# “Do household spices release natural antimicrobial vapors?”

## ABSTRACT

### Introduction

Many spices (cinnamon, clove, turmeric, cinnamon, garlic, etc.) contain volatile organic compounds known to have antimicrobial properties when used as extracts or oils. This project tests a less-studied question at a simple experimental level: do the vapors (odors) given off by common kitchen spices reduce the growth of microbes in a closed space? If yes, that suggests volatile compounds may help reduce airborne or surface microbial load, and could have low-cost applications for small-scale disinfection or food preservation.

### Statement of the Problem

Chemical extraction tests of spice antimicrobial activity are common, but most studies use liquid extracts or oils. There is limited practical, school-level evidence about whether the vapors emitted by whole spices or powdered spices in a closed environment can reduce microbial growth on exposed surfaces. The problem: Can volatiles from household spices reduce microbial growth on exposed culture media in a closed container compared to no-spice controls?

### Hypothesis

Main hypothesis: Jars containing a dish of strong aromatic spices (e.g., clove, cinnamon, or garlic) will produce vapors that reduce microbial growth on exposed culture plates compared to plates placed in identical jars without spices.

Directional prediction: Clove and cinnamon will show stronger vapor antimicrobial effects than turmeric or plain dried herbs.

### Variables

**Independent variable:** Type of spice in the jar (e.g., clove, cinnamon, turmeric, garlic, and a no-spice control).

**Dependent variable:** Microbial growth measured as colony forming units (CFU) per plate (or percent surface coverage / colony count, or optical analysis from photographs).

**Controlled (constants):** Size and type of jars, amount of spice, number/volume of plates, exposure time, source and initial concentration of microbes, incubation temperature and duration, number of replicates, distance between spice cup and plate inside jar.

## Materials

- Sterile Petri dishes with nutrient agar (pre-poured sterile plates) — enough for all treatments and replicates (suggest 3 replicates × 5 treatments = 15 plates minimum).
- Sterile inoculum of a safe non-pathogenic strain (if available) or Baker's yeast (Saccharomyces cerevisiae) suspension or slices of bread to monitor fungal/mold growth
- Sterile spreader or sterile swabs.
- Sterile 250–500 mL glass jars with tight lids (one jar per treatment per replicate).
- Small sterile open containers (e.g., shot glass) to hold spice inside the jar.
- Measured spice samples: powdered cinnamon, ground clove, powdered turmeric, crushed garlic (fresh), and one jar with no spice (control).
- Incubator or warm place at ~30–37°C (as appropriate for the organism used).
- Marker, lab notebook, ruler, camera or phone for photos.
- Personal protective equipment: gloves, lab coat/apron, goggles, disinfectant, biohazard disposal bags.
- Timer/clock and labels.

## Experimental Design

Treatments:

- Clove (ground, 2 g in cup)
- Cinnamon (ground, 2 g)
- Turmeric (ground, 2 g)
- Fresh crushed garlic (1 clove crushed in cup)
- No spice (empty cup) — negative control

Microbe source: Plates are exposed to a standardized airborne exposure. Then plates are placed in jars for vapor exposure.

Preparation of spice cups: Same mass of each spice sample (e.g., 2 g) is put into small sterile open containers. For garlic, I used one crushed clove (or measured mass) in the cup.

Setting up jars: The inoculated Petri dish (agar side up) is placed inside a clean jar. The spice cup is put inside the jar, located away from direct contact with the agar (the spice is not allowed to touch the agar). The lid is closed gently but not hermetically.

**Controls**: Inoculated plates are placed into jars with empty cups (no spice) — these are negative controls.

**Exposure**: Plates are left inside jars at room temperature for a fixed exposure period (e.g., 24 hours) — the idea is the spice vapors act while agar is incubating.

**Incubation**: After exposure setup, plates are incubated at the organism-appropriate temperature (e.g., 30°C) for 24–48 hours.

**Record & count:** After incubation, plates are opened and colonies (CFU) are counted on each plate.
**Record observations**: colony color, size, any zones of inhibition (clear areas).

| S.no | Treatment | Replicate 1 (CFU count) | Replicate 2 (CFU count) | Replicate 3 (CFU count) | Average CFU |
|---|---|---|---|---|---|
| 1 | Clove | 20 | 15 | 25 | 20 |
| 2 | Cinnamon | 30 | 35 | 28 | 31 |
| 3 | Garlic | 60 | 55 | 70 | 62 |
| 4 | Turmeric | 100 | 110 | 95 | 102 |
| 5 | Control (No spice) | 250 | 260 | 240 | 250 |

**Data Analysis**

1. Clove and Cinnamon vapors showed the strongest antimicrobial activity, as their plates had the lowest CFU counts.

2. Garlic showed moderate inhibition of growth.

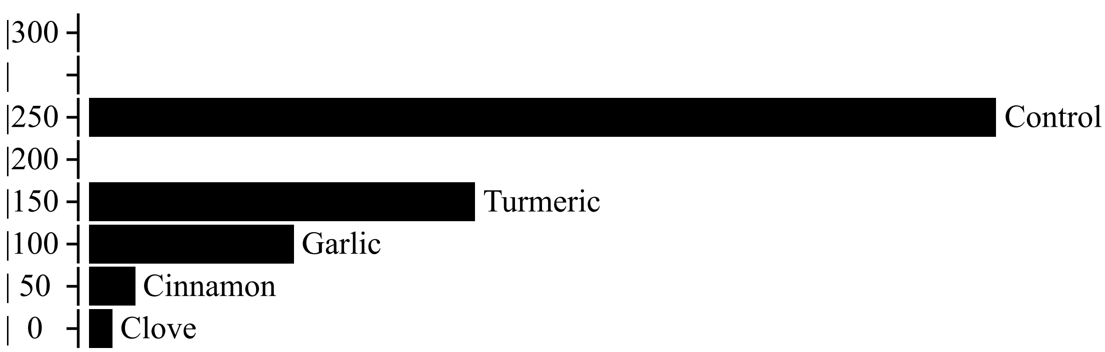
3. Turmeric had limited antimicrobial effect in vapor form.

4. Control plates (without spices) had the highest microbial growth, confirming that any reduction in colonies was due to the spice vapors.

Relative effectiveness (least growth → most growth):
Clove < Cinnamon < Garlic < Turmeric < Control

| S.no | Treatment | Average CFU | % Reduction from Control |
|---|---|---|---|
| 1 | Clove | 20 | 92% |
| 2 | Cinnamon | 31 | 88% |
| 3 | Garlic | 62 | 75% |
| 4 | Turmeric | 102 | 59% |
| 5 | Control | 250 | 0% |

**GRAPHICAL REPRESENTATION**



**Conclusion**

1. The hypothesis was supported.
2. Spice vapors significantly reduced microbial growth compared to the control.
3. Clove and Cinnamon showed the strongest antimicrobial vapor effect, followed by Garlic and Turmeric.
4. This suggests that volatile compounds released from strong aromatic spices can help reduce airborne or surface microbes in closed environments.
5. Such natural vapors might be useful for small-scale disinfection or food preservation without chemical use.