# MICROBIOLOGY OF LIBRARY BOOKS: EVALUATION AND EFFECTIVE PROTECTION

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Received: April 02, 2019 Accepted: May 13, 2019

***ABSTRACT:*** *Since centuries, books are known as knowledge carriers or known for the wisdom they carry. The library is the most known place to get books on loan. In today's world, a library and its books are easily accessible to anyone, and books are passing from one user to another. On the other side, these books might have the possible infection ground of various microbes from numerous library users. The present study aims to evaluate microbiology and to study their control using nanotechnology. The 30 different books from the college library were studied. The number of microbes present on pages of the book has a direct relation with the number of usages. From enumeration study, 240 CFU/dcm2 – 9950 CFU/dcm2 were found on book pages. Microbes in a book remain alive for longer duration, in our observation, E. coli and S. aureus remain alive for an extra 7 days and 10 days, respectively, compared to open surface area. Silver has good antimicrobial activity and it was selected as a safe solution. Nano silver was applied on pages of a library book. This application reduced the number of microbes to a really low level and provided long term action. From this study, library books preserve microbes for longer duration which may promote cross infection and it can be stopped using silver nanotechnology.*

***Key Words:*** *Cross infection, Nanotechnology, Nano silver, Contamination*

## I. Introduction

Microorganisms are present everywhere on earth[1, 2]. Among them, few are infectious and/or deadly. They are known to spread person to person through direct and/or indirect routes (Valencia & Ann, 2019). There transmit has been studied and shown to occur through various fomites such as paper money, toys, towel, bed lines [4].

Libraries are equally important in sharing knowledge as school or college does. It provides an environment which is conducive to the building up of a habit of self-learning. There's a lot of knowledge and wisdom in pages of libraries.So, it has a very important role in developing society. But could those thousands of free books be harbouring microbes?No much studied or thought about what might be crawling or oozing around between the pages of library books. The truth is that library book grossness is a pretty subjective concept. So, it is necessary to apply antimicrobial which is safe, effective, long lasting, and tasteless as many users use sputum to turn the pages.

This study aimed to investigate microbiology of book, as potential fomite and prevention using nanotechnology. As there are no establishes methods to define the level of bacterial contamination on pages of a book.

## II. Materials& Methods

### Ethics statement:

Microbial viability test and Evaluation of antimicrobial activity of Nano-silverwere performed on the separate books and were incinerated after completion of a test. All experiments were performed in triplicates.

### Normal Saline

0.9 g of NaCl (SD Fine-Chem Limited) dissolved in 100 mL of distilled water[5].

### Enumeration of bacteria in library book

31 different books were selected based on usage, as mentioned in the table. An assumption was made, an index is a most touched page. A paper (70 gsm) was attached before an index paper. After a week of usage by readers, attached 70gsm paper was removed under aseptic condition. Paper was sliced into pieces and dipped into a sterile saline solution (15 mL/dcm$^2$). From this saline,the bacterial number was counted as CFU using Serial dilution method[6].Soybean casein agar was used as a media and plates were incubated at room temperature in a library.

**Microbial Viability Test**

*E. coli* and *S. aureus*, isolated from soil, suspensions were prepared from a 24 h old culture in sterile normal saline, whose turbidity was adjusted to that of 0.5 McFarland standard suspension [7].

Three paper (70 gsm from JK Easy Copier) were attached in a book, on middle page, bacterial suspension was sprayed (1 ml/dcm$^2$). After regular interval, a small portion of the paper was sliced into pieces and dipped into saline (2ml/cm$^2$). CFU was counted from this saline.

The same experiment was conducted simultaneously without a book, keeping three papers outside a book.

**Evaluation of antimicrobial activity of Nano silver**

Two books were studied, a book coated with Nano silver (0.1 mg of silver /dcm$^2$) which was prepared using green method[8]and another was a non-coated book.

15 mL of saline solution was drained on hand of the library user. Saline was collected, which has a pool of bacteria from the hand of library reader. This contaminated saline was sprayed on pages of a book (1 ml/dcm$^2$). After regular intervals, a small portion of the paper was sliced into pieces and dipped into saline (2ml/cm$^2$). The bacterial number were enumerated as CFU.

## III. Result & Discussion

This entire study was conducted in a college library.

Result of enumeration of bacteria in the library book and evaluation of antimicrobial activity of Nano silver are presented in table 1 & 2 and result of Microbial Viability Test in Chart 1& 2. All experiments were performed in triplicate and mean values are used in the comparison.

Microbial counts were observed in books as mentioned in table 1. Maximum count was found in a book which has higher usage. As books are passing from one user to another, the microbial load is increasing. This may be due to microbes present on the hand of the user are getting transfer to pages of the book. This all bacteria may not be harmful. Some of them may cause some serious disease. User-health status is not known to anyone. If they are having any microbial infection, it can cross-infect next user.

Every user has to do an entry in the register, before entering a library. Because of this procedure, this register has the highest amount of microbial load.

**Table 1: Total count of bacteria from book pages.**

| | Usage (users/week) | CFU/dcm2 |
|---|---|---|
| **Entry register** | | 21400 ± 1708.8 |
| **Group 1** | Less than 10 | 240 ± 125.5 |
| **Group 2** | 11-20 | 3470 ± 1519.5 |
| **Group 3** | More than 20 | 9950 ± 2216.2 |

From results, bacteria have longer viability in books compare to open pages (chart 1 & 2) and *S. aureus*(10 days) shows longer viability (D50) than *E. coli*(4 days) in books. Outside of nutrients and water, each species of bacteria has a specific environmental preference. Preferences include the best pH, temperature range, moisture.Environment (temperature and moisture) in the close book does not fluctuate so asto open pages which protects microbes from conditional shock. Bacteria live longer in such an environment.

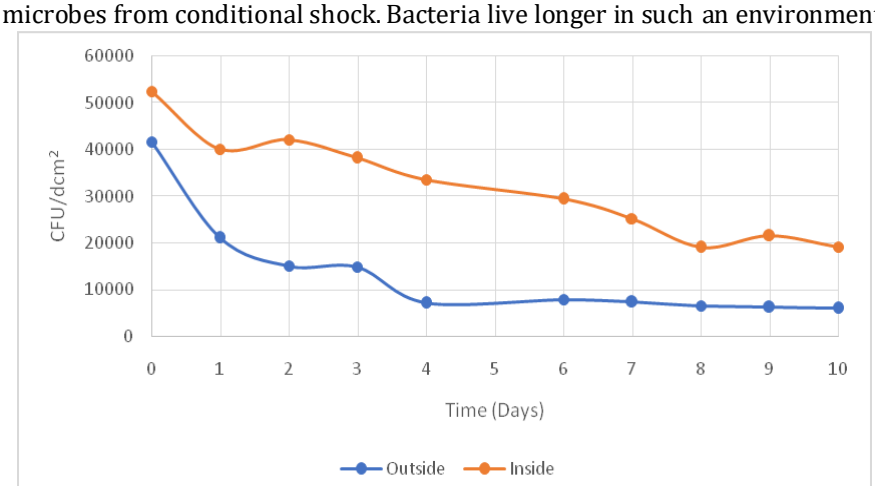


**Chart 1:**Viability plot of*E. coli*

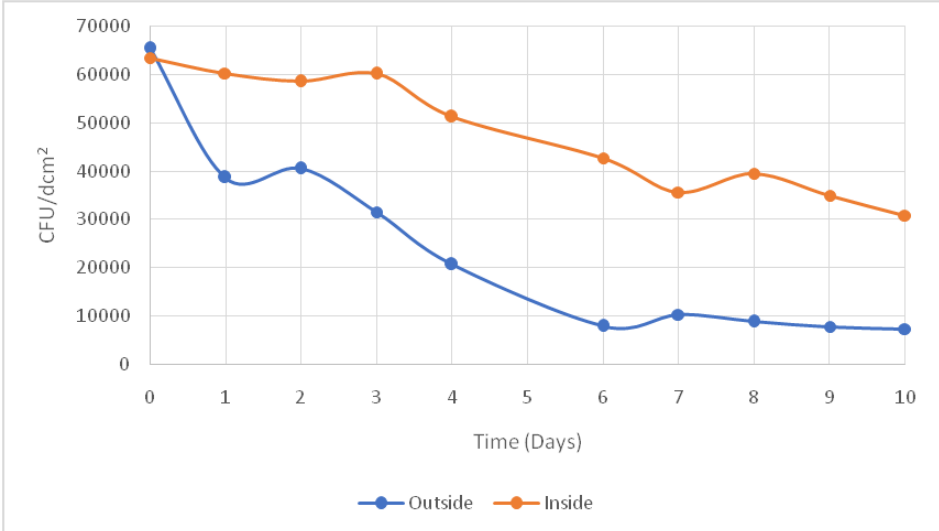


**Chart 2.**Viability plot of*S. Aureus*

This microbial load (table 1) does not indicate the infective agent load. But to take precaution, low level of microbial load is necessary. So, treatment with antimicrobials is necessary. Table 2 shows the result of CFU on coated and non-coated pages. It has been previously reported and well-studied, Nano silver as good antimicrobial activity [9] which is effective, long lasting[10], safe [11] and tasteless[12] too. Mode of action nano-silver is not known, but it is acting at multiple levels to kill the cell (Sintubin, L.; De Gusseme, B.; Van der Meeren, P.; Pycke, B. F.; Verstraete, W.; Boon, N.;, 2011). Result (table 2) shows nono silver provides effective and long term protection, even after 14 days, only 11 CFU/dcm² was observed.

**Table 2:** Viability of microbes on Nano Ag coated and non-coated pages (CFU/dcm²)

| | **Day 0** | **Day 7** | **Day 14** |
|---|---|---|---|
| **Coated** | <10 | <10 | 11 |
| **Nanocoated** | 234 | 350 | 540 |

## IV. Conclusion

This study confirms the results of a recent microbiological study of books from the college library. Contamination in the book increasing with increasing its frequency of usage. Entry register had highest CFU counts, which must be used by every user. The fact that books are harder to clean means that they are less likely to be cleaned. Bacteria can survive longer in books than in an open environment. This may increase the chance of infection passing from user to users. Nano silver coated pages shows long term antimicrobial action of nano silver. Nano silver coating to books can provide perfect protection to the library user.

This small study raises a myriad of further questions for research. Does the potential for infection shown in this study indicate an actual risk of disease transmission? Should s book be treated using Nano silver? Are waiting room books and magazines similarly contaminated? Whatever the answers to these questions it would appear that library books have high levels of contamination. Isn't it time to add a new hygiene method (Nano-coat) to the library?

## V. Acknowledgment

Author thank Smt GN Pandya Commerce & Science College, Surat for financial and infrastructural support and Kalva Nanotech for supporting in nanoparticle synthesis.

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