

MICROBIOLOGICAL ASSESSMENT OF AIR BLOWN FROM ELECTRONIC HAND DRYERS IN PUBLIC RESTROOMS

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Abstract– The study was conducted locally to quantify and identify the microbial load in hand dryers installed in restrooms of eateries and malls. All the local malls and eateries were surveyed and petri plates containing nutrient and selective media were exposed to the air blown by the hand dryers installed in these places. Plates were incubated at 37 °C for 48 hours and colonies were counted. Air of the restrooms before switching on the dryers was used as control. It has been observed that most of the hand dryers are heavily contaminated with bacterial and fungal populations. Based on the colony characteristics, cultural characteristics and microscopic observations, most of the organisms have been identified to be potential intestinal pathogens.

INTRODUCTION

Health and hygiene are crucial aspects of an individual's well-being and overall quality of life. The importance of maintaining good health and hygiene extends to various aspects of personal, social, and environmental well-being. To uphold hygiene, washing and drying hands are the pivotal steps. Since wet hands can collect more bacteria than dry hands while contacting surfaces which spread infection (Alharbi *et al.*, 2016), there are various handwashers for decontamination of hands but rare attention is given to hand dryers. Studies have shown that hand drying pose greater risk of dissemination of microbes after handwashing (Best, *et al.*, 2018). Humid and warm environment provide better chance of survival of microbes such as *Acinetobacter baumannii*, *Staphylococcus aureus*, *Shigella* sp., *Escherichia coli*, *Enterococcus* sp., *Klebsiella* sp. Moreover, viruses like human adenovirus & Norovirus and fungal spores found near flushing area gather in hand dryers.

Among all the other means of hand drying, namely, jet air dryers, paper towels, hot air dryers and cloth towels, air dryers pose greater contamination threats due to accumulation of aerosols from toilets and uncleaned hands. Redway

and Fawdar (2008) indicated lower microbial contamination in air flow of dryer than paper towels. According to the report of Smith and Lokhorst (2009), 96% European consider paper towels more hygienic than air dryers. Interestingly, hand dryers facilitated with HEPA filters assist in reducing the number of pathogenic bacterial dispersal but fail to eliminate the risk entirely (Huesca, 2018). Hence, using air dryers after washing hands arises doubts about the overall hygiene and well-being of the consumers. As public hygiene standards can vary greatly geographically, this study was planned with local (Ludhiana, Punjab) public places in mind. The study may help public safety authorities to consider alternate hand drying facilities in the local public places.

MATERIALS AND METHODS

Nutrient agar, potato dextrose agar, MacConkey agar and Eosin Methylene Blue agar were procured from HiMedia Laboratories LLC.

The study aims to examine contamination of hands after using hand dryers, for which washrooms of eateries and malls were selected. Petri dishes containing two types of media namely, Nutrient agar and Potato dextrose agar were exposed to air flow of

dryers for 10 seconds. Likewise, both media containing petri dishes were exposed to normal air for same time-period to examine presence of bacteria and fungi respectively. Later, petri dishes placed under incubation temperature of 37 °C for 48-72 hours and colonies were counted. Petri plates exposed to normal air of the restrooms were used as control. All the samples were run in triplicate.

Bacterial and Fungal Identification

Identification of bacteria was done by analyzing morphological features of colonies, growth characteristics on Nutrient agar. While incubation, plates were examined regularly and colonies counted after 4-5 days. Further, bacteria were isolated and grown on selective media (Eosin & methylene blue agar and MacConkey agar) and physiological characterization was done by identifying type of bacterial colony shape and color through gram staining (Cappucino and Sherman, 2005). Likewise, fungal growth was noticed on potato dextrose agar which indicates presence of spores in the atmosphere.

RESULTS

Public restrooms in eateries and malls serve as vital spaces where hygiene practices are of utmost importance. Among the various amenities, hand dryers, designed for convenience, have become ubiquitous in these facilities. However, the hygiene implications of hand dryers, particularly concerning the microbial load they might harbor, raise pertinent questions. In this local study, we sought to systematically quantify and identify the microbial populations residing in hand dryers installed in restrooms across eateries and malls. A comprehensive survey was conducted across all local malls and eateries, employing petri plates containing nutrient and selective media exposed to the air blown by the hand dryers. These plates were subsequently incubated at 37 °C for 48 hours, and the resulting colonies were counted. The air within the restrooms before activating the hand dryers served as the control. The recorded data, presented in Table 1 unveils a substantial contamination of hand dryers with bacterial and fungal populations. The isolate numbers (A-1 to A-10) employed in Table 2 demonstrate varied colony shapes, surface characteristics, and margins, of bacterial contaminants reflecting the diverse microbial composition within the hand dryers. Table 3

provides a snapshot of the observed colors and Gram staining results of the isolated colonies, further emphasizing the complexity of the microbial communities present. The distinctive features of colonies grown on Eosin Methylene Blue (EMB) and MacConkey agar facilitate the identification of associated bacterial colonies. These colonies signify the presence of Enterobacteriaceae bacteria, including *E. coli*, *Serratia* sp., *Enterobacter* sp., as well as others such as *Pseudomonas* sp., *Bacillus* sp., *Micrococcus* sp., *Streptococcus* sp., *Staphylococcus* sp., and more. Additionally, minimal variation is observed among fungal contaminants, as indicated by microscopy, revealing the existence of *Aspergillus* sp. and *Penicillium* sp. spores. However, it is worth noting that these fungal contaminants pose significant risks to human health.

Table 1. Number of colonies of bacteria and fungi on agar medium in the air upon 10 second exposure

Sample	Control	Hand Dryer
1	0	44
2	0	6
3	4	92
4	4	66
5	30	36
6	30	1
7	1	90
8	1	8

Table 2. Morphological characters of bacterial isolates

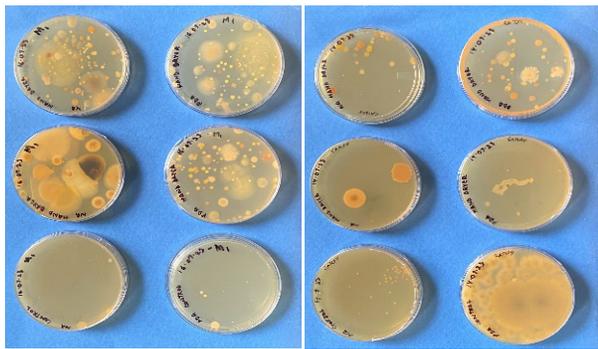
Isolate number	Colony shape	Surface	Margin
A-1	Round	Smooth	Undulate
A-2	Irregular	Concentric	Undulate
A-3	Round	Smooth	Entire
A-4	Punctiform	Wrinkled	Curled
A-5	Irregular	Smooth	Curled
A-6	Round	Concentric	Curled
A-7	Round	Concentric	Curled
A-8	Punctiform	Wrinkled	Lobate
A-9	Irregular	Concentric	Wavy
A-10	Round	Smooth	Entire

DISCUSSION

The substantial microbial contamination observed in hand dryers, as evidenced by the diverse colony characteristics and high colony counts, raises significant concerns regarding hygiene in public restrooms. The identification of potential intestinal

Table 3. Interpretation of colony characters according to the colony color developed on selective media.

Isolate No.	Color	Gram Staining	EMB	MacConkey	Identification
A-1	Cream	+	Colorless	Colorless	<i>Bacillus</i> sp.
A-2	Light yellow	-	Pale	Yellow	<i>Pseudomonas</i> sp.
A-3	Dark orange	+	Colorless	Colorless	<i>Micrococcus</i> sp.
A-4	Light orange	-	Pink	Pink	<i>Serratia</i> sp.
A-5	Cream- brown	-	Green metallic sheen	Pink	<i>E. coli</i>
A-6	Red	-	Pink	Pink	<i>Serratia</i> sp.
A-7	Pink	+	Colorless	Colorless	<i>Streptococcus</i> sp.
A-8	White	+	Colorless	Colorless	<i>Bacillus</i> sp.
A-9	Dark yellow	+	Colorless	Colorless	<i>Staphylococcus</i> sp.
A-10	Grey-white	-	Pink	Pink	<i>Enterobacter</i> sp.



pathogens among the isolated organisms underscores the public health risks associated with these commonly used devices. The presence of gram-negative bacteria on MacConkey agar, along with the observed colors and colony characteristics, suggests the potential involvement of faecal contamination. Such presence prompts a critical examination of the factors influencing microbial presence in hand dryers, potentially linked to variations in restroom usage patterns or maintenance practices. Overall, these findings necessitate a reassessment of hand dryer hygiene protocols and the implementation of more effective cleaning measures to mitigate the risk of microbial transmission. Further research is warranted to understand the dynamics of microbial colonization in hand dryers and explore strategies for enhancing hygiene in high-traffic public spaces.

CONCLUSION

Exploring the microbial landscape within hand dryers installed in local eateries and malls has revealed a substantial presence of bacterial and fungal populations, some of which are potential intestinal pathogens. The diverse bacterial and

fungal populations, including *E. coli*, *Serratia* sp., *Enterobacter* sp., *Pseudomonas* sp., *Bacillus* sp., *Micrococcus* sp., *Streptococcus* sp., and *Staphylococcus* sp., raise concerns about hygiene standards. The observed fecal contamination indicators on MacConkey agar prompt a reassessment of current protocols, urging immediate implementation of more robust cleaning measures. Future research should explore the dynamics of microbial colonization in hand dryers to inform targeted interventions for improved hygiene in high-traffic public spaces. These findings emphasize the need for scientific advancements in maintaining microbial hygiene within hand dryers, impacting public well-being.

Conflict of Interest: None

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