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How Do Spices Affect Cell Death?

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Abstract

This experiment tests the antimicrobial effects of garlic, ginger, cinnamon, black pepper, and mustard by measuring their ability to inhibit bacterial growth. We used discs covered with each spice that were placed onto agar plates inoculated with bacteria, and the zones of inhibition were measured after incubation. The hypothesis was that garlic and ginger would show the larger zones of inhibition due to their known antimicrobial properties. The results revealed that garlic, cinnamon, and mustard showed the most significant inhibition, while ginger and black pepper had no effect. This highlights the potential of components of garlic, cinnamon, and mustard as possible natural antimicrobial agents.

Introduction

Spices are not just used for flavoring food but also have significant biological and medicinal properties. Many spices contain bioactive compounds that contribute to human health by aiding digestion, reducing inflammation, and fighting infections. Our group decided to study some of the most commonly found household spices to include: Ground Cinnamon, Black Pepper, Garlic Powder, Mustard Powder, and Ginger Powder. Our hypothesis was that garlic powder, ginger powder, and black pepper would have the best antimicrobial effects compared to the rest of the spices. During our investigation we were looking for cell death after a 48 hour period and found that Garlic Powder and Cinnamon to be the most effective at stopping yeast growth.

Methods

Materials & Location

In our experiment, we used agar plates, sterile disc, various spices (Cinnamon, garlic, ginger, black pepper, and mustard), a micropipette, 5g of baker's yeast, and sterile water. The experiment was conducted in the lab environment to ensure accuracy and prevent contamination. Whenever any container was opened, we ensured it was kept at an angle or covered with its lid to prevent anything from falling into it. Also, when placing the plates into the incubator, remember to place them upwards to prevent the discs from falling off from the agar. Anyone attempting to replicate the experiment will need these same materials, along with a sterile workspace to maintain proper conditions.

Procedure

- Wear gloves. Keep everything sterile horizontal or covered. No lids on the table.
- Create a yeast suspension by adding 5g of yeast to 50 mL of dH2O
- Using a marker, divide your plate into 4 quadrants
- Label your plate on the agar side corresponding to the treatment for each disc
- Pipette 200 uL of the yeast suspension onto a plate *(remember aseptic technique)*
- Pour about 10 glass beads onto the plate *(remember aseptic technique)*
- Swirl the beads around the plate in all directions
- Dip discs into the sterile water
- Dip wet discs into a Spice
- Lightly push the discs into the agar (Be careful not to puncture the agar it is very sensitive).
- Repeat for all plates until each quadrant is filled with one disc.
- DO NOT Place upside down (agar side up) into the incubator
- After 48 hours of incubation, place the plates into the refrigerator until it is time to measure the cell death, or measure immediately after the incubation period
- Use a ruler to measure the zone of inhibition
- Record your results

Plates after Incubation Period

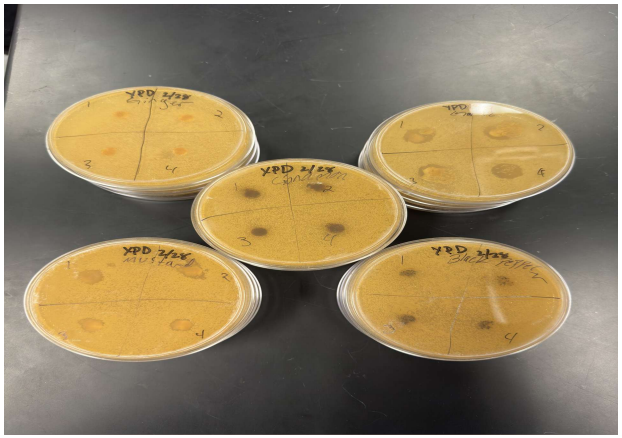

Figure 1. This is a picture of the five petri plates. Each contains one of the following spices: ginger, mustard, cinnamon, garlic, and black pepper. As you can see, garlic, cinnamon, and mustard showed the largest inhibition area.

Spice Inhibition

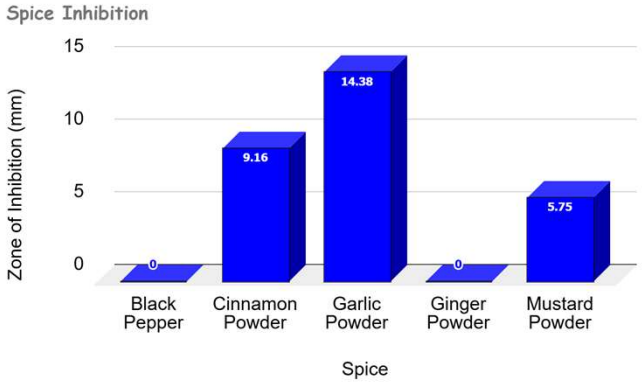

Figure 2. This is a chart of the inhibition of the 5 spices. Where Garlic Powder show the most cell death, while Cinnamon Powder and Mustard Powder showed the least amount of inhibition. Black Pepper and Ginger Powder do not show any results for cell death.

Discussion

Our experiment aimed to assess the inhibitory effects of common household spices on yeast growth by measuring the zone of inhibition. Our original hypothesis predicted that ginger powder, garlic powder, and black pepper would exhibit the strongest antimicrobial effects. The results partially supported this hypothesis, as garlic powder demonstrated the largest zone of inhibition (14.38 mm), while ginger powder showed no measurable effect. Additionally, cinnamon powder (9.16 mm) and mustard powder (5.75 mm) displayed inhibitory effects, whereas black pepper had no effect. These findings underscore garlic's potent antimicrobial properties but suggest that ginger may not be as effective against yeast as initially anticipated.

The varying degrees of yeast inhibition likely stem from the unique chemical compositions of the tested spices. Garlic contains allicin, a well-documented antimicrobial compound that disrupts cell membranes and essential metabolic pathways in microorganisms. Cinnamon, which we did not initially expect to be highly effective, contains cinnamaldehyde, known for its antifungal properties. Mustard powder, while showing less inhibition, contains isothiocyanates, compounds with mild antimicrobial activity. The unexpected lack of inhibition from ginger powder suggests that its active compound, gingerol, may be ineffective against yeast or that the concentration used was insufficient to produce a measurable effect. Factors such as solubility, diffusion in the testing medium, and susceptibility of the yeast strain may have influenced these outcomes.

Our findings align with previous studies that have examined the antimicrobial properties of various spices. A study published in the *International Journal of Advanced Research* found that garlic powder in culture media unexpectedly encouraged fungal growth when autoclaved, suggesting that its antimicrobial properties may be altered by preparation methods (A.W., & S.A., 2014). Another study on common spices demonstrated that cinnamon and clove exhibited potent enough antimicrobial effects to prevent food spoilage, whereas other spices, like black pepper, had little to no inhibition (A.H., 2021). These studies support our findings that garlic and cinnamon have significant antimicrobial properties, while black pepper and ginger may be less effective in inhibiting yeast growth.

Future studies could explore higher spice concentrations, different yeast strains, or combinations of spices to determine if synergistic effects exist. Additionally, using microscopy or viability staining could help confirm whether yeast cells were completely killed or merely inhibited (Z.L., et al 2015, Dec). While our hypothesis was only partially supported, the results reinforce the antimicrobial potential of garlic and cinnamon, suggesting possible applications in food preservation and alternative antifungal treatments.

Acknowledgements

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