studies can be attributed to storage conditions, the type of raw materials used, transportation methods, or regional climatic differences [16].

Cosmetic tools in salons serve as significant vectors for infection. Many opportunistic microbes found on tools such as sponges, lipsticks, mascaras, and brushes can cause severe skin and eye infections [17]. In this study, contamination levels in brushes were higher than in other tools, which aligns with previous findings [18]. This may be due to the larger surface area of brushes and the ability of pathogens to adhere effectively to polyethylene oxide (PEO) coatings [19].

Furthermore, skin products were found to be the most contaminated category. This high susceptibility may result from frequent exposure to air or the presence of ingredients like bentonite and talc, which can harbor microbes [20]. Additionally, shared skin products are in constant contact with powder puffs and facial pads, which facilitates cross-contamination.

Our results also indicate that cream-based products are significantly more prone to contamination than dry products. Specifically, 43 samples were contaminated with bacteria and 17 with fungi. This vulnerability is likely related to the high moisture content of the ingredients, the efficacy of the preservative systems used, and the conditions during transit and storage [21].

5. Conclusion

This study concludes that the shared and repeated use of cosmetic products and tools in beauty salons leads to high levels of pathogenic contamination, posing a risk for serious skin and ocular infections. To mitigate these risks and control person-to-person transmission, it is essential to implement strict preventive measures. These include the rigorous sterilization and washing of tools, avoiding the use of shared "public" makeup kits, and ensuring that all cosmetic materials are stored in appropriate, dry conditions.

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