Polylactic acid-carbon nanofiber-based electro-conductive sensing material and paper-based colorimetric sensor for detection of nitrates

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(a)

S. No.	Exposure Concentration (mg/L)	Algal cell density		Total number of cells (72h-0h)	% Inhibition of Yield at 72 h
		0h	72h		
1	0	52542	1018750	966208	0
2	100	52542	1050000	997458	-3.23429

(b)

S. No.	Exposure concentration (mg/L)	Mean of section-by-section growth rate at 72h	% Inhibition of growth rate 72 h
1	0	2.964349	0
2	100	2.994775	-1.02638

Supplementary Table 1. Effects of CNF membrane on percent inhibition of growth rate (a) and Yield (b) of *Pseudokirchneriella subcapitata* after short-term exposure to limit dose (100 mg/L).

S. No.	Test Organism	Exposure concentration	Duration	% Survival					Cumulative % Survival
				0 h	24 h	48 h	72 h	96 h	
1	Danio rerio (Zebrafish)	100 mg/L (Limit test)	96 h	100	100	100	100	100	100

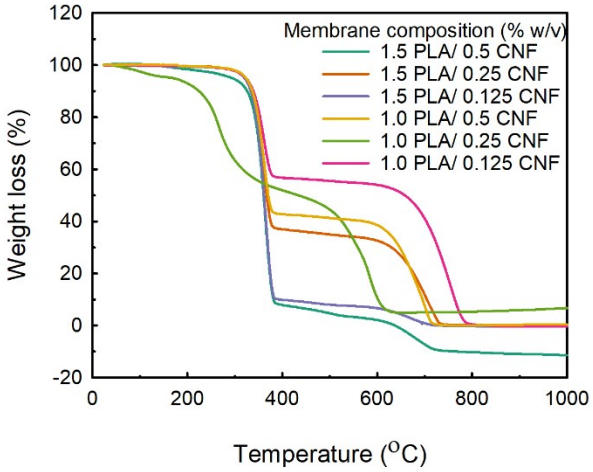
Supplementary Table 2. Effects of CNF membrane on the survival rate of adult zebrafish after short-term exposure to limit dose (100 mg/L).

S. No.	Test Organism	Exposure concentration	Duration	% Survival			Cumulative % Survival
				0 h	24 h	48 h	
1	*D. magna* (<24 h old daphnids)	100 mg/L (Limit test)	48 h	100 %	100 %	100 %	100 %

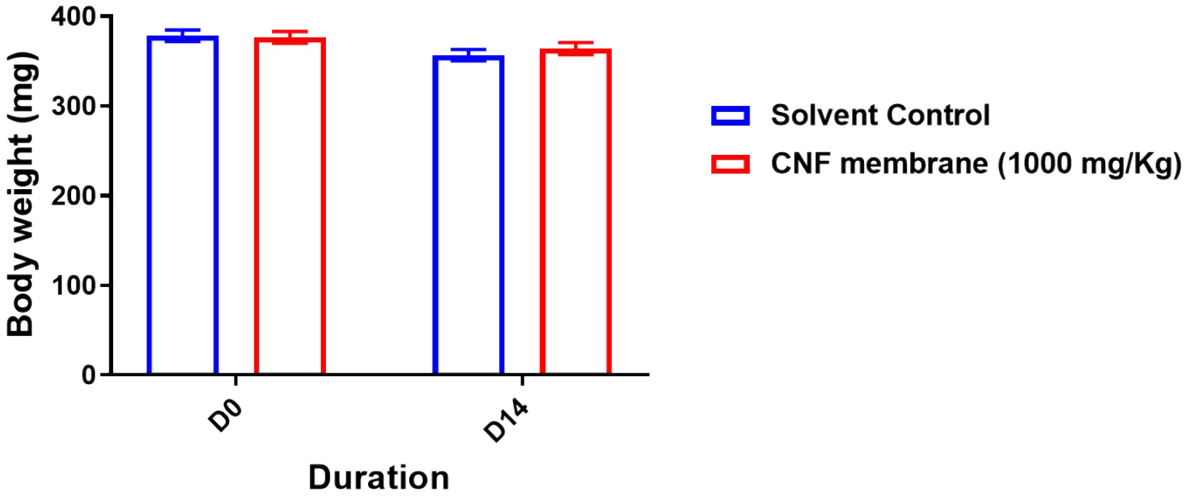
Supplementary Table 3. Effects of CNF membrane on the survival rate of Daphnids after Short term exposure to limit test concentrations (100 mg/L).

S. No.	Existing technologies for the detection of nitrates	Linear range (ppm)	Detection limit (ppm)	Ref.
1	Flow-injection with luminol chemiluminescence detection	2×10^{-5} to 5×10^{-2}	2×10^{-5}	[1]
2	HPLC with UV absorption (HPLC/DAD)	5-35	4×10^{-3}	[2]
3	UV-Irradiated Photochemical Conversion to Peroxynitrite and Ion Chromatography-Luminol Chemiluminescence System	6×10^{-5} to 18×10^{-2}	1.8×10^{-3}	[3]
4	Electrothermal atomic absorption spectrometry	1×10^{-4} to 25×10^{-3}	1.3×10^{-5}	[4]
5	Two-electrode interdigitated sensors (IDEs)	4 to 14	4	[5]
6	UV spectroscopy	0.08 to 4.0	0.04	[6]
7	Ambient-pressure helium-plasma ionization-mass spectrometry (HePI-MS)	0.02 to 20	2×10^{-4}	[7]
8	Capillary electrophoresis technique	16.1 to 285	0.027	[8]
9	Present study (Electrochemical sensor)	78 to 5×10^{3}	0.046	
10	Present study (Paper-based colorimetric sensor)	1.56×10^{2} to 10×10^{3}	1.56×10^{2}	

Supplementary Table 4. Comparative table of existing technologies and developed technologies for the detection of nitrates.



Supplementary Figure. 1: TGA analysis of membranes composed of different concentrations of PLA and CNF.



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55 **Supplementary Figure. 2.** No significant changes in body weight were observed ($p>0.05$) in the
56 earthworm *(Eisenia fetida)* after short-term exposure to CNF membrane. Values expressed in
57 mean ± SEM.

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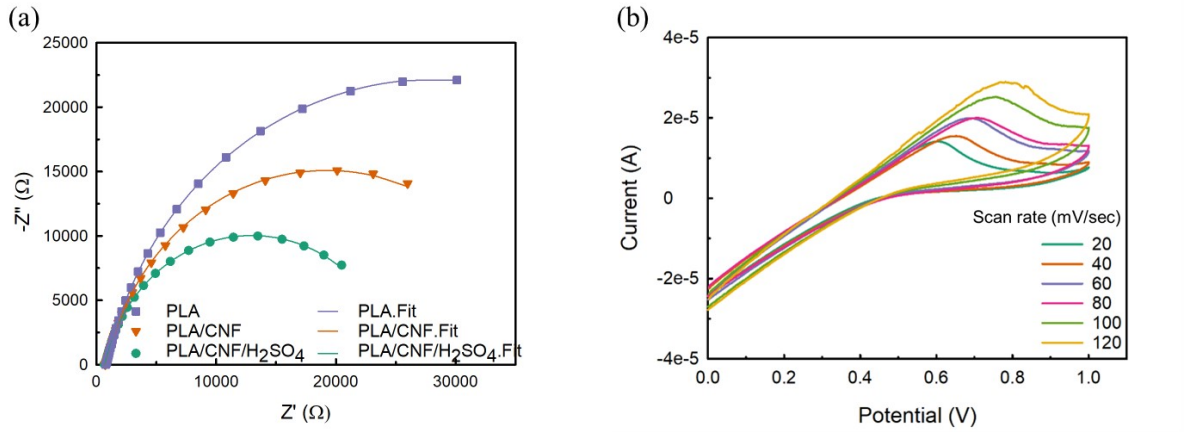
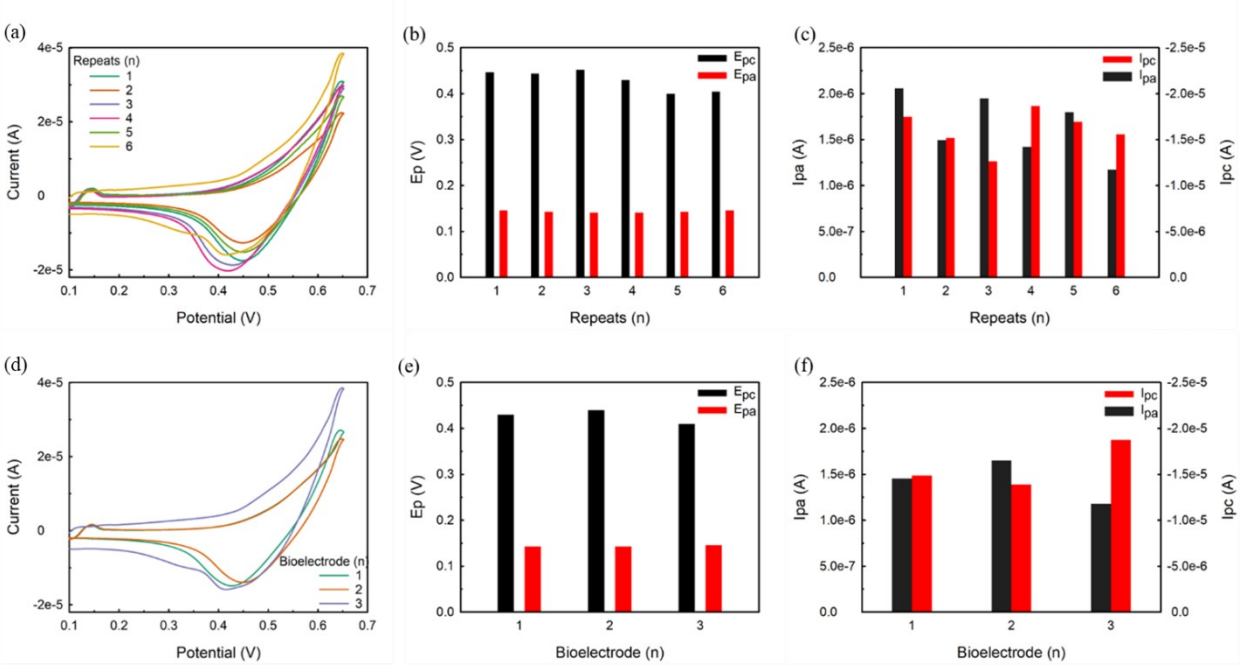


Supplementary Figure. 3: Electrochemical behavior of membrane in the presence of one-electron redox system of Fe $(CN)_6^{3-}$ / Fe $(CN)_6^{4-}$ (a) Nyquist plot shows reduced resistance to charge transfer on electrode surface after treatment with acid. PLA membrane had an Rct of 36893Ω. The introduction of CNF to the membrane resulted in a decrease in the Rct to 27135 Ω. Further activation of PLA/CNF membrane with H_2SO_4 resulted in an Rct of 19200 Ω. A decrease in the Rct value is indicative of the increased charge movement along the surface of the membrane. (b) Cyclic voltammogram of acid-activated PLA/CNF membrane at scan rate 20-120 mV s^{-1} showed an increase in Ip on increasing the scan rate.



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70 **Supplementary Figure. 4:** (a) Cyclic voltammogram showing repeatability (n=6) of bio-based
71 electrode tested with 10000 ppm of CAN in the presence of test solution. (b) Peak potential vs.
72 repeat (n) showing non-significant variation in potential (E_{pa}: +0.15 V and E_{pc}: 0.42V). (c) Peak
73 current vs repeat (n) showing non-significant variation in current (I_{pa} and I_{pc}). (d) Cyclic
74 voltammogram showing reproducibility (n=3) of bio-based electrode tested with 10000 ppm of
75 CAN in the presence of test solution. (e) Peak potential vs. bio-based electrode (n) showing non-
76 significant variation in potential (E_{pa}: +0.15 V and E_{pc}: 0.42V). (f) Peak current vs bio-based
77 electrode (n) showing non-significant variation in current (I_{pa} and I_{pc}).

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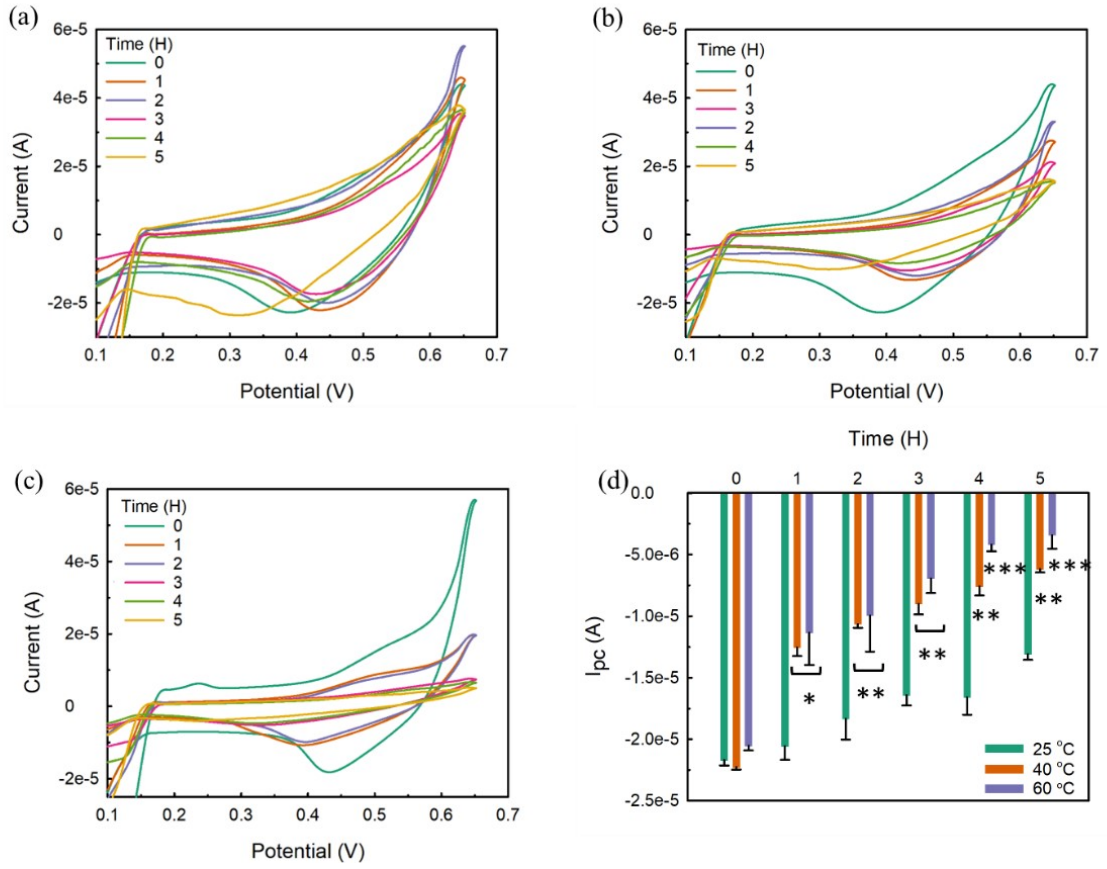

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81 **Supplementary Figure. 5:** Cyclic voltammogram of bio-based electrode in the presence of test
82 solution after storage at (a) 25, (b) 40 and (c) 60 °C. (d) Stability of the bio-based electrode tested
83 with 10000 ppm of CAN where *: $p<0.05$; **: $p<0.01$; ***<0.001.

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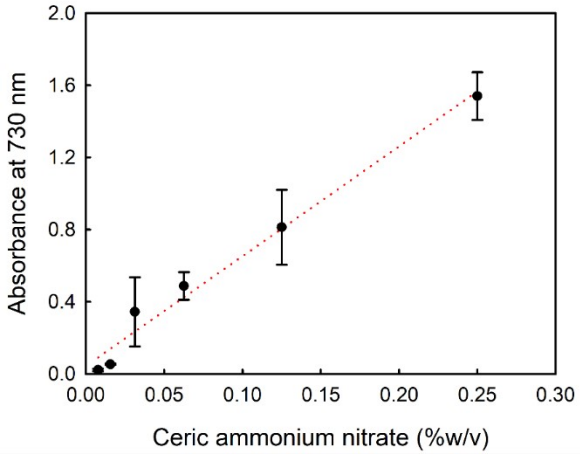

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86 **Supplementary Figure. 6:** Dose-response of test solution and Ceric ammonium nitrate observed
87 at 730 nm.

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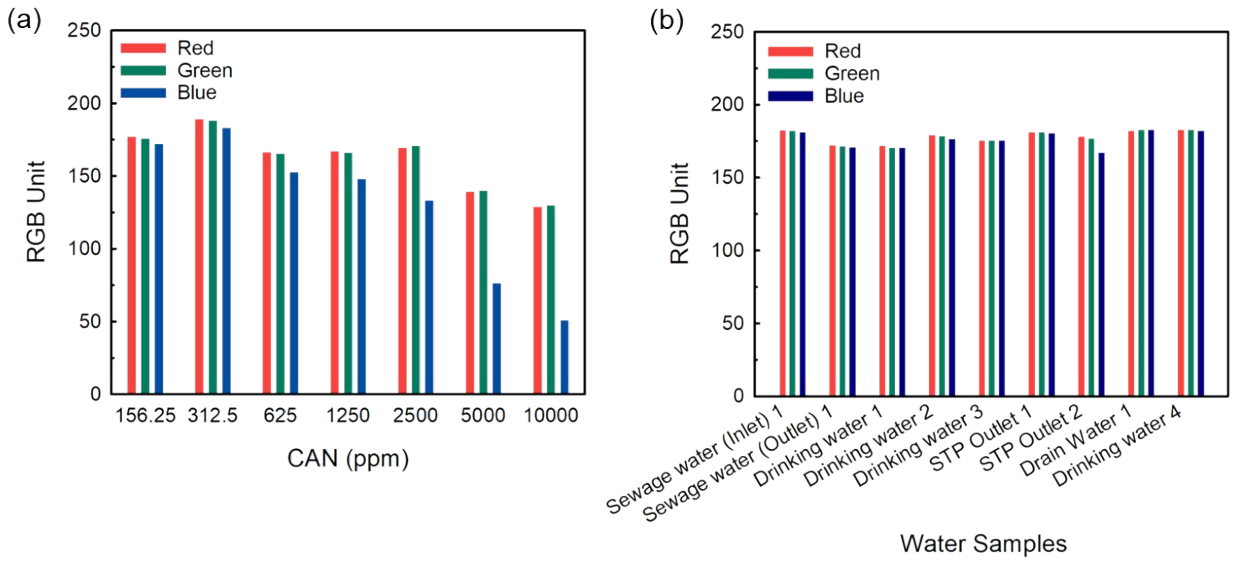

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90 **Supplementary Figure. 7:** RGB analysis of chromogenic test strips tested with (a) ceric
91 ammonium nitrate standards and (b) water samples.

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