UNIVERSITI TEKNOLOGI MARA

ANALYSIS OF GLUCOSE LEVEL DETECTION DEVICE PERFORMANCE BY CHEMOMETRICS APPROACHED AND DIFFUSE REFLECTANCE FOURIER TRANSFORM NEAR INFRARED SPECTROSCOPY

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ABSTRACT

Diabetes mellitus is a chronic disease attributed by body that experiences abnormal insulin production that causes high level of glucose in blood. There are three types of blood glucose monitoring which are invasive, minimal invasive and non-invasive. Current glucose measurement method is an invasive type of measurement that require draw out blood sample several times a day with pain and stressful feeling. Meanwhile, non-invasive optical glucose detection is a painless and harmless method that has been shown in this study to help patients monitor their glucose level and improved patient's health. Therefore, the initial investigations were conducted to evaluate the potential of FT-NIRS spectra towards non-invasive level glucose detection using chemometrics analysis. An optical device has been developed for the measurement of glucose level which consists of tungsten halogen light source, Fourier Transform Near Infrared (FT-NIR) with photodetector, bifurcated optical fibre as a waveguide, NIR cuvette sample holder and white reflectance standard. Samples in this study were glucose in water, glucose in intralipid, human skin and intracardiac rat's blood. The analysis tools to analyse all these data were Principal Component Analysis (PCA) to analysis and classify types of sample and Partial Least Squared (PLS) to predict glucose concentration. The glucose solutions with different pH, glucose in Allura red and human body skin were classified by PCA. Meanwhile, PLS regression model gave good prediction values for the glucose level in water, glucose in intralipid and rat's intracardiac blood sample. The PLS regression model developed was validated by Root Mean Square Error (RMSE) and Coefficient of Determination (R^2). The best PLS model was achieved by using Multiplicative Signal Correction (MSC) data preprocessing for the glucose level detection in water which are 125 mg/dl (6.9 mmol/l) RMSE and 0.55 R^2. Meanwhile, glucose in intralipid model by Savitzky Golay (SG) showed 16.3 mg/dl (0.9 mmol/l) RMSE and 0.99 R^2. As for intracardiac rat's blood, the best model was obtained with the application of SG since it provide the lowest RMSE which is 2.05 mg/dl (0.11 mmol/l) and highest value of R^2 which is 0.96. This analysis showed promising results for application on human.

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CHAPTER ONE
INTRODUCTION

1.1 INTRODUCTION

The development of near infrared (NIR) spectroscopy has growth rapidly in the past few decades and become valuable analytical tools with many application in area such as chemical, pharmaceutical, dermatological, food industry and agricultural (Jaafar, 2011). New technologies emerge with new approached solved crucial problem such as blood glucose monitoring that faced by many people. The technologies such as NIR offer a rapid, non-destructive, non-invasive method for qualifying and quantifying glucose level concentration. This kind of research have gained interest for many medical practicioner and diabetic patients and this chapter provides the background knowledge on which the studies are based.

1.1.1 Diabetes Mellitus

Diabetes mellitus is a condition in which the body natural control not adequately produces the quantity and quality of insulin needed to maintain normal glucose level in the blood (Amaral & Wolf, 2007). The nineteenth century has greatly contributed to the understanding of diabetes. These include numerous discoveries made by Claude Bernard in the field of metabolism and diabetes (DeFronzo, 2010). The storage of glucose in the liver was described as glycogen and the acute hyperglycemia that followed experimental damage of the medulla oblongata known as piqûre diabetes. Langerhans had suggested that pancreatic islets produced a glucose-lowering substance which was later named insulin by Jean de Meyer in 1909. Since then, major advances have been accomplished in the understanding of diabetes and metabolism.

The major effects of diabetes mellitus include long-term damage, malfunction and failure of various organs. For most patients, diabetes once diagnosed is for life (Zuzarte, 2008). Diabetic involved whether in termed type 1, Insulin Dependent Diabetes Mellitus (IDDM), type 2 Non-Insulin Dependent Diabetes Mellitus and type 3, gestational diabetes that is a complication of pregnancy. In January 2011, the American Diabetes Association statistic data estimates that 25.8 million people of US