Decomposition of S-nitrosothiols and colorimetric analysis on microfluidic paper-based analytical devices

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Abstract

A disposable microfluidic paper based analytical was developed to colorimetrically analyse different S-nitrosothiols.

Introduction

S-nitrosothiols (RSNOs) are very important biomolecules due to their capability to store nitric oxide (NO). In addition, they are responsible for many physiological (vasodilatation, antiplatelet aggregation, antimicrobial and signaling…) and physio-pathological functions (neurodegenerative diseases such as Parkinson and Alzheimer, apoptosis, chronic obstructive pulmonary disease, preeclampsia, diabetes)[1]. Microfluidic paper-based analytical devices (µPADs) coupled with colorimetric detection has become very popular for analysis of compounds with clinical importance including reactive nitrogen species[2]. In this scenario, we describe for the first time the use of µPAD combined with colorimetric detection to analyse the decomposition of RSNOs promoted by different light sources (LEDs) like ultraviolet (UV), visible (Vis) and infrared (IR) radiation.

Results and Discussion

Additional information about the fabrication of µPADs through wax printing technology and the procedure for colorimetric measurements using a scanner are described elsewhere[2,3]. LEDs were positioned at fixed distance from µPAD using a 3D printed polymeric device (Figure 1). Decomposition of S-nitrosoglutathione (GSNO), S-nitrosocysteine (CySNO) and S-nitrosoalbumine (AlbSNO) was performed using mercuric ion as well as UV and Vis lights at physiological pH.

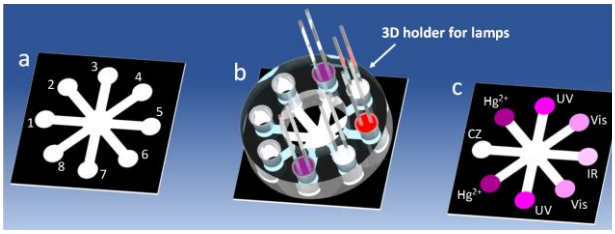

Figure 1. Layout of µPAD containing eight zones (a) before and (b) after coupling with a 3D holder for lamps. (c) resulting device showing colored zones after decomposition and Griess reaction for nitrite detection. In (c), the label CZ means control zone.

A calibration curve for nitrite was used as reference to investigate the decomposition procedure. The sensitivity observed for the decomposition product of GSNO using mercuric ion (Fig. 2A) exhibited a value similar to that obtained with nitrite. UV decomposition made after 25 min of illumination was less effective indicating that only 60% of GSNO is decomposed to nitrite. On the other hand, the decomposition using Vis light for 25 min of illumination was lower than that obtained by Hg^{2+} and UV. Similar experiments were performed for CySNO and it was found that mercuric decomposition is the most efficient one, leading to total CySNO decomposition. As it can be seen in Fig. 2B, the use of Vis light to decompose CySNO provided the lowest sensitivity. The limits of detection (LODs) achieved for GSNO decomposed by Hg^{2+}, UV, visible, and were 4, 6 and 11 µM, respectively. For CySNO, the values ranged from 4 to 7 µM. Decompositions of CySNO and GSNO were also performed using IR light, however, no coloration or poor sensitivity was observed. Finally, AlbSNO was the most stable towards light decomposition since no decomposition was detected (not shown).

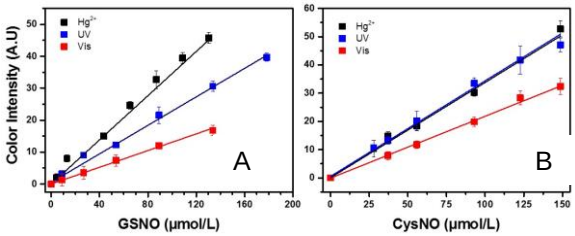

Figure 2. Calibration curves for a) GSNO and b) CySNO.

Conclusions

We have presented the first methodology to detect RSNOs on µPADs. Decomposition of low molecular weight and high molecular weight RSNOs was made on the paper using mercuric and various light decomposition processes. Mercuric decomposition was total for the three RSNOs used. This is a simple point of care device able to differentiate low molecular weight RSNO from high molecular weight RSNO.

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