Bacteriological Examination of Used Towels from Female and Male Hostel of Federal University of Lafia

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Authors' contributions

This work was carried out in collaboration among all authors. Authors NSH, SOO and SB designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors FAY and KSA managed the analyses of the study, literature searches. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Bath towels have the ability to retain microbes, moist and warm environment offers microbes a favorable place to grow and survive. These microbes can be transmitted through direct contact with our hands and other inanimate objects within the environment. This study aimed at examining bacterial contamination of used towels. Used towels from male and female hostels at Federal University of Lafia, were assessed to determine their bacterial concentration. A total of sixteen (16) used towels were sampled, eight towels each from female and male hostels were sampled between April and May 2021. Identification and characterization of bacterial isolates was carried out using standard cultural, morphological and biochemical methods. *Pseudomonas* spp, *Staphylococcus aureus, Klebsiella* spp, *Escherichia coli, Streptococcus, Micrococcus* spp, *Serratia sp* and *Coagulase Negative Staphylococcus* were identified as contaminants in the towel samples analyzed. The female towels assessed in this study had the highest number of colonies with 4.39×10^9, while the male towels had the least number of colonies 3.88×10^9. Male and female towels sampled were all contaminated, but with no significant difference in the contamination rates

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(*p*>0.05). *Staphylococcus aureus* and coagulase-negative *Staphylococcus* were the most prevalent organisms isolated from male (62.5%; 5/8) and female (100%; 8/8) towels respectively. The high prevalence of diverse bacterial species is worrisome considering the epidemiology and clinical importance of the isolates, compounded by antimicrobial resistance and high mortality rate. Hence, there is need to enforce and improve hygiene practice among students. Frequent washing of towels and use of medicated soaps and disinfectants in bathing and washing water is hereby canvassed.

1. INTRODUCTION

Within the home surroundings there are so many microbes, these microbes are abundant in nature they can be found everywhere. The risk of microbial transmission and infection within the environment is high. Used towels in our homes have the ability to retain microbes, moist and warm environment offers microbes a favorable place to grow and survive. These microbes can be transmitted through direct contact with our hands and other inanimate objects within the environment. Washing-up with liquid and disinfectant has proven to be an effective way of decontaminating them, the efficiency of the cleansing procedure depends on variables [1]. Most microbes found in towels have the ability to cause certain infections like acne, ringworm, pimples etc. Used towels left unwashed provide a perfect place for pathogenic and non-pathogenic microbes to grow. Most people don't practice proper hygiene, that is regular hand wash, so, they tend to transmit microbes from the environment to their towels. Most contaminated hands play a major role in transmitting microbes [2;3]. Microbes found on skin encompasses both inhabitant and transient pathogenic and nonpathogenic floras [4]. Transient floras take over the apparent covers of the skin, and are simply detached by washing, which may be transmitted through direct contact with human hands and the surroundings, this temporary or transient floras include microbes linked with nosocomial infection, such as *Staphylococcus aureus*, enterococci, *Pseudomonas* spp., *Klebsiella* spp., and *Acinetobacter* spp. [4]. Therefore, washing of hand is important in reducing the spread of pathogenic microbes on hands, several research have concentrated on topics such as hand-washing practices [5], variety and handling of hand-washing agents [6;7;8], and approaches to increase and amend hand hygiene observance for health care workers [9;10;11;12]. Transmission of microbes is more effective in wet and moist settings than dry surroundings, which is also a thread to public health. The aim of the study is to assess the occurrence of bacteria on used towels from female and male hostel at Federal University of Lafia. The Objectives of this study are: to isolate and identify bacteria from used towels; to investigate the bacterial contaminant of used towels and to determine the most prevalent bacterial species on used towels from both Male and Female hostel.

2. METHODOLOGY

2.1 Sample Collection

Sixteen (16) different towels, eight (8) from the Female Hostel (Ruqayyat Ahmed Rufai Hostel) and eight (8) were from Male Hostel (Abubakar Adamu Rasheed hostel) were sampled between April and May 2021. Samples were collected using a sterile swab stick, to swab the towels, transported immediately to the laboratory for further analysis, at Federal University of Lafia, Nasarawa state.

2.2 Laboratory Analysis

2.2.1 Isolation and enumeration of bacterial isolates

A 10-fold serial dilution was carried out to reduce microbial load. Swab sticks were dipped into test tubes containing 10mL sterile peptone water as stock solutions. 1mL from each stock solution was pipetted and serially diluted to 10^{-9} dilution. Aliquot (0.1mL) from 10^{-7} was inoculated on nutrient agar plates using pour plate technique and incubated for 20 hours at $35\pm2{-}^{0}$C. Colonial growths were enumerated using standard plate count technique and expressed as CFU/mL

2.2.2 Identification of bacterial isolates

Identification and characterization of bacteria isolates was carried out using cultural and morphological (colonial appearance) characteristics such as shapes, size, consistency, color, and elevation of colonies. Gram staining was also performed to determine

Gram reaction. Biochemical tests were carried out in other to identify the organisms as described by [13]. Biochemical tests carried out include: catalase, coagulase, urease, motility, indole, Methyl Red Voges-Proskauer (MRVP), citrate, oxidase, haemolysis on blood agar and sugar fermentation on triple sugar iron agar methods

2.3 Data Analysis

Data analysis were analyzed using one way Anova.

3. RESULTS

3.1 Biochemical Characteristic and Identification of Bacterial Isolates

Table 1 shows the biochemical results of the bacterial isolates. Organisms identified include *Bacillus spp, Pseudomonas* spp*, Staphylococcus aureus, Klebsiella* spp*, E. coli, Streptococcus, Micrococcus* spp*, Serratia* spp *and Coagulase negative staphylococcus.*

3.2 Total Bacterial Count of Towels

The total bacterial counts from towel samples in both hostels (female and male) is as shown in Table 2. Female towels had more total bacterial count of 4.39×10^9 CFU/mL than male towels that have a total bacterial count of 3.88×10^9 CFU/mL. Rooms three and five had the highest count of 7.30×10^8 CFU/mL and 9.00×10^8 CFU/mL respectively from both female and male hostels respectively. Room six had the least bacterial count of 1.00×10^8 CFU/mL and 2.70×10^8 CFU/mL from male and female towels respectively.

3.2.1 Prevalence of bacterial isolates from towel samples

Table 3 shows the frequency and percentage prevalence of bacteria isolated from female and male towels. Coagulase-negative *Staphylococcus* and *Staphylococcus aureus* the most prevalent organisms isolated with a prevalence rate of 22.81% (13/57) and 21.05% (12/57) respectively while *Pseudomonas* and *Klebsiella* species where the least frequent with prevalence rate of 3.51% (2/57) each. At least 2 organisms were not isolated from both male and female towels.

4. DISCUSSION

This study showed that there is a high prevalence of bacterial contaminants from towel samples used by students of Federal University of Lafia. Room 3 had the highest plate count of 7.30×10^7 CFU/mL while room 7 had the lowest plate counts with 3.50×10^7 CFU/mL from sampled towels in the female hostels. From male towels, room 5 had the highest plate count of 9.0×10^8 CFU/mL and room 6 had the least plate count of 1.0×10^8 CFU/mL. In the present study, female towels had the highest bacterial count of 4.39×10^9, while the male towels had the least bacterial count with 3.88×10^9. Women have been reported to have a significant diversity of microbes on their palms than men, this could be as a result of women activities like poor hygiene practices, Furthermore, poor hygiene practices may result in higher bacterial concentrations [14]. This finding contradicts the traditional belief that microbial contaminant levels from female hostel would be lower than in male hostel [15]. [16] have shown that the functional variation between male and female leads to the substantial difference of bacteria species in the hostel. According to [17] female towels had the highest bacteria load than male towels, this is a well-known fact that the regular cleaning of the body with water done by female attract more bacterial and chances of infection. Therefore, the findings in this study concur with the report of [18] that females skin have varied microorganisms. According to [1], two major contributing factors microbe characteristics and fabric properties, and environmental factors enhances microbes' survival on fabrics such as towels. These microbes (which are capable of surviving for a long time) even in small quantities can infect their host when they come in contact.

Both male and female towels sampled in this study were contaminated with *Pseudomonas* spp*, Staphylococcus aureus, Klebsiella sp, E. coli, Streptococcus, Micrococcus* spp*, Serratia* spp*, Bacillus* spp *and Coagulase Negative Staphylococcus.* Coagulase-negative *Staphylococcus* was the most prevalent bacteria (22.81%; 13/57) while *Pseudomonas* spp and *Klebsiella* spp were the least prevalent bacteria (3.51%; 2.57). *Staphylococcus aureus* was the most prevalent organism isolated from male towels (62.5%; 5/8) while Coagulase-negative *Staphylococcus* was the most prevalent (100%; 8/8) bacteria on female towels. With a prevalence rate of 0% (0/8), *Bacillus* and *Serratia* species were the least prevalent on female

towels whereas *Pseudomonas* and *Klebsiella* were the least prevalent on male towels with same prevalent rate of 0% (0/0). This study has shown that *Micrococcus* spp, *Klebsiella* spp, *E. coli, Coagulase-negative Staphylococcus* and *Staphylococcus aureus* which are of great importance to medical and public health are prevalent on towels. The findings in this study agrees with that of [19] which recorded high incidence (1.4x10^4) of *S. aureus* from bath

towels. In the environment, *Staphylococci* are widespread and can be found on clothing as well as environmental surfaces [1].

Most of the organisms identified in this study are found mainly in environment, soil, water and dust. Normally, used towels from this study are usually dried outside after use, this may likely expose these towels to microbes in environment, water and dust as a result these bacteria strains

Table 1. Biochemical test

Shape	Morphology	Gram reaction	Catalase	Indole	MR	VP	Citrate	Coagulase	TSI
Round	Chain cocci	+ve	-ve	-ve	+ve	-ve	+ve	-ve	-ve
Round	Moderate rod	-ve	+ve	-ve	+ve	-ve	+ve	-ve	-ve
Round	Cluster cocci	+ve	+ve	-ve	+ve	-ve	-ve	+ve	-ve
Round	Long rod	-ve	+ve	-ve	-ve	+ve	-ve	-ve	+ve
Round	Short Rod	-ve	+ve	+ve	+ve	-ve	+ve	-ve	-ve
Round	Cluster cocci	+ve	+ve	-ve	+ve	-ve	+ve	-ve	-ve
Round	Rod	+ve	+ve	-ve	+ve	-ve	+ve	-ve	-ve
Irregular	Rod	-ve	+ve	-ve	+ve	-ve	+ve	-ve	-ve

Key: MR: methyl red; VP: Voges-Proskauer; TSI: Triple Sugar Iron; +ve: positive; -ve: negative

Table 2. Total bacterial count from towels from both male and female hostels (CFU/mL)

Location	Female*	Male*
Room one	5.00x10^8	5.30 x10^8
Room two	6.90 x10^8	6.30 x10^8
Room three	7.30 x10^8	7.00 x10^8
Room four	6.60 x10^8	5.60 x10^8
Room five	5.40 x10^8	9.00 x10^8
Room six	2.70 x10^8	1.00 x10^8
Room Seven	3.50 x10^8	3.50 x10^8
Room Eight	6.50 x10^8	1.10 x10^8
Total	4.39 x10^9	3.88 x10^9

: no significant difference in total bacterial count at $p≤0.05$

Table 3. Frequency and percentages of bacteria from Female and Male towels (hostel)

Organism	Female (%) n=8	Male (%) n=8	Cumulative Total (%) N=57
Pseudomonas species	2 (25.0)	0	2 (3.51)
Micrococcus luteus	2 (25.0)	2 (25.0)	4 (7.02)
Staphylococcus aureus	7 (87.5)	5 (62.5)	12 (21.05)
Klebsiella species	2 (25.0)	0	2 (3.51)
Escherichia coli	4 (50)	2 (25.0)	6 (10.53)
Coagulase-negative *Staphylococci*	8 (100)	4 (50)	13 (22.81)
Streptococcus species	4 (50)	3 (37.5)	7 (12.28)
Micrococcus roseus	5 (62.5)	4 (50)	9 (15.79)
Bacillus spp	0	4 (50)	4 (7.02)
Serratia spp	0	3 (37.5)	3 (5.26)
Total (%) N=57	30 (52.6)	27 (47.4)	57 (100)

can be isolated from used towels. It was earlier reported in a study that *Staphylococci* can live for years in dust and soil particles, also it can resist the dry conditions and tolerate high temperature, allowing it to last on fabric and clothes for a long time. These fabrics and clothes including undergarments frequently make contact with skin, allowing for possible transmission of pathogenic bacteria [1]. It was reported by [20] and [21] that *Staphylococcus* spp. can survive for long periods on hospital fabrics to become epidemiological. Currently, *Staphylococcus* spp. is capable of causing superficial skin lesions such as boils, pneumonia, meningitis, and urinary tract infections; and deep-seated infections, such as osteomyelitis that is why it is considered as the main cause of both sporadic infections and epidemics of varying scope [22]. Bacteria of clinical importance were encountered in this study. These organisms cause varying degree from mild to fatal infections and diseases. *Staphylococcus* spp produces heat-stable toxin and is capable of causing superficial skin lesions such as boils, pneumonia, meningitis, and urinary tract infections; and deep-seated infections, such as osteomyelitis that is why it is considered as the main cause of both sporadic infections and epidemics of varying scope [22]. Traveler's diarrhea and hemorrhagic colitis is caused by *E. coli* [13]. Hemorrhagic colitis is often misdiagnosed and have reported globally causing 70,000 deaths annually [23]. This study showed that towels from male hostel had 16% *Bacillus* spp, *Bacillus* spp has a unique cell structure endospore with ability to remain dormant for years and resistant to damaging conditions such as heat, desiccation, toxic chemicals and ultraviolet irradiation [24]. Previous study has confirmed that *Bacillus spp* are capable of causing food poisoning and control measures involve washing hands after handling soiled bed linen or clothes [25]. Other enteric organisms have been reported to cause diarrhoea infections with adverse effect on intestinal absorption, child development and nutrition with high mortality rate globally [26]. This implied that, females had a greater chance of acquiring *E. coli* related sickness/diseases than males.

5. CONCLUSION

In this study, the bacterial concentrations of used towels were examined and analyzed from female and male hostel at Federal University of Lafia. It was observed that there is high prevalence of bacterial contaminants on bath towels, with towels from female hostels having higher microbial counts than those from male hostels. One possible explanation for this observation may be women activities such as poor hygiene practice. Because of the unique characteristic of university students, special attention should be paid to the health risks presented by biological pollutants in order to ensure greater efficiency in studying the health development of students. Contaminated towels pose a great risk to the public; more worrisome as the microorganisms isolated from the towels are pathogenic to human. The following control measures are recommended, proper hygiene practice, avoid using towels for a long period of time (especially when they are dirty), frequent and adequate washing of towels with disinfectants and detergent. The study also recommend that students should avoid sharing towels with other people by any way, students should use their towels only to themselves.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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