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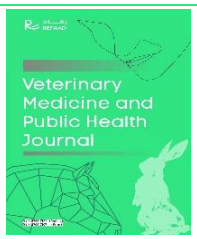

Antibacterial Efficacy of Saudi *Coriandrum sativum* L. Seed Extract: A Potential Natural Preservative for Enhancing Food Safety and Shelf Life

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Abstract:

Objective: This study aimed to demonstrate the antimicrobial activity of an aqueous extract of Saudi Coriandrum sativum L. seeds against bacteria that cause food contamination and food poisoning.

Methods: The study utilized an aqueous extract of Saudi Coriandrum sativum L. seeds to assess its antibacterial activity against various bacterial strains associated with food contamination and food poisoning. The bacterial strains tested included Streptococcus sp., Enterococcus faecalis, Bacillus cereus, Staphylococcus aureus, Escherichia coli, Salmonella enteritidis, Pseudomonas aeruginosa, and Listeria monocytogenes. The bacteria were exposed to the extract for a period of 72 hours, after which their growth rates were measured and categorized to determine the extract's effectiveness in inhibiting bacterial proliferation.

Results: The bacterial isolates were divided into three groups based on their growth rates after 72 hours of exposure to the aqueous extract. The first group, which demonstrated the highest susceptibility, included Streptococcus sp. and Enterococcus faecalis, with an average growth reduction of 9.2%. The second group, comprising Bacillus cereus, Staphylococcus aureus, and Escherichia coli, exhibited an average growth reduction of 22.5%. The third group, which included Salmonella enteritidis, Pseudomonas aeruginosa, and Listeria monocytogenes, showed the least susceptibility, with an average growth reduction of 45.8%.

Conclusions: The aqueous extract of Coriandrum sativum L. seeds has shown effective inhibition of bacterial growth. While additional research is needed to fully assess its potential, the extract could be recommended as a natural preservative in the food industry. It has the potential to extend shelf life, improve food quality, and safeguard consumer health.

Keywords: *Coriandrum sativum L. seeds; Streptococcus sp.; Enterococcus faecalis; Bacillus cereus; Staphylococcus aureus; Escherichia coli; Salmonella enteritidis; Pseudomonas aeruginosa; Listeria monocytogenes.*

1 Introduction

In Saudi Arabia, Coriandrum sativum L. seeds are commonly known as "Al-kozbarah." These seeds contain a total aroma content of 90.17%, with the crude essential oil composed of various compounds, including 1-decanol (17.85%), decanal (11.04%), trans-2-dodecen-1-ol (7.87%), menthone (6.71%), 2-decen-1-ol, trans- (5.44%), dodecanal (4.76%), trans-tetradec-2-enal (3.14%), sedanolide (3.02%), and thymol (3.01%). The major volatile compound in the essential oil is β-linalool, which makes up 66.07% of the oil. The essential oil also exhibits radical scavenging activity, with 51.05% inhibition, and contains bioactive constituents such as fatty acids, tocols, sterols, and carotenoids (Foudah, et.al, 2021).

The essential oils of Coriandrum sativum L. seeds contain compounds like carvacrol, thymol, p-cymene, and γ-terpinene, which have garnered increasing attention from scientists in the fields of biomedicine for their potential to inhibit microbial pathogens. These natural aromatic oils are being explored for their antimicrobial properties. Studies have shown that extracts from Coriandrum sativum L. seeds can reduce the growth of various bacteria (Ali & Malik, 2021).

Coriandrum sativum L. seeds exhibit significant antibacterial activity against *Escherichia coli*, *Staphylococcus aureus*, and *Salmonella typhi*. The seed extract showed the highest reduction in bacterial growth and displayed strong antibiofilm activity, particularly against *Bacillus* species (Kačániová, et al., 2020). The antimicrobial effects of Coriandrum sativum L. seeds have been demonstrated through their ability to damage bacterial cells and inhibit the growth of *Streptococcus* sp., *Staphylococcus aureus*, *Enterococcus faecalis*, *Listeria monocytogenes*, *Bacillus cereus*, *Escherichia coli*, *Salmonella enteritidis*, and *Pseudomonas aeruginosa* (Shoaib, et al., 2023).

The use of an aqueous extract of Saudi Coriandrum sativum L. seeds is significant for preserving food, reducing contamination by foodborne microbes that lead to food poisoning, and prolonging the shelf life of preserved foods.

The objective of this study was to demonstrate the ability of the aqueous extract of Saudi Coriandrum sativum L. seeds to eliminate microbes responsible for food contamination and food poisoning. The study was conducted through laboratory experiments using the aqueous extract of the seeds against various bacteria associated with food contamination and poisoning.

2 Methodology

The Saudi Coriandrum sativum L. seeds used in this study were purchased from an herbalist shop at a local market. To prepare the water extract, residents at the market were consulted on the traditional method. Based on their guidance, five grams of Saudi Coriandrum sativum L. seeds were added to 100 ml of water, and the mixture was placed in a water bath and boiled for five minutes. The resulting water extract was then stored in a refrigerator until the experiment began (Alqethami, & Aldhebiani, 2021).

The bacteria used in this study, which included *Bacillus cereus*, *Staphylococcus aureus*, *Streptococcus* sp., *Salmonella enteritidis*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Listeria monocytogenes*, and *Enterococcus faecalis*, were collected from a private laboratory. These isolates had been previously identified as contaminants from food sources or patients with food poisoning. To prepare the bacteria for the experiment, the isolates were first cultured on Muller Hinton Agar for 24 hours at 37°C. Following this, the bacterial colonies were transferred into Muller Hinton Broth and incubated for six hours at 37°C, ensuring they were active and ready for testing (Okaiyeto, et al., 2024).

For the experimental procedure, nine sterile lidded glasses were prepared for each bacterial sample. Three milliliters of the bacterial broth culture were added to each glass, followed by three milliliters of the Saudi Coriandrum sativum L. seeds water extract. The solutions were thoroughly mixed, and three tubes were prepared for each bacterial sample to obtain an average. The mixtures were incubated at 37°C and observed at intervals of 24, 48, and 72 hours. After each incubation period, the cultures were re-plated on Muller Hinton Agar and incubated for another 24 hours at 37°C to assess bacterial growth following exposure to the water extract. The bacterial growth results were recorded, and the averages were calculated using Microsoft Excel, which facilitated easy display and analysis of the data (Odongo, et al., 2023).

3 Results

The results are presented in Table 1 which shows bacterial growth after exposure to the aqueous extract of Saudi *Coriandrum sativum* L. seeds, measured at three different time points: 24, 48, and 72 hours. Bacterial growth was categorized into

three levels: substantial growth (70-75%), moderate growth (20-25%), and minimal growth (0-5%).

For *Bacillus cereus*, the bacterial growth was substantial at 24 hours, with 45-50% growth observed. By 48 hours, the growth rate decreased to moderate levels, between 20-25%. After 72 hours of exposure, growth was minimal, ranging from 0-5%. The average growth reduction across the entire observation period was 22.5%, reflecting a significant antibacterial effect of the extract on this bacterium.

Similarly, *Staphylococcus aureus* also showed substantial growth (45-50%) at the 24-hour mark, which diminished to moderate growth (20-25%) by 48 hours. By 72 hours, the growth was minimal (0-5%), indicating effective inhibition by the extract. The average reduction in growth over the 72 hours was the same as for *Bacillus cereus*, at 22.5%.

For *Streptococcus* sp., the growth was moderate (20-25%) after 24 hours but dropped to minimal levels (0-5%) by both 48 and 72 hours. The average growth reduction was 9.2%, indicating that while the extract was effective, it was less potent against *Streptococcus* sp. compared to the other bacteria tested.

Salmonella enteritidis demonstrated substantial growth (70-75%) after 24 hours, which decreased to moderate growth (45-50%) at 48 hours and then to moderate (20-25%) by 72 hours. The average growth reduction was 45.8%, showing a strong effectiveness of the extract against this bacterium.

Similarly, *Pseudomonas aeruginosa* and *Listeria monocytogenes* both exhibited substantial growth (70-75%) at 24 hours, which reduced to moderate levels (45-50%) by 48 hours and further decreased to 20-25% by 72 hours. The average growth reduction for both bacteria was 45.8%, indicating significant antibacterial activity of the extract.

Finally, *Enterococcus faecalis* had moderate growth (20-25%) at 24 hours, which dropped to minimal levels (0-5%) by 48 and 72 hours. The average growth reduction was 9.2%, similar to *Streptococcus* sp., suggesting that this bacterium was less susceptible to the extract compared to others.

Overall, the results demonstrate that the aqueous extract of Saudi *Coriandrum sativum* L. seeds effectively inhibits bacterial growth, with varying degrees of effectiveness depending on the bacterial strain.

Table 1: The bacterial growth after exposure to Saudi Coriandrum sativum L seeds aqueous extract

Bacterial isolates	Incubation hours			
	24	48	72	Means
Bacillus cereus	++ (45-50%)	+ (20-25%)	- (0-5%)	22.5%
Staph. aureus	++ (45-50%)	+ (20-25%)	- (0-5%)	22.5%
Strept. sp.	+ (20-25%)	- (0-5%)	- (0-5%)	9.2%
Salmonella enteritidis	+++ (70-75%)	++ (45-50%)	+ (20-25%)	45.8%
E. coli	++ (45-50%)	+ (20-25%)	- (0-5%)	22.5%
Pseudomonas aeruginosa	+++ (70-75%)	++ (45-50%)	+ (20-25%)	45.8%
Listeria monocytogenes	+++ (70-75%)	++ (45-50%)	+ (20-25%)	45.8%
Enterococcus faecalis	+ (20-25%)	- (0-5%)	- (0-5%)	9.2%

4 Discussion

In this study, bacterial isolates were categorized into three groups based on their growth rates after 72 hours of exposure to the extract of Saudi *Coriandrum sativum* L. seeds. The first group, which showed the highest susceptibility to the extract, included *Streptococcus* sp. and *Enterococcus faecalis*, with an average growth reduction of 9.2%. This group was more easily inhibited by the aqueous extract, suggesting that these bacteria are particularly sensitive to the chemical components of Saudi *Coriandrum sativum* L. seeds. This makes the extract effective in reducing food contamination and food poisoning caused by these bacteria (Foudah, et al., 2021, Ali & Malik, 2021, Kačániová, et.al, 2020, Shoaib, 2023, Talebi & Naser, 2024).

The second group, which included *Bacillus cereus*, *Staphylococcus aureus*, and *Escherichia coli*, exhibited an average growth reduction of 22.5%. Although this group was less susceptible than the first, the extract still significantly inhibited bacterial growth. However, to achieve a more substantial reduction in food contamination and food poisoning, a longer exposure time or higher concentration of the extract may be required (Foudah, et al., 2021, Ali & Malik, 2021, Kačániová, et.al, 2020, Shoaib, 2023, Al-Khayri, et al., 2023).

The third group, consisting of *Salmonella enteritidis*, *Pseudomonas aeruginosa*, and *Listeria monocytogenes*, was the most resistant to the extract, with an average growth reduction of 45.8%. These bacteria proved to be more challenging to eliminate, indicating that higher concentrations and prolonged exposure to the extract are necessary to effectively reduce food contamination and food

poisoning caused by these pathogens (Foudah, et al., 2021, Ali & Malik, 2021, Kačániová, et.al, 2020, Shoaib, 2023, Meenu, et al., 2023).

The study underscores the potential of using natural herbs, such as Saudi *Coriandrum sativum* L. seeds, to reduce bacterial contamination in food and lower the incidence of food poisoning. The chemical properties of the herb make it a valuable natural preservative, enhancing food safety and extending shelf life. This suggests a promising application of herbal treatments in food preservation, which could play a significant role in maintaining food quality and consumer health (Foudah, et al., 2021, Ali & Malik, 2021, Kačániová, et.al, 2020, Shoaib, 2023, Aouini, et al., 2024).

5 Conclusion

The study concluded that the aqueous extract of *Coriandrum sativum* L. seeds effectively inhibited the growth of several foodborne bacterial pathogens in vitro.

Recommendation:

It is recommended to use the aqueous extract of *Coriandrum sativum* L. seeds as a natural preservative in the food industry. From a pharmaceutical standpoint, this extract has the potential to reduce bacterial contamination, extend the shelf life of foodstuffs, and maintain food quality. However, further studies are needed to fully evaluate its efficacy and safety for broader application.

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