3D Printed Electrochemical Immunosensor for the early diagnosis of Alzheimer's disease through recognition of the biomarker Clusterin

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The diagnosis of Alzheimer's disease is still a challenge due to the limited availability of effective early detection methods[1,2]. In this context, electrochemical immunosensors have emerged as promising alternatives, offering advantages including cost-effectiveness, portability, rapid response, and compatibility with microfabrication technologies. Furthermore, the development of conductive filaments for 3D printing has gained prominence, with the incorporation of plasticizers improving printability[3]. In this regard, 3D-printed electrodes composed of graphite (GR), castor oil (CO), and polylactic acid (PLA) were developed for the detection of Clusterin, a biomarker for Alzheimer's disease. The conductive composites were prepared by dispersing GR powder (45% w/w) in dichloromethane with CO (15% w/w) and PLA (up to 30 g)[3,4]. Both the filament and electrodes were characterized using physicochemical and electrochemical techniques. To construct the immunosensor, anti-clusterin antibodies were directly immobilized onto the electrode surface using EDC/NHS, while bovine serum albumin (BSA) was employed as a blocking agent. Clusterin was detected via cyclic voltammetry, exhibiting a linear response from 100–650 nM, with a LOD of 55 nM and a LOQ of 184 nM (ΔI_{pa}= $0.0345C_{clusterin}$ – 10.33; R^2= 0.993). Moreover, the immunosensor demonstrated satisfactory performance in complex matrices, with recovery values ranging from 89.1–108.6% in commercial serum samples. These results highlight the potential of this 3D-printed label-free electrochemical immunosensor as a rapid and effective tool for detecting Clusterin. **Acknowledgments:** FAPESP (2023/10141-2 and 2024/16548-0), CAPES, FAPERJ (E-26/290.009/2023) and CNPq (406419/2021-3, 408001/2023-2, 401977/2023-4 and 408338/2024-5).

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