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A Novel Silver Nanoparticles-based Sensing Probe for the Detection of Japanese Encephalitis Virus Antigen

(Penderia Baru yang Berasaskan Nano zarah Perak untuk Pengesanan Antigen Virus Ensefalitis Jepun)

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ABSTRACT

A novel silver nanoparticles (Ag NPs)-based optical sensing probe has been developed for the detection of Japanese Encephalitis virus (JEV). Ag NPs were initially deposited onto amine functionalized glass slides. Subsequently, JEV antibodies were self-assembled onto surfaces of Ag NPs to form optical sensing probes. The detection of JEV antigen was observed via changes in light absorbance by Ag NPs upon occurrence of JEV antigen-antibody bindings. A highly sensitive and rapid optical sensing probe for JEV antigen with a detection limit of 12.8 ng/mL (for S/N ratio = 3) and an analysis assay time of 1 h had been demonstrated.

Keywords: Antibody; biosensor; Japanese Encephalitis Virus (JEV) antigen; optical sensing probe; silver nanoparticles (Ag NPs)

ABSTRAK

Biopenderia optik baru yang berasaskan nano zarah perak (Ag NPs) telah dihasilkan untuk pengesanan antigen virus Ensefalitis Jepun (JEV). Ag NPs telah dimendapkan di atas slaid kaca yang difungsikan dengan amino. Seterusnya antibodi JEV dipegunkan pada permukaan Ag NPs untuk membentuk biopenderia optik. Pengesanan terhadap JEV antigen diperhatikan melalui perubahan penyerapan cahaya oleh Ag NPs apabila berlakunya pengikatan antara JEV antigen dan antibodi. Satu biopenderia optik yang sensitif bagi pengesanan JEV dengan had pengesanan (LOD) sebanyak 12.8 ng/mL (ratio S/N = 3) dan 1 jam masa analisis telah dihasilkan.

Kata kunci: Antibodi; antigen virus Ensefalitis Jepun (JEV); biopenderia; nano zarah perak (Ag NPs); perangsang optik

INTRODUCTION

Japanese encephalitis virus (JEV) is one of the leading causes of childhood encephalitis infection in Asia. It has a fatality rate of close to 30% (Solomon 1997) and neurological complications in 30% to 50% of those infected with JEV (Solomon et al. 1998). Globally, approximately three billion people are exposed and at risk of JEV infection (Oya & Kurane 2007). Nearly 68,000 clinical cases of JEV infection are reported worldwide each year (Campbell et al. 2011). Rapid detection of JEV infection at an early stage would be important for early clinical intervention and prevention of a JEV outbreak.

Several conventional diagnostic methods have been developed for the detection of JEV infection, such as, enzyme-linked immunoglobulin assay (ELISA), plaque reduction neutralization test (PRNT) (Lee et al. 2014; Sirivichayakul et al. 2014) and reverse transcription polymerase chain reaction (RT-PCR) (Swami et al. 2008). Nonetheless, all of these diagnostic techniques have disadvantages such as high cost of consumables, expensive instrumentation and long analysis assay time (Chen et al. 2011). Most importantly, they are not suitable to be used at remote rural areas, where there are high frequencies of JEV infection (Kumar et al. 2012). During the past decade, various types of biosensors had been developed to replace conventional diagnostic methods. These biosensors offer advantages such as short analysis assay time, inexpensive instrumentation and easy operation (Labib et al. 2011; Li et al. 2011; Tam et al. 2010; Tran et al. 2012). In 2011, Li et al. reported a novel magnetite bead-based electrochemical immunoassay technique for the diagnosis of JEV infection. Subsequent studies by Tran et al. (2012) demonstrated the use of an immunosensor for the detection of JEV antigen using an electrochemical immunosensing method.

Noble metal nanomaterials such as gold and silver are known to have extraordinary and size-dependent optical properties. These nanoparticles possess strong absorption properties in the visible region, often known as the localized surface plasmon resonance. Surface plasmon resonance happens when the incident photon frequencies are resonant with the collective oscillations of conduction electrons of the metal nanomaterials (Zhao et al. 2006). Among noble metal nanomaterials, silver nanoparticles (Ag NPs) have received considerable attention due to their attractive physico-chemical properties. Surface plasmon resonance and large effective scattering cross section of Ag NPs (Jensen et al. 2000) make them ideal candidates as nanoscale optical biosensors (Riboh et al. 2003). The surface plasmon energy and intensity of Ag NPs have been found to be sensitive to a number of factors, including