*Available online at*
http://currentagriculturetrends.vitalbiotech.org/

**ISSN (E): 2583 – 1933**

*Curr. Agri.Tren.:e- Newsletter*, (2025) *4*(10), 29-32

Current Agriculture Trends: e-Newsletter

Article ID: 475

# Quorum Quenching (QQ) in Bacteria: Mechanism and Applications

**Kolli Leela Bhavani[1], Prashant Gigaulia[2], Yogendra singh[3], and Aneesh Kumar Kol[4]**

[1]M.Sc Research Scholar, Biotechnology Centre, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P)
[2]Guest Faculty, Molecular Biology and Biotechnology, Biotechnology Centre, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P)
[3]Assistant Professor (Senior Scale)-Biotechnology, Department of Genetics and Plant Breeding, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P)
[4]M.Sc Research Scholar, Biotechnology Centre, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P)

Open Access

*Corresponding Author
**Yogendra singh***

**Article History**
Received: 28. 9.2025
Revised: 3. 10.2025
Accepted: 8. 10.2025



## INTRODUCTION

Bacteria are not just solitary organisms. They can communicate with neighbouring cells and synchronize their behaviours through a process called Quorum Sensing (QS). The term "Quorum Sensing" was first introduced by P. Greenberg in 1994, emphasizing how population thresholds trigger coordinated genetic responses. This mechanism relies on the production, release, and detection of chemical signals known as autoinducers (AI). These signals allow bacterial communities to gauge their population density and adjust gene expression accordingly. Quorum sensing controls many physiological activities. These include producing virulence factors, forming biofilms, bioluminescence, symbiosis, competence, conjugation, motility, sporulation, and regulating antibiotic production and resistance. Quorum sensing (QS) plays an important role in managing bacterial virulence and persistence, which leads to the failure of antimicrobial treatments. Unlike antibiotics that aim to kill bacteria, disrupting QS (a process known as quorum quenching) provides a non-lethal method to weaken pathogens. This method avoids strong selective pressure and may lessen the development of resistance. Therefore, quorum quenching (QQ) has drawn interest as a new antimicrobial strategy.

QQ refers to disrupting bacterial communication that is mediated by Quorum Sensing (QS) signals. This process interferes with QS pathways by breaking down, inactivating, or blocking signal molecules. As a result, it prevents bacteria from coordinating bacterial community behaviours such as virulence and biofilm formation. As a non-lethal strategy, QQ serves as a promising alternative to conventional antibiotics. It has potential applications in medical, agricultural, and industrial settings for managing bacterial pathogenicity. QQ is receiving more attention as an alternative strategy to fight antibiotic resistance by focusing on bacterial communication instead of survival.

The most significant effects of QQ have been seen in medicine, especially in treating stubborn bacterial infections linked to biofilms and chronic wounds, where traditional antibiotics often do not work. Beyond clinical environments, QQ also shows potential in aquaculture. Enzymes and inhibitors are used to control harmful bacteria and decrease disease outbreaks in fish farms. In agriculture, researchers are looking into quorum quenching as a way to hinder plant pathogens by disrupting their QS systems, which helps protect crops from infection. Both natural and synthetic QQ agents, including quorum-quenching enzymes and QS inhibitors (QSI) , are being actively studied for their potential to manage bacterial communities across medical, agricultural, and environmental areas.

**Mechanism**

Quorum Quenching (QQ) disrupts bacterial communication by interfering with Quorum Sensing (QS) pathways. There are three main types of QQ mechanisms: enzymatic degradation of signaling molecules, interference using signal analogs or inhibitors, and receptor inactivation

1. **Enzymatic Degradation:** This is the most direct form of QQ. Certain enzymes break down QS signals like N-acyl homoserine lactones (AHLs) found in Gram-negative bacteria. Three major classes of QQ enzymes have been identified:

a. **AHL-lactonases,** which break the lactone ring of AHLs and make them inactive. These are common in *Bacillus* and *Rhodococcus* species (Dong et al., 2007).

b. **AHL-acylases,** which cut the amide bond between the acyl chain and the homoserine lactone part, thus inactivating the signal (Hong et al., 2012).

c. **Oxidoreductases,** which change the acyl side chain structure and lower the signal's ability to bind to receptors (Uroz et al., 2009).

These enzymes stop the buildup of active autoinducers. This disruption affects QS-regulated gene expression and halts coordinated behaviours such as biofilm formation and virulence.

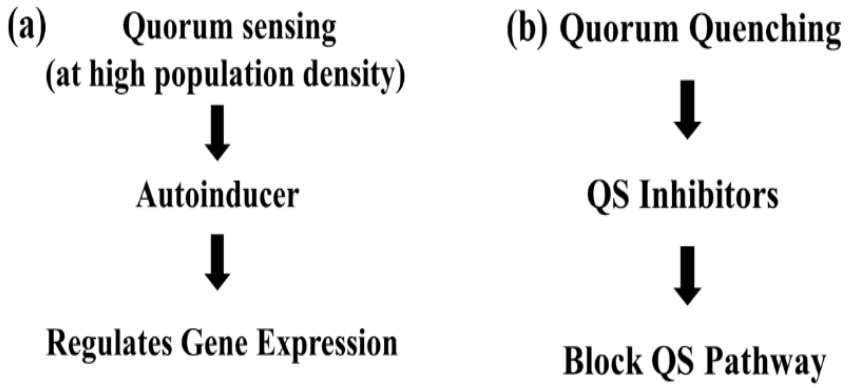


**Fig 1: Simple flowchart explaining the mechanism of (a) Quorum Sensing and (b) Quorum Quenching**

**Table 1: Quorum sensing molecules and Quorum Sensing Inhibitors (QSIs) across different bacterial classes**

| Class | Signalling Molecules | Strains | QSI |
|---|---|---|---|
| Gram-negative Bacteria (G –ve) | Acyl-homoserine lactones (AHLs) | *V. fischeri* & *P. aeruginosa* | Halogenated furanones, Ajoene |
| Gram-positive Bacteria (G +ve) | Oligopeptides Autoinducer (AIPs) | *B. subtilis* & *S. aureus* | RNAIII-inhibiting peptide (RIP), Solonamide B |
| G –ve Bacteria & G +ve Bacteria | Autoinducer-2 (AI-2) | *E. Coli* & *V. harveyi* | LuxS inhibitors, D-ribose, Boronic acid derivatives |

2. **Signal Analogs Interference and Competitive Inhibitors:** Synthetic or natural compounds can mimic QS signals but act as blockers. For example, furanones from marine algae attach to QS receptors without activating them, blocking the real signal. Unlike enzymatic degradation, this method doesn't destroy the signal molecule but makes it ineffective by confusing or outcompeting it.
3. **Receptor Inactivation or Modification:** Some agents directly inactivate or change QS receptors, preventing them from recognizing their specific autoinducers even when those are present.

These methods disrupt communication at different stages—signal production, stability, or perception—making QQ a useful tool for controlling harmful bacterial behaviour.

**Applications**

Quorum quenching (QQ) offers a strategic advantage by disrupting bacterial communication without killing the microbes, reducing the risk of resistance. In medicine, QQ targets biofilm-associated infections caused by *P. aeruginosa*, *S. aureus*, and oral pathogens, enhancing antibiotic efficacy. In agriculture, Plant pathogens such as *Erwinia carotovora* and *Agrobacterium tumefaciens* rely heavily on QS to coordinate the expression of virulence genes. QQ-based biocontrol strategies aim to prevent infections by disrupting QS in the rhizosphere, using either QQ-producing microbes or QQ enzymes, offering eco-friendly crop protection. In aquaculture, QQ agents reduce disease by suppressing virulence in fish pathogens, promoting sustainable farming. Environmental applications include using QQ enzymes or microbes to prevent biofouling in wastewater systems. Overall, QQ presents a promising, resistance-minimizing alternative to conventional antimicrobials across health, agriculture, and environmental sectors.

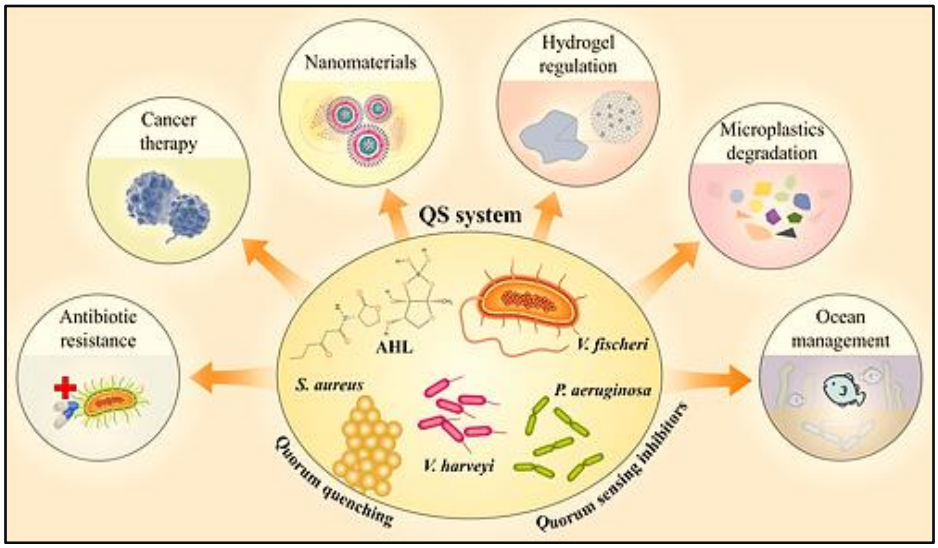


**Figure 2: Quorum quenching system (source: *Liu, et al. 2025*)**

## CONCLUSION

Quorum quenching represents a paradigm shift in antimicrobial strategy, targeting bacterial communication rather than growth. By intervening in quorum sensing pathways, QQ mechanisms such as enzymatic degradation, signal mimicry, and receptor interference can effectively suppress pathogenic behaviours like biofilm formation and virulence. With promising applications in medicine, agriculture, and aquaculture, QQ is a powerful tool for managing bacterial populations in a more sustainable and resistance-conscious manner. However, challenges remain, including the potential for QQ resistance, the stability of enzymes under field conditions, and the delivery of QQ agents in complex environments.

## REFERENCES

Boban, T., Nadar, S., & Tauro, S. (2023). Breaking down bacterial communication: a review of quorum quenching agents. *Future Journal of Pharmaceutical Sciences*, 9(1), 77.

Dong, Y. H., Wang, L. H., & Zhang, L. H. (2007). Quorum-quenching microbial infections: mechanisms and implications. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 362(1483), 1201–1211.

Grandclément, C., Tannières, M., Moréra, S., Dessaux, Y., & Faure, D. (2016). Quorum quenching: role in nature and applied developments. *FEMS Microbiology Reviews*, 40(1), 86–116.

Hong, K. W., Koh, C. L., Sam, C. K., Yin, W. F., & Chan, K. G. (2012). Quorum quenching revisited—from signal decays to signalling confusion. *Sensors*, 12(4), 4661–4696.