

DEDICATION

“Try not to become a man of success. Rather become a man of value.”

— Albert Einstein

I dedicate my dissertation work to my family and friends who supported me in pursuing a road of value. Who kept me on track and endured my emotional, mental and physical stress during my research work.

I dedicate my work to my mother, who kept pushing me forward with encouragements and prayers at times and with arguments at different times.

I dedicate my success to my friends who were my best cheerleaders even when they were not available in the country; who went through the trouble of finding the components which was not available in Sudan, and delivered them in time and who filled my place at work whenever I needed extra time for my research and never complained about it.

I dedicate my results to all those who volunteered for the experiment and endured the pain of multiple finger pricks, hoping that their minor contribution might one day result in a major change in diabetic lifestyle.

I dedicate this research to all those who wish to follow the path toward a painless life for diabetics.

ACKNOWLEDGEMENTS

This research project would not have been possible without the support of many people. The author wishes to express her gratitude to her supervisor, Dr. **Alaa Aldeen Awouda** who was abundantly helpful and offered invaluable assistance, support and guidance.

The deepest gratitude also to **Eng. Mohammed Yahiya** for the tremendous help and consultancy during the circuit design process, without his help this research would not been as satisfying.

The greatest gratitude is also due to **Dr. Yasin Hamdan** and the **Mechanical Engineering School** at Sudan University of Science and Technology, for their help in material selection and fabrication of the laser cell.

The author would also like to convey thanks to **Elbarbary Medical Company**, the suppliers of B|Braun Omnitest[®] plus meters in Sudan, for providing the invasive device and all its supplement; without their support and enthusiasm the experiment would not been done efficiently.

I wish to express my sincere gratefulness to **Alyaa Specialized Medical Center** and their laser clinic staff, for providing the laser source necessary for the experiment and creating a friendly and encouraging environment during the performance of the experiment.

The author wishes to express her love and gratitude to her beloved family, friends and co-workers; for their understanding and endless support, through the duration of her studies.

ABSTRACT

Diabetes is a worldwide spreading disease according to the World Health Organization (2009). In order for diabetic patients to adhere a strict diet, exercise and medication; an accurate and reliable ways glucose measurement must be available.

The frequent puncturing of skin in the invasive measuring devices may cause an increase in skin permeability; at the same time noninvasive techniques produce a high percentage of error compared to the invasive techniques. A Joint noninvasive technique was proved to reduce the root mean squared error of prediction.

In this study two noninvasive techniques were used in the measurements; the scattering spectroscopy technique based on the Raleigh scattering theory and the linear relation between glucose concentration and the scattering angle, and the Photo-Acoustic Spectroscopy technique. The equations relating each of the methods with glucose concentration was derived.

The reading of each method was evaluated against a reference invasive device (Omnitest[®] plus from B|Braun); using the Clarke Error Grid Analysis (EGA) and the Mean Squared Error of prediction (MSE).

The Linear equation relating glucose concentration with the scattering angle produced the best measurements among the three with 63.4% of the reading falling into region A, 36.6% into region B and MSE of (525.8).

The three measurements were then combined using the measurements of central tendency; the mean, median and mode. The mean results were the best since 68.2% of the result fell into region A, 31.8% into region B and the MSE was reduced to (452.2).

المستخلص

مرض السكري يعد من أكثر الأمراض انتشاراً في العالم بحسب منظمة الصحة العالمية (2009). وجود جهاز دقيق للسكري يمثل ضرورة لا غنى عنها لمرضى السكري لمساعدتهم في تطبيق نظام صارم و مثالي للتنظيم السكر.

طرق القياس المباشرة التي تعتمد على الوخز المتكرر لها مساوئها المتمثلة في زيادة نفاذية الجلد، في المقابل طرق القياس الغير مباشرة (اللاإخترافية) غير دقيقة ولها هامش خطأ أعلى.

في هذا البحث تم دراسة طريقتين من طرق القياس اللاإخترافي وهما طريقة طيف التشتت الضوئي (scattering spectroscopy) اعتماداً على نظرية رايلي للتشتت (Rayleigh Scattering Theory) والعلاقة الخطية بين زاوية التشتت وتركيز الجلوكوز، و طريقة طيف التحليل الضوئي الصوتي (Photo-Acoustic Spectroscopy).

وقد تم استخدام جهاز (Omnitest[®] plus) من شركة براون كمرجع لتقييم الطريقتين. حيث تم تقييم الطريقتين باستخدام تحليل كلارك للخطأ (Clarke Error Grid Analysis) بالإضافة إلى قيمة مربع خطأ الوسط الحسابي (Mean Squared Error).

المعادلة الخطية التي تربط زاوية التشتت مع تركيز الجلوكوز أعطت أفضل نتائج حسب تحليل كلارك للخطأ، حيث كانت 63.4% من القراءات تقع في المنطقة A ، بينما 36.6% تقع في المنطقة B و قيمة مربع خطأ الوسط الحسابي (525.8).

تم دمج القراءات الثلاثة لتركيز الجلوكوز باستخدام معايير النزعة المركزية (المتوسط الحسابي، الوسيط و المنوال). تم الحصول على أحسن نتيجة باستخدام المتوسط الحسابي، حيث أصبحت نسبة القراءات في المنطقة A هي 68.2%، ونسبة القراءات في المنطقة B هي 31.8%، و نقصت قيمة مربع خطأ الوسط الحسابي إلى (452.2).