SINTESIS DAN APLIKASI NANOPARTIKEL PERAK (AgNPs) HASIL REDUKSI PEREAKSI TOLLENS BERBASIS AMONIUM BIKARBONAT DENGAN REDUKTOR GLUKOSA UNTUK DETEKSI GLUKOSA DALAM URIN MENGGUNAKAN KOLORIMETRI CITRA DIGITAL

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INTISARI

Telah dilakukan sintesis nanopartikel perak (AgNPs) menggunakan pereaksi Tollens berbasis amonium bikarbonat dengan glukosa sebagai pereduksi. AgNPs yang terbentuk dimanfaatkan untuk mendeteksi glukosa dalam urin secara kolorimetri citra digital. Sintesis AgNPs diawali dengan optimasi kondisi pH, konsentrasi amonium bikarbonat, suhu, dan waktu pemanasan. Reduksi pereaksi Tollens oleh glukosa menghasilkan larutan koloid berwarna kuning keemasan dan memiliki panjang gelombang serapan maksimum (λ_{max}) sebesar 405 nm, menunjukkan terbentuknya AgNPs. Kondisi optimum diperoleh pada 1,5 mL $AgNO_3$ 0,02 M; 1,5 mL glukosa 10 µM; 5 mL amonium bikarbonat 0,004 M; dengan waktu pemanasan selama 7 menit pada suhu 80 °C. Karakterisasi (FTIR, XRD, PSA, TEM) menunjukkan bahwa AgNPs berbentuk bulat dengan ukuran partikel 13 ± 0,5 nm. Studi kinetika menunjukkan bahwa pembentukan AgNPs pada 80 °C mengikuti model pseudo orde 1. Uji performa metode menunjukkan bahwa kolorimetri citra digital memiliki linearitas sangat baik (R^2 = 0,999), bahkan lebih tinggi daripada spektrofotometri UV-Vis (R^2 = 0,988) pada rentang 0–10 µM. Namun, sensitivitas spektrofotometri lebih unggul dengan LoD 0,07 µM dan LoQ 0,2 µM dibandingkan kolorimetri citra digital (LoD 3 µM; LoQ 9 µM). Secara keseluruhan, metode kolorimetri citra digital ini dapat digunakan untuk mendeteksi glukosa dalam urin. Meski demikian, akurasinya masih terganggu oleh interferensi senyawa lain seperti kreatinin, urea, $FeSO_4$, natrium sitrat, dan asam askorbat.

Kata kunci : AgNPs, glukosa, kolorimetri citra digital, dan Tollens.

SYNTHESIS AND APPLICATION OF SILVER NANOPARTICLES (AgNPs) FROM AMMONIUM BICARBONATE-BASED TOLLENS REAGENT REDUCED BY GLUCOSE FOR URINARY GLUCOSE DETECTION USING DIGITAL USING DIGITAL IMAGE COLORIMETRY

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ABSTRACT

Silver nanoparticles (AgNPs) were synthesized using Tollens reagent based on ammonium bicarbonate with glucose as the reducing agent. The resulting AgNPs were utilized for glucose detection in urine through digital image colorimetry. The synthesis was initiated by optimizing pH, ammonium bicarbonate concentration, temperature, and heating time. The reduction of Tollens reagent by glucose produced a yellowish-golden colloidal solution and has maximum absorption wavelength (λ_{max}) of 405 nm, indicating the formation of AgNPs. Optimum conditions were achieved with 1.5 mL $AgNO_3$ 0.02 M, 1.5 mL glucose 10 µM, and 5 mL ammonium bicarbonate 0.004 M, with a heating reaction time of 7 min at 80 °C. Characterization using FTIR, XRD, PSA, and TEM confirmed that the AgNPs were spherical with particle size of 13 ± 0.5 nm. Kinetic studies revealed that AgNPs formation at 80 °C followed a pseudo-first-order model. Performance evaluation showed that digital image colorimetry exhibited excellent linearity (R^2 = 0.999), even higher than UV-Vis spectrophotometry (R^2 = 0.988) in the range of 0–10 µM. However, UV-Vis spectrophotometry demonstrated superior sensitivity, with a limit of detection (LoD) of 0.07 µM and a limit of quantification (LoQ) of 0.2 µM, compared to 3 µM and 9 µM, respectively, for digital image colorimetry. Overall, the proposed digital image colorimetry method is applicable for glucose detection in urine, although its accuracy remains limited by interferences from creatinine, urea, $FeSO_4$, sodium citrate, and ascorbic acid.

Keywords: AgNPs, digital image colorimetry, glucose, and Tollens.