



## Research Article

### COMPARISON OF NATURAL AGENTS TO DEVELOP ANTIBACTERIAL KITCHEN TEXTILES

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#### ABSTRACT

In the present scenario, there is a vital potential for home textile products for healthy life style, on which kitchen fabrics are noteworthy. The study conducted a survey for 7 days with 5 dish cloths, on which the survey was at normal kitchen environment with normal temperature at the various districts of Tamilnadu. The kitchen fabrics contaminated with a strain were investigated biochemically and fabric supports the growth of bacteria/genus, namely *Staphylococcus*, *Klebsiella*, *Shigella species*. The natural agents such as *Murraya Koenigii*, Pomegranate peels, Banana peel, Casein & Cyclodextrin in extract form were applied to the kitchen fabric by conventional pad-dry-cure method. Antibacterial tests carried out following AATCC 100 2004 on these treated fabric samples proved that the plant extracts & natural agents act as a good antibacterial agent for kitchen fabrics. The treated samples have good bacterial growth reduction % that too with *Murraya Koenigii* (curry leaf) superior among the tested plant extracts.

**Keywords:** *Murraya Koenigii*, Pomegranate peels, Banana peel, Casein & Cyclodextrin

#### INTRODUCTION

Home textiles namely kitchen fabrics and Wiping cloths are frequently contaminated with *Escherichia coli* and these may be important reservoirs of bacteria for contamination of the hands of catering staff<sup>1</sup>. When bacteria contaminated fabrics (such as hand towels, dish cloths) were used on other surfaces it may result in cross contamination<sup>2</sup>. Increasing global competition in textile has created many challenges for textile researchers and industrialists. The rapid growth in home textiles and their end uses has generated many opportunities for the application of innovative finishes. Microorganisms can be found almost everywhere in the environment. Cotton textiles in contact with the human body offer an ideal environment for microbial growth. Bacteria both pathogenic and odour causing, interact with fibres in several phases including the initial adherence, subsequent growth and damage to the fibres and dissemination from them<sup>3</sup>. Textile materials need to have antimicrobial finishes to avoid infections, control infestation and to safeguard the textile product from deterioration<sup>4</sup>. Antibacterial/antifungal/antiviral finish is a special type of protective finish given for the fabrics used in healthcare applications to protect them from parasites such as bacteria, fungi, virus, etc. Synthetic chemicals such as silver<sup>5,6</sup>, zinc oxide<sup>7,8</sup>, copper<sup>3</sup>, quaternary ammonium compounds<sup>9,10</sup> and triclosan<sup>11</sup> were applied as antibacterial agent on cotton fabric to inhibit commonly known bacteria such as *Escherichia coli*, *Staphylococcus aureus* and *Bacillus species* but most of them are not ecofriendly in nature<sup>12</sup>. Similarly eco friendly natural agents such as neem<sup>13,14</sup>, prickly chaff<sup>12</sup>, tulsi leaf<sup>15</sup>, quercus infectoria<sup>16</sup>, mexican daisy<sup>13</sup>, aloe vera<sup>17</sup> and chitosan<sup>18</sup> were applied on cotton fabric against the same set of bacteria.

Contamination of food products by microbial growth can cause potential health hazards to human beings. In recent years, much emphasis has been put on the safety aspects of food, since mass contamination is caused by food spoilage microorganisms<sup>8</sup>. Kitchen fabrics which are used in hotels, canteens in colleges and schools and home kitchens may act as one of the source for these contaminations. Studies conducted at South Africa, USA, UK, Saudi Arabia, Turkey and Netherlands on kitchen fabrics proved that these fabrics harbour bacteria, namely *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Streptococcus faecalis*, *Staphylococcus epidermis*, *Bacillus cereus*, *Bacillus subtilis*, *Salmonella species*, *Shigella species*, *Clostridium perfringens*, *Pseudomonas aeruginosa*, *Proteus vulgaris*, *Enterobacter cloacae*, *Listeria species* and *Campylobacter jejuni* due to two aspects, namely wetness<sup>19-24</sup> and improper washing after use<sup>25</sup>. No such attempt was made in India and hence information pertaining to presence of bacteria on fabrics used in Indian kitchen environments is not available.

The survey was at normal kitchen environment with normal temperature at the various districts of Tamilnadu. The study conducted for both vegetarian and non-vegetarian foods to identify the bacteria that grow in cotton fabric and find an eco friendly solution to overcome the above problem by using a suitable natural antibacterial agent. Various plants<sup>26-34</sup> do have good medicinal values but its antibacterial activity on kitchen environment bacteria were not considered which is focused in this study. Extracts obtained from plants powder form such as *Murraya Koenigii*, Pomegranate peels, Banana peel (alone dried and subjected to extraction), Casein & Cyclodextrin was used as an antibacterial agent.

## MATERIALS AND METHODS

### Materials

Specifications on the fabric Sample used in this study were tabulated in Table 1. The ripened yellow banana peels were collected from the local market of Coimbatore. Peel were cut into small pieces and dried separately under shade for 15 days. The Casein and Cyclodextrin were collected from Precision & Scientific co, Gandhipuram, and Coimbatore. The freshly collected *Murraya Koenigii* (curry leaves), Pomegranate peels from the local surroundings were shadow dried and finely powdered and confirmed its originality by Indian Medical Practitioner's Co-operative Pharmacy and Stores Ltd., India. Methanol (AR) used for the extraction purpose were procured from Sriram Chemicals, Chennai manufactured by Changshu Yangyuan Chemical, China.

### Sample preparation

The 100% pre treated ((10 g/l) at 90°C with liquor to material ratio (l:m) 50:1 for 90 min followed by hot and cold washes, five times each, and dried at ambient conditions) cotton fabric were subjected to survey. The study has been carried out for 7days. 5samples are totally tested each sample at the individual kitchen environment, were all time vegetarian and non-vegetarian foods cooked. The house wives during the survey period were instructed to follow the steps given below in using the cotton fabric: a) to wash the utensils only with standard detergent, b) to keep the washed utensils in an inverted position to bring down the water content present in them, c) to wipe these utensils using the dishcloth supplied to them, d) to dry the dishcloth under shade after every use, e) to use the dishcloth for 1 to 5 days without subjecting it to washing. After the survey completed the research samples are taken for the identification of bacteria

### Identification of Type of Bacteria

The given used fabric sample was added to about 50 ml of sterile nutrient broth in a conical flask and left overnight at 37 °C in shaker. After incubation, the bacterial predominant were isolated by serial dilution and plating technique. The bacterial predominant were isolated from the nutrient agar plates by repeated sub culturing of the isolated colonies on the sterile nutrient agar plates. The purified cultures were subjected to microscopic and biochemical identification. Among the different isolates, only three were chosen for identification based on the predominant occurrence. The isolates were then subjected to

standard microscopic and biochemical tests to identify to which genus the predominant belonged to. The individual bacterial colonies obtained were removed using inoculating loop and cultured separately in a 25ml prepared liquid nutrient medium overnight at 37°C in an orbital shaker at 120 rpm to identify the classification (gram positive/gram negative) and type of bacterium following the standard procedure<sup>35,36</sup>.

### Extraction from Natural Agents

Active substances were extracted from *Murraya Koenigii*, Pomegranate peels, Banana peel with the help of Soxhlet extraction and vacuum evaporation techniques, using methanol. Methanolic extract of the plant powdered grains were obtained by treating 8g of powder with 80 ml of mixture of methanol at room temperature in an air tight flask to dissolve the active substance that the extraction were carried out for 10 hour in boiling condition. Natural agents namely casein and cyclodextrin were directly used as powdered material along with banana peel extract, since its key chemical components might run away when it is subjected to Soxhlet method.

### Application of Herbal Extract

The pretreated bleached cotton fabric were treating with *Murraya Koenigii* (curry leaf), Pomegranate peels extracted solution with different concentration (3gpl, 5gpl, 10gpl OWM) both in individual and combined form by pad-dry-cure method. Pretreated bleached cotton fabric was also similarly padded with 10 gpl OWM of combined banana peel extract, Casein powder and Cyclodextrin powder (1:1:1 ratio) using pad-dry-cure technique. 60% wet pick-up while padding followed by drying at 80°C for 5 min and curing at 120°C for 3 min were used. Then the treated samples were taken for FTIR characterization and antibacterial testing.

### Testing of Anti-Microbial Activity (AATCC 100- 2004)

According to AATCC 100-2004 test method the natural agents extract treated cotton fabric samples were placed in separate glass jar and 1 ml of test bacterial inoculum was introduced. Diluted with distilled water to 10 folds the jar was stirred vigorously. The solution was then serially diluted, plated on nutrient agar and incubated for 24 h at 37 ± 2°C. Colonies of bacteria recovered on the agar plate for both untreated and treated fabrics were counted and the percentage reduction of bacteria was determined.

Table 1: Fabric sample specification

|                                     |             |
|-------------------------------------|-------------|
| Yarn count (Warp & Weft)            | 35 & 27s Ne |
| Bleached Fabric mass (GSM)          | 100         |
| Ends per inch                       | 72          |
| Picks per inch                      | 62          |
| Cover factor                        | 18.91       |
| Stiffness (Warp & Weft way) (in cm) | 6.2 & 4.7   |
| Thickness (in mm)                   | 0.21        |

**Table 2: Antibacterial activity of the natural extracts treated cotton fabric**

| Tests                              |          | Isolate 1                                 | Isolate 2                      | Isolate 3           |
|------------------------------------|----------|---|--------------------------------|---------------------|
| Indole production                  |          | -   | +                              | +                   |
| Methyl red test                    |          | -   | -                              | -                   |
| Voges Proskauer test               |          | +   | +                              | -                   |
| Citrate utilization test           |          | +   | +                              | -                   |
| Triple sugar iron test             |          | A/A                                       | A/A                            | A/A                 |
| Gelatin liquefaction               |          | +   | +                              | +                   |
| Carbohydrate fermentation test     | Glucose  | -   | +                              | +(G)                |
|                                    | Sucrose  | -   | +(G)                           | -                   |
|                                    | Dextrose | -   | +                              | -                   |
|                                    | Lactose  | -   | +                              | -                   |
| Catalase production                |          | +   | +                              | -                   |
| Nitrate reduction test             |          | -   | +                              | +                   |
| Starch hydrolysis                  |          | -   | -                              | +                   |
| Casein hydrolysis                  |          | +   | +                              | +                   |
| MacConkey agar                     |          | NLF                                       | LF                             | NLF                 |
| Mannitol salt agar                 |          | +   | -                              | -                   |
| Endo agar                          |          | -   | -                              | +                   |
| Grams staining                     |          | + coccus                                  | - rod                          | - rod               |
| Colony morphology in nutrient agar |          | Small yellow oily paint appearance colony | Pin headed pale colored colony | Smooth dirty colony |

A/A – Acid Slant and Acid butt, G – Gas production, NLF – Non lactose fermenters, LF – lactose fermenters

**Table 3: Bacterial growth reduction % of the natural extracts treated cotton fabric**

|                               | Treated samples<br>(Bacterial Growth Reduction %) |                       |        |       |  |        |       |                        |        |        |                            |  |
|-------------------------------|---|-----------------------|--------|-------|--|--------|-------|------------------------|--------|--------|----------------------------|--|
|                               | Sample specifications                             |                       |        |       |  |        |       |                        |        |        |                            |  |
|                               | Control Sample – Untreated Cotton fabric          |                       |        |       |  |        |       |                        |        |        |                            |  |
|                               | untreated   | Murraya Koenigii (MK) |        |       | (1:1)<br>Murraya Koenigii:<br>Pomegranate peels<br>(50%:50%) |        |       | Pomegranate peels (PP) |        |        | Banana<br>peel &<br>Casein | Banana<br>peel,<br>Casein<br>&<br>Cyclode<br>xtrin |
|                               | 3 gpl   | 5 gpl                 | 10 gpl | 3 gpl | 5 gpl  | 10 gpl | 3 gpl | 5 gpl                  | 10 gpl | 10 gpl | 10 gpl                     |  |
| <b>Escherichia species</b>    | 0   | 6.7                   | 11.1   | 29.2  | 6.6  | 14.6   | 15.49 | 6.4                    | 15.2   | 12.8   | 67.44                      | 82.05  |
| <b>Staphylococcus species</b> | 0   | 8.1                   | 13.0   | 28.2  | 6.1  | 12.7   | 21    | 5.9                    | 13.2   | 16.4   | 23.80                      | 62.06  |
| <b>Klebsiella species</b>     | 0   | 7.4                   | 12.0   | 29.2  | 7.1  | 13.2   | 23.4  | 4.4                    | 12.2   | 14.4   | 34.80                      | 69.46  |



**Figure 1: Broth plate with isolated colonies which subjects for further biochemical tests**

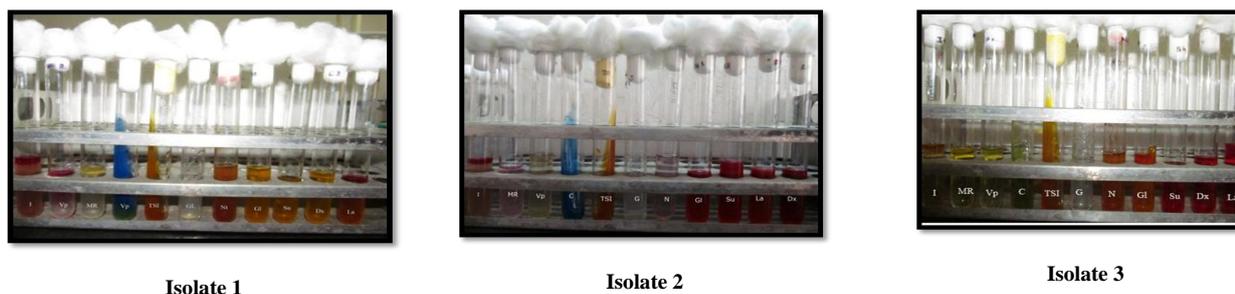


Figure 2: Isolated colonies on biochemical characteristics

## RESULTS AND DISCUSSION

### Types of Bacteria Isolated

The samples collected from a time span of 1-5 days from each home kitchen were evaluated initially for different colonies. The entire 5 days sample from each kitchen environments was found to have same 3 different morphological colonies. Based on the morphology and colour, four bacterial colonies were identified in the diluted solutions containing the extract from fabrics used in the kitchen environment and among these environmental bacteria were present which excludes from further investigations.

The broth was spread plated on nutrient agar plates. The number of predominant bacterial cultures were determined and isolated for further studies. The bacterial predominant were isolated from the nutrient agar plates by repeated sub culturing of the isolated colonies on the sterile nutrient agar plates. The colonies initial broth conditioned colonies and purified isolates were shown in Figure 1. Table 2 and Figure 2 represent the bio chemical results obtained for the isolate and the positive/negative response of the colonies were also summarized in the table. Finally the bacteria were identified through the isolation method, they were confirmed in terms of generic means namely *Staphylococcus*, *Klebsiella*, *Shigella species*. The identification of exact species in the various genus identified requires further studies to be carried out.

### FTIR Characterisation

From Figure 3: Analysis of FTIR curves, clearly depicts that the following points can be noted in well defined manner,

- 3278.99 cm<sup>-1</sup> presence of O-H group of phenols for Banana Peel,
- 3340.71 cm<sup>-1</sup> presence of N-H group of amines for Casein.
- 1056.90 cm<sup>-1</sup> presence of N-O asymmetric stretch for *Murraya Koenigii* (curry leaf).
- 2730.39 cm<sup>-1</sup> presence of N-H group of amines for Pomegranate peels.
- 3039.81 cm<sup>-1</sup> presence of N-H group of amines for Cyclodextrin.

### Antibacterial Activity

The antimicrobial test using AATCC 100 standard procedures were determined against the identified bacterial genus namely *Staphylococcus*, *Klebsiella* and *Shigella species*. The results obtained were detailed in Table 2. Counting the number of colonies counted that were present over the agar plates done in AATCC 100 test method. Lesser in number indicates the inability of the bacteria to multiply in the nutrient medium, but initially sample got more number of colonies over the sample agar plates. The dilution way of colony counting followed and dilutions went till six series of concentration of nutrient agar reduces from 10<sup>-2</sup> to 10<sup>-7</sup>. Less number of colonies count obtained in 10<sup>-2</sup> series of dilution itself indicates good antibacterial activity of the plant extracts treated cotton fabric. Table 3 indicates that the natural extract treated cotton fabric possesses the trace of applied natural extracts and thereby contributes to antibacterial activity of the treated fabric samples against the strains of *Staphylococcus*, *Klebsiella*, *Shigella species* which were identified in the kitchen environment used fabric.

Untreated samples (control samples) showed zero bacterial growth reduction %, shows that the pretreated fabric does not possess antibacterial activity. From Figures 4 and 5: It can be observed that the bacterial growth reduction % against the 3 bacteria for the lower and higher concentrations considered varying from 4.4 to 29.2 % for the plant agents *Murraya Koenigii*, Pomegranate peels and its different combinations. The Banana peel, Casein and Cyclodextrin extracts treated cotton fabric had higher bacterial growth reduction %, in comparison with *Murraya Koenigii* and Pomegranate peels, especially combination of Banana peel, Casein and Cyclodextrin extracts treated cotton fabric showed highest efficiency among the other treated fabric samples. Although we tried banana peel, Casein and Cyclodextrin extract (individually) for antibacterial tests, the measurable reduction % were not repetitive, hence went for combinations. From the above it is clear that the agent, each natural agent were effective against the identified kitchen bacteria. The establishment of individual role of Casein and Cyclodextrin in the above treatment requires further studies to be carried out.

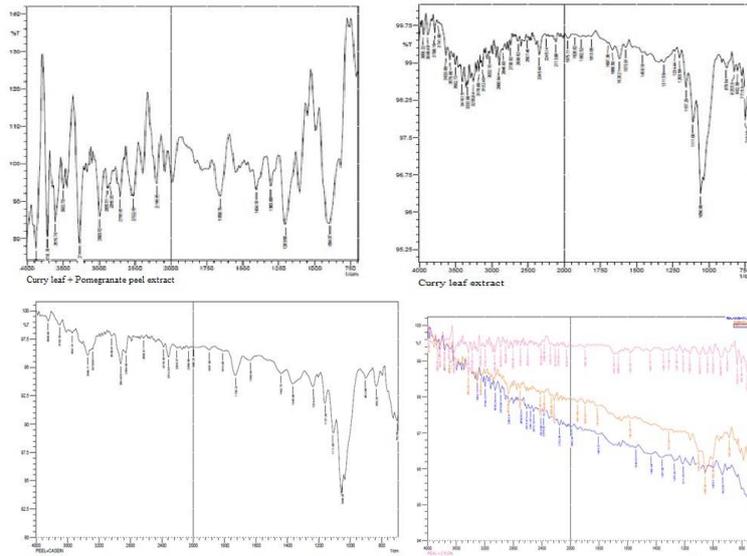


Figure 3: FTIR of natural extracts treated cotton fabric

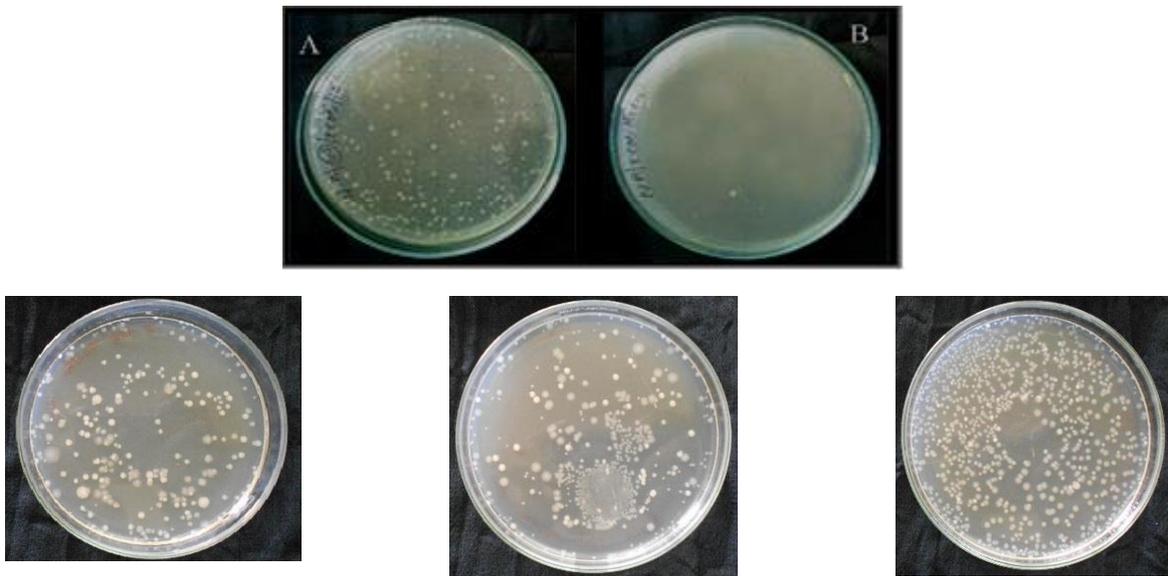


Figure 4: Bacterial growth reduction % of the natural extracts treated cotton fabric

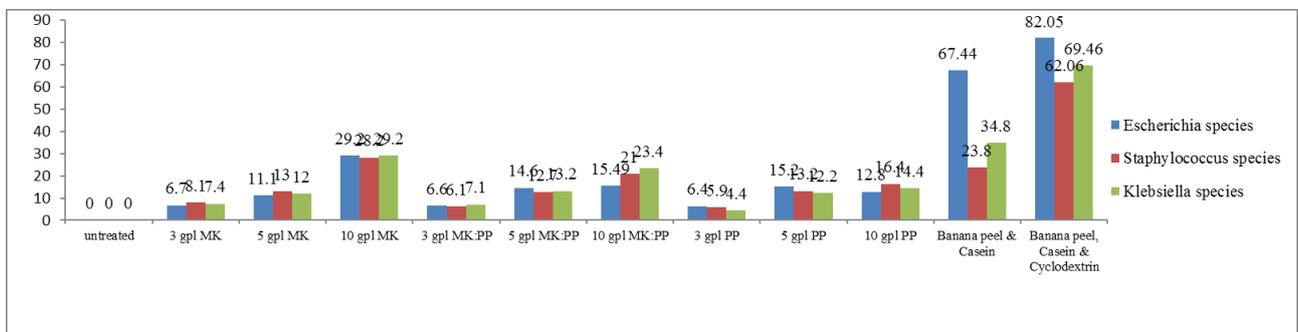


Figure 5: Bacterial growth reduction % of the natural extracts treated cotton fabric

## CONCLUSION

*Staphylococcus*, *Klebsiella* and *Shigella* species were identified on the pretreated bleached cotton fabric used in kitchen environment. The pretreatment used in the study found to possess no antibacterial activity against the bacteria. All the natural agents in extract form are found to have good antibacterial efficiency for kitchen environment considered in this study. The activity of combined 10 gpl concentration (Banana peel, Casein and Cyclodextrin) extracts had increased bacterial growth reduction % among the other two plant extracts and even in its own individual form. The plant extracts need to be evaluated further for all possible bacteria by exploring the survey with more number of kitchen fabric samples and its further biochemical investigations.

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