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DEVELOPMENT OF SALIVA-BASED CORTISOL BIOSENSORS USING SMARTPHONE-BASED IMAGE ANALYSIS

Rodolfo Nino-Esparza[1], Angela Riveroll[1], Laurie A. McDuffee[2], William J. Montelpare[1] and Ali Ahmadi[3]

[1]Department of Applied Human Sciences, University of Prince Edward Island
[2]Atlantic Veterinary College, University of Prince Edward Island
[3] School of sustainable Design engineering, University of Prince Edward Island

ABSTARCT

Cortisol, a steroid hormone, is important in a variety of physiological processes and follows a circadian rhythm throughout a day-night cycle [1]. Abnormal levels of cortisol can be contributed to diseases, but most notably, it is a cause of psychological and emotional stress. Therefore, cortisol is known to be a stress biomarker [1]–[3].

Developing devices for point-of-care analysis of salivary cortisol has become important to identify environmental and behavioural triggers towards stress. Saliva-based cortisol sensing has the advantage of obtaining samples in a non-invasive and minimal discomfort to the specimen, and minimizing any additional stress [1]. Point-of-care analysis devises should be portable, easy to use, fast, and cost effective [1]–[3]. However, standard methods of measurement such as enzyme-linked immunosorbent assay (ELISA) are time-consuming, expensive and challenging to implement in a point-of-care application.

Lateral flow assays (LFA) have been used for rapid, point-of-care applications for qualitative and quantitative analysis of salivary cortisol concentrations [2], [3]. LFA strips are constructed using several components, sample absorption pad, conjugate release pad, nitrocellulose membrane and absorption pad. Samples are placed on the sample absorption pad and then flow through the LFA strip by capillary action. Two indicator lines, a test and control lines, become present on the nitrocellulose membrane as the sample flows through the LFA strip [4]–[6]. These lines can then be measured using image processing techniques, to quantify the concentration of cortisol in the salivary sample [2], [3], [7]. Therefore, the image processing is an important step in precise quantification of cortisol in the saliva using LFA.

Smartphones and their cameras have been used in a wide range of biosensing applications [8], [9]. Previous studies have implemented the use of smartphones alongside LFAs to quantify the concentration of salivary cortisol. Roda et al. demonstrated the use of a smartphone and an image processing software, ImageJ, to measure the concentration of cortisol [2]. Jung et al. developed an algorithm using the Android software developer, to create an Android application for cortisol measurements [3]. To decrease the processing time and enhance the precision of measurement, automated smartphone image processing technique must be developed for LFA-based cortisol sensing in saliva.

In this paper, MATLAB was used to develop an automated image processing algorithm. This algorithm is then embedded into a smartphone application, to measure cortisol using LFA. Compared to the previous systems, the developed system could enable automated and faster point-of-care measurement of cortisol in saliva.

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