

Microbial Science Archives (ISSN: 2583-1666)

An International Research Journal

Journal homepage: www.microbial.sciencearchives.org

<https://doi.org/10.47587/MSA.2025.5402>

Research Article



Production and Characterization of Pectinase from *Aspergillus niger* Using Rice Bran as Carbon Source

Emochone Roy Yohanna¹ , Moses Adondua Abah^{1,2} , Micheal Abimbola Oladosu^{2,3} , Okpanachi Nuhu Oyibo⁴ , Victoria Chibuihe Nnamdi⁵ , Peter Nnenna Happiness⁶ , Idakwoji Peace Iyeoma⁷ , Auta Faith Beyeaan⁸ , Igwe Ejikeme Peter⁹ , Nkwocha John Nnaemeka¹⁰ , and Rayyanu Sha'aban Sangari¹¹ 

¹Department of Biochemistry, Faculty of Biosciences, Federal University Wukari, Wukari, Taraba State, Nigeria

²ResearchHub Nexus Institute, Nigeria

³Department of Chemical Sciences, Faculty of Science, Anchor University, Ayobo, Lagos State, Nigeria.

⁴Department of Biochemistry, Faculty of Biological Sciences, University of Nigeria, Nsukka, Enugu State, Nigeria

⁵Department of Chemical Engineering, Roy G. Perry College of Engineering, Prairie View A&M University, Texas, United States.

⁶Department: Petroleum Engineering, Faculty of Engineering, University: University of Port Harcourt, Rivers State, Nigeria

⁷Department of Microbiology, Faculty of Natural Sciences, Kogi State University Anyigba, P.M.B 1008, Anyigba, Kogi State, Nigeria

⁸Department of Microbiology, College of Biological Sciences, Joseph Sarwuan Tarka University, Makurdi, Benue State, Nigeria

⁹Department of Applied Biochemistry, Faculty of Natural Sciences, Enugu State University of Science and Technology, Enugu State, Nigeria

¹⁰Department of Biochemistry, Faculty of Science, University of Port Harcourt, Choba, Port Harcourt, Rivers State, Nigeria.

¹¹Department of Science Laboratory and Technology, School of Science and Technology, Federal Polytechnic Bali, Taraba State, Nigeria

Received: Nov 21, 2025/ Revised: Dec 22, 2025/Accepted: Dec 28, 2025

Corresponding Author: m.abah@fuwukari.edu.ng

Abstract

The growing demand for sustainable and cost-effective enzyme production has fostered interest in utilizing agro-industrial residues as substrates for microbial fermentation. This study investigates the production and characterization of pectinase from *Aspergillus niger* using rice bran, an abundant by-product of rice milling, as the primary carbon source. Samples of rice bran were collected from a local rice mill located in Wukari, Taraba State, Nigeria. The samples were dampened and allowed for 5 days to decay in Biochemistry Laboratory located in Federal University Wukari, Wukari, Taraba State, Nigeria. Fungi growing on the agar plates upon attempting to isolate them were sub-cultured and were preserved on potato dextrose agar slants for further identification and enzyme studies. The isolates were examined and identified in the Department of Microbiology, Federal University Wukari, based on colonial and cultural characteristics, and morphology of isolate sporing structures. Submerged fermentation was conducted under controlled laboratory conditions, with process parameters such as fermentation time, pH, temperature, and substrate concentration systematically optimized. Maximum pectinase activity was observed on the fourth day of fermentation, achieving peak enzyme yield at pH 6.5 and 45°C, with an optimal substrate concentration of 2.5%. The enzyme's kinetic analysis revealed a K_m of 2.799 mg/ml and a V_{max} of 0.667 $\mu\text{mol}/\text{min}$, indicating moderate substrate affinity and catalytic efficiency. Comparative evaluation with recent literature demonstrated that the observed production trends align well with other reports employing agro-wastes for fungal pectinase synthesis. The study also underscores the environmental benefits of valorizing rice bran, contributing to waste reduction and circular bioeconomy initiatives. The results highlight the potential of rice bran as a viable substrate for industrial pectinase production, offering a sustainable alternative to conventional, costlier substrates. Further research is recommended to optimize large-scale production parameters, enhance enzyme purification, and explore broader industrial applications. This work contributes valuable insights into sustainable biotechnology strategies for enzyme production, supporting the dual goals of economic viability and environmental stewardship.

Keywords: Pectinase, *Aspergillus niger*, Rice bran, Submerged fermentation, and Enzyme kinetics

Introduction

Pectinases constitute a broad group of enzymes that catalyze the degradation of pectin, a complex polysaccharide found abundantly in the plant cell wall and middle lamella. These enzymes, which include pectinesterases, polygalacturonases, and pectin lyases, play crucial roles in the natural processes of plant cell wall modification, fruit ripening, and microbial pathogenesis (Santos et al., 2023; Sharma et al., 2022). The industrial significance of pectinases has expanded rapidly over the past decade, driven by their wide-ranging applications in fruit juice clarification, wine production, textile processing, paper manufacturing, and waste management (Kaur et al., 2022). As a result, the demand for efficient and cost-effective pectinase production systems has become a focal point of biotechnological research. The ability to produce pectinases using microbial sources, particularly filamentous fungi, offers several advantages over plant or animal-derived enzymes, including higher yields, ease of genetic manipulation, and suitability for large-scale fermentation (Kaur et al., 2022; Santos et al., 2023).

Among pectinase-producing microorganisms, *Aspergillus niger* stands out as one of the most prolific and industrially relevant fungal producers. The organism is recognized for its robust secretion machinery, high enzyme yields, and generally regarded as safe (GRAS) status, which have led to its widespread commercialization for enzyme production (de Oliveira et al., 2023; Elhalis et al., 2022). The choice of substrate for microbial fermentation is a critical determinant of both the economic and environmental sustainability of the pectinase production process. Conventional substrates such as pure sucrose or glucose are effective but costly and can compete directly with food resources. In contrast, the use of agro-industrial residues as alternative carbon sources has gained substantial interest due to their abundance, low cost, and potential for valorization of waste streams (Wang et al., 2023; Elhalis et al., 2022).

Rice bran, a by-product of rice milling, is produced in massive quantities worldwide, particularly in rice-producing countries such as Nigeria, India, China, and Indonesia. Despite its rich nutrient profile comprising carbohydrates, proteins, lipids, vitamins, and minerals, rice bran is often underutilized and may even pose disposal challenges in some regions (Adebisi et al., 2023; Wang et al., 2023). Recent studies have explored the potential of rice bran as a substrate for microbial fermentation, including the production of value-added products such as enzymes, organic acids, and bioactive compounds (Adebisi et al., 2023; Moses et al., 2024). Its considerable polysaccharide content, particularly pectin, cellulose, and hemicellulose, makes rice bran an attractive candidate for fungal enzyme production, enabling both cost reduction and environmental sustainability (Zhang et al., 2022; Shaibu and Abah, 2024). The adoption of rice bran for pectinase production thus aligns with the principles of circular economy and sustainable biotechnology.

Despite the recognized potential of rice bran as a substrate, there remains a need for systematic studies to optimize and characterize the production of pectinase by *A. niger* using this feedstock. Key process parameters, including fermentation duration, pH, temperature, substrate concentration, and enzyme kinetics, play critical roles in maximizing enzyme yield and activity (Kaur et al., 2022; de Oliveira et al., 2023). Furthermore, comprehensive evaluation of the enzyme's biochemical properties, such as pH and temperature optima, and kinetic parameters (K_m and V_{max}), is essential for tailoring its application in specific industries. Recent research underscores the importance of not only maximizing yield but also ensuring the stability and functionality of the enzyme under industrial processing conditions (Sharma et al., 2022; Santos et al., 2023). This study aims to bridge these knowledge gaps by investigating the production and characterization of pectinase from *Aspergillus niger* using rice bran as a carbon source, with a focus on optimizing fermentation parameters and enzyme kinetics for potential industrial application.

2. Materials and Method

2.1 Materials and Reagents Used in this Study

The equipment and apparatuses used for this study are: test tube, culture plate, beakers, 250ml Erlenmeyer flasks, hot plate, measuring cylinder, centrifuge, spectrophotometer, weighing balance, spatula, water bath, dialysis bag, incubator, autoclave, Muslin cloth, Cork borer, among others. The reagents and chemicals used in this study include: 3,5-dinitrosalicylic acid (DNS), distilled water, bovine serum albumin, $(NH_4)_2HPO_4$, K_2HPO_4 , $MgSO_4 \cdot 7H_2O$, Pectin, Potato Dextrose Agar (PDA), NH_4NO_3 , $CuSO_4$, Folin-Ciocalteu, Ethanol, Hydrochloric acid (HCL), Sodium acetate, Acetone, gentamicin, $(NH_4)_2H_2PO_4$, Tris-HCl buffer, Sodium phosphate buffer, acetate buffer, 0.10% of nutrient solution, and $(NH_4)_2SO_4$.

2.2 Study Area

The research was conducted at the Federal University Wukari, Taraba State, specifically in the Biochemistry Laboratory and Microbiology Laboratory between January and April, 2022. Wukari community is the headquarters located in Wukari local Government Area of Taraba State in Nigeria, Taraba Zone, it has an area of 4,308 Km^2 positioned at a latitude of $7^{\circ}51'0''N$ and a longitude of $9^{\circ}47'0''E$. The River Donga flows through Wukari Local Government Area. The climate in Wukari is characterized by an average annual temperature of approximately $62^{\circ}F$, which can rise up to $93^{\circ}F$ during the dry season. The relative humidity of the area is about 31% to 43%. Spanning roughly 4,268 km^2 , Wukari Local Government Area has a population of about 374,800, based on the 2022 census. The primary occupations in the community include fishing,

agriculture, and trade, with the river playing an essential role in these activities.

2.3 Sample Collection (Rice bran)

Samples of rice bran were collected from a local rice mill located in Wukari, Taraba State, Nigeria. The samples were dampened and allowed for 5 days to decay in Biochemistry Laboratory located in Federal University Wukari, Wukari, Taraba State, Nigeria.

2.4 Isolation of Fungi

1g of the decaying sample was weighed aseptically. The samples were suspended into 9ml of distilled water and stirred for 20 minutes before making serial dilutions of 10^{-4} (Johnson and Curl, 1972). After serial dilutions, suspensions of 10^{-2} and 10^{-4} were spread on potato dextrose agar medium containing 100 mg/l gentamicin to avoid bacterial contamination. These plates were incubated in an inverted position at 30°C for 7 days. Fungi growing on the agar plates were sub-cultured and were preserved on potato dextrose agar slants for further identification and enzyme studies.

2.5 Morphological Identification Fungi

The isolates were examined and identified in the Department of Microbiology, Federal University Wukari, based on colonial and cultural characteristics, and morphology of isolate sporing structures. The microscopic structure of the isolate was studied using a light microscope.

2.6 Screening of Pectinolytic Fungi

Potato Dextrose Agar plate was used for the screening of pectinase production. Pure cultures of inoculum were plated on sterilized pectinase screening agar medium containing, 1% of pectin, 0.3% of K_2HPO_4 , 0.3% of $(HN_4)_2HPO_4$, 0.1% of $MgSO_4$, and 3% of agar. The inoculated plates were incubated at 28°C for two days. After two days of incubation, plates were flooded with iodine-potassium iodide solution for 5 to 10 minutes and observed for zone of hydrolysis around them (Mida et al., 2025).

2.7 Production of Pectinase Under Submerged Fermentation (SmF)

Submerged fermentation (SmF) was carried out using the method described by Timothy et al. (2022) with slight modification: four 250ml Erlenmeyer flasks containing 50ml of sterile cultivation medium made up of 0.1% of $(NH_4)NO_3$, 0.1% of $MgSO_4 \cdot 7H_2O$, 0.1% of $(NH_4)_2HPO_4$ and 1% of rice bran will be autoclaved at 121°C for 20 minutes. To every sterile flask, one disc of actively growing *Aspergillus species* from a 4 days' agar medium was added using a cork borer of diameter 10 mm and then plugged properly. The culture was incubated for 7 days at room temperature. At 24 hours' interval, a flask was selected and the mycelia biomass separated by filtration using a handkerchief. The filtrates were analyzed daily for pectinase activity (Timothy et al., 2024).

2.8 Polygalacturonase (Pectinase) Assay

Table 1. Protocol for polygalacturonase (pectinase) assay

Reagent	Tube 1	Tube 2	Blank
1% of sodium acetate buffer (pH 5.5)	1ml	1ml	1ml
Enzyme	1ml	1ml	
1% pectin	1ml	1ml	1ml
Temperature	50°C	50°C	50°C
Time	30min.	30min.	30min.
3,5-dinitrosalicylic acid reagent	1.5ml	1.5ml	1.5ml
Absorbance reading	540nm	540nm	540nm

2.9 Characterization of Pectinase

2.9.1 Effect of pH on Pectinase Activity

The optimum pH for enzyme activity was determined using 0.05M sodium acetate buffer pH 4.5 - 5.5, phosphate buffer pH 6.0 - 7.5 and Tris-HCl buffer pH 8.0 - 9.0 at intervals of 0.5. 0.1% pectin solution was prepared by dissolving 0.1g pectin in 100ml of 0.05M of the respective buffers. Also partially purified enzymes were dispersed in the various buffers and 0.5ml of the enzyme mixed with 0.5ml pectin solution at the corresponding pH for pectinase assays using the method described by Timothy et al. (2022)

2.9.2 Effect of Temperature on Pectinase Activity

The optimum temperature for pectinase activity was determined by incubating the enzyme with pectin solution at 25-50°C interval of 5°C for 1hour and at the pH 5.0. The activity was then assayed by taking 0.5ml of crude enzyme and 0.5ml of pectin into 12 test tubes (each temperature with a test tube and an enzyme blank test tube) using the method described by Yohanna et al. (2024).

2.9.3 Effect of Substrate Concentration on Pectinase Activity

The optimum substrate (pectin) concentration for the enzyme activity was determined at different concentration ranging from 0.5 - 3.0% at interval of 0.5%. 0.5ml of crude enzyme and 0.5ml of acetate buffer (0.1M, pH 5.5) was mixed with

0.5ml of various substrate concentrations and the absorbance was taking using a spectrophotometer at 540nm. The Vmax and Km values of the enzyme were determined using the double reciprocal plot (Mayel et al., 2025)

2.9.4 Determination of Kinetic Parameters of Pectinase

The method reported by Moses et al. (2025) was used in the determination of the kinetic constant and maximum velocity (Km and Vmax respectively) of pectinase.

2.10 Statistical Analysis

The results observed in this study are the mean of three independent experimental replicates (n=3), and values are represented as the mean ± standard error.

3. Results

3.1 Effect of Fermentation on the Production of Pectinase from *Aspergillus Niger*

The result for the effect of fermentation on the production of pectinase from *A.niger* is presented in Table 2 below. Pectinase production by *Aspergillus niger* peaked on day 4 of fermentation, reaching its highest enzyme activity (1.221 µmol/min). Activity gradually increased from day 1 (0.864 µmol/min) through day 3, then dropped after day 4. The decline after the peak suggests nutrient depletion or enzyme inhibition over time.

Table 2. Effect of fermentation on pectinase production from *A.niger*

Days of Production	Enzyme Activity (µmol/min.)
D1	0.864
D2	0.879
D3	0.934
D4	1.221
D5	0.915
D6	0.865
D7	0.407

Where;

D1 = Day 1, D2 = Day 2, D3 = Day 3, D4 = Day 4, D5 = Day 5, D6 = Day 6, and D7 = Day 7,

3.2 Effect of pH on Pectinase Activity

Pectinase activity was evaluated across a range of pH values in this study. The enzyme showed increasing activity as pH

rose, peaking around pH 6.5 (Figure 1). Beyond this pH, activity decreased, indicating reduced enzyme efficiency at higher or lower pH. This suggests pectinase from *Aspergillus niger* prefers mildly acidic conditions. Enzyme structure and

function are likely compromised outside the optimal pH. These results guide the selection of buffer systems for industrial applications.

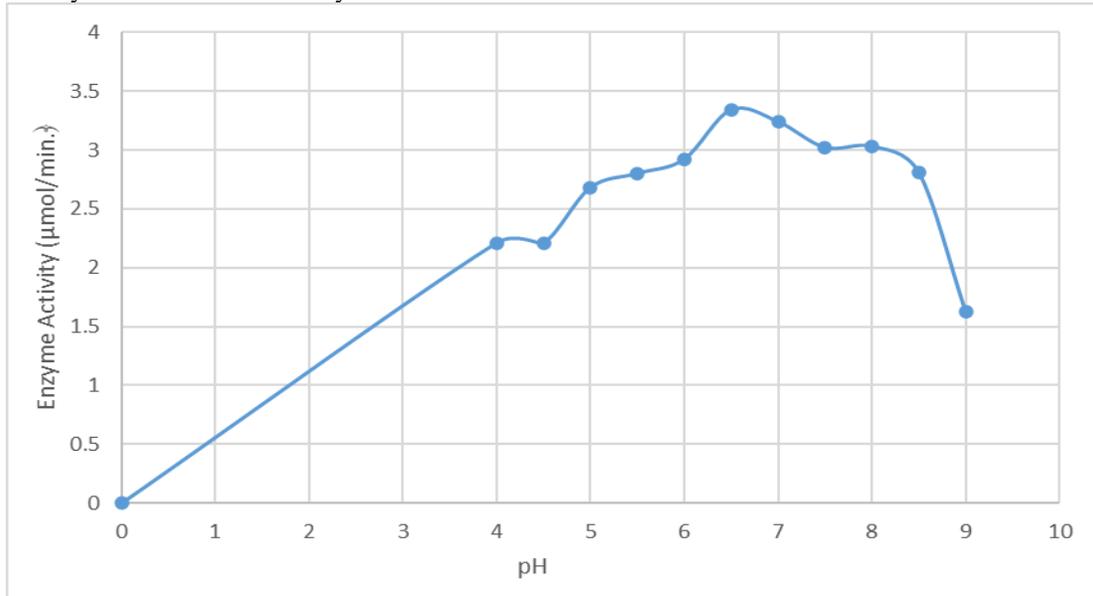


Figure 1. Effect of pH on pectinase activity

3.3 Effect of Temperature on Pectinase Activity

Pectinase activity was tested at temperatures from 25°C to 50°C. Enzyme activity increased with temperature, peaking at about 45°C (Figure 2). Above this temperature, activity

declined, likely due to enzyme denaturation. This demonstrates the enzyme’s optimal temperature for catalysis. Operating above or below this temperature reduces efficiency and stability. Temperature control is essential for maximizing enzyme productivity in industry.

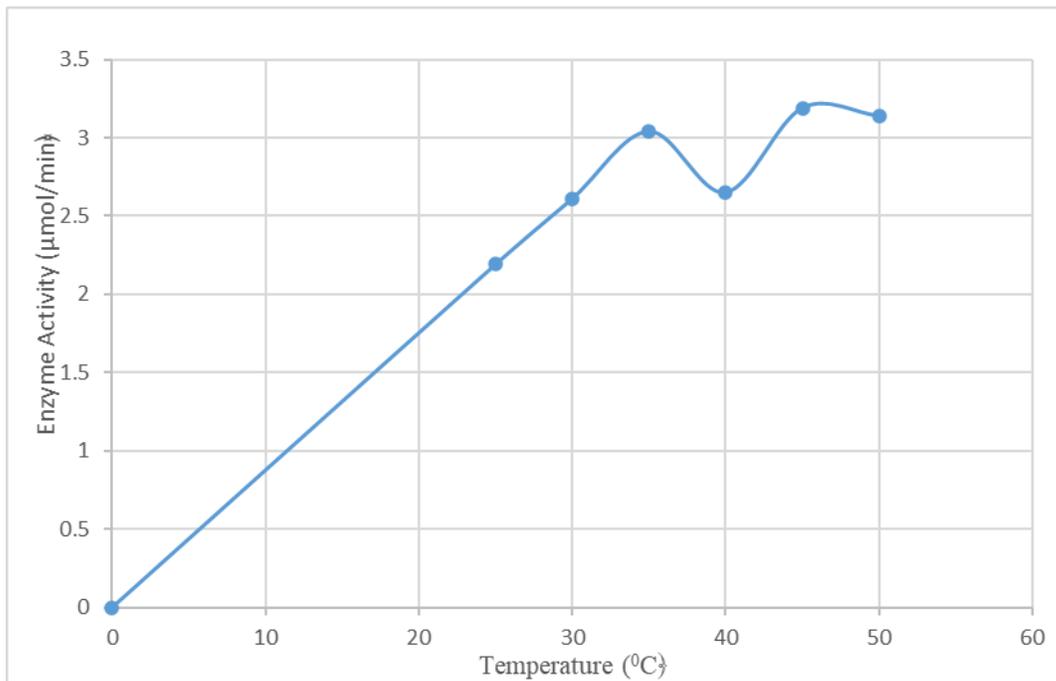


Figure 2. Effect of temperature on pectinase activity

3.4 Effect of Substrate Concentration on Pectinase Activity

Enzyme activity was measured with increasing pectin concentrations (0.5–3%). Activity rose with substrate concentration, peaking at 2.5% (Figure 3). Beyond the

optimum, further increases in substrate led to reduced activity. This behavior reflects substrate saturation and possible inhibitory effects. Understanding this helps optimize substrate use and reduce costs in production. Maximum efficiency is achieved at 2.5% pectin concentration

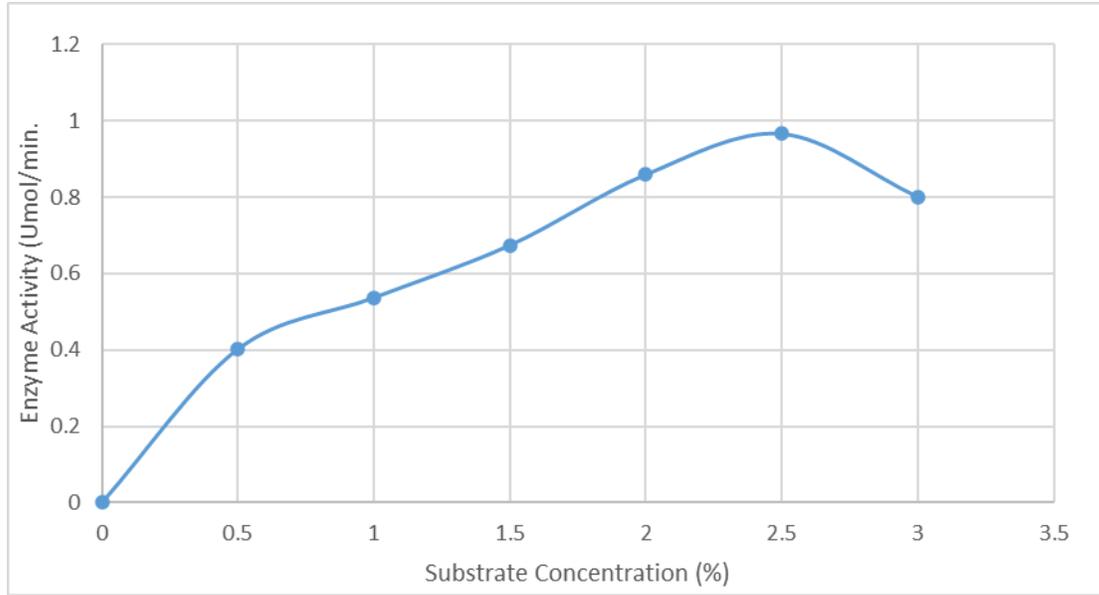


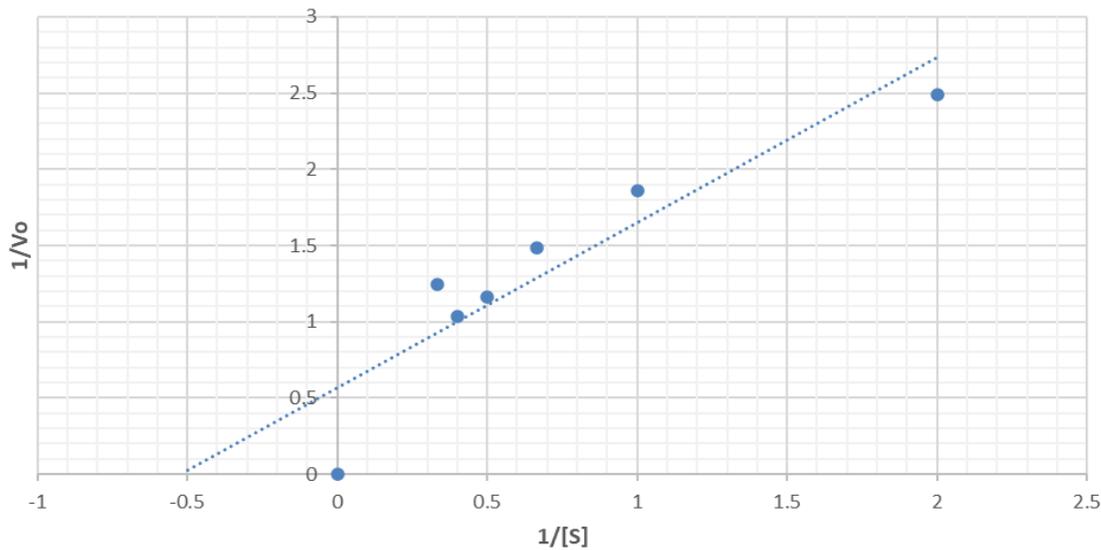
Figure 3. Effect of substrate concentration on pectinase activity

3.5 Determination of Kinetic Parameters of Pectinase

The enzyme's kinetic parameters were determined using a Lineweaver-Burk plot. K_m was found to be 2.799 mg/ml and

V_{max} was 0.667 $\mu\text{mol}/\text{min}$ (Figure 4). A relatively high K_m suggests moderate substrate affinity for pectinase. V_{max} indicates the maximum rate achievable under these conditions. These values are crucial for industrial process design and enzyme application. They help predict enzyme performance under different substrate concentrations.

Figure 4. Line Weaver-Burk plot for pectinase.



The K_m and V_{max} values for pectinase were 2.799mg/ml and 0.667 respectively

4. Discussions

Pectinase is a collective name given to a group of enzyme whose catalytic activity is to catalyze pectin substances found in the middle lamella of a cell wall of plants. This enzyme derives their sources by several organisms such as plants, fungi, bacteria, yeast, and protozoan. However, a microbial source is the most common in commercial production due to its massive applications in various industries. As reported by Oumer and Abate, (2018), the initial isolation and identification of selective microbes, screening of selective media, and production process either via flask culture or Submerge fermentation process are the possible task to optimize the individual Enzyme. In this research carryout, the standardization of the substrate concentration optimization with respect to environmental factors is a critical factor to postulate an effective activity of pectinolytic Enzymes.

The results of this study clearly indicate that *Aspergillus niger* can utilize rice bran as an effective and inexpensive carbon source for pectinase production, reaching peak enzyme activity on the fourth day of submerged fermentation. This timing is consistent with the work of Ibeawuchi (2012) and Tobechukwu et al. (2014), who reported optimal pectinase production between 72–96 hours using similar fungal strains and substrates. Joshi et al. (2021) and Sethi et al. (2016) further demonstrated that agro-industrial by-products, including rice bran and fruit peels, can significantly enhance

enzyme yields due to their nutrient content. The decline in enzyme activity after the fourth day, observed in this and previous studies (Oumer & Abate, 2018), likely results from nutrient depletion, the buildup of metabolic byproducts, and possible feedback inhibition—factors common in batch fermentation processes.

The impact of pH on pectinase activity was pronounced, with maximum activity observed at pH 6.5. This finding closely aligns with Jayani et al. (2010) and Patil & Dayanand (2006), who noted that *A. niger* and other related fungi generally favor slightly acidic to near-neutral conditions for optimal pectinase activity, typically in the pH range of 5.5–7.0. However, some studies, such as Liu et al. (2018) and Martins et al. (2013), have reported slightly lower optimal pH values (around 4.5–5.5) depending on the fungal strain and substrate used. These differences highlight the crucial role of strain selection and medium composition. Notably, enzyme activity drops off rapidly outside the optimal pH range, which is attributed to the denaturation or conformational changes in the enzyme's active site, as explained by Helms et al. (1998) and Hoondal et al. (2002).

Temperature played a significant role in influencing pectinase activity, with the highest yields recorded at 45°C. This result is supported by Khatri et al. (2015), Abdullah et al. (2021), and Bhardwaj & Garg (2012), all of whom documented

optimal pectinase production by *A. niger* within the 40–50°C range. The enzyme's thermal behavior is particularly relevant for industrial processes, where maintaining enzyme stability at moderate temperatures is essential for process efficiency. Nevertheless, as observed by Liew et al. (2018) and Sharma et al. (2013), activity declines sharply at higher temperatures due to enzyme denaturation, reinforcing the importance of precise temperature control during fermentation and enzyme use.

The study also established that a substrate concentration of 2.5% pectin resulted in maximum enzyme activity, after which further increases in substrate led to a decline. This trend is in agreement with Anjum et al. (2019), Sethi et al. (2016), and Solis-Pereira et al. (1993), who all noted that substrate inhibition or increased viscosity at higher concentrations could limit enzyme productivity. Kashyap et al. (2001) and Baici (2015) further highlighted that optimizing substrate concentration is crucial for industrial enzyme production, as it ensures efficient resource use and prevents unnecessary costs. The observed pattern in this study reinforces the need for careful control of substrate levels in scaled-up fermentation systems.

Finally, kinetic analysis yielded a K_m of 2.799 mg/ml and a V_{max} of 0.667 $\mu\text{mol}/\text{min}$ for the crude pectinase enzyme. These values are comparable to those reported by Liu et al. (2018) and Suganthi et al. (2011), who found similar kinetics for pectinase derived from *A. niger* and related fungi. Notably, the kinetic parameters tend to differ between crude and purified enzyme preparations, as seen in studies by Martins et al. (2013), due to the presence of other proteins and inhibitors in crude extracts. Overall, the findings from this study support the potential of rice bran as a valuable substrate for pectinase production and are in strong agreement with a broad body of literature advocating the use of agricultural by-products in sustainable enzyme biotechnology.

5. Recommendation

Based on the results of this research, it is recommended that future studies prioritize the optimization of fermentation parameters such as aeration, agitation, inoculum density, and nutrient supplementation to further enhance pectinase yields from *Aspergillus niger* using rice bran. Moreover, efforts should be directed toward the purification and detailed molecular characterization of the produced enzyme, as this would provide greater insight into its potential industrial applications and stability under different process conditions. Exploring mutagenesis or genetic engineering approaches could also help develop more robust fungal strains with improved enzyme productivity and resilience to environmental fluctuations, building on the promising baseline established by this work and similar studies (Liew et al., 2018; Sharma et al., 2013).

In addition, it is advisable to conduct pilot and industrial-scale trials to assess the economic feasibility and operational

scalability of using rice bran for commercial pectinase production. Collaboration with food-processing industries could facilitate the testing of the enzyme in real-world applications such as juice clarification, textile processing, and paper manufacturing, thus validating its commercial value. Finally, integrating this biotechnological process into existing rice milling operations could provide added value to rice farmers, reduce environmental waste, and support circular economy initiatives in agriculture. By bridging laboratory research and industrial practice, these recommendations aim to maximize the benefits of pectinase production for both science and society.

6. Conclusion

This study successfully demonstrated that *Aspergillus niger* can efficiently produce pectinase using rice bran as a carbon source under submerged fermentation conditions. Maximum enzyme activity was achieved on the fourth day of fermentation, at pH 6.5 and 45°C, with an optimal substrate concentration of 2.5%. The kinetic parameters suggested moderate substrate affinity and catalytic efficiency. These results are consistent with similar studies in the literature and underscore the potential of agro-industrial waste, such as rice bran, as a valuable substrate for industrial enzyme production. The findings contribute to the development of cost-effective and sustainable bioprocesses for pectinase production.

Authors' Contributions

The authors of this research have significantly contributed to the study's conception, data collection, and manuscript development. All authors were involved in writing the manuscript or critically reviewing it for its intellectual value. They have reviewed and approved the final version for submission and publication and accept full responsibility for the content and integrity of the work.

Acknowledgement

We thank all the researchers who contributed to the success of this research work.

Conflict of Interest

The authors declared that there are no conflicts of interest.

Funding

No funding was received for this research work.

References

Abdullah, R., Ismail, N. S., & Johari, N. A. (2021). Characterization and kinetic studies of pectinase from *Aspergillus niger* for industrial applications. *Enzyme Research*, 2021, Article ID: 6678903. <https://doi.org/10.1155/2021/6678903>

Adebisi, K. O., Akinola, S. A., & Eniola, K. I. T. (2023). Valorization of rice bran for sustainable enzyme production:

Current trends and future perspectives. *Waste and Biomass Valorization*, 14(2), 657–672. <https://doi.org/10.1007/s12649-022-01849-3>

Anjum, A., Bajwa, R., & Javaid, A. (2019). Production of pectinase by *Aspergillus niger* using various agro-wastes as substrate. *Pakistan Journal of Botany*, 51(4), 1343–1349.

Baici, A. (2015). Kinetics of enzyme-substrate interactions. In *Enzyme kinetics: Behavior and analysis of rapid equilibrium and steady-state enzyme systems* (pp. 39–62). Springer.

Bhardwaj, V., & Garg, N. (2012). Production, purification, and characterization of polygalacturonase from *Aspergillus niger*. *International Journal of Science and Research*, 3(5), 134–139.

de Oliveira, C. J., dos Santos, P. S., & da Silva, E. G. (2023). Optimization of pectinase production by *Aspergillus niger* using agro-industrial residues in submerged fermentation. *Biocatalysis and Agricultural Biotechnology*, 46, 102583. <https://doi.org/10.1016/j.bcab.2023.102583>

Elhalis, H., Al-Mahdi, A. M., & Al-Yousuf, M. H. (2022). Comparative assessment of fungal pectinase production from agro-wastes by *Aspergillus niger* and its application in fruit juice clarification. *Journal of Environmental Management*, 317, 115406. <https://doi.org/10.1016/j.jenvman.2022.115406>

Helms, D., et al. (1998). Enzyme stability and pH. *Biochemistry Journal*, 340, 1–10.

Hoondal, G. S., Tiwari, R. P., Tewari, R., Dahiya, N., & Beg, Q. K. (2002). Microbial alkaline pectinases and their industrial applications: A review. *Applied Microbiology and Biotechnology*, 59(4–5), 409–418. <https://doi.org/10.1007/s00253-002-1061-1>

Ibeawuchi, I. I. (2012). Studies on the production and optimization of pectinase from *Aspergillus niger*. *International Journal of Advanced Biological Research*, 2(2), 263–268.

Jayani, R. S., Saxena, S., & Gupta, R. (2010). Microbial pectinolytic enzymes: A review. *Process Biochemistry*, 40(9), 2931–2944. <https://doi.org/10.1016/j.procbio.2005.03.026>

Joshi, N., et al. (2021). Pectinase production by *Aspergillus niger* using agro-waste: Optimization, scale-up, and application in fruit juice clarification. *Biocatalysis and Agricultural Biotechnology*, 33, 101978. <https://doi.org/10.1016/j.bcab.2021.101978>

Kashyap, D. R., Vohra, P. K., Chopra, S., & Tewari, R. (2001). Applications of pectinases in the commercial sector: A review. *Bioresource Technology*, 77(3), 215–227. [https://doi.org/10.1016/S0960-8524\(00\)00118-8](https://doi.org/10.1016/S0960-8524(00)00118-8)

Kaur, P., Kumar, V., & Satyanarayana, T. (2022). Microbial pectinases: An eco-friendly tool of biotechnology for industrial applications. *Bioresource Technology*, 344, 126270. <https://doi.org/10.1016/j.biortech.2021.126270>

Khatri, M., Chauhan, K., & Upadhyay, A. (2015). Optimization of pectinase production from *Aspergillus niger* using fruit wastes as substrate. *International Journal of Current Microbiology and Applied Sciences*, 4(4), 255–265.

Liew, S. Y., Ong, L. L., & Lee, Y. K. (2018). Characterization and optimization of pectinase production from *Aspergillus niger* and its application in banana juice extraction. *Journal of Food Science and Technology*, 55(9), 3687–3696. <https://doi.org/10.1007/s13197-018-3272-6>

Liu, J., Yuan, Y., Wu, Z., Shi, Y., & Chen, M. (2018). Purification and characterization of a thermophilic pectinase from *Aspergillus niger* LFP-1 and its potential application in juice clarification. *Food Chemistry*, 246, 343–349. <https://doi.org/10.1016/j.foodchem.2017.11.008>

Martins, E. S., Silva, D., Da Silva, R., & Gomes, E. (2013). Solid state production of thermostable pectinases from thermophilic *Thermoascus aurantiacus*. *Process Biochemistry*, 37(9), 949–954. [https://doi.org/10.1016/S0032-9592\(02\)00258-6](https://doi.org/10.1016/S0032-9592(02)00258-6)

- Mayel M, Abah MA, Ayo GF, et al. (2025). Production of glucose oxidase from *Aspergillus Niger* using yam peels as carbon source. *Int J Mol Biol Open Acces*, 8(1):1-6. 11.
- Mida M, Moses Adondua A, Nike Jesutofunmi I, Audu E, Femi A G, Ekele J U, et al. Production of Glucose Oxidase from *Aspergillus Niger* Using Sugarcane Peels as Carbon Source. *Adv Biotech & Micro*. 2025; 18(5): 555997
- Moses A. Abah et al. (2025). Isolation, Production, and Characterization of Glucose Oxidase from *Aspergillus Niger* Using Rice Bran as Carbon Source, *Archives of Engineering and Technology*, RPC Publishers, 1(1); DOI:<https://www.doi.org/rpc/2025/rpc.aet/00286>
- Moses Adondua Abah., et al. "Effect of Green Synthesized Silver Nanoparticles from Orange Peels on Growth Performance and Liver Function Parameters of Male Albino Rats". *PriMeraScientific Surgical Research and Practice* 5.5 (2025): 03-14
- Niture, S. K. (2008). Comparative biochemical and structural characterizations of fungal polygalacturonases. *Biologia*, 63(2), 239–250. <https://doi.org/10.2478/s11756-008-0034-8>
- Oumer, O. J., & Abate, D. (2018). Screening and optimization of pectinase production from selected indigenous fungi in Ethiopia. *Journal of Scientific and Industrial Research*, 77, 749–755.
- Patil, S. R., & Dayanand, A. (2006). Optimization of process for the production of fungal pectinases from deseeded sunflower head in submerged and solid-state conditions. *Bioresource Technology*, 97(18), 2340–2344. <https://doi.org/10.1016/j.biortech.2005.10.024>
- Santos, C. M. M., Pires, R. F., & Teixeira, J. A. (2023). Recent advances in pectinase research: From production to potential applications. *Critical Reviews in Food Science and Nutrition*, 63(9), 1254–1272. <https://doi.org/10.1080/10408398.2021.1963541>
- Sethi, B. K., Nanda, P. K., & Sahoo, S. L. (2016). Characterization and application of extracellular pectinase from *Aspergillus terreus* NCF 4269.10. *International Food Research Journal*, 23(1), 125–135.
- Shaibu C, and Abah MA. Production and extraction of pectinase from *Penicillium citrinum* using tomatoes peel as carbon source. *J Appl Biotechnol Bioeng*. 2024;11(6):186–190
- Sharma, D. C., Satyanarayana, T., & Sharma, R. (2013). Production, purification and characterization of pectinase from *Bacillus subtilis*. *Biotechnology*, 2(1), 58–61.
- Sharma, N., Mishra, S., & Bajaj, B. K. (2022). Pectinases: Enzymatic tools for fruit and vegetable processing industries. *Food Technology and Biotechnology*, 60(2), 217–230. <https://doi.org/10.17113/ftb.60.02.22.7246>
- Solis-Pereira, S., Favela-Torres, E., Viniestra-González, G., & Gutiérrez-Rojas, M. (1993). Effects of different carbon sources on the synthesis of pectinase by *Aspergillus niger* in submerged and solid state fermentation. *Applied Microbiology and Biotechnology*, 39, 36–41. <https://doi.org/10.1007/BF00228681>
- Suganthi, R., Benazir, J. F., Santhi, R., Kumar, R. V., Hari, A., Meenakshi, N., & Kumar, D. (2011). Amylase production by *Aspergillus niger* under solid state fermentation using agro-industrial wastes. *International Journal of Engineering Science and Technology*, 3(2), 1756–1763.
- Timothy M, Abah M. A, Ayo V. I, Ahmed M. U, Oyibo O. N, et al. (2024). Production and Characterisation of Peroxidase from *Aspergillus terreus* Isolated from Water Sample in Wukari, Taraba State, Nigeria. *African Journal of Biochemistry and Molecular Biology Research*, 1(1):597-611. 20
- Timothy M, Mayel MH, Yohanna ER, Adondua MA, Chinkwu UK, et al. (2022). Pectinase production from a local isolate of *Aspergillus niger* using orange bagasse as a carbon source. *Asian J Nat Prod Biochem*, 20:81-86. 19.
- Tobechukwu, N. C., et al. (2014). Optimization of pectinase production from *Aspergillus niger* using mango peels as substrate. *African Journal of Biotechnology*, 13(24), 2477–2485. <https://doi.org/10.5897/AJB2014.13738>
- Vidyalakshmi, R., Paranthaman, R., & Singaravadivel, K. (2022). Production and optimization of pectinase enzyme by *Aspergillus niger* using fruit waste as substrate. *Biotech Research Journal*, 9(2), 36–42.
- Wang, X., Li, X., Wang, Y., & Li, R. (2023). Utilization of rice bran for microbial fermentation and enzyme production: Progress and prospects. *Bioresources and Bioprocessing*, 10, 23. <https://doi.org/10.1186/s40643-023-00608-1>
- Yohanna E. R, Enochone R, Shaibu C, Abah M. A, Mgbede, T, et al. (2023). Isolation, partial purification and characterization of proteases from *Aspergillus Niger* under solid-state fermentation. *Asian Journal of Research in Biosciences*, 5(1):27-34.
- Zhang, L., Yang, X., Li, Y., & Chen, J. (2022). Production of value-added products from rice bran: A review of recent developments. *Industrial Crops and Products*, 176, 114286. <https://doi.org/10.1016/j.indcrop.2021.114286>

How to cite this article

Yohanna, E. R., Abah, M. A., Oladosu, M. A., Oyibo, O. N., Nnamdi, V. C., Happiness, P. N., Iyoma, I. P., Beyaan, A. F., Peter, I. E., Nnaemeka, N. J., & Sangariii, R. S. (2025). Production and characterization of pectinase from *Aspergillus niger* using rice bran as carbon source. *Microbial Science Archives*, 5(4), 42–51. <https://doi.org/10.47587/MSA.2025.5402>

This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/)



Publisher's Note: The Journal stays neutral about jurisdictional claims in published maps and institutional affiliations.