International Review of Practical Innovation, Technology and Green Energy (IRPITAGE)| ISSN(e): 2808-8611
Volumes 5 No. 1 (2025)

EFFECTIVENESS OF SOME NON PATHOGENIC ENDOPHYTIC BACTERIA NUTMEG ON VIABILITY OF ORIGIN PLANT SEED RICE (Oryza sativa L)

Saiful Mahdi[1]*, Danar Hadisugelar[2], Dianawati[3], Afriyani[4], Safrizal[5]
[1,2,3]Agrotechnology, Faculty of Agriculture, Universitas Samudra, Langsa City, Aceh
[4]Departement of Plant Protection, Faculty of Agriculture, Universitas Syiah Kuala, Aceh
[5]Agribusiness, Faculty of Agriculture, Universitas Samudra, Langsa City, Aceh
Corresponding E-mail: saifulmahdi@unsam.ac.id* , danarhadisugelar@unsam.ac.id , dianawati@unsam.ac.id , yani@usk.ac.id, safrizal@unsam.ac.id

Received : 21 April 2025	Published : 11 June 2025
Revised : 30 April 2025	DOI : https://doi.org/10.54443/irpitage.v5i1.2968
Accepted : 15 April 2025	Publish Link : https://radjapublika.com/index.php/IRPITAGE/

Abstract

This study aimed to determine the effectiveness of several non-pathogenic endophytic bacteria isolated from nutmeg plants on the viability of rice seeds. The experimental design used was a non-factorial completely randomized design (CRD) with three replications. The study included 14 endophytic bacterial treatments and one control. The research was conducted at the Biological Control Laboratory, Plant Protection Study Program, Faculty of Agriculture, Syiah Kuala University, Banda Aceh, from August 2023 to September 2023. The results showed that the application of non-pathogenic endophytic bacteria from nutmeg had a highly significant effect on rice seed viability, particularly on growth potential and germination. The highest seed viability was observed in the treatment with the bacterial isolate S - S AG 1 I. Endophytic bacterial isolates from nutmeg plants were proven to enhance the viability of Ciherang rice seeds, especially in terms of growth potential and germination. The isolate S - S AG 1 I produced the best results, with a growth potential of 84.4% and germination rate of 77.8%

Keywords: ***endophytic bacteria, rice seeds and seed viability.***

INTRODUCTION

Currently, endophytic microbes are getting more attention because the usefulness of endophytes is found to protect host plants from attacks by plant-disturbing organisms such as pests and pathogens. In addition, endophytic bacteria are able to provide a positive influence on plant growth and development. Endophytic bacteria are able to provide growth-regulating hormones for plant seedlings, this is because in the germination process, seeds need phytohormones for growth and development. There are several IAA hormone-producing bacteria found in certain plants and produce phytohormones that are beneficial for plant growth such as auxins, gibberellins and cytokinins.(Mohite, 2013).Endophytic microbes are microorganisms that grow in plant tissues without causing disease in their hosts. Endophytes are microorganisms that are found in healthy host plant tissues without causing disease symptoms for all or part of their life cycle. (Kuźniar et al., 2025). The presence of endophytic bacteria is increasingly being considered in the context of sustainable agriculture, due to their ability to replace or reduce dependence on chemicals such as pesticides and synthetic fertilizers. Recent studies have shown that endophytic bacteria play a role in improving plant resistance to drought, salinity, and pathogen infection.(Mburu et al., 2021). Therefore, further understanding of the interactions between endophytic bacteria and plants is essential, not only to improve agricultural yields, but also to support the concept of environmentally friendly agriculture.

Several studies have shown that endophytic bacteria can be used as biological agents, including producing bioactive compounds as plant protection.(Kandasamy & Kathirvel, 2023), controlling nematodes on patchouli plants(Harni & Ibrahim, 2020), increasing the resistance of potato plants to yellow cyst nematode attacks(Istifadah et al., 2018), and as an anti-bacterial (Staphylococcus aureus and E. coli) in mangrove plants.(Rori et al., 2020). Endophytic bacteria and plants can live in symbiosis and mutually beneficial, in this case endophytic microbes obtain nutrients from plant metabolism and protect plants against herbivores, insects or pathogenic tissues while plants obtain nutritional derivatives and active compounds needed during their life.(Putri et al., 2018). Endophytic bacteria and other rhizobacteria are part of the natural microflora of healthy plants in the field. According toRismawati et al.,

(2024)Endophytic bacteria can affect plant health in terms of: (1) direct antagonism, (2) inducing systemic resistance and (3) increasing plant tolerance to the environment.

Endophytic bacteria can be isolated from the surface of plant tissues or extracted from internal plant tissues such as roots, stems, leaves and twigs of various types of plants. Endophytes can be beneficial for plants because they can be used as biological agents for pathogens and also to promote plant growth.(Fadiji & Babalola, 2020). Endophytic bacteria have become a rapidly growing research focus in recent years. These bacteria can be found throughout the plant, including the roots, stems, and leaves. One of the main roles often associated with endophytic bacteria is their ability to increase plant resistance to abiotic stresses such as drought and salinity. Research byUllah et al., (2019)showed that endophytic bacteria isolated from adaptive plants can help increase drought tolerance through the mechanism of producing growth hormones such as auxin and gibberellin.

METHOD

Place and Time

This research was conducted at the Plant Pest and Disease Laboratory, Agrotechnology Study Program, Faculty of Agriculture, Syiah Kuala University from August 2023 to September 2023.

Materials and tools

The materials used in this study were Ciherang variety rice seeds, endophytic bacteria from nutmeg plants (collection of Plant Pest and Disease Laboratory, Agrotechnology Study Program, Faculty of Agriculture, Syiah Kuala University) NA media, aquadesh and spiritus. The tools used in this study were petri dishes, autoclaves, Erlenmeyer flasks, razor blades, light microscopes, test tubes, plastic wrap, oasis needles and stationery.

Experimental Design

The experimental design used in this study was a non-factorial Completely Randomized Design (CRD) with 15 treatments and 3 replications, thus obtaining 45 experimental units. The factors studied were the types of endophytic bacteria, namely: S - S AB 1, S - S AB 2, S - S AG 1 I, S - S AG 1 II, S - S AG 2 I, S - S AG 2 II, PS - S AB 1, PS - S AB 2, PS - S AG 1 I, PS - S AG 1 II, PS - S AG 2 I, PS - S AG 2 II, PS - S AG 2 III, PS - S AG 2 IV and control. Before the F test was carried out, the data from each variable were transformed with Arcsin then, if the F test showed a significant effect, it was continued with the BNT test at the 5% level.

Research Implementation

This study was conducted with a viability test conducted using the petridish method. Petridish germination by placing NA media into a petridish which aims to be a growing medium for rice seeds in the germination test. Furthermore, planting seeds on NA media as many as 25 seeds arranged in a circle. Then wrapped in a plastic bag cover so as not to be contaminated with other microbes. Rice seed viability testing was carried out by germinating seeds on NA media. The total number of seeds used was 1125 grains. To maintain an optimum germination environment, they were placed on a germination rack. The variables observed were the characteristics of endophytic bacteria, growth potential (PT), germination power (DB).

RESULTS AND DISCUSSION

Characteristics of Endophytic Bacteria in Nutmeg Plants

The characteristics of several collections of endophytic bacteria from the Plant Pest and Disease Laboratory, Agrotechnology Study Program, Syiah Kuala University are presented in Table 1.

Table 1. Microscopic Characteristics of Endophytic Bacteria

Isolate Name	Colony Surface Shape	Colony color
S - S AB 1	Sunken	Yellowish white
S - S AB 2	Round	Clear white
S - S AG 1 I	Sunken	Reddish white
S - S AG 1 II	Sunken	Pink

S - S AG 2 I	Convex	Yellowish white
S - S AG 2 II	Convex	Yellowish white
PS - S AB 1	Sunken	Clear white
PS - S AB 2	Sunken	Pink
PS - S AG 1 I	Sunken	Clear white
PS - S AG 1 II	Sunken	Reddish white
PS - S AG 2 I	Sunken	Yellowish white
PS - S AG 2 II	Sunken	Yellowish white
PS - S AG 2 III	Convex	Yellowish white
PS - S AG 2 IV	Sunken	Yellowish white

Table 1 can be explained that observations of the color of bacterial colonies vary such as yellowish white, clear white, reddish white and pink. Observation of the shape and color of endophytic bacterial colonies is the first step in identifying these microorganisms. Variations in the shape and color of colonies are influenced by genetic factors and the growth environment. Understanding the morphological characteristics of endophytic bacterial colonies is very important in microbiology research and its applications in agriculture and environmental health.(Singh et al., 2017). The shape of endophytic bacterial colonies has three forms of bacterial colony surfaces, namely round colony surface shape, convex colony surface shape and concave colony surface shape. The concave colony surface shape is the most common colony surface shape of all isolates. The results of the F test showed that the effectiveness of several endophytic bacteria had a very significant effect on growth potential (PT) and germination power (DB).

Potential for Rice Seed Growth Due to Several Endophytic Bacteria Originating from Nutmeg Plants

The effect of endophytic bacteria effectiveness has a significant effect on the growth potential of rice seeds. The average growth potential of Ciherang rice seeds is presented in Table 2.

Table 2. Average potential for rice seed growth due to several endophytic bacteria originating from nutmeg plants.

Endophytic Bacteria	**Growth Potential (PT)**	
	Arcsin $\sqrt{\%}$	**(%)**
S - S AB 1	46.9 cde	53.3
S - S AB 2	53.6 defg	64.4
S - S AG 1 I	67.5 fg	84.4
S - S AG 1 II	65.2 fg	82.2
S - S AG 2 I	56.2 defg	68.9
S - S AG 2 II	55.1 defg	66.7
PS - S AB 1	48.2 cdef	55.6
PS - S AB 2	57.6 efg	71.1
PS - S AG 1 I	13.5 a	13.3
PS - S AG 1 II	40.5 cd	42.2
PS - S AG 2 I	23.9 ab	17.8
PS - S AG 2 II	52.2 cdefg	62.2
PS - S AG 2 III	63.4 fg	80
PS - S AG 2 IV	41.7 cde	44.4
Control	36.3 bc	37.8

Description: Numbers followed by the same letter are not significantly different at the 5% probability level (LSD test). SS = Healthy among the sick, PS-S = Healthiest among the healthy, AB = Alu Baroe Village, AG = Ie Dingin Village.

Based on Table 2, it is explained that the potential for rice seed growth due to the treatment of several endophytic bacteria from nutmeg ranges from 13% to 84%. The highest growth potential was found in bacteria SS AG 1 I, SS AG 1 II, PS - S AG 2 III which was significantly different from bacteria PS - S AG 1 I, PS - S AG 2 I, PS - S AG 1 II, S - S AB 1, PS - S AG 2 IV and control and did not significantly affect bacteria S - S AB 2, S - S AG 2 I, S - S AG 2 II, PS - S AG 2 II. The highest growth potential was found in the treatment of bacteria S - S AG 1 I with a value of 67.5 and the lowest growth potential was found in the treatment of bacteria PS - S AG 1 I with a value of 13.5. The role of bacteria in increasing the viability of rice seeds is due to endophytic bacteria having the ability to contribute hormones and dissolve phosphate. This is in line with the statementThakuria et al., (2004)which explains that the mechanism of plant growth by endophytic bacteria can occur in several ways, including dissolving phosphate compounds, nitrogen fixation, stimulating lateral root growth and producing growth hormones such as auxin, ethylene and cytokinin.

The presence of endophytic bacteria in plants can affect several vital aspects, including increasing plant tolerance to environmental stress, the ability to inhibit pathogens, and increasing the availability of nutrients.(Najjar, 2025), plants meet their need for growth hormones through their ability to synthesize the hormone auxin from microorganisms in their tissues.(Herlina et al., 2017). IAA-producing bacteria have the potential to cooperate with several physiological processes of plants by inserting the IAA produced into the plant. The effect on the plant itself is that the plant is faster in forming lateral roots and adventitious roots.(Leveau & Lindow, 2005). In addition, several recent studies have shown that endophytic bacteria can also increase the availability of plant nutrients. For example, according to(Puri et al., 2018), some species of endophytic bacteria can increase nitrogen fixation in legume plants, improve the availability of other important nutrients such as phosphorus and potassium, and increase the efficiency of nutrient absorption by plant roots. Furthermore, endophytic bacteria are also known to have potential as biocontrol agents that can fight plant pathogens. According to research by(Teja et al., 2025), endophytic bacteria can produce antimicrobial compounds that inhibit the growth of plant pathogens, such as fungi and pathogenic bacteria. This provides ecological benefits because it reduces the use of chemical pesticides that can have negative impacts on the ecosystem.

Rice Seed Germination Power Due to Several Endophytic Bacteria Originating from Nutmeg Plants

The effect of endophytic bacteria effectiveness has a significant effect on the germination power of rice seeds. The average growth potential of Ciherang rice seeds is presented in Table 3.

Table 3. Average germination power of rice seeds in several endophytic bacteria from nutmeg

Endophytic Bacteria	Germination Power (DB)	
	Arcsin $\sqrt{\%}$	(%)
S - S AB 1	19.3 ab	11.1
S - S AB 2	44.4 defg	48.9
S - S AG 1 I	63.5 g	77.8
S - S AG 1 II	53.5 fg	64.4
S - S AG 2 I	43.0 defs	46.7
S - S AG 2 II	52.4 fg	62.2
PS - S AB 1	31.9 bcde	28.9
PS - S AB 2	40.2 cdef	42.2
PS - S AG 1 I	0.57 a	0
PS - S AG 1 II	22.5 bc	15.6
PS - S AG 2 I	14.0 ab	8.9
PS - S AG 2 II	48.2 efg	55.6
PS - S AG 2 III	43.7 def	48.9
PS - S AG 2 IV	25.0 bcd	24.4
Control	17.7 ab	13.3

Description: Numbers followed by the same letter are not significantly different at the 5% probability level (LSD test). SS = Healthy among the sick, PS-S = Healthiest among the healthy, AB = Alu Baroe Village, AG = Ie Dingin Village.

Based on Table 3, it can be explained that the germination power of rice seeds ranges from 0.00% -77.8%. The highest germination power was found in S - S AG 1 I bacteria which was significantly different from the treatment of PS - S AG 1 I, PS - S AG 1 II, PS - S AG 2 I, PS - S AG 2 III, PS - S AG 2 III, PS - S AG 2 IV, S - S AB 1, S - S AG 2 I, PS - S AB 1, PS - S AB 2 and Control and had no effect on the treatment of S, - S AG 1 II, S - S AG 2 II, PS - S AG 2 II, S - S AB 2. The highest germination power was found in the treatment of S - S AG 1 I bacteria with a value of 63.5 and the lowest germination power was found in the treatment of PS - S AG 1 I bacteria with a value of 0.57. Various research results report that several groups of endophytic microbes are able to produce compounds such as IAA production which can accelerate plant growth. For example, Azospirillum brasilense in wheat. IAA affects the development of wheat roots and can improve plant productivity through hormone stimulation.(Lestari et al., 2007).

Azospirillum is also able to increase crop yields in various types of soil and climate due to the addition of auxin from Azospirillum. Auxin is a type of hormone that can stimulate plant growth by increasing the process of cell elongation and stem elongation as well as cell differentiation.(Mehdipour Moghaddam et al., 2012). Endophytic

bacteria also have a significant role in modulating the plant immune system. According toChaudhary et al., (2022), endophytic bacteria can stimulate the systemic response of plants to pathogens by inducing the production of defense compounds, such as flavonoids and phenolics, which provide additional protection against infection. This makes endophytic bacteria an important component in the natural management of plant diseases.

CONCLUSION

The best growth potential value was found in S - S AG 1 I bacteria and the best germination power value was found in S - S AG 1 II and S - S AG 2 II bacteria. Non-pathogenic endophytic bacterial isolates from nutmeg plants have a very significant effect on the viability of Ciherang variety rice seeds, especially in terms of growth potential and germination power. Treatment with S - S AG 1 I isolate gave the best results in increasing the growth potential of rice seeds up to 84.4%. Meanwhile, the highest germination power was achieved by the S - S AG 1 I isolate treatment with a value of 77.8%.

REFERENCES

Chaudhary, P., Agri, U., Chaudhary, A., Kumar, A., & Kumar, G. (2022). Endophytes and their potential in biotic stress management and crop production. *Frontiers in Microbiology*, *13* (October), 1–22. https://doi.org/10.3389/fmicb.2022.933017

Fadiji, A. E., & Babalola, O. O. (2020). Elucidating Mechanisms of endophytes used in plant protection and other bioactivities with multifunctional prospects. *frontiers in bioengineering and biotechnology*, *8*(may), 1–20. https://doi.org/10.3389/fbioe.2020.00467

Harni, R., & Ibrahim, M. S. D. (20211). Potensi bakteri endofit menginduksi ketahanan tanaman lada terhadap infeksI Meloidogyne incognita. *Jurnal Penelitian Tanaman Industri*, *17*(3), 118–123. https://doi.org/10.21082/jlittri.v17n3.2011.118-123

Herlina, L., Pukan, K. K., & Mustikaningtyas, D. (2017). The endophytic bacteria producing IAA (Indole Acetic Acid) in Arachis hypogaea. *Cell Biology and Development*, *1*(1), 31–35. https://doi.org/10.13057/cellbioldev/v010106

Istifadah, N., Pratama, N., Taqwim, S., & Sunarto, T. (2018). Effects of bacterial endophytes from potato roots and tubers on potato cyst nematode (*Globodera rostochiensis*). *Biodiversitas*, *19*(1), 47–51. https://doi.org/10.13057/biodiv/d190108

Kandasamy, G. D., & Kathirvel, P. (2023). Insights into bacterial endophytic diversity and isolation with a focus on their potential applications –A review. *Microbiological Research*, *266*(March 2022), 127256. https://doi.org/10.1016/j.micres.2022.127256

Kuźniar, A., Kruczyńska, A., Włodarczyk, K., Vangronsveld, J., & Wolińska, A. (2025). Endophytes as Permanent or Temporal Inhabitants of Different Ecological Niches in Sustainable Agriculture. *Applied Sciences (Switzerland)*, *15*(3), 1–29. https://doi.org/10.3390/app15031253

Lestari, P., Susilowati, D. N., & Riyanti, E. I. (2007). Pengaruh Hormon Asam Indol Asetat yang Dihasilkan Azospirillum sp. terhadap Perkembangan Akar Padi. *Jurnal AgroBiogen*, *3*(2), 66. https://doi.org/10.21082/jbio.v3n2.2007.p66-72

Leveau, J. H. J., & Lindow, S. E. (2005). Utilization of the plant hormone indole-3-acetic acid for growth by Pseudomonas putida strain 1290. *Applied and Environmental Microbiology*, *71*(5), 2365–2371. https://doi.org/10.1128/AEM.71.5.2365-2371.2005

Mburu, S. W., Koskey, G., Njeru, E. M., & Maingi, J. M. (2021). Revitalization of bacterial endophytes and rhizobacteria for nutrients bioavailability in degraded soils to promote crop production. *AIMS Agriculture and Food*, *6*(2), 496–524. https://doi.org/10.3934/agrfood.2021029

Mehdipour Moghaddam, M. J., Emtiazi, G., & Salehi, Z. (2012). Enhanced auxin production by Azospirillum pure cultures from plant root exudates. *Journal of Agricultural Science and Technology*, *14*(5), 985–994.

Mohite, B. (2013). Isolation and characterization of indole acetic acid (IAA) producing bacteria from rhizospheric soil and its effect on plant growth. *Journal of Soil Science and Plant Nutrition*, *13*(3), 638–649. https://doi.org/10.4067/S0718-95162013005000051

Najjar, A. A. (2025). Therapeutic Potential of Endophytic Microbes: Emphasizing Both Fungal and Bacterial Endophytes. *Applied Microbiology (Switzerland)*, *5*(1), 1–15. https://doi.org/10.3390/applmicrobiol5010005

Puri, A., Padda, K. P., & Chanway, C. P. (2018). Nitrogen-Fixation by Endophytic Bacteria in Agricultural Crops: Recent Advances. *Nitrogen in Agriculture - Updates*, *5*(2), 73–94. https://doi.org/10.5772/intechopen.71988

Putri, M. F., Fifendy., M., & Putri., D. H. (2018). Diversitas bakteri endofit pada daun muda dan tua tumbuhan andaleh (*Morus macroura* miq.) *Eksakta*, *19*(1), 126–130.

Rismawati, R., Budi, I. S., & . M. (2024). Efektivitas Bakteri Endofit Asal Lahan Basah untuk Menekan Penyakit Hawar Daun Bakteri (Xanthomonas oryzae) pada Padi Beras Merah (Oryza nivara L.). *Jurnal Proteksi Tanaman Tropika*, *7*(1), 789–797. https://doi.org/10.20527/jptt.v7i1.2401

Rori, C. A., Kandou, F. E. F., & Tangapo, A. M. (2020). Aktivitas Enzim Ekstraseluler dari Bakteri Endofit Tumbuhan Mangrove Avicennia marina. *Jurnal Bios Logos*, *11*(2), 48. https://doi.org/10.35799/jbl.11.2.2020.28338

Singh, A. K., Sharma, R. K., Sharma, V., Singh, T., Kumar, R., & Kumari, D. (2017). Isolation, morphological identification and in vitro antibacterial activity of endophytic bacteria isolated from Azadirachta indica (neem) leaves. *Veterinary World*, *10*(5), 510–516. https://doi.org/10.14202/vetworld.2017.510-516

Teja, B. S., Jamwal, G., Gupta, V., Verma, M., Sharma, A., Sharma, A., & Pandit, V. (2025). Biological control of bacterial leaf blight (BLB) in rice–A sustainable approach. *Heliyon*, *11*(2), e41769. https://doi.org/10.1016/j.heliyon.2025.e41769

Thakuria, D., Talukdar, N. C., Goswami, C., Hazarika, S., Boro, R. C., & Khan, M. R. (2004). Characterization and screening of bacteria from rhizosphere of rice grown in acidic soils of Assam. *Current Science*, *86*(7), 978–985.

Ullah, A., Nisar, M., Ali, H., Hazrat, A., Hayat, K., Keerio, A. A., Ihsan, M., Laiq, M., Ullah, S., Fahad, S., Khan, A., Khan, A. H., Akbar, A., & Yang, X. (2019). Drought tolerance improvement in plants: an endophytic bacterial approach. *Applied Microbiology and Biotechnology*, *103*(18), 7385–7397. https://doi.org/10.1007/s00253-019-10045-4