Annual Methodological Archive Research Review
http://amresearchreview.com/index.php/Journal/about
Volume 4, Issue 3 (2026)

Online ISSN 3007-3197
Print ISSN 3007-3189

http://amresearchreview.com/index.php/Journal/about

Comparative Assessment Of Soil Physicochemical Modifications Induced By *Neisseria* And *Streptococcus* Species And Their Implications For Agricultural Soil Fertility Enhancement

Saman Ahmad
Department of Health & Biological Sciences, Abasyn University, Peshawar, Pakistan

Sidra Farooq
Department of Health & Biological Sciences, Abasyn University, Peshawar, Pakistan
Email: sidra.farooq@abasyn.edu.pk

Iraj Zaib
Department of Health & Biological Sciences, Abasyn University, Peshawar, Pakistan

Zobia Afsheen
Department of Health & Biological Sciences, Abasyn University, Peshawar, Pakistan

Sultan Shah
Department of Health & Biological Sciences, Abasyn University, Peshawar, Pakistan

Nimra Rashid
Department of Health & Biological Sciences, Abasyn University, Peshawar, Pakistan

Talha Fayaz
Department of Health & Biological Sciences, Abasyn University, Peshawar, Pakistan

Asif Mehmood (Corresponding author)
Sarhad Institute of Allied Health Sciences, Sarhad University of Science and information technology, Peshawar, Pakistan
Email: asif.siahs@suit.edu.pk

ABSTRACT

Soil fertility underpins sustainable agriculture, yet its decline due to industrial pollution and excessive fertilizer use has become a global concern. Soil microorganisms play a vital role in maintaining soil fertility through biochemical transformations that regulate nutrient cycling and organic matter decomposition. This research signifies the importance of identifying and comparing microbial agents capable of naturally improving soil health through biochemical processes. This comparative approach highlights the differential potential of distinct bacterial species in restoring soil quality and promoting eco-friendly agricultural productivity. This research presents a

Annual Methodological Archive Research Review
http://amresearchreview.com/index.php/Journal/about
Volume 4, Issue 3 (2026)

Online ISSN 3007-3197
Print ISSN 3007-3189
http://amresearchreview.com/index.php/Journal/about

comparative evaluation of two bacterial species, *Neisseria* and *Streptococcus*, to assess their capacity to modify soil physicochemical properties including pH, electrical conductivity (EC), organic matter, and major macronutrients (N, P, K) essential for agricultural fertility. Soil samples from Syrup section of Cidex Industry, Peshawar, were inoculated under controlled laboratory conditions to analyze changes in soil physicochemical parameters. Results revealed that *Streptococcus* inoculation increased soil pH (8.0→8.2), EC (0.08→0.40 dS/m), and potassium content (68→80 mg/kg), while nitrogen and phosphorus slightly declined. In contrast, *Neisseria* inoculation also elevated pH (8.0→8.1) and potassium levels (68→96 mg/kg), but decreased organic matter (0.69→0.34%) and nitrogen. Both bacterial treatments enhanced potassium levels and pH, while *Neisseria* exhibited a stronger effect on EC and ion mobilization. *Streptococcus* primarily improved pH regulation and cation exchange. The findings suggest both bacteria significantly influence soil fertility, with *Neisseria* showing higher ion mobilization and *Streptococcus* exhibiting greater pH regulation potential. Thus, both species demonstrate promising biofertilizer potential for sustainable agriculture, warranting further field-level validation.

Keywords— Soil fertility, Neisseria, Streptococcus, Biofertilizer, Nutrient cycling, Physicochemical properties

Introduction

Soil is a living dynamic system whose fertility is determined by its physicochemical and biological properties. The overuse of synthetic fertilizers, rapid industrialization, and land degradation have disrupted nutrient cycling and organic balance (Fierer & Jackson, 2006). Microbes play a crucial role in restoring this balance through nutrient mineralization, organic matter decomposition, and the production of compounds that improve soil structure (Vessey, 2003). Biofertilizers—microbial inoculants that enhance soil fertility—are now a cornerstone of sustainable agriculture (Bhattacharyya & Jha, 2012).

Among the bacterial communities involved in soil nutrient dynamics, *Neisseria* and *Streptococcus* species have recently gained attention for their biochemical versatility. *Neisseria* species exhibit denitrification and nitrate reduction properties, influencing nitrogen and sulfur cycles (Musa *et al*., 2024). *Streptococcus* species, while traditionally known as human commensals, have demonstrated environmental adaptability by modulating soil pH and mobilizing potassium (Patel & Desai, 2020). The current study compares the impact of these two bacterial species on soil physicochemical parameters to explore their potential as sustainable biofertilizers.

Microbial activity governs the transformation of soil nutrients through biochemical and enzymatic processes. Nitrogen-fixing bacteria, such as *Rhizobium* and *Azospirillum*, convert atmospheric nitrogen to ammonia, improving nitrogen availability (Vessey, 2003). Phosphate-solubilizing bacteria release organic acids to liberate bound phosphorus (Rodríguez & Fraga, 1999). Similarly, potassium-solubilizing bacteria enhance the mobility of K ions, vital for plant enzyme activation and osmotic balance (Meena *et al*., 2014). Recent studies have extended these findings to less explored species such as *Neisseria* and *Streptococcus*, suggesting their potential as biofertilizers

Annual Methodological Archive Research Review
http://amresearchreview.com/index.php/Journal/about
Volume 4, Issue 3 (2026)

Online ISSN 3007-3197
Print ISSN 3007-3189
http://amresearchreview.com/index.php/Journal/about

(Musa *et al*., 2024; Patel & Desai, 2020).

2. Materials And Methods

Soil samples were collected from the Syrup Section of Cidex Industry, Peshawar, at a depth of 15 cm. Samples were air-dried, sieved, and stored at 4°C. Samples were processed in the Microbiology Research Laboratory, Abasyn University. The serial dilution and pour plate method were used for bacterial isolation on nutrient agar media. Gram staining and biochemical tests (catalase, urease, indole, citrate, oxidase) confirmed the identity of *Neisseria* and *Streptococcus* species (MacWilliams, 2009; Wamala *et al*., 2018). The inoculated sterile soil samples were incubated for 30 days at 37°C, and pre- and post-inoculation soil parameters were analyzed for pH, EC, organic matter, nitrogen, phosphorus, and potassium following standard protocols (Chamekh *et al*., 2019).

3. Results

Isolated Bacteria

A total of 15 bacterial samples were collected from Syrup Section of Cidex Industry. Among them 05 samples showed growth on the nutrient agar media. The bacterial growth over nutrient agar was frequently cultured and sub-cultured to obtain pure culture of the bacteria. The selected bacterium for this study from the obtained bacterial species were *Streptococcus* and *Neisseria species*.

Gram Staining and Cultural Characteristics

The Gram staining results and cultural characteristics of the *Streptococcus* and *Neisseria species* are shown in the table 1 and Figure 1a and 1b.

Table 1. Culture Characteristics and Microscopy

Isolates	Culture characteristics on Nutrient Agar	Color	Shape	Arrangement	Gram Staining Reaction
1	Circular, smooth, entire margins	Grayish white	Spherical cocci	Chains or pairs	+
2	Small round, smooth and moist colonies	Greyish-white, translucent	Diplococci	Pairs, short chain	-

Annual Methodological Archive Research Review
http://amresearchreview.com/index.php/Journal/about
Volume 4, Issue 3 (2026)

Online ISSN 3007-3197
Print ISSN 3007-3189

http://amresearchreview.com/index.php/Journal/about

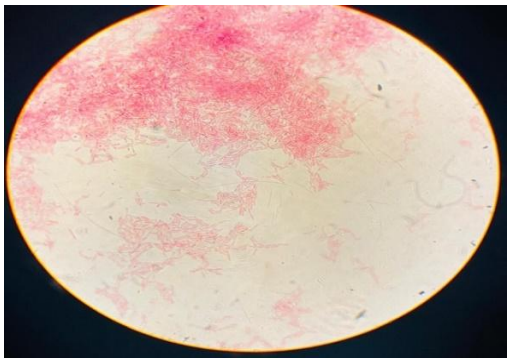

Figure 1a. Gram Negative Diplococci

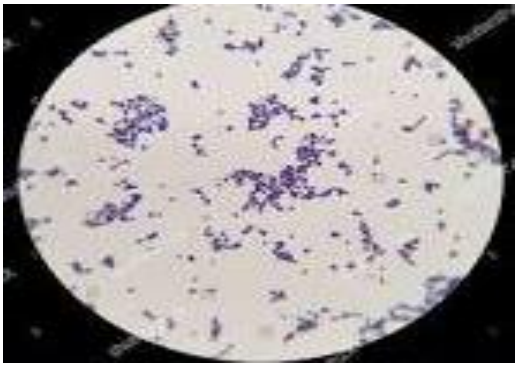

Figure 1b. Gram Positive Cocci

Biochemical Tests

The biochemical tests of the isolated bacteria *Streptococcus specie* yielded the result shown in table 2.

Table 2. Biochemical test results of isolated bacteria streptococcus specie

Isolates	Bacteria	Biochemical Tests							
							TSI		
		Citrate	Indole	Urease	Oxidase	Catalase	(Slant/Butot agulase	Gas	H_2S
1	*Streptococcus specie*	-	-	-	-	-	- Alkaline/ Acid	-/+	-
2	*Neisseria specie*	-	-	+	+	-	- Alkaline/ Acid	-	-

Physiochemical Analysis of soil samples (Syrup section)

The physiochemical characteristics of soil sample that was inoculated with only one type of bacteria each separately are shown in **Table 3**. The inoculation of *Neisseria* and *Streptococcus* led to observable modifications in soil chemistry. *Neisseria* increased EC from 0.08 to 1.42 dS/m, while *Streptococcus* enhanced EC to 0.40 dS/m. Both species raised soil pH from 8.0 to slightly alkaline levels (8.1–8.2). Potassium levels significantly improved in both treatments, while nitrogen and organic matter slightly decreased due to microbial consumption during metabolic processes as depicted in Table 3 and Figure 2.

Table 3. Soil Physicochemical Dynamics after Inoculation with *Streptococcus* and *Neisseria species*

Annual Methodological Archive Research Review
http://amresearchreview.com/index.php/Journal/about
Volume 4, Issue 3 (2026)

Online ISSN 3007-3197
Print ISSN 3007-3189

http://amresearchreview.com/index.php/Journal/about

Parameter	Before	*Streptococcus species*	*Neisseria species*
pH	8.0	8.2	8.1
EC (dS/m) Electrical conductivity	0.08	0.40	1.42
Organic Matter (%)	0.69	0.20	0.34
Nitrogen (mg/kg)	0.034	0.010	0.017
Phosphorus (mg/kg)	9.8	6.4	8.2
Potassium (mg/kg)	68	80	96
Texture	Sandy Loam	Silt Loam	Silt loam

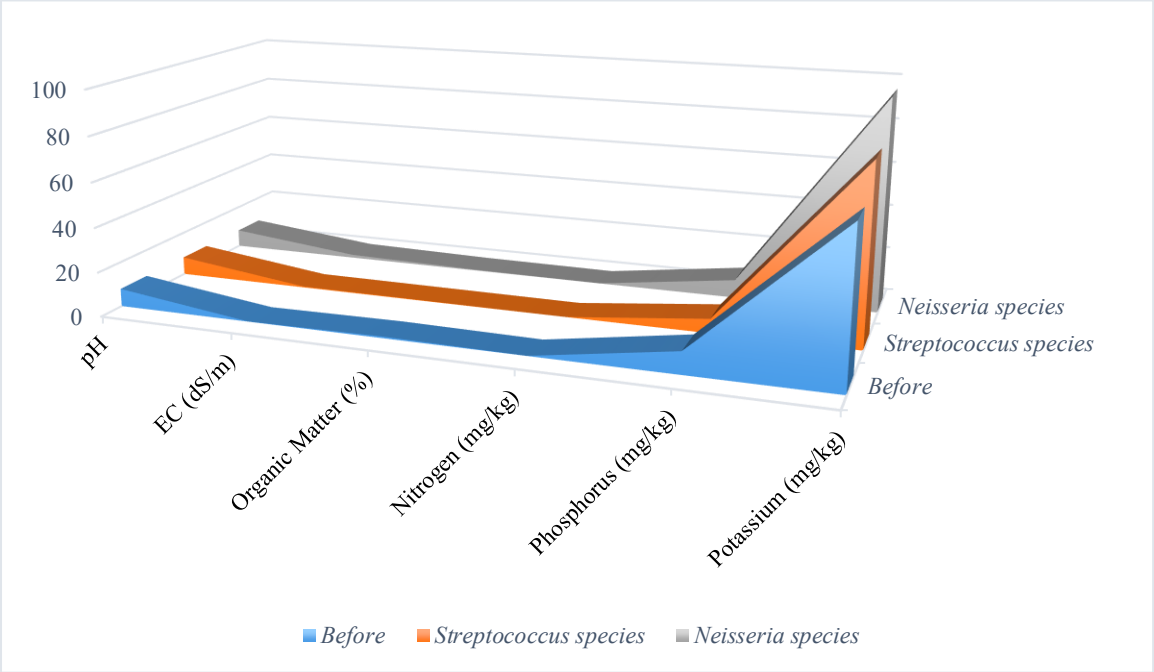

Figure 2. Soil Physicochemical Dynamics after Inoculation with *Streptococcus* and *Neisseria species*

4. Discussion

The comparative findings of this study reveal that both *Neisseria* and *Streptococcus* species substantially modify soil physicochemical characteristics. *Neisseria* enhanced potassium content and EC to a greater extent, indicating high ion mobilization potential, possibly due to denitrification and acidification reactions. *Streptococcus*, in contrast, demonstrated a stronger pH stabilization effect, signifying active organic acid production and ion exchange modulation. The observed decline in nitrogen and organic matter is likely due to microbial consumption during metabolic processes, which, while temporarily reducing available nutrients, contributes to long-term soil restructuring.

These findings align with those of Musa *et al*. (2024) and Kim (2019), who observed similar microbial-driven nutrient transformations. Both species demonstrate resilience in industrial soils, suggesting their potential as biofertilizers in challenging agroecosystems. Their combined application could balance nutrient solubilization and

Online ISSN 3007-3197
Print ISSN 3007-3189
http://amresearchreview.com/index.php/Journal/about

pH regulation, providing a multifaceted approach to soil fertility improvement.
Soil physicochemical parameters such as pH, EC, organic matter, and nutrient levels directly influence microbial survival and crop productivity. The observed alterations following bacterial inoculation highlight the role of *Neisseria* and *Streptococcus* as biofertilizers capable of reshaping soil chemistry.

Effect on Soil pH
An optimal pH range (6.5–7.5) supports maximum nutrient availability. *Streptococcus* increased pH more effectively, likely due to enzymatic degradation of organic acids, enhancing cation exchange (Prosser & Nicol, 2012).
Effect on EC
Electrical conductivity reflects ionic concentration in soil. The marked EC increase in *Neisseria*-inoculated soil indicates enhanced nutrient solubilization (Kim *et al*., 2019).

Effect on Organic Matter
Microbial decomposition reduces OM temporarily but improves humification and carbon sequestration in the long term (Cotrufo *et al*., 2013).

Effect on Nitrogen
Both microbes utilized nitrogen during metabolism, with *Neisseria* potentially cycling nitrogen through denitrification, stabilizing N in soil (Musa *et al*., 2024).

Effect on Phosphorus
Although a slight reduction occurred, microbial activity may mobilize insoluble phosphate reserves, improving long-term availability (Sharma *et al*., 2013).

Effect on Potassium
Both species increased potassium mobility; *Neisseria* showed stronger solubilization, similar to *Frateuria aurantia* strains (Meena *et al*., 2014).

5. Conclusion
This comparative analysis demonstrates that both *Neisseria* and *Streptococcus* species influence key soil fertility parameters. *Neisseria* exhibited greater potassium mobilization and EC enhancement, while *Streptococcus* contributed more effectively to pH regulation. These traits suggest their potential integration into biofertilizer formulations for sustainable agriculture. Further studies should evaluate their field-level efficacy and synergistic effects when applied together or in microbial consortia.

References
Ahmed, M., Khan, M. N., & Bano, A. (2019). Role of soil microbes in nutrient cycling and plant health: A sustainable approach to agriculture. *Microbial Biotechnology*, 12(3), 412–424.
Ali, H., Khan, E., & Ilahi, I. (2019). Environmental chemistry and ecotoxicology of hazardous heavy metals. Journal of Chemistry, 2019.
Ayangbenro, A. S., & Babalola, O. O. (2017). A new strategy for heavy metal polluted

Online ISSN 3007-3197
Print ISSN 3007-3189

environments. International Journal of Environmental Research and Public Health, 14(1), 94.
Bhattacharyya, P. N., & Jha, D. K. (2012). Plant growth-promoting rhizobacteria (PGPR). World Journal of Microbiology and Biotechnology, 28(4), 1327–1350.
Chamekh, R., *et al*. (2019). Isolation, identification and enzymatic activity of halotolerant fungi. Mycobiology, 47, 230–241.
Cotrufo, M. F., *et al*. (2013). The microbial efficiency-matrix stabilization framework. Nature Climate Change, 3(1), 33–40.
Fierer, N., & Jackson, R. B. (2006). The diversity and biogeography of soil bacterial communities. PNAS, 103(3), 626–631.
Kim, J. H., Park, S. J., & Lee, C. R. (2019). Influence of microbial organic acids on soil minerals. Soil Biology & Biochemistry, 135, 120–129.
MacWilliams, M. P. (2009). Citrate test protocol. American Society for Microbiology.
Meena, V. S., *et al*. (2014). Potassium solubilizing microbes for sustainable agriculture. Ecological Indicators, 36, 529–537.
Musa, A., *et al*. (2024). Soil microbial dynamics and nutrient transformation roles of *Neisseria* species. Journal of Applied Soil Microbiology, 18(2), 201–210.
Patel, D., & Desai, P. (2020). Biofertilizer potential of *Streptococcus* species. Journal of Applied Microbiology Research, 8(2), 101–108.
Prosser, J. I., & Nicol, G. W. (2012). Archaeal and bacterial ammonia-oxidisers in soil. Trends in Microbiology, 20(11), 523–531.
Rodríguez, H., & Fraga, R. (1999). Phosphate solubilizing bacteria and their role in plant growth. Biotechnology Advances, 17(4–5), 319–339.
Sharma, S. B., *et al*. (2013). Phosphate solubilizing microbes. SpringerPlus, 2(1), 587.
Vessey, J. K. (2003). Plant growth-promoting rhizobacteria as biofertilizers. Plant and Soil, 255(2), 571–586.