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Monitoring Key Biomarkers Related to the Risk of Low Breastmilk Production in Women, Leading to a Positive Impact in Infant's Health

Authors : R. Sanchez-Salcedo, N. H. Voelcker

Abstract : Currently, low breast milk production in women is one of the leading health complications in infants. Recently, It has been demonstrated that exclusive breastfeeding, especially up to a minimum of 6 months, significantly reduces respiratory and gastrointestinal infections, which are the main causes of death in infants. However, the current data shows that a high percentage of women stop breastfeeding their children because they perceive an inadequate supply of milk, and only 45% of children are breastfeeding under 6 months. It is, therefore, clear the necessity to design and develop a biosensor that is sensitive and selective enough to identify and validate a panel of milk biomarkers that allow the early diagnosis of this condition. In this context, electrochemical biosensors could be a powerful tool for assessing all the requirements in terms of reliability, selectivity, sensitivity, cost efficiency and potential for multiplex detection. Moreover, they are suitable for the development of POC devices and wearable sensors. In this work, we report the development of two types of sensing platforms towards several biomarkers, including miRNAs and hormones present in breast milk and dysregulated in this pathological condition. The first type of sensing platform consists of an enzymatic sensor for the detection of lactose, one of the main components in milk. In this design, we used gold surface as an electrochemical transducer due to the several advantages, such as the variety of strategies available for its rapid and efficient functionalization with bioreceptors or capture molecules. For the second type of sensing platform, nanoporous silicon film (pSi) was chosen as the electrode material for the design of DNA sensors and aptasensors targeting miRNAs and hormones, respectively. pSi matrix offers a large superficial area with an abundance of active sites for the immobilization of bioreceptors and tunable characteristics, which increase the selectivity and specificity, making it an ideal alternative material. The analytical performance of the designed biosensors was not only characterized in buffer but also validated in minimally treated breastmilk samples. We have demonstrated the potential of an electrochemical transducer on pSi and gold surface for monitoring clinically relevant biomarkers associated with the heightened risk of low milk production in women. This approach, in which the nanofabrication techniques and the functionalization methods were optimized to increase the efficacy of the biosensor highly provided a foundation for further research and development of targeted diagnosis strategies.

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