

CHAPTER 1

INTRODUCTION

1.1 Background of study

Human chorionic gonadotropin (HCG) is a placenta-produced hormone after the fertilization of male and female gametes. HCG is capable of maintaining the corpus luteum in the female reproductive system at the early stage of pregnancy. This induces the increase in the amount of progesterone, secreted by corpus luteum, encouraging the enrichment of endometrium walls with thick blood vessel coating to sustain foetal development. Since HCG is structurally similar to its counterpart, luteinizing hormone, HCG is used clinically to induce ovulation in ovaries and testosterone production in gonads.

However, that gestational trophoblastic disease and testicular seminoma can be detected early if HCG is found in the urine of the patient due to the malignant tumour secretion as stated by the PDQ Adult Treatment Editorial Board (2018), and Tidy and Hancock (2010). HCG is indicated as a tumour marker when abnormal discharge rate of HCG can indicate plausibility of tumour growth.

In a practical side of medical field, point-of-care testing (POCT) device is an useful device to every medical personnel that gives a rapid and reliable medical diagnostic analysis nearby or at the side of patient as described in National Point of

Testing Policy by Ministry of Health Malaysia (2012). POCT device also served a critical purpose of providing immediate medical results in medically inaccessible areas such as inland areas of aborigines' society. Due to its versatility and robustness, Ministry of Health Malaysia established National Point of Care Testing Policy and Guidelines to ensure high standard of practice in the use of POCT devices and comprehensive governance of all aspects surrounding the usage of POCT devices. With the policy established, the commitment of Ministry to provide better, efficient, and reliable patient care can be achieved.

Driven by the aforementioned issues, development of sensory system with high sensitivity and specificity for detection of HCG is highly sought after and carried out by numerous researchers all over the world. Usage of gold nanoparticles (AuNPs) as chemical sensor for detection of HCG has been the rage in the scientific community, as AuNPs-based sensors are known with its high reliability and flexibility to be used in any detection method, i.e. amperometry, potentiometry, colorimetry, and fluorometry, mentioned in the works of Nagatani et al. (2006), Tanaka et al. (2006) and Wang et al. (2018). Coupled along with microfluidic paper-based analytical device (μ PAD) as an analysis platform that supports POCT, AuNPs-based sensor possesses additional value of being portable and simpler analytical device.

1.2 Problem statement

The common method of detecting HCG in solution is using immunoassay methods, which utilizes enzymatic reaction along with marking techniques to pronounce the presence of HCG in solution. Immunoassay methods are used to achieve high selectivity due to the lock-and-key binding mechanism from the enzymatic reaction from the antibody, and to measure out the signal given in response to the binding reaction. Hence, a variety of antibody-based methods are developed, such as fluorescence, electrochemical, photoluminescence, and immunochromatographic assays.

Traditional immunoassay method restricted its user to a multitude of drawbacks such as, prolonged time of analysis and sample preparation, limits the usage of testing into laboratory environment only, and requires complementing analytical instrument to measure the signal. In an effort to combat the disadvantages imposed by the traditional immunoassay method, portable and user-friendly test strip was developed in 1978 to ensure HCG detection can be accessible to the public as mentioned by Vaitukaitis (2004).

To date, as reported by Nagatani et al. (2006), Tanaka et al. (2006) and Wang et al. (2018), an immuno gold chromatographic test strip and a photoluminescence sensor have been developed with low detection thresholds and high sensitivity for HCG detection. However, both of them required marking procedure, multistage operations, and costly analytical instrument apart from unable to attain rapid analysis.

Hence, a design of simple POCT device for sensitive HCG sensing is desirable.

In this study, AuNPs was synthesized and characterized along with the glutathione

disulfide-functionalized AuNP as an effort to develop a simple POCT device with μ PAD as its intended sensing platform. The performance of functionalized AuNPs to detect HCG in solution was measured in terms of its linearity, sensitivity and selectivity.

1.3 Objectives

The purpose of this research are as follows:

1. To synthesize and characterize gold nanoparticles and its sensory derivatives
2. To fabricate μ PAD and evaluate its performance
3. To evaluate the performance of the sensor responses in the presence of HCG in terms of linearity, sensitivity and selectivity