



Article

The Anti-Bacterial Activity of Resveratrol Against a Group of Gram-Negative and Gram-Positive Bacteria

Mayes Mohammed Tayeh^{*1}

1. Assistant Lecturer, Medical Laboratory Technologies, Dijlah University

* Correspondence: mais.mohammed@duc.edu.iq

Abstract: Resveratrol, a polyphenolic compound abundantly present in grape skins and seeds, is recognized for its antioxidant and antibacterial properties. Its capacity to inhibit microbial growth and interfere with essential cellular processes has made it a subject of increasing interest as a natural antimicrobial candidate. The study aimed to evaluate the antibacterial activity of grape-derived resveratrol against selected Gram-positive and Gram-negative bacterial species at different concentrations. Four bacterial species were tested: two Gram-positive (*Bacillus subtilis* and *Staphylococcus aureus*) and two Gram-negative (*Escherichia coli* and *Salmonella typhimurium*). Resveratrol solutions were prepared at concentrations of 25, 50, and 75 mg/ml. The antibacterial activity was assessed using the well-diffusion method on Mueller-Hinton Agar. Bacterial suspensions were standardized according to the McFarland method and incubated at 37 °C for 24 hours. Inhibition zone diameters were then measured. Resveratrol exhibited inhibitory effects against all tested bacterial strains, with varying levels of sensitivity. *Bacillus subtilis* showed the highest susceptibility (35 mm at 75 mg/ml), followed by *Staphylococcus aureus* (28 mm) and *Escherichia coli* (25.5 mm), while *Salmonella typhimurium* displayed the lowest sensitivity. Overall, resveratrol was more effective against Gram-positive bacteria than Gram-negative, likely due to the structural complexity of the Gram-negative cell wall and outer membrane, which restrict compound penetration.

Keywords: Resveratrol, Natural Antibacterial Agents, Gram-Positive Bacteria, Gram-Negative Bacteria, Antibiotic Resistance

Citation: Tayeh M. M. The Anti-Bacterial Activity of Resveratrol Against a Group of Gram-Negative and Gram-Positive Bacteria. Central Asian Journal of Medical and Natural Science 2025, 6(4), 2211-2214.

Received: 30th Jul 2025

Revised: 11th Aug 2025

Accepted: 25th Aug 2025

Published: 15th Sept 2025



Copyright: © 2025 by the authors. Submitted for open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>)

1. Introduction

The plant flavonoid resveratrol (3, 4, 5-trihydroxy-trans-stilbene) has a number of biological activity linked to health enhancement [1]. Resveratrol has a yellowish white color, a molecular weight of 228.247 g/mol, and a chemical formula of $C_{14}H_{12}O_5$. It is made up of two aromatic rings joined by an ethylene bridge. It is poorly soluble in water (about 3 mg/100 ml), but more soluble in ethanol and other polar solvents [2], [3]. When plants are afflicted, their natural defense mechanism produces resveratrol, a physiologically active substance [4]. More than 70 plant species contain it, particularly in the seeds and skins of berries, peanuts, and grapes [5], [6]. The peanut plant contains resveratrol in its leaves, shells, and roots, among other parts. One nutrient that shows promise is resveratrol, which is found in peanuts. Compared to mature peanuts, smaller, immature peanuts have a greater resveratrol content. [7] Since its discovery in 1940, resveratrol has been shown to provide health advantages [8]. One of the most significant polyphenolic substances with a range of health benefits is resveratrol. As a nutrition, it

has been employed extensively in recent decades. Due to the compound's widespread acceptance, it is being studied both alone and in conjunction with traditional antibiotics as an anti-pathogen. At low doses, resveratrol has shown its effectiveness as a potent antibacterial against a variety of bacterial, viral, and fungal species. Its function is to prevent the development of biofilms and the expression of virulence characteristics by bacteria, which lowers the amount of hazardous compounds produced [9,10]. shown that resveratrol's anti-Gram-positive bacterial effects are based on modifications to cell shape and DNA content [11]. A number of sophisticated methods have been developed to extract resveratrol. It has been extracted using organic solvents, such as ethanol and other solvents [12]. The effects of temperature, duration, and solvent type on the extraction of resveratrol from grapes using ethanol (in water) were also studied. They discovered that 30 minutes at 60°C produced the maximum extraction yield.

Numerous research have shown the great potential of resveratrol, especially when it comes to its use in food items. This is because it is inexpensive, has many advantages, and has few negative effects. Since resveratrol is a naturally occurring, non-toxic substance, its use in goods has grown in popularity as a potentially beneficial ingredient for health [13]. Resveratrol contributes to improving health and preventing a number of illnesses, particularly those that are associated with ageing, such diabetes, cancer, and neurological problems [14].

2. Materials and Methods

a. Chemical materials

Mueller-Hinton Agar: Use the medium prepared by Oxoid Company and prepare 13 g in 1 liter of water according to the instructions of the company that prepared it. Use the medium to test the inhibitory activity.

b. Testing the inhibitory activity of resveratrol compound against a number of bacteria:

The inhibitory activity of the resveratrol compound was tested against the isolates used in the study using the diffusion method described by [11]. The isolates were grown in 10 ml of the liquid nutrient medium prepared in accordance with the protocol and incubated at 37°C for 24 hours. Then, 0.1 ml of a concentration of 108 CfU/ml was spread on the surface of the solid culture medium Muller Hinton Agar using a sterile glass diffuser (L-shaped). Using a cork drill, a 6 mm hole was drilled in the culture medium's surface. 50 microlitres of TiO₂NP were then added to each hole at concentrations of 75, 50, and 25 mg/ml using a micropipette with For comparison, a hole was left with a control sample of distilled water. Following a 24-hour incubation period at 37°C, the width of the inhibitory zone was measured on the plates. Keep in mind that the clear halo around the hole or the region devoid of development is the inhibition zone.

c. Organisms used: Escherichia coli, Salmonella typhimurium, Bacillus subtilis, and Staphylococcus aureus

3. Results and Discussion

Table 1. Resveratrol's ability to inhibit both Gram-positive and Gram-negative bacteria

25mg/ml	50mg/ml	75mg/ml	Bacteria
14	21	25.5	E .coli
10	14	18	Salmonella typhimurium
18	26	35	Bacillus subtilis
12	24	28	Staphylococcus aureus

The three concentrations' inhibitory effects on both Gram-positive and Gram-negative bacteria are shown in the table. Bacillus bacteria exhibited the greatest inhibition at 75 mg/ml, with an average inhibition diameter of 35 mm and 18.26 mm at 25 and 50 mg/ml.

The inhibition diameter of *E. Coli* bacteria was 14.21 mm at doses of 25 and 50 mg/ml and 25.5 mm at a dosage of 75 mg/ml. This is in line with the findings of [15] regarding the antibacterial activity of resveratrol against *E. coli*, which indicated that the compound's inhibitory function results from the inhibition of Fts Z, a protein required for prokaryotic cell division and the formation of the Z-ring (the division ring in bacterial cell division). The chemical had an impact on *Staphylococcus* bacteria, as shown by the inhibition diameter reaching 28 mm at a dosage of 75 mg/ml and 24.12 mm at a concentration of 50.25 mg/ml. However, *Salmonella* germs were less sensitive than the other bacteria that were tested. The molecule resveratrol was more effective against Gram-positive bacteria than against Gram-negative bacteria. This is in line with the findings of [16], who discovered that resveratrol is more effective against Gram-positive bacteria than Gram-negative bacteria as an antibiotic. This might be because some negative bacteria have more complex wall structures than Gram-positive bacteria, making it harder for resveratrol to penetrate their outer membrane. Nevertheless, because resveratrol seems to be more effective against Gram-positive bacteria, it reduces their growth by stopping cell division.

4. Conclusion

According to the study's results, resveratrol that has been extracted from grapes has significant inhibitory effect against both Gram-positive and Gram-negative bacteria, with a definite advantage in its ability to inhibit Gram-positive strains like *Staphylococcus aureus* and *Bacillus subtilis*. The structural complexity of Gram-negative bacteria's outer membrane, which serves as a barrier to the entry of bioactive substances and lessens their direct influence on the bacterial cell, is responsible for this variation in sensitivity. Additionally, the data show a dose-dependent relationship, with wider inhibitory zones created by greater resveratrol concentrations, demonstrating that the antibacterial action of the compound is concentration-dependent and more prominent at higher dosages. Given the growing bacterial resistance to traditional antibiotics, these results lend credence to the idea that resveratrol is a viable natural antibacterial agent. They also point to the possibility of further studies to increase the effectiveness of resveratrol by using it in combination with conventional antibiotics or by using cutting-edge delivery methods like nanoparticles or bioactive films, which may enhance its stability, solubility, and overall therapeutic potential. Furthermore, broadening the study's focus to include a larger variety of harmful bacteria—particularly those that are resistant to several drugs—would provide important new information on the whole range of its antimicrobial capabilities. To clarify its precise interactions with bacterial cell components such the cell wall, plasma membrane, and genetic material, mechanistic investigations at the molecular level are also necessary. Furthermore, controlled clinical studies should be used to priorities safety evaluations and the best dose recommendations for human or veterinary uses.

REFERENCES

- [1] R. E. King, J. A. Bomser, and D. B. Min, "Bioactivity of resveratrol," *Comprehensive Reviews in Food Science and Food Safety*, vol. 5, no. 3, pp. 65–70, 2006.
- [2] B. V. Fiod Riccio, B. Fonseca-Santos, P. C. Ferrari, and M. Chorilli, "Characteristics, biological properties and analytical methods of trans-resveratrol: A review," *Critical Reviews in Analytical Chemistry*, vol. 50, no. 4, pp. 339–358, 2020.
- [3] S. W. Hwang, J. K. Shim, S. E. Selke, H. Soto-Valdez, L. Matuana, M. Rubino, and R. Auras, "Poly (L-lactic acid) with added α -tocopherol and resveratrol: optical, physical, thermal and mechanical properties," *Polymer International*, vol. 61, no. 3, pp. 418–425, 2012.
- [4] M. A. Hussein, "A convenient mechanism for the free radical scavenging activity of resveratrol," *International Journal of Phytomedicine*, vol. 3, no. 4, pp. 459–465, 2011.
- [5] C. A. Lastra and I. Villegas, "Resveratrol as an antioxidant and pro-oxidant agent: mechanisms and clinical implications," *Biochemical Society Transactions*, vol. 35, no. 5, pp. 1156–1160, 2007.

- [6] B. Salehi et al., "Resveratrol: A double-edged sword in health benefits," *Biomedicines*, vol. 6, no. 3, p. 91, 2018.
- [7] M. M. Hasan, M. Cha, V. K. Bajpai, and K. H. Baek, "Production of a major stilbene phytoalexin, resveratrol in peanut (*Arachis hypogaea*) and peanut products: a mini review," *Reviews in Environmental Science and Bio/Technology*, vol. 12, pp. 209–221, 2013.
- [8] L. Paulo, S. Ferreira, E. Gallardo, J. A. Queiroz, and F. Domingues, "Antimicrobial activity and effects of resveratrol on human pathogenic bacteria," *World Journal of Microbiology and Biotechnology*, vol. 26, pp. 1533–1538, 2010.
- [9] M. Vestergaard and H. Ingmer, "Antibacterial and antifungal properties of resveratrol," *International Journal of Antimicrobial Agents*, vol. 53, no. 6, pp. 716–723, 2019.
- [10] E. Abedini, E. Khodadadi, E. Zeinalzadeh, S. R. Moaddab, M. Asgharzadeh, B. Mehramouz, and H. S. Kafil, "A comprehensive study on the antimicrobial properties of resveratrol as an alternative therapy," *Evidence-Based Complementary and Alternative Medicine*, vol. 2021, no. 1, p. 8866311, 2021.
- [11] Y. J. Cho, J. Y. Hong, H. S. Chun, S. K. Lee, and H. Y. Min, "Ultrasonication-assisted extraction of resveratrol from grapes," *Journal of Food Engineering*, vol. 77, no. 3, pp. 725–730, 2006.
- [12] B. Tian and J. Liu, "Resveratrol: A review of plant sources, synthesis, stability, modification and food application," *Journal of the Science of Food and Agriculture*, vol. 100, no. 4, pp. 1392–1404, 2020.
- [13] M. Vestergaard and H. Ingmer, "Antibacterial and antifungal properties of resveratrol," *International Journal of Antimicrobial Agents*, vol. 53, no. 6, pp. 716–723, 2019.
- [14] V. Filip, M. Plockova, J. Šmidrkal, Z. Špičková, K. Melzoch, and Š. Schmidt, "Resveratrol and its antioxidant and antimicrobial effectiveness," *Food Chemistry*, vol. 83, no. 4, pp. 585–593, 2003.
- [15] S. P. L. F. Oliveira, L. C. Bertan, C. M. V. B. De Rensis, A. P. Bilck, and P. C. B. Vianna, "Whey protein-based films incorporated with oregano essential oil," *Polímeros*, vol. 27, pp. 158–164, 2017.
- [16] S. W. Hwang, J. K. Shim, S. E. Selke, H. Soto-Valdez, L. Matuana, M. Rubino, and R. Auras, "Poly (L-lactic acid) with added α -tocopherol and resveratrol: optical, physical, thermal and mechanical properties," *Polymer International*, vol. 61, no. 3, pp. 418–425, 2012.