**Supplementary Information**

# Nanocellulose from Coconut Midrib used for Antibacterial and Electromagnetic Interference Shielding Applications

**Joshua Jose and Vinod T. P.***

Department of Chemistry, CHRIST University, Bengaluru 560029, India
E-mail: vinod.tp@christuniversity.in

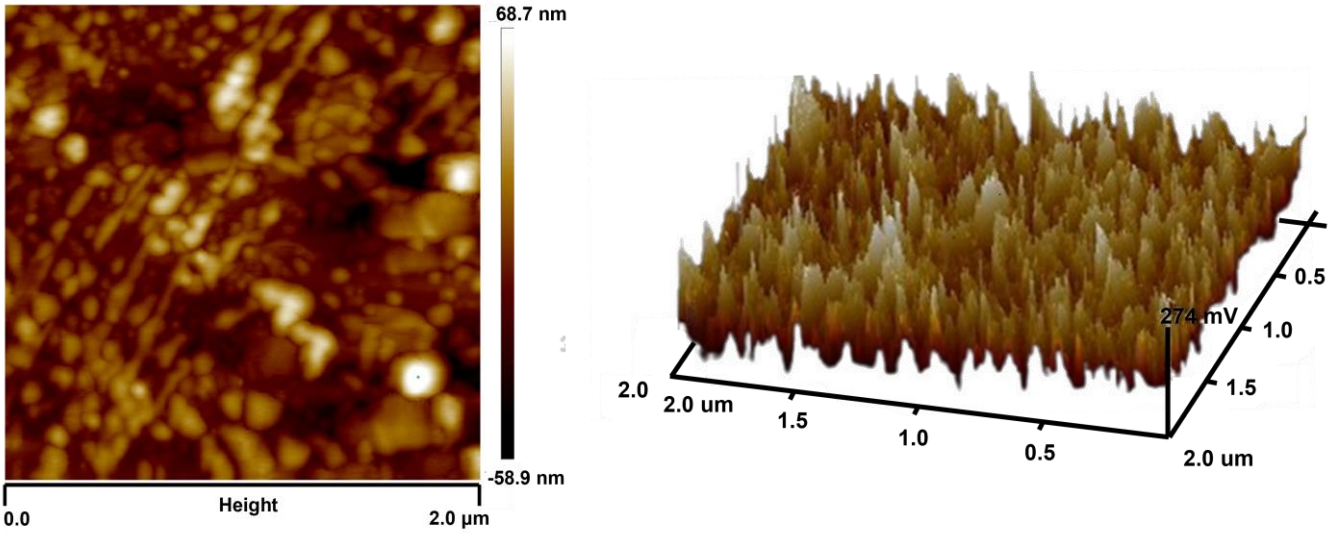


**Figure S1.** The 2D and 3D AFM images of coconut midrib nanocellulose. The average diameter of the particles was found to be 88 nm from the AFM analysis.

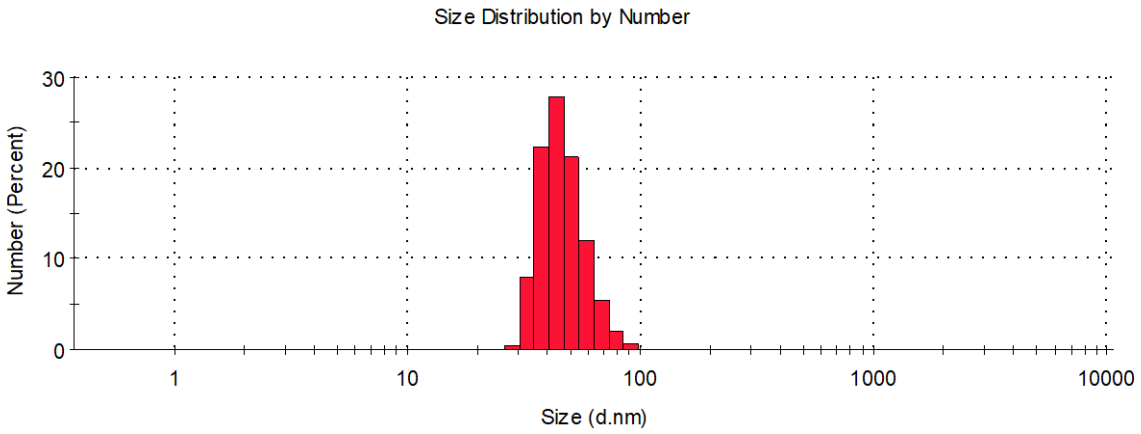


**Figure S2.** DLS analysis of Coconut midrib cellulose nanomaterial. (Average particle size is around 63.17 nm).

**Results**

| | | Mean (mV) | Area (%) | St Dev (mV) |
|---|---|---|---|---|
| **Zeta Potential (mV):** -35.8 | **Peak 1:** | -40.0 | 83.7 | 7.81 |
| **Zeta Deviation (mV):** 12.5 | **Peak 2:** | -12.7 | 16.3 | 4.90 |
| **Conductivity (mS/cm):** 0.0609 | **Peak 3:** | 0.00 | 0.0 | 0.00 |
| **Result quality** Good | | | | |

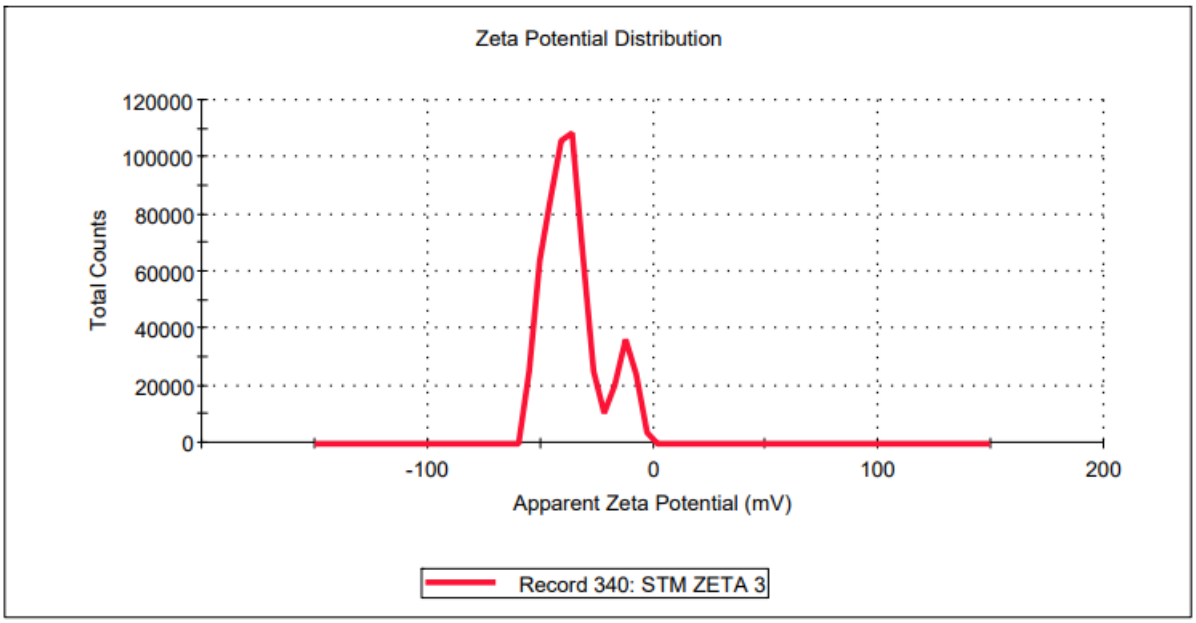


**Figure S3.** Zeta potential of Coconut midrib cellulose nanomaterial.

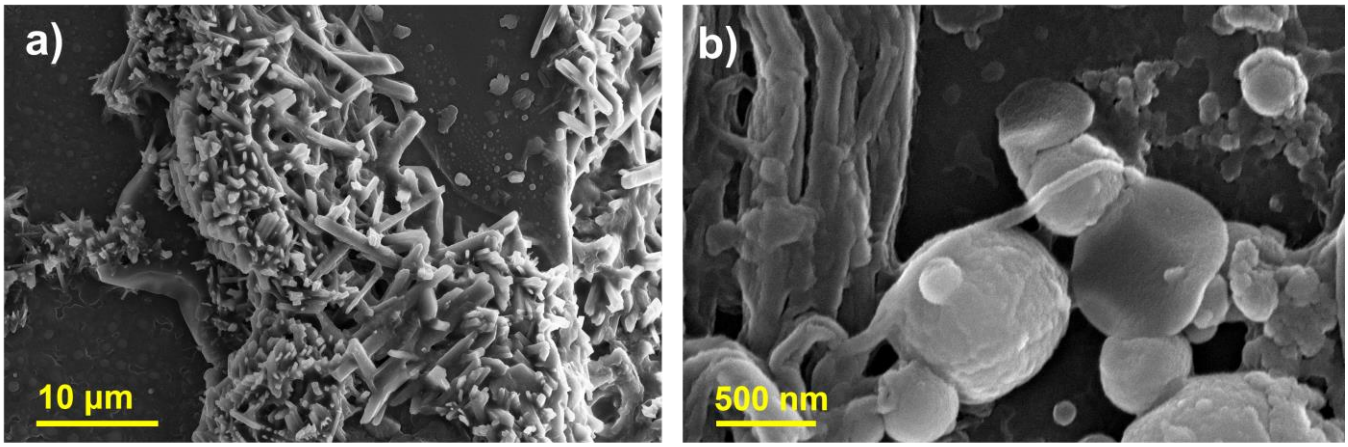


**Figure S4.** SEM images of coconut midrib nanocellulose a) Scale bar: 10 µm and b) Scale bar: 500 nm.

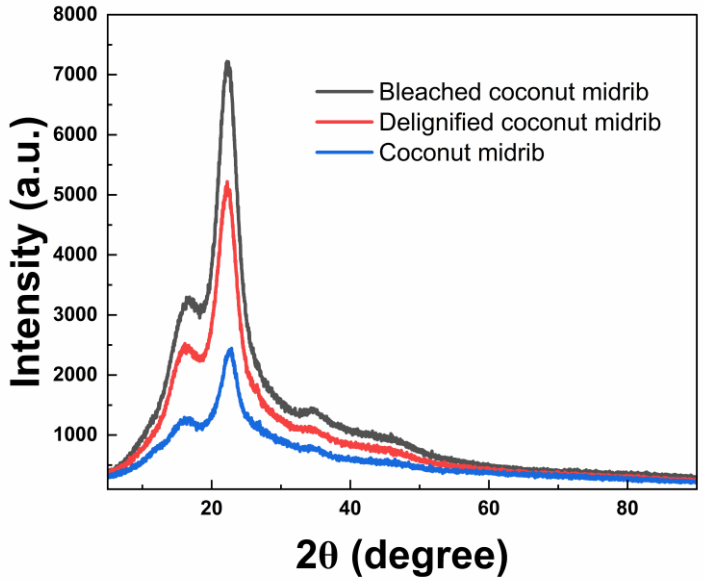


**Figure S5**. XRD plot of coconut midrib,delignified coconut midrib and bleached coconut midrib.

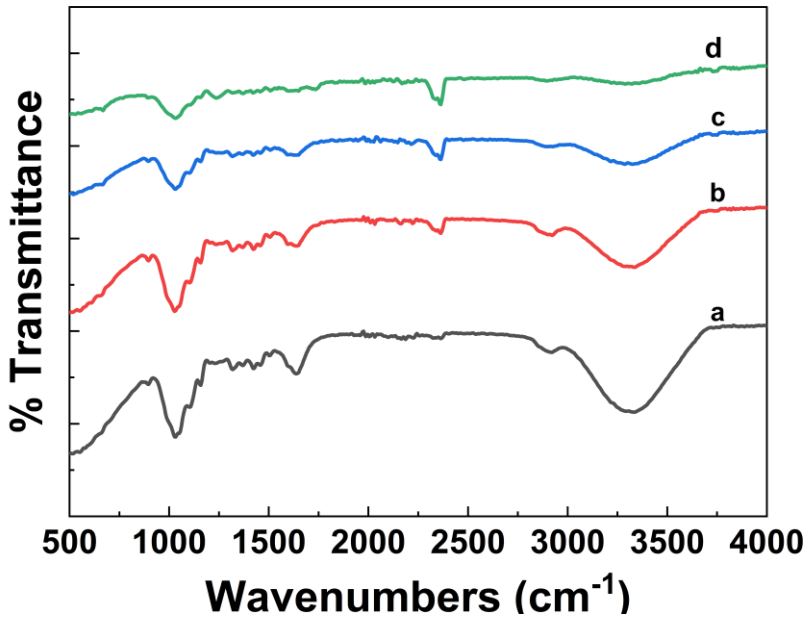


**Figure S6.** FTIR plots of a) raw coconut midrib, b) delignified coconut midrib, c) coconut midrib after first bleaching and d) coconut midrib after second bleaching.

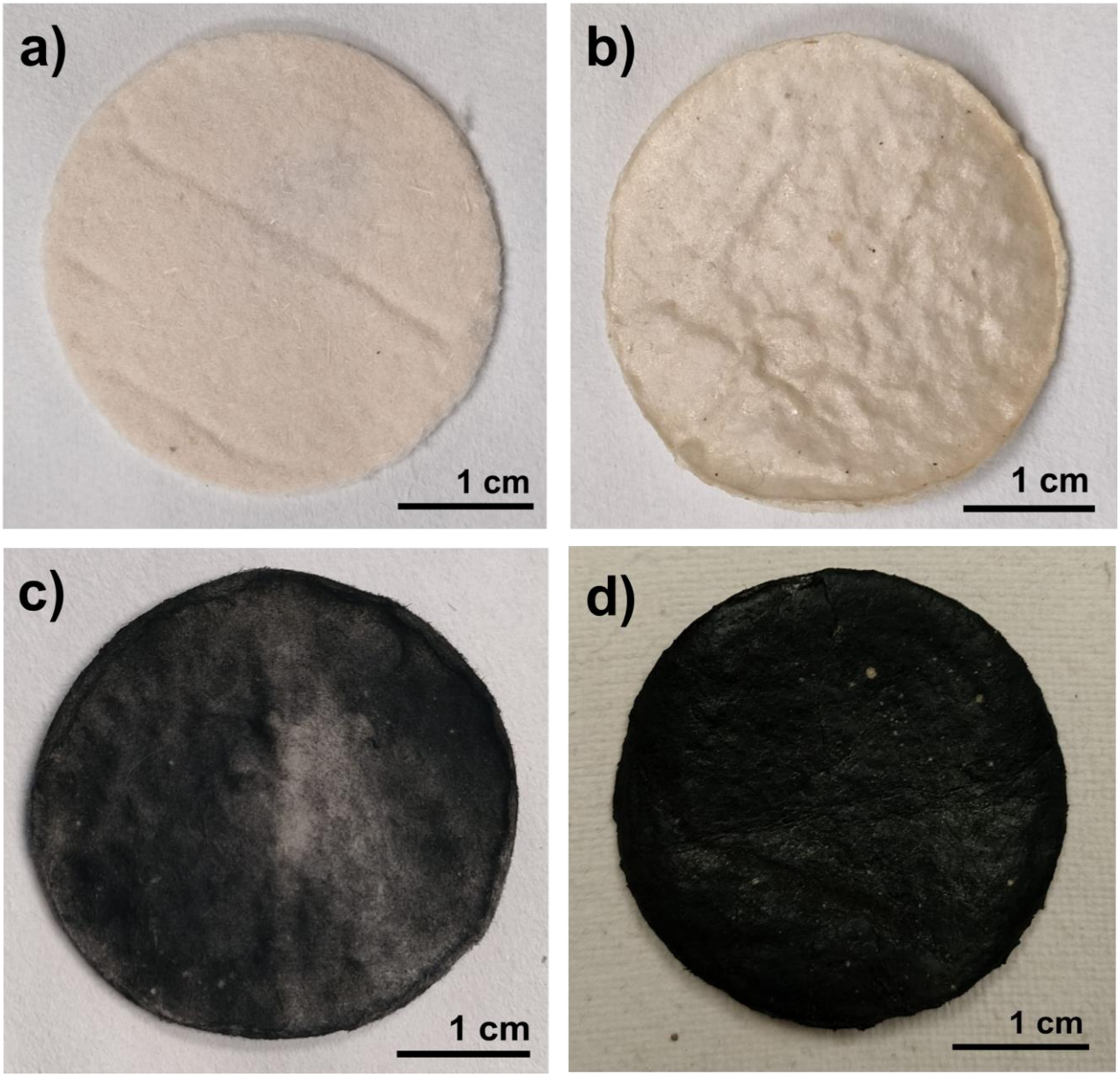


**Figure S7.** Digital photographs of nanopaper. a) CN nanopaper b) CN/CS nanopaper c) CN/PPy nanopaper and d) CNP/CS/PPy nanopaper (Scale bar: 1cm, in all the images).

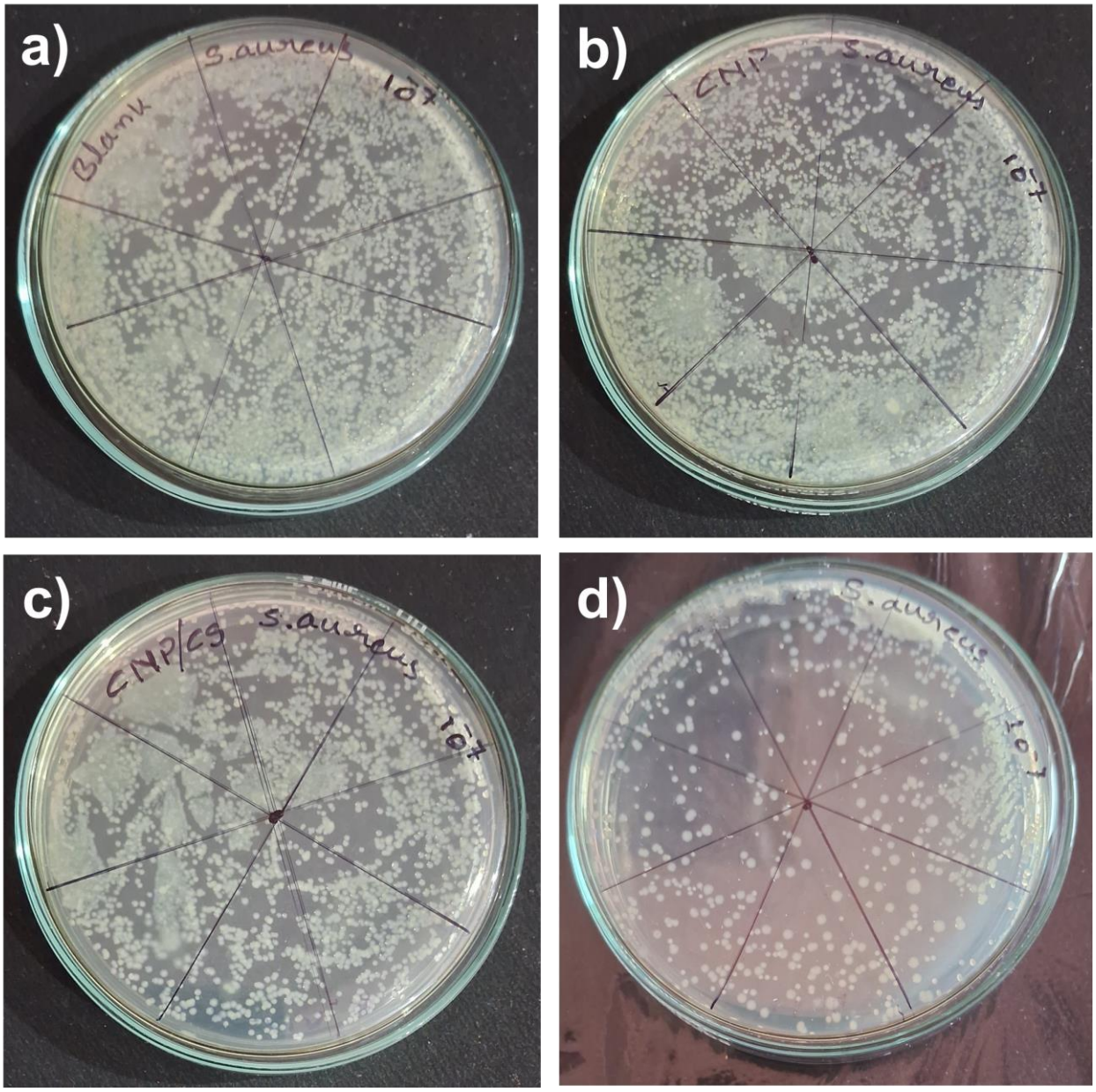


**Figure S8.** The images of antibacterial study depicting inhibition zones (gram positive Staphylococcus aureus) a) Blank, b) CN, c) CN/CS and d) CN/CS/PPy.

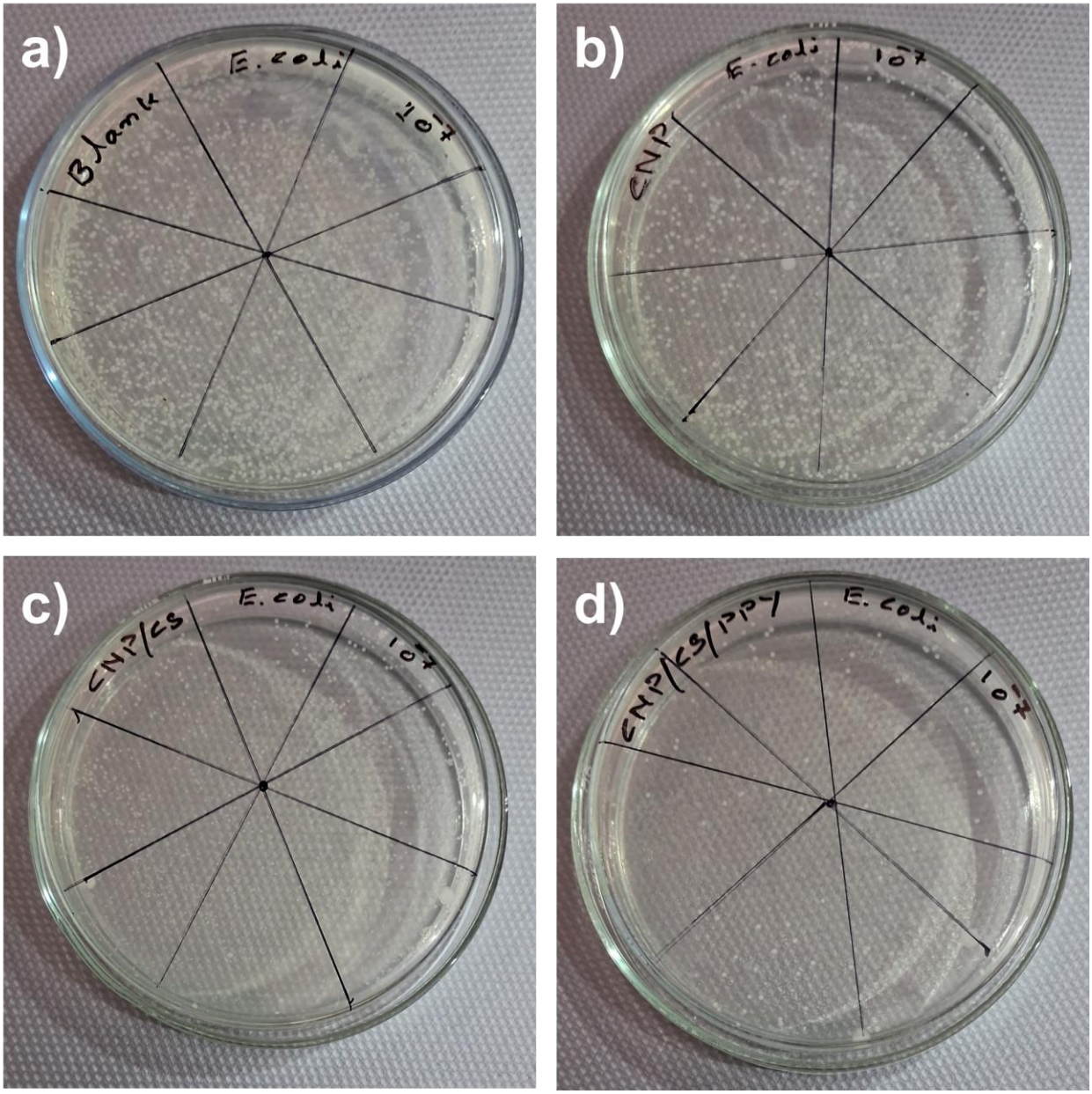


**Figure S9.** The images of antibacterial study depicting inhibition zones (gram-negative E. coli.) a) Blank, b) CN, c) CN/CS and d) CN/CS/PPy.

**Table S1.** Tensile strength data of CN, CN/CS, CN/PPy and CN/CS/PPy films.

| Samples | CN | CN/CS | CN/PPy | CN/CS/PPy |
|---|---|---|---|---|
| Strength (MPa) | 88.18 | 124.75 | 80.69 | 115.56 |

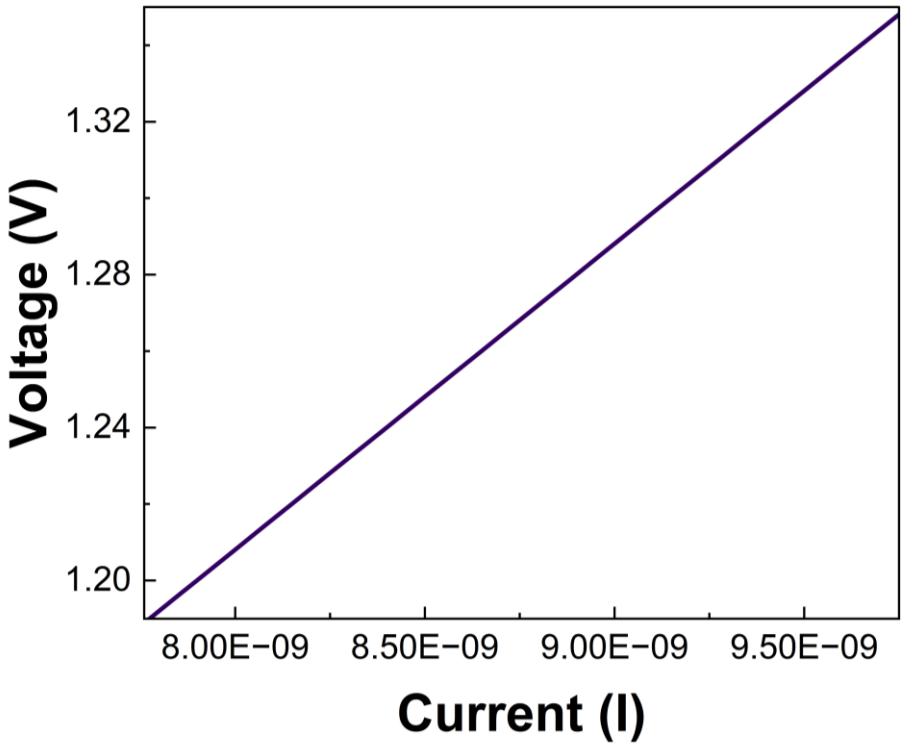


**Figure S10.** Current (I) vs Voltage (V) plot of Coconut midrib nanopaper/Chitosan/Polypyrrole (CN/CS/Py).

The current vs voltage graph is plotted to find the resistance (R) of the sample. The resistance value is used to calculate the sheet resistance ($R_s$) with the formula $R_s = \pi R/\ln 2$

The conductivity ($\rho$) of the film can be thus calculated using the equation. $\rho = 1/R_s.t$

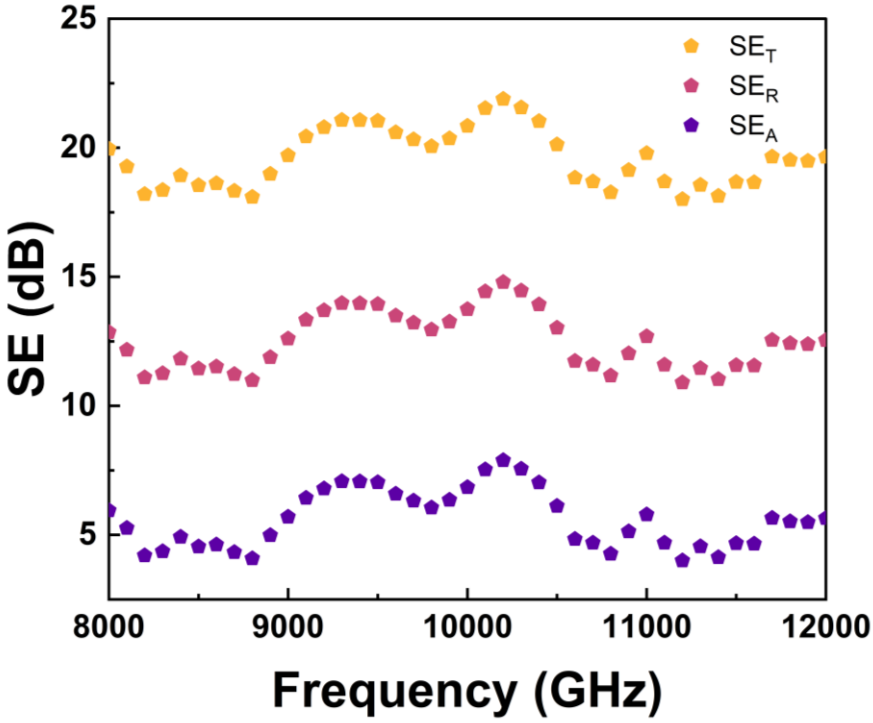


**Figure S11.** The $SE_T$, $SE_A$ and $SE_R$ values of CN/CS/PPy film.