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Research Article

DEVELOPMENT OF A SUSTAINABLE *ARECA CATECHU* POLYSACCHARIDE-BASED SOLID BIOPOLYMER ELECTROLYTE WITH ENHANCED ELECTROCHEMICAL AND ANTIBACTERIAL PROPERTIES

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ABSTRACT

The development of environmentally friendly methods for synthesizing solid biopolymer electrolyte film has become very important in the field of electrochemical research. In this study, a simple and eco-friendly method was used to prepare a solid biopolymer electrolyte (SBE). Polysaccharides were extracted from *Areca catechu* using hot water extraction followed by ethanol precipitation. The extracted polysaccharides were then used to prepare composite films via the solution casting technique, which acted as sodium-ion conducting membranes. The prepared samples were characterized using various analytical techniques. X-ray diffraction (XRD) analysis was used to determine the crystalline and amorphous nature of the materials. Fourier Transform Infrared (FTIR) spectroscopy was used to identify the functional groups present in the sample. Scanning Electron Microscopy (SEM) was used to study the surface morphology of the prepared films. The electrochemical behavior of the film was analyzed using Cyclic Voltammetry (CV), which showed a stability window ranging from -1.5 V to 2 V. The antibacterial activity of the prepared films was also tested. The results showed good antibacterial performance against *Escherichia coli* (70.76% inhibition) and *Klebsiella pneumoniae* (66.08% inhibition) at a concentration of 100 µg/mL. These results indicate that $NaClO_4$-doped *Areca catechu* films can be used as an effective and eco-friendly solid polymer electrolyte with antibacterial properties for electrochemical energy storage devices.

Keywords: *Areca catechu*, Polysaccharides, Electrochemical, Sodium Perchlorate, Eco-friendly.

INTRODUCTION

The demand for safe, sustainable, and environmentally friendly materials for energy storage devices has increased significantly in recent years. Conventional liquid electrolytes used in batteries often suffer from problems such as leakage, flammability, and environmental hazards. Owing to these limitations, researchers have focused on developing solid polymer electrolytes from natural, biodegradable materials. Natural biopolymers are attractive because they are renewable, low-cost, non-toxic, and environmentally friendly (Thomas *et al.,* 2025; Grira *et al.,* 2024). These materials can also form flexible films and provide suitable pathways for ion transport when combined with an appropriate salt. Polysaccharides extracted from plant sources have gained considerable attention as promising materials for solid biopolymer electrolyte applications (Maithilee *et al.,* 2022; Pandurangan, 2023). Among various natural sources, *Areca catechu* seeds contain a significant number of polysaccharides that can be used to prepare solid biopolymer electrolyte films. These polysaccharides possess good film-forming ability and functional groups that can interact with ionic salts, which helps enhance ion conduction in the polymer matrix (Perumal *et al.,* 2019).

When an inorganic salt is added to a polymer, the salt dissociates into ions and increases the number of mobile charge carriers, thereby improving the ionic conductivity of the electrolyte (Abdulwahid *et al.,* 2023). In this study, *Areca catechu* seed polysaccharide was used as the host polymer for the preparation of solid biopolymer electrolyte films. Different compositions were prepared by doping the polymer with sodium perchlorate ($NaClO_4$) salts. The addition of sodium perchlorate is expected to improve the ionic mobility within the polymer matrix and enhance the

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overall conductivity of the electrolyte. Among the prepared samples, 0.5 g of $NaClO_4$ exhibits the highest ionic conductivity, indicating that the increased salt concentration provides a greater number of mobile sodium ions and improves ion transport within the polymer structure. Owing to its superior ionic conductivity, the highest-ionic-conductivity sample is considered the most suitable candidate for battery and energy storage applications. The use of sodium-ion-conducting solid biopolymer electrolytes is also gaining attention as an alternative to lithium-based systems because of the abundance and low cost of sodium resources. In addition to electrochemical performance, the biological stability of natural polymer materials is important, especially for long-term applications. Biopolymer electrolytes can be affected by microbial growth or degradation.

Therefore, the antibacterial properties of the prepared films were investigated. The electrolyte films demonstrated effective antibacterial activity against common pathogenic bacteria, including *Escherichia coli*, *Klebsiella pneumoniae*, *Vibrio cholerae, Salmonella Typhi,* and *Bacillus cereus*. This antibacterial behavior indicates that the prepared electrolyte films possess not only good electrochemical performance but also improved resistance to microbial contamination. Overall, the development of sodium perchlorate-doped *Areca catechu* seed polysaccharide electrolyte films provides a promising approach for producing eco-friendly and biodegradable solid polymer electrolytes.

MATERIALS AND METHODS

Chemicals Needed

Fresh *Areca catechu* seeds were obtained from a local agricultural farm in the Tirunelveli district of Tamil Nadu, India. The climatic and soil conditions of the Tirunelveli region are suitable for the growth of *A. catechu*, which helps obtain seeds with rich bioactive components. Before starting the experiment, the collected seeds were cleaned and processed using standard procedures to remove dust and other impurities from them. Analytical-grade dimethyl formamide (DMF) and the required chemical reagents used in this work were purchased from Sigma-Aldrich, India.

Preparation of *Areca Catechu* Seed Polysaccharide

Polysaccharides from *Areca catechu* seeds were extracted using a modified procedure based on previously reported methods (Ji *et al.,* 2022). Initially, the areca nut seeds were dried and ground into a fine powder using a grinder. The powdered material was then mixed with distilled water and heated at 90 °C for approximately 2 h to facilitate polysaccharide extraction. After extraction, the mixture was filtered to obtain a liquid extract, and the supernatant was concentrated. Ethanol was added to the concentrated solution to induce precipitation and isolate the polysaccharides. The mixture was kept at 40 °C for 12 h to allow complete formation of the polysaccharide precipitate. The precipitated material was collected by centrifugation to collect the precipitate, and it was freeze-dried to obtain purified *Areca catechu* seed polysaccharide powder in Figure 1.

Figure 1. Preparation of *Areca catechu* polysaccharide.

Preparation of Biopolymer Film

To prepare the biopolymer electrolyte film, 1 g of *Areca catechu* seed polysaccharide powder was dissolved in 50 mL of dimethylformamide (DMF). DMF was selected because it is a polar aprotic solvent that can effectively dissolve many polymers and organic compounds. The solution was stirred for 6 hours until the polysaccharide completely dissolved, forming a uniform mixture. After complete dissolution, different concentrations (0.2 g and 0.5 g) of sodium perchlorate ($NaClO_4$) salt were added to separate the solutions to prepare different compositions. Each mixture was stirred continuously for 24 h to obtain a homogeneous dispersion of salt within the polysaccharide matrix. The resulting solution was then poured into a Petri dish using the solution-casting method to form biopolymer films. The cast solution was dried at 50 °C for 18 h under controlled conditions to remove the solvent and obtain solid biopolymer films.

Figure 2. The highest conducting $NaClO_4$-doped *Areca catechu* polysaccharide (SBE) film.

Evaluation of Antibacterial Activity Using Agar Well Diffusion Assay

The antibacterial activity of the composite material, comprising sodium perchlorate ($NaClO_4$) doped with *Areca catechu* seed polysaccharides, was evaluated using the agar well diffusion assay, adhering to standardized protocols. Fresh cultures of the target bacterial pathogens were cultivated in nutrient broth and adjusted to a concentration of 10^8 colony-forming units per milliliter (CFU/mL) using the McFarland standard, ensuring uniformity in microbial inoculum density. The test samples were prepared at three distinct concentrations (50, 75, and 100 µg/mL) to assess dose-dependent antibacterial efficacy. Positive controls, consisting of standard antibiotics, and negative controls, comprising sterile distilled water, were included to validate the assay. Mueller-Hinton agar plates, a medium optimized for antibacterial susceptibility testing, were inoculated with the standardized bacterial suspensions. Wells of 6 mm diameter were aseptically punched into the agar, and 100 µL of each test sample or control solution was dispensed into the respective wells. The plates were incubated at 37°C for 24 hours under controlled conditions to facilitate bacterial growth and diffusion of the test compounds (Choi *et al.,* 2021). Post-incubation, the zones of inhibition (ZOI) surrounding the wells were measured in millimeters using a precision caliper. The antibacterial efficacy of the test samples was quantified by calculating the percentage inhibition relative to the positive control using the following formula:

$$\%\,Inhibition = \frac{Inhibition\ zone\ of\ sample - Zone\ of\ negative\ control}{Zone\ of\ positive\ control - Zone\ of\ negative\ control} \times 100$$

This method provides a quantitative measure of the antibacterial activity, enabling comparison of the inhibitory effects of the $NaClO_4$-doped polysaccharide composite at varying concentrations against the reference antibiotic controls. The results were interpreted to determine the potential of the composite material as an antibacterial agent, with larger inhibition zones and higher percentage inhibition values indicating greater efficacy.

Characterization of Biopolymer Film

The crystalline structure and phase were determined using X-ray diffraction (XRD) analysis, which was performed using a Bruker Model D_2 PHASER diffractometer equipped with a 2.2 kW Cu anode X-ray source operating at 40 kV and 40 mA. The molecular interactions and functional groups were investigated using FTIR spectroscopy. Spectra were recorded using a PerkinElmer spectrum analyzer across a wavenumber range of 4000 to 350 cm^{-1}. The electrical properties of the sample were analyzed using electrochemical impedance spectroscopy (EIS) to evaluate its ionic conductivity and overall electrical behavior. The measurements were performed using a HIOKI 353101 LCR Hi-Tester. The surface morphology and microstructure of the composite films were examined using Scanning Electron Microscopy (SEM) at various magnifications. The thickness of the biopolymer films was measured using a high-precision screw gauge.

RESULTS AND DISCUSSION

Figure 3 shows the diffraction pattern of the pure polysaccharide displayed a prominent peak at approximately 19.4°, 30.2° and 40°, indicating that the material possessed a semi-crystalline nature (Mudgil *et al.,* 2012). These peaks represent the regular arrangement of polysaccharide chains within the matrix. With the addition of 0.2 g and 0.5 g of $NaClO_4$, a decrease in the peak intensities is observed. This reduction in crystalline peak intensity, along with the broadening of the diffraction humps, suggests a shift toward a more amorphous structure. The decrease in crystallinity is due to the interaction between Na^+ ions and the polar groups of the *Areca catechu* polysaccharide, causing a breakdown of local structural order and hydrogen bonding. Moreover, the disappearance of sharp $NaClO_4$ diffraction peaks indicates full salt dissociation and uniform dispersion within the polymer matrix. The rise in amorphous nature enhances the ionic conductivity, providing a flexible pathway for ion conduction (Kadir *et al.,* 2010). Hence, the XRD results indicate that $NaClO_4$ incorporation improves the structural characteristics of *Areca catechu* polysaccharide for enhanced performance as a solid biopolymer electrolyte.

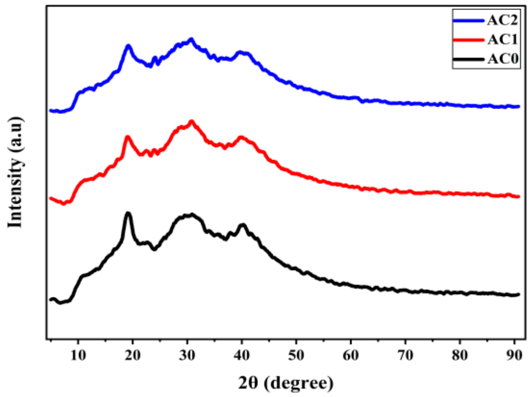

Figure 3. XRD pattern of synthesized *Areca catechu* polysaccharide-$NaClO_4$ (SBE) film.

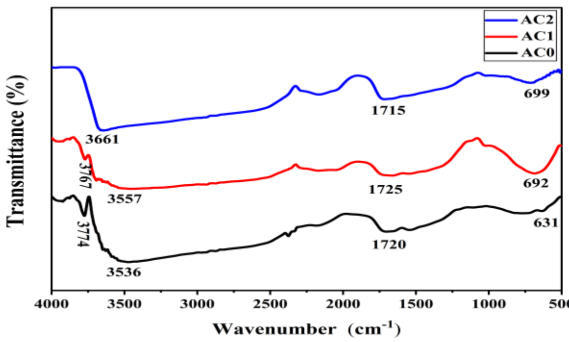

Figure 4. FTIR spectrum of the synthesized *Areca catechu* polysaccharide-$NaClO_4$ (SBE) film.

FTIR analysis was carried out to determine the functional groups and molecular interactions present in the prepared composite film in the spectral range of 4000–350 cm^{-1}, shown in Figure 4. In pure AC0, a broad OH band is observed at ~3536 cm^{-1} (Ali *et al.,* 2011). Upon adding $NaClO_4$, it shifts to higher wavenumbers, indicating weakened hydrogen bonding and coordination between Na^+ ions and hydroxyl groups. This shift changes the disruption of native hydrogen bonding structure and confirms the interaction between Na^+ ions and polymer hydroxyl groups. The peak at 1720 cm^{-1} (AC0) shifts to 1725 cm^{-1} (AC1) and 1715 cm^{-1} (AC2) confirming the role of carbonyl oxygen as coordinate sites. Significant changes are also evident in the fingerprint region, with the peak shifting from 631 cm^{-1} to 692 cm^{-1} and 699 cm^{-1} suggest the involment of perchlorate anion vibrations within the polymer matrix. Additionally, the appearance of new peaks in the 3767 cm^{-1} and 3774 cm^{-1} region highlights new interaction- induced vibrational modes, confirming $NaClO_4$ complexation and enhanced ion mobility. (Gnanasambandam & Proctor, 2000; Porto *et al.,* 2015). The ionic conductivity of the *Areca catechu* polysaccharide electrolyte was investigated using AC impedance spectroscopy. The Nyquist plot obtained from the impedance analysis is shown in Figure 5. The pure polysaccharide sample (AC0) exhibits a large, indistinct semicircle, suggesting a high bulk resistance 150592.16 (R_b), due to the absence of mobile ions. With the incorporation of sodium perchlorate ($NaClO_4$), a significant decrease in the diameter of the high frequency semicircle is revealed. The bulk resistance R_b is dropping to 18346.710 for AC1 and 4912.180 for AC2. The observed decrease in R_b is due to the enhanced mobility of Na^+ ions and the increased amorphous nature of the polymer matrix, as confirmed by XRD and FTIR analysis. Using the measured values of the film thickness (l) and electrode surface area (A), the ionic conductivity (σ) of the membrane was calculated using the following relation:

$$\sigma = \frac{d}{AR_b} \qquad (1)$$

From equation (1), the ionic conductivity of pure *Areca catechu* polysaccharide (AC0) solid biopolymer electrolyte membrane attained 1.7×10^{-7} S cm^{-1}. When sodium perchlorate salt is added to the pure *Areca catechu* polysaccharide (AC0) solid biopolymer electrolyte membrane, the ionic conductivity gradually increases as the semicircle's diameter decreases. Upon the addition of 0.5 g of $NaClO_4$ the ionic conductivity reached at 4.16×10^{-6} S cm^{-1}. This conductivity value indicates that ion movement occurs through the polymer matrix, although the mobility of the charge carriers may be limited. Reduced mobility is likely due to the formation of ion clusters or aggregates within the polymer structure, which can restrict the mobility of free ions and slightly reduce the overall ionic conduction of the electrolyte (Sowmiya *et al.,* 2023; Manap *et al.,* 2024). Table 1 denotes the bulk resistance and ionic conductivity with increasing $NaClO_4$ concentrations. As a result, AC2 exhibited the highest ionic conductivity among all the samples.

Table 1. Ionic conductivity and bulk resistance of prepared SBE membranes.

Samples	Bulk Resistance (R_b) (Ω)	Conductivity σ (S cm^{-1})
AC0	150592.16	1.7×10^{-7}
AC1	18346.71	1.02×10^{-6}
AC2	4912.18	4.16×10^{-6}

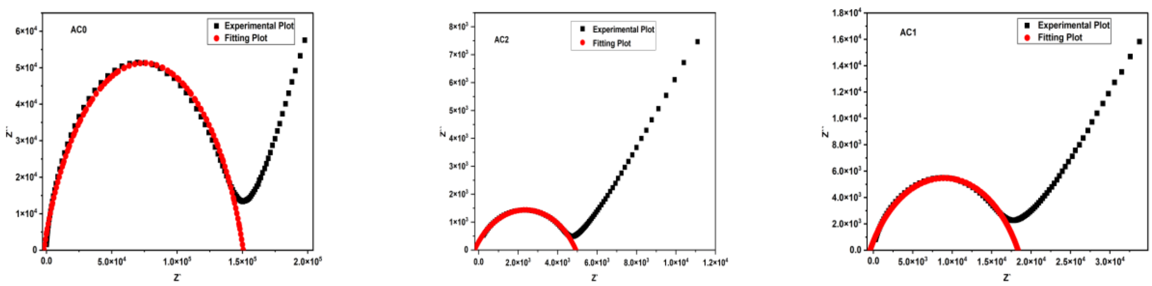

Figure 5. Nyquist plot of the synthesized *Areca catechu* polysaccharide-$NaClO_4$ (SBE) film.

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Dielectric spectra of pure solid biopolymer electrolyte membrane and $NaClO_4$ doped solid biopolymer electrolyte membrane illustrated in (Figure 6). By using the impedance data, the real and imaginary components of the complex permittivity are determined using equation (2)

$$\varepsilon^* = \varepsilon' - \varepsilon'' \qquad (2)$$

where ε' is the real component of the complex permittivity, commonly known as the dielectric constant, and ε'' is the imaginary component known as the dielectric loss. Figure (a,b) represents the variation of ε' (ω) and ε'' (ω) with frequency at room temperature. The dielectric permittivity of ε' and ε'' is high at low frequencies for all the complex solid biopolymer electrolytes, which is attributed to the space charge effect at the electrode–electrolyte interface. With increasing frequencies, both ε' and ε'' decrease. This occurs because the rapid reversal of the applied field hinders the alignment of charge carriers along the field direction, thereby limiting their diffusion (Arya *et al.,* 2018). Notably, the solid biopolymer electrolyte (AC2) exhibits the highest conductivity, which shows a markedly enhanced dielectric permittivity. The increase in ε' and ε'' at low frequencies indicates a high charge carrier density in the low-frequency region.

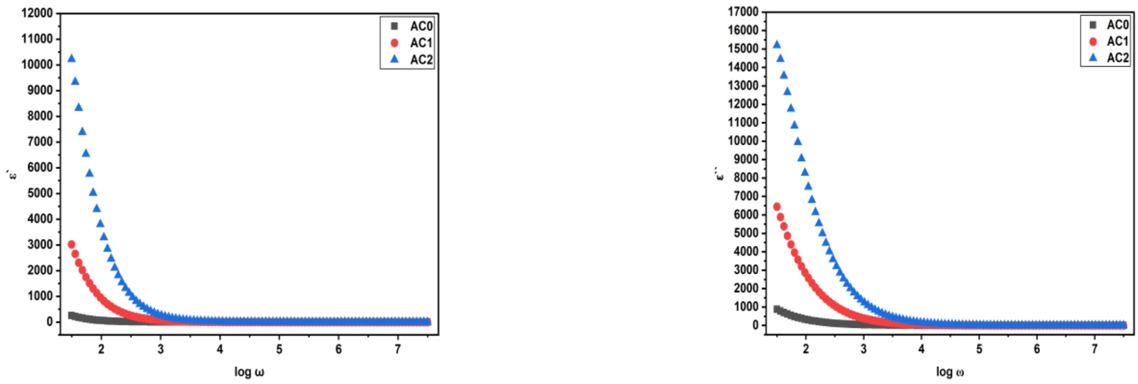

Figure 6. Real and imaginary dielectric frequency versus angular frequency of the synthesized *Areca catechu* polysaccharide-$NaClO_4$ (SBE) film.

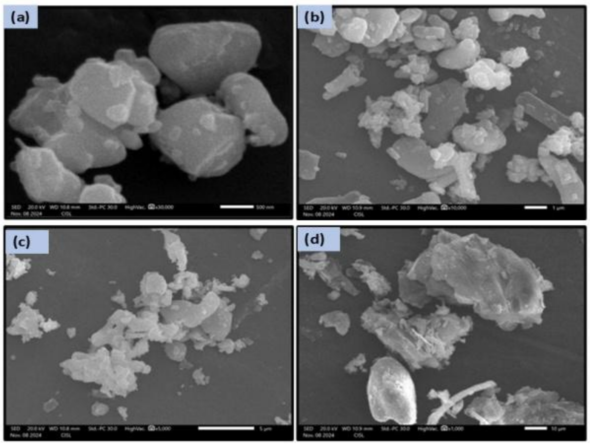

Figure 7. Scanning electron micrographs of the highest conducting (AC2) *Areca catechu* polysaccharide-$NaClO_4$ (SBE) film at different magnifications.

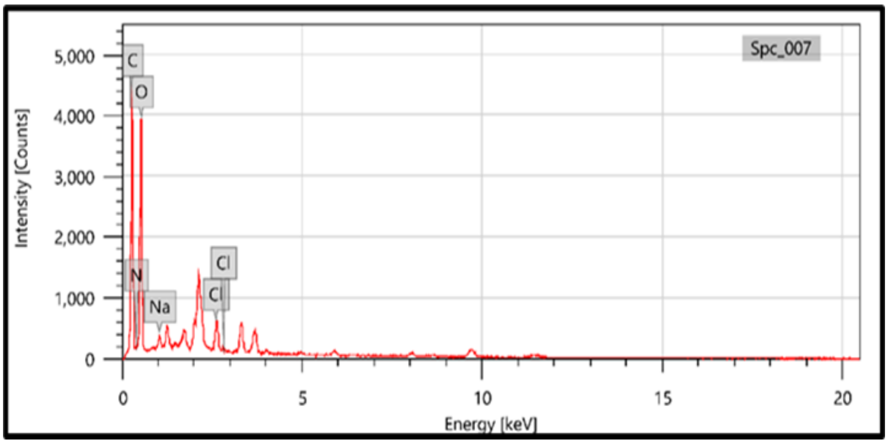

Figure 7.1 EDAX spectrum confirming the presence of C, N, O, Na, and Cl in the highest conducting (AC2) *Areca catechu* polysaccharide-$NaClO_4$ (SBE) film.

The surface morphology of the $NaClO_4$-doped *Areca catechu* polysaccharide composite film was examined using SEM at magnifications of 1,000× to 30,000×. The micrographs in Figure 7 revealed a heterogeneous microstructure with irregularly stratified particulate aggregates ranging from 500 nm to 10 µm. The surface displayed layered structures with distinct edges distributed among rougher regions, suggesting morphological modifications induced by the high $NaClO_4$ concentration. This heterogeneity likely resulted from the ionic interactions between the perchlorate anions and polysaccharide hydroxyl groups during film formation. Energy Dispersive X-ray Spectroscopy (EDAX) analysis shown in Figure 7.1 confirmed the elemental composition, which included carbon (C), nitrogen (N), oxygen (O), sodium (Na), and chlorine (Cl). The carbon and oxygen peaks corresponded to the polysaccharide structure, whereas the nitrogen peak may have originated from residual proteins in *Areca catechu* seeds. Sodium and chlorine detection validated the successful incorporation of $NaClO_4$ into the biopolymer matrix, confirming the formation of the composite rather than physical mixing (Kayambu & Ramasubbu, 2022; Liu *et al.,* 2024). The electrochemical behavior of the prepared solid biopolymer electrolyte film was examined using cyclic voltammetry (CV), and the obtained voltammograms are shown in Figure 8. The curves were recorded at different scan rates of 20, 50, 100, and 200, and the corresponding current responses were measured within the applied voltage range. The CV profiles displayed both anodic and cathodic peaks, indicating the occurrence of reversible redox reactions within the electrolyte system. As the scan rate increased, the current response also increased, suggesting improved charge transfer and ion mobility in the polymer matrix. The electrolyte film remained stable over a wide potential range of approximately −1.5 to 2 V, indicating good electrochemical stability. This stability window confirms that the prepared electrolyte film is suitable for electrochemical energy storage applications, particularly in sodium-ion battery systems (Arrieta *et al.,* 2024).

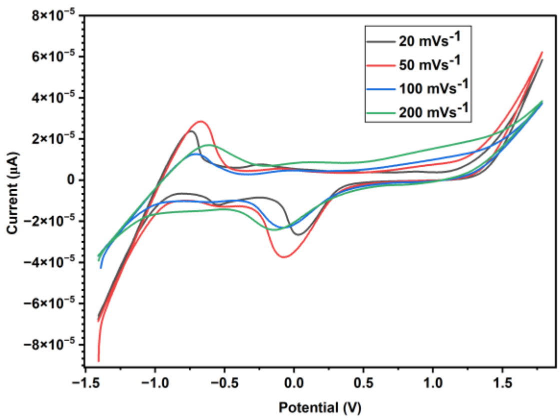

Figure 8. Cyclic voltammetry of the synthesized highest conducting *Areca catechu* polysaccharide-$NaClO_4$ (SBE) film.

The average thickness of the synthesized biopolymer film was measured to be 0.033 cm using a high-precision screw gauge. This specific thickness provides the necessary stiffness for deployment while remaining sufficiently permeable to facilitate the distribution of active components, such as $NaClO_4$ and polysaccharides, upon contact with bacterial growth. The antibacterial efficacy of the $NaClO_4$-doped *Areca catechu* polysaccharide composite was evaluated using the agar well diffusion method, which demonstrated broad-spectrum activity with dose-dependent responses shown in Figure 9 and Table 2. Among Gram-negative bacteria, *Escherichia coli* exhibited the highest susceptibility with a zone of inhibition (ZOI) of 12.10 ± 1.04 mm (70.76% inhibition) at 100 µg/mL, followed by *Klebsiella pneumoniae* (11.30 ± 1.52 mm, 66.08% inhibition). *Vibrio cholerae* and *Salmonella Typhi* showed lower inhibition rates of 29.02% and 28.37%, respectively. Among Gram-positive bacteria, *Bacillus cereus* demonstrated the highest sensitivity (14.30 ± 1.15 mm, 61.37% inhibition), whereas *Staphylococcus aureus* showed moderate activity (5.00 ± 0.50 mm, 40.98% inhibition). The dose-dependent response confirmed the concentration-activity relationship, with variations in efficacy reflecting differences in cell wall composition and membrane permeability. The broad-spectrum activity against both Gram-positive and Gram-negative bacteria suggests multiple antimicrobial mechanisms, including membrane disruption and oxidative stress through $NaClO_4$-mediated reactive species generation.

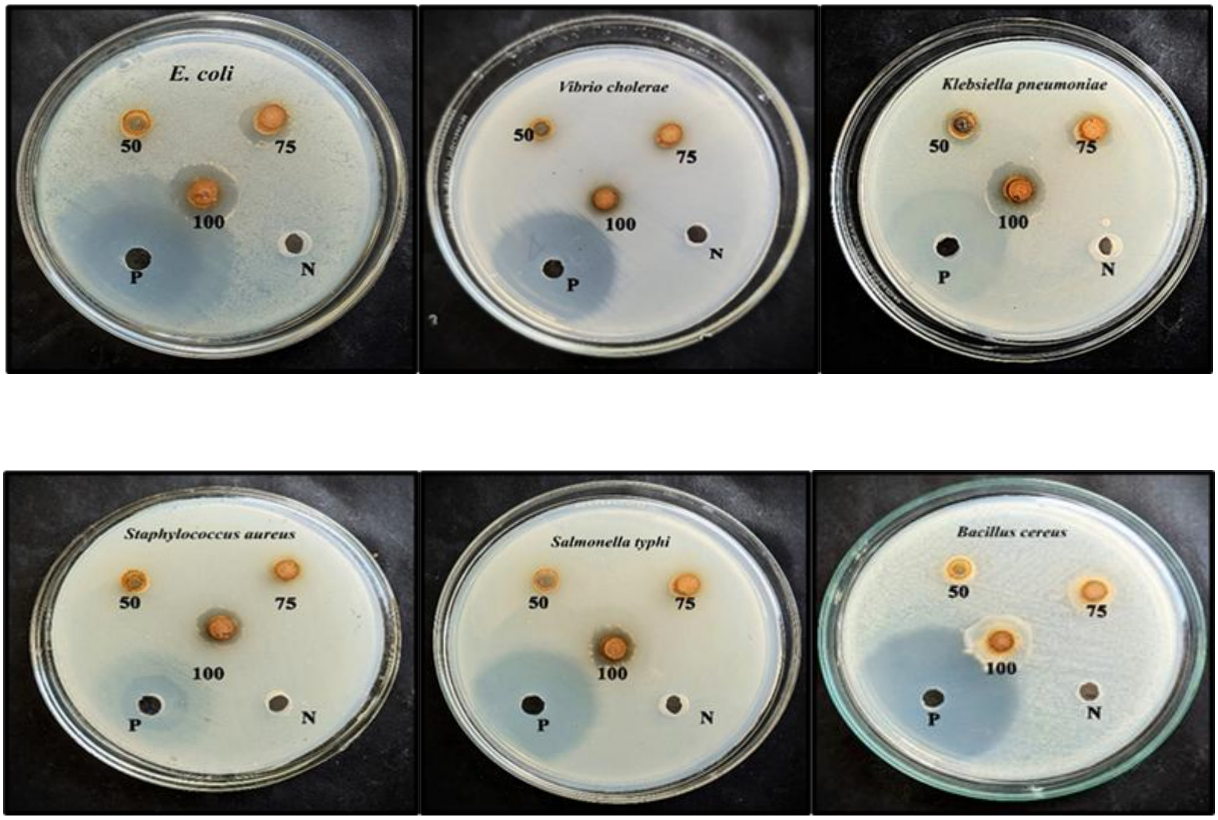

Figure 9. Antibacterial studies of the prepared highest conducting (AC2) *Areca catechu* polysaccharide-$NaClO_4$ (SBE) film.

Table 2. Antibacterial activity of $NaClO_4$-doped *Areca catechu* polysaccharide.

Pathogen	Sample	Zone of Inhibition (mm)	Inhibition (%)
E. coli	50	1.83 ± 0.28	10.70
	75	7.66 ± 1.15	44.79
	100	12.1 ± 1.04	70.76
	P	0.60 ± 1.04	–

	N	0 ± 0	–
Staphylococcus aureus	50	0.66 ± 0.57	5.409
	75	2.5 ± 0.5	20.49
	100	5 ± 0.5	40.98
	P	12.2 ± 1.25	–
	N	0 ± 0	–
Vibrio cholerae	50	1.66 ± 0.57	8.512
	75	4.16 ± 1.04	21.33
	100	5.66 ± 1.15	29.02
	P	19.5 ± 0.86	–
	N	0 ± 0	–
Salmonella Typhi	50	1.33 ± 0.57	9.851
	75	2.5 ± 0.5	18.51
	100	3.83 ± 0.76	28.37
	P	13.5 ± 0.86	–
	N	0 ± 0	–
Klebsiella pneumoniae	50	4.16 ± 0.28	24.32
	75	6.66 ± 0.28	38.94
	100	11.3 ± 1.52	66.08
	P	17.1 ± 1.04	–
	N	0 ± 0	–
Bacillus cereus	50	3.33 ± 0.57	14.29
	75	6.66 ± 0.57	28.58
	100	14.3 ± 1.15	61.37
	P	23.3 ± 1.04	–
	N	0 ± 0	–

The antibacterial properties of $NaClO_4$ doped with *Areca catechu* seed polysaccharides can be attributed to multiple complementary mechanisms. This novel composite material appears to disrupt bacterial cellular integrity through several pathways. The polysaccharide components interact with bacterial cell walls, particularly binding to the peptidoglycan layer of Gram-positive bacteria and disrupting the outer membrane of Gram-negative bacteria, leading to increased permeability and potential cytoplasmic leakage (Nguyen *et al.,* 2024). Simultaneously, the $NaClO_4$ dopant functions as an oxidizing agent, generating reactive oxygen species (ROS) including superoxide radicals, hydrogen peroxide, and hydroxyl radicals within bacterial cells, which damage essential cellular components such as DNA, proteins, and lipids (Da Cruz *et al.,* 2024). The polysaccharides likely enhance this oxidative effect by facilitating more efficient delivery of the $NaClO_4$ to bacterial cells. Additionally, the *Areca catechu* seed polysaccharides may inhibit crucial bacterial enzymes involved in cell wall synthesis and metabolism, such as transpeptidases and glycosyltransferases, further compromising bacterial structural integrity (Che *et al.,* 2024) The synergistic relationship between the polysaccharides and $NaClO_4$ creates a multifaceted antibacterial mechanism, with the polysaccharides enhancing adhesion and penetration while simultaneously disrupting cellular structures. This composite material also demonstrates potential to inhibit biofilm formation by preventing bacterial adhesion and disrupting extracellular polymeric substances, addressing a significant factor in bacterial persistence and resistance (Rendueles *et al.,* 2013). This multifaceted approach to bacterial inhibition likely explains the broad-spectrum efficacy observed in antimicrobial testing.

CONCLUSION

In summary, a solid biopolymer electrolyte was successfully prepared using an *Areca catechu* seed polysaccharide doped with sodium perchlorate ($NaClO_4$). Structural studies confirmed that the addition of salt altered the polymer structure and reduced its crystalline nature, leading to the formation of a more amorphous phase that supports easier ion movement. Electrochemical investigation showed that the prepared film possessed an ionic conductivity of 4.16×10^{-5} S cm^{-1}, indicating its capability to effectively conduct sodium ions. Cyclic voltammetry results revealed a stable electrochemical potential range of −1.5 to + 2.0 V, demonstrating that the electrolyte remained stable during redox processes. In addition to its electrochemical performance, the film also exhibited antibacterial activity, showing strong inhibition against *Escherichia coli* and *Klebsiella pneumoniae* at a concentration of 100 µg/mL. The presence of sodium perchlorate in the polymer matrix is believed to contribute to this antimicrobial effect, which helps prevent microbial contamination and degradation of the materials. Overall, the $NaClO_4$-doped *Areca catechu* biopolymer film shows good potential as an environmentally friendly solid electrolyte for sodium-ion battery applications. Further studies should focus on improving the ionic conductivity and optimizing the material properties for better performance in practical energy storage devices.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest

ETHICS APPROVAL

Not applicable

FUNDING

This study received no specific funding from public, commercial, or not-for-profit funding agencies.

AI TOOL DECLARATION

The authors declare that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on request

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