

***Panicum maximum*- DERIVED CELLULOSE NANOPARTICLES INCORPORATED MEMBRANE FOR TARGETED CO₂ CAPTURE IN AIR PURIFICATION**

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Air pollution poses a profound threat to the environment, imperiling human health, ecosystems, biodiversity, and exacerbating climate change. Carbon dioxide (CO₂), released through industrial processes, burning fossil fuels and deforestation, stands out as the most significant contributor to atmospheric degradation. This study presents the development of an advanced, sustainable cellulose nanoparticle (CNP) based membrane engineered for effective CO₂ removal from contaminated air. CNPs were isolated from *Panicum maximum* through a chemical treatment followed by delignification, bleaching and acid hydrolysis. The scanning electron microscopy, granulometry and X-ray diffraction confirm the formation of CNPs with diameters less than 100 nm. These CNPs were subsequently integrated into cotton fabric substrates in the presence of polyvinyl alcohol (PVA) as the binding agent. These modified cotton fabrics (MCFs) were tested with untreated bare cotton fabrics (BCFs) serving as controls. A custom-built experimental system comprising calibrated CO₂ and pressure sensors, a controlled CO₂ injection unit, and test chambers was employed to evaluate the filtration efficacy of the membranes. Initial trials at ambient CO₂ concentrations (~430 ppm) demonstrated a substantial reduction of 90 ppm (decrease to 340 ppm) with MCFs, whereas BCFs showed no change. Pressure fluctuations mirrored CO₂ removal patterns, confirming membrane performance. Further tests at elevated CO₂ levels (2,000 and 5,000 ppm) revealed concentration-dependent removal efficiency. Although absolute reduction was less pronounced at higher concentrations, MCFs still achieved meaningful CO₂ capture, particularly at lower CO₂ loadings. These findings validate the potential of CNP-coated cotton membranes as scalable filtration media for CO₂ mitigation. Future work will focus on optimising fabrication parameters such as nanoparticle loading, PVA concentration, membrane thickness and functionalisation, to further enhance the CO₂ filtration capacity and operational robustness for practical air purification applications.

Keywords: Cellulose nanoparticles (CNPs), CO₂ filtration membrane, *Panicum maximum*, Sustainable air purification