Colorimetry-Based Detection of Biomarkers in Exhaled Breath for Predicting COVID-19 Disease

Undergraduate Student, Health and Biomedical Science

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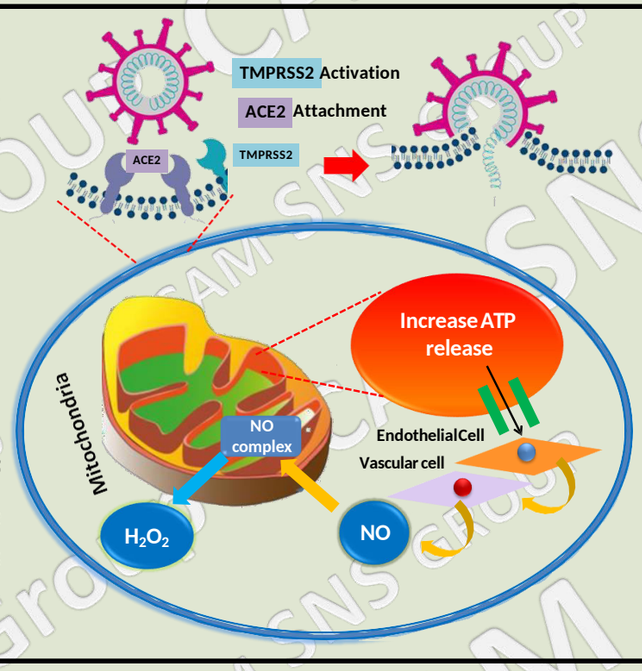
Abstract

Exhaled breath is the biological medium that carries relevant medical information and can be used to analyse biomarkers characteristic for detecting abnormal health status. Thus, by systematically analysing the interaction mechanism of the coronavirus with the human cell and its effect on the biological activity, it is possible to indentify the compounds whose proportion in the exhale breath is affected. One such biomarkers are hydrogen peroxide (H_2O_2) and nitric oxide (NO), which represents oxidative stress in the body. The present study represents the colorimetry-based quantification of H_2O_2 and NO using $KMnO_4$ and m-Cresol Purple dye, respectively. The dyes exhibited 0.01 ppm limit of detection (LOD) for H_2O_2 and LOD of 0.02 ppm was estimated for NO. Moreover, dyes apprehended high degree of selectivity towards other bio-compounds present in the breath. The colorimetry sensor is best suited for quantifying oxidative stress in the body, which is one of the indicator of coronavirus infection. Thus, the sensor offers rapid point-of-detection for predicting COVID-19 infection in human body.

Keywords:- Non-invasive; Exhaled breath; Oxidative stress; Colorimetry; COVID-19

Mechanism

- Interaction of the coronavirus with ACE2 and endothelium damages their protocol of the biological activities.
- Creates a unbalance metabolism of the cell.
- Excess Release of ATP
- Unbalance metabolic activity of endothelium cells results in the imbalance of reactive oxygen species (H_2O_2 and NO)

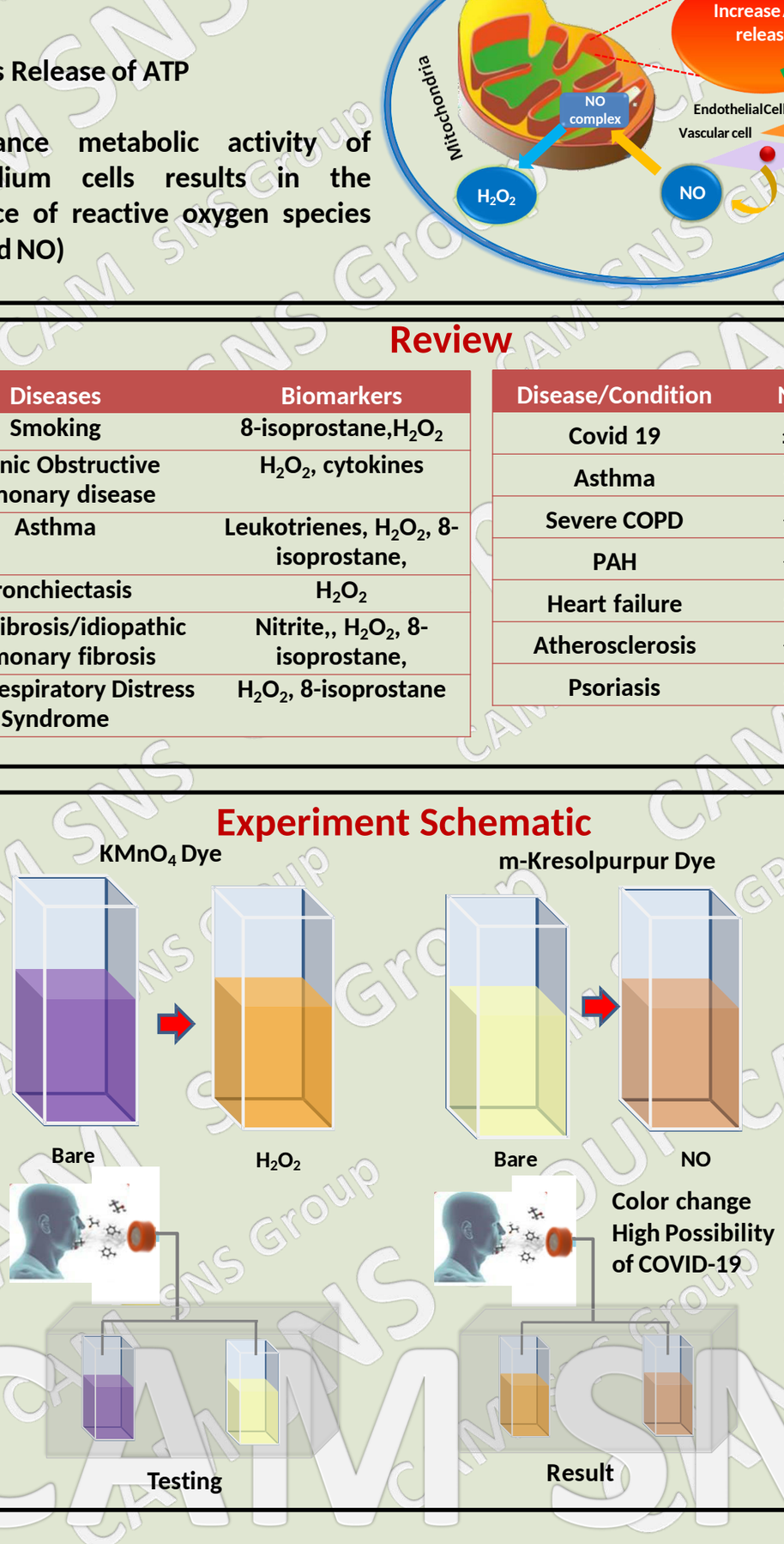


Review

Diseases	Biomarkers
Smoking	8-isoprostane,H_2O_2
Chronic Obstructive pulmonary disease	H_2O_2, cytokines
Asthma	Leukotrienes, H_2O_2, 8-isoprostane,
Bronchiectasis	H_2O_2
Cystic fibrosis/idiopathic pulmonary fibrosis	Nitrite,, H_2O_2, 8-isoprostane,
Acute Respiratory Distress Syndrome	H_2O_2, 8-isoprostane

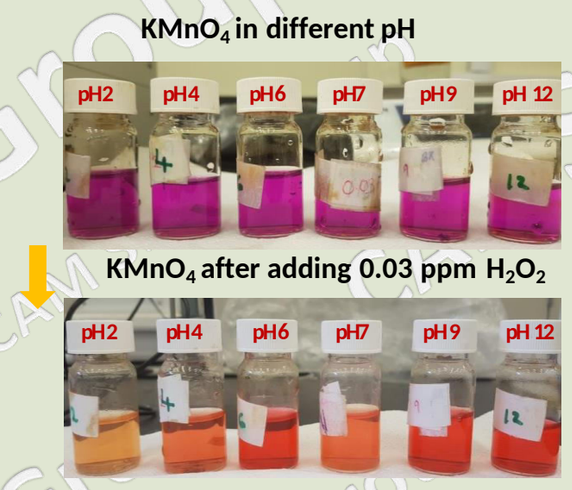
Disease/Condition	NO Level
Covid 19	≤25ppb
Asthma	>45 ppb
Severe COPD	<10 ppb
PAH	<10 ppb
Heart failure	>20 ppb
Atherosclerosis	<10 ppb
Psoriasis	>20 ppb

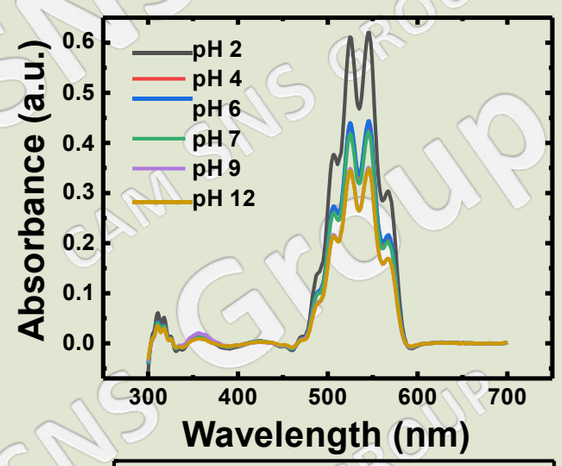
Experiment Schematic

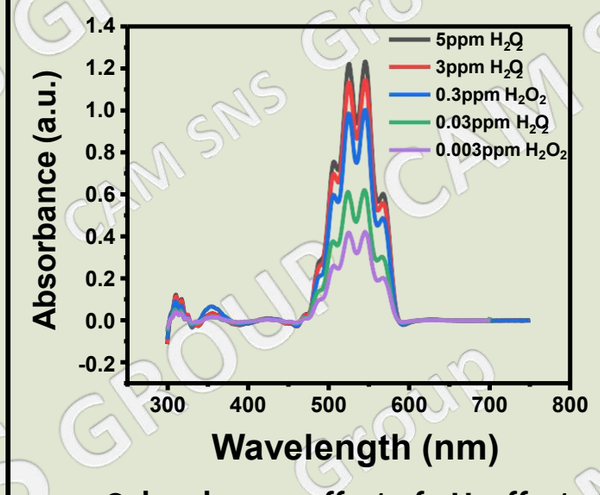


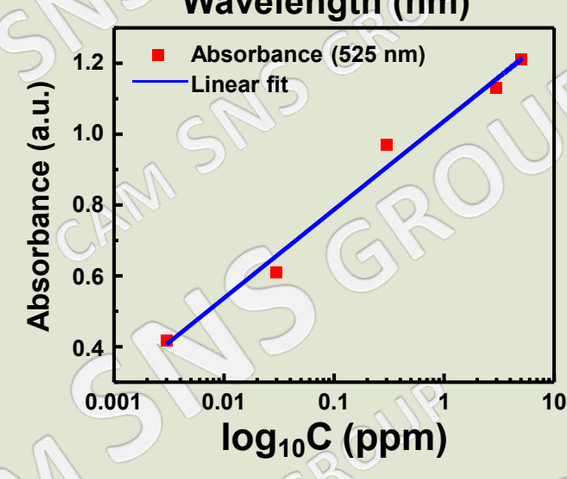
Results

Colorimetry based quantification of H_2O_2

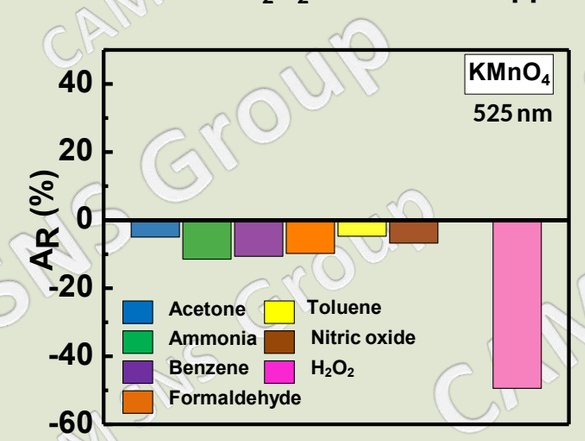








- Color change, effect of pH, effect of H_2O_2 concentration of and calibration curve for Limit of detection calculation.
- Estimated H_2O_2 LOD was 0.01 ppm.



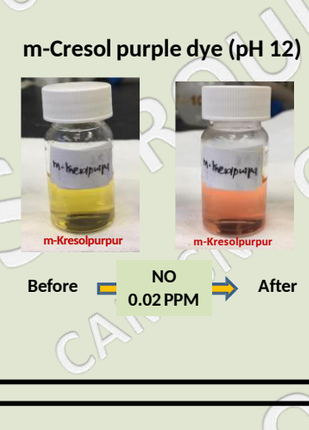
Sensitivity towards other Biomarker in exhaled breath

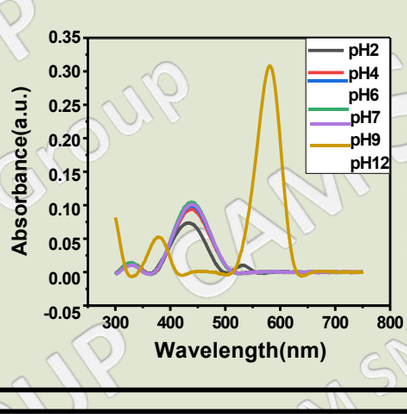
$$A_R = \frac{A - A_O}{A_O} \times 100$$

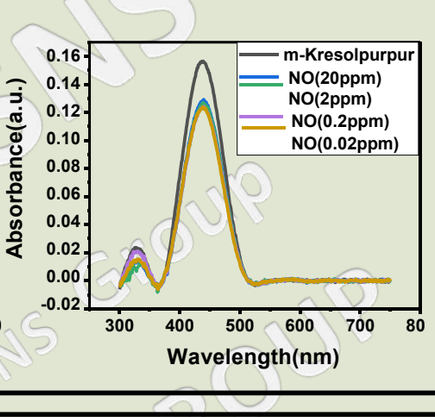
A is biomarker absorbance at 525 nm

A_O is absorbance bare of $KMnO_4$ dye at 525 nm

Colorimetry based quantification of nitric oxide (NO)







Key Features

Point-of-care | Portable | Hand held | Low cost | Naked-eye detection | Increase number of testing | Regular monitoring

Conclusion

- The dyes show increase in the absorption peak with increase in the ppm level of H_2O_2 and NO
- The dyes offers detection limit of 0.01ppm towards H_2O_2 and 0.02ppm towards NO.
- The dyes shows nearly linear increase in the absorption peak with increase in the ppm level of H_2O_2.
- The linear increase behaviors of the dyes assists in easy characterization of various ppm level of NO andH_2O_2.

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