Enhancing Glucose Detection in Clinical and Point-of-Care Applications Using Gold and Silver Nanoparticles

Jood Al Aghawani[1], Moath Mahmoud Daoud[2], Reem Al-Dhaleai[3], Mohammed Sufyaan Shaikh[4], Roshan Deen[5]

RCSI MEDICAL UNIVERSITY OF BAHRAIN

INTRODUCTION

Diabetes is one of the most significant global health challenges, directly contributing to approximately 1.5 million deaths in 2019, with the number continuing to rise in subsequent years.[1]

The primary method for monitoring blood glucose levels remains the fingerstick blood glucose monitoring, which is widely used due to its reliability and accessibility[2] However Testing particularly for diabetic patients, can be painful and uncomfortable due to the need for blood draws. In the pursuit of a superior alternative to standard blood glucose tests, nanoparticles have demonstrated unique properties that enable them to interact with glucose in ways larger molecules cannot.[3]

Our project is an attempt to show that glucose levels can be accurately measured from human saliva using these nanoparticles, offering a promising and less invasive alternative to traditional blood sugar testing methods.

AIMS

- **Exploring the Potential of Nanoparticles for Glucose Monitoring:**
  Investigate the use of gold and silver nanoparticles to measure glucose levels in saliva as a non-invasive alternative to traditional methods.
- **Addressing Challenges of Traditional Monitoring:**
  Develop a method that overcomes the physical, psychological, and practical challenges associated with fingerstick blood glucose monitoring.
- **Enhancing Patient Comfort and Compliance:**
  Provide a less invasive, patient-friendly approach to improve comfort, compliance, and overall diabetes management.

DISCUSSION

The findings from our research demonstrate that gold and silver nanoparticles exhibit a visible color change in response to varying glucose concentrations, highlighting a significant potential for the development of non-invasive glucose monitoring systems. By incorporating this nanoparticle-based technology into wearable devices or smart sensors, diabetic patients could continuously monitor their glucose levels through simple visual indicators. This approach could be particularly beneficial for pediatric diabetic patients. Such a device would increase patient comfort and adherence and contribute to more effective diabetes management.

METHODS

Gold and silver nanoparticles were synthesized using gold salts and silver nitrate, with sodium borohydride as the reducing agent and sodium citrate as the stabilizer. Glucose solutions, ranging from 1 mM to 16 mM (spanning standard to diabetic levels), were mixed with gold nanoparticles in a 1:1 ratio. [4] Heat was applied to accelerate the reaction before silver nanoparticles were introduced. Various tests were conducted, including comparing samples with and without heat, different concentrations of gold and silver nanoparticles, and using a reducing agent without a stabilizer. The UV absorption spectra of the resulting solutions were subsequently measured to evaluate the outcomes.

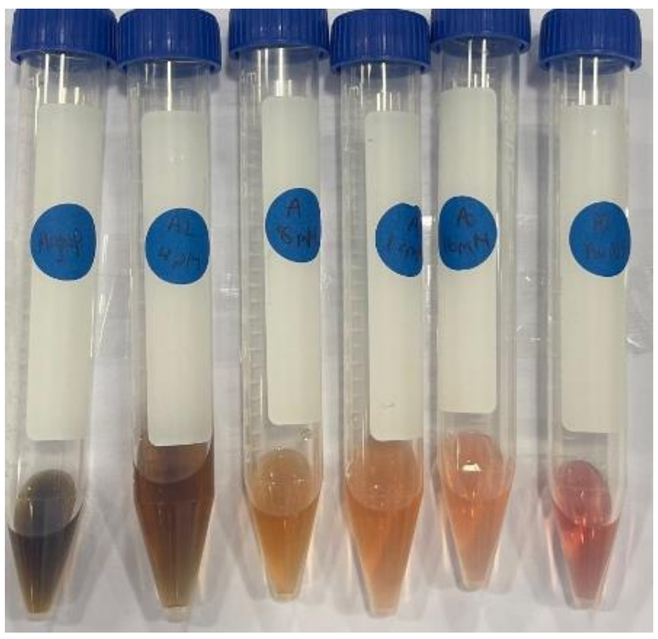

Fig 1. Glucose solutions, ranging from 1 mM to 16 mM mixed with 1:1 gold nanoparticles

RESULTS

Gold and silver nanoparticles were stable, showing interaction with glucose via decreased UV absorption. The UV spectrum displayed peaks for both metals. Higher glucose concentrations led to lower absorbance. Heating before adding silver enhanced the gold–glucose reaction, reducing the gold peak and increasing the silver peak due to less glucose availability for the silver reaction.

CONCLUSION

This research introduces a groundbreaking, non-invasive method for blood glucose monitoring using saliva as the testing medium. Departing from traditional fingerstick methods, this technique employs gold and silver nanoparticles to measure glucose levels across normal to diabetic ranges.

The interaction between glucose and gold nanoparticles produces hydrogen peroxide, which dissolves silver nanoparticles, leading to shifts in their localized surface plasmon resonance (LSPR) band. Experiment results demonstrated visible color changes, transitioning from silver to gold nanoparticle hues as glucose concentrations increased, providing a clear correlation.

This novel approach is reliable, cost-effective, and minimally invasive, making it a promising alternative to current methods. Beyond glucose detection, it highlights significant potential for advancing healthcare diagnostics, offering more accessible, user-friendly, and innovative solutions for diverse populations

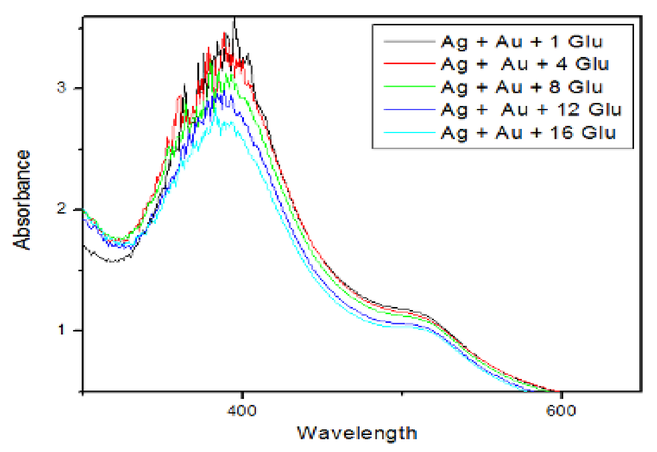

Fig 2. UV-Vis Spectroscopy Analysis of Glucose-Induced Optical Changes in Gold and Silver Nanoparticle Solutions

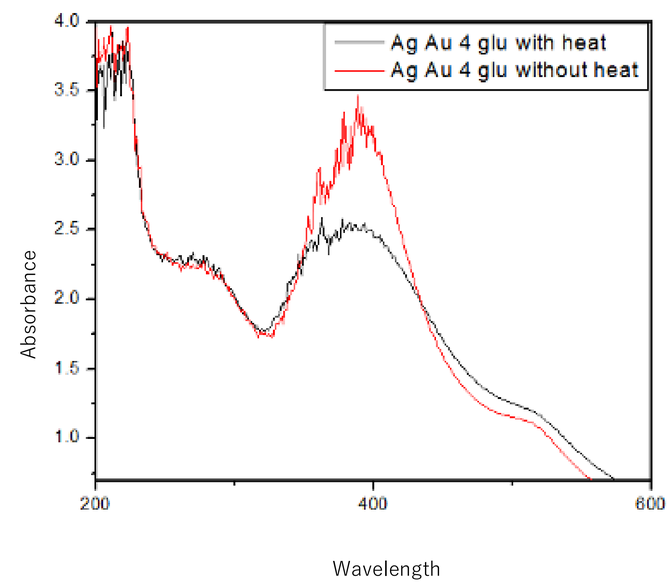

Fig 3. Impact of Thermal Conditions on LSPR Characteristics of Gold and Silver Nanoparticles in Glucose Solutions

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