UNIVERSITI TEKNOLOGI MARA

DEVELOPMENT OF BRAIN GLUTAMATE MICROBIOSENSOR USING PLATINUM (Pt) ELECTRODE AND APPLICATION OF *IN VIVO*

SITI KARTIKA BINTI HAMDAN

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ABSTRACT

Monitoring of extracellular brain glutamate (Glu) level by microbiosensor is a promising approach for further investigation of the important role of neurotransmitter. The neurotransmitter glutamate has shown in development of brain function including cognition, memory and learning process. Glutamate microbiosensor should serve high sensitivity which able to response for low concentration, high selectivity from interferences, fast and accurate result. Surface teflon encapsulated platinum (Pt) electrode disk design of internal size diameter 50 µm, electropolymerized with poly-*o*-phenylenediamine (PPD), layered with nafion (Naf), immobilized with glutamate oxidase (GluOx) and cross-linked glutaraldehyde (GA) (Pt_{50}/PPD/Naf/GluOx/GA) has chosen in glutamate detection and performed promising glutamate biosensor using constant potential amperometry (CPA) where Michaelis-Menten for glutamate response, J_{max} = 120 µAcm^{-2}, K_M= 60 µM and limit of detection (LOD) is 2.5 µM ± 0.5 µM were obtained. The response time was ~9s which is three times faster as compared to Pt_{50}/PPD/GluOx/Ga. The developed glutamate microbiosensor have established an excellent in rejection against ascorbic acid (AA) and other interferences. This electrode designed configuration shows good sensitivity in neutral pH range at pH 7.5. The stability of the electrode was stable until 3 days and kept in cold temperature at 4^{o}C. The reduced enzyme activity on the electrode was due to dissolution of the enzymatic membrane during storage and causing the sensitivity of electrode less stable along the period. In vivo studied shows that data sampling rate of electrode without enzyme (Pt_{50}/PPD/Naf) and with enzyme (Pt_{50}/PPD/Naf/GluOx/GA) were 0.0022 µA and 0.0039 µA, respectively. The ability of glutamate microbiosensor in monitoring the presence of glutamate in the prefrontal cortex of anaesthetized rats was proven.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND

1.1.1 Glutamate

Glutamate was known as neurotransmitter and it required a long investment to acknowledge it. The researcher group figure it in spite of the fact that it was noted as of now 70 years back and in light of glutamate is rich in cerebrum and assumes a critical part in mind digestion system. Unexpectedly, the explanation behind the deferral appears to have been its staggering significance. Glutamate is one of the common 20 amino acids which are utilized to make proteins and takes parts in run of the mill metabolic capacities like vitality creation and smelling salts detoxification notwithstanding protein blend. It was difficult to trust that a compound with such a variety of capacities and which is available practically all over in high focuses could assume an extra part as transmitter.

Glutamate (Glu) molecular structure as shown in Figure 1.1 is not only important neurotransmitter in the brain of mammals but also plays a main role in development of brain, neurotransmission, synaptic plasticity, neurotoxicity but also involves in some brain or neurological disorder such as ischemia (Camacho & Massieu, 2006; Baltan, 2009), schizophrenia (Breese et al, 1995; Boison et al, 2012), epilepsy (Babb et al, 1998), Alzheimer's disease (AD) (Walton & Dodd, 2007; Gong et al, 2009; Fayed et al, 2011), Parkinson's disease (PD) (Gubellini et al., 2004). Moreover, brain injury also can cause elevation of glutamate level (Richards et al, 2003; Luo et al, 2011). Hence, it is very important to observe the levels of extracellular glutamate concentration in the affected brain due to the importance in neurotransmission. Recent discoveries have revealed that glutamatergic neurotransmission in the central nervous system (CNS) is mediated by a dynamic interaction between neurons and astrocytes because in order to control the concentration of glutamate from become excitotoxicity, a complex system required to regulate glutamate metabolism (Niciu et al, 2012).