Smartphone-based electrochemical immunosensor for ciguatoxins detection

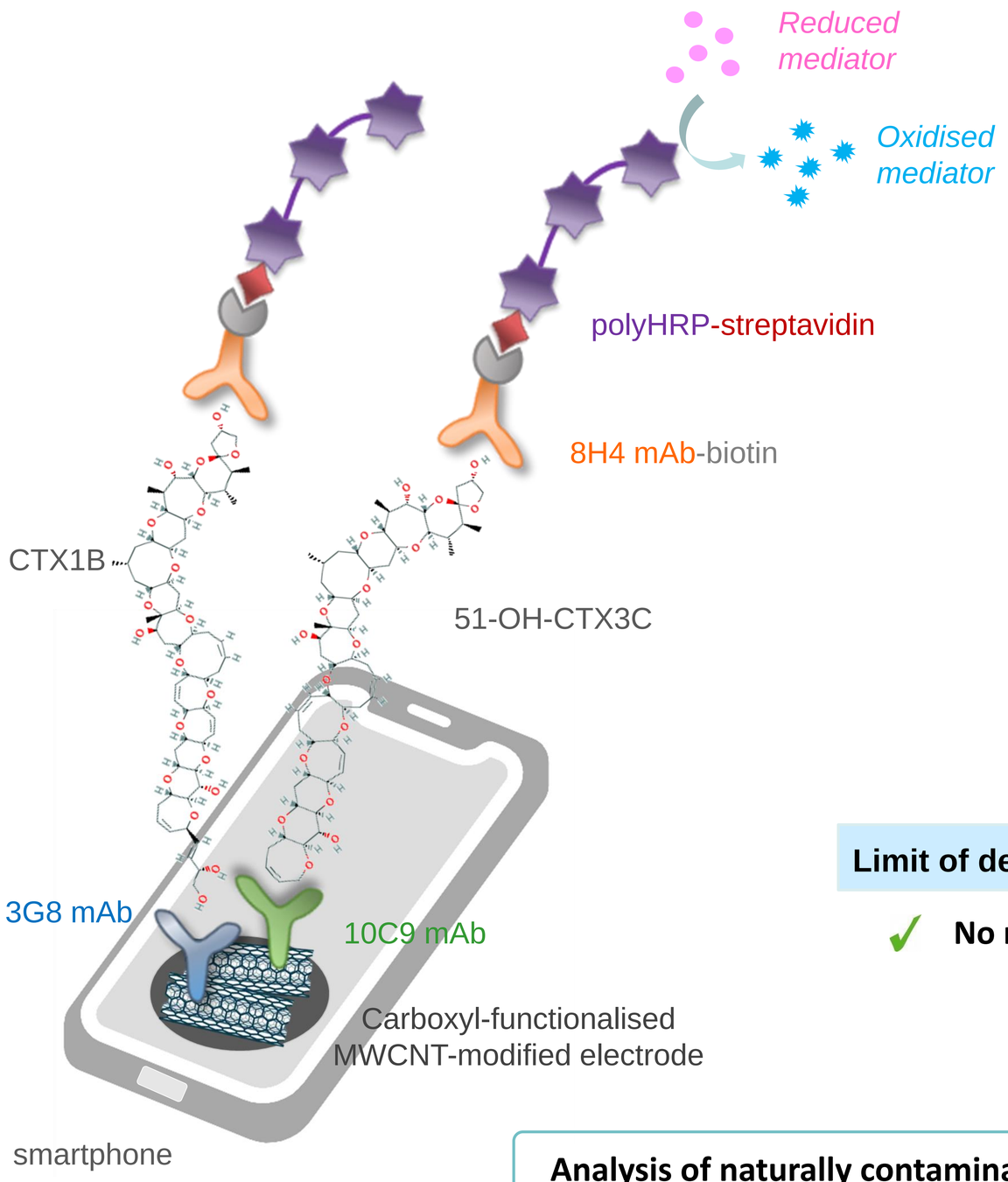
Sandra Leonardo[a], Takeshi Tsumuraya[b], Naomasa Oshiro[c], Masahiro Hirama[b], Jorge Diogène[a], Mònica Campàs[a]

[a] IRTA, Ctra. Poble Nou, km. 5.5, 43540 Sant Carles de la Ràpita, Spain
[b] Deparment of Biological Science, Graduate School of Science, Osaka Prefecture University, Osaka 599-8570, Japan
[c] National Institute of Health Science, 3-25-26 Tonomachi, Kawasaki, Kanagawa 2150-9501, Japan

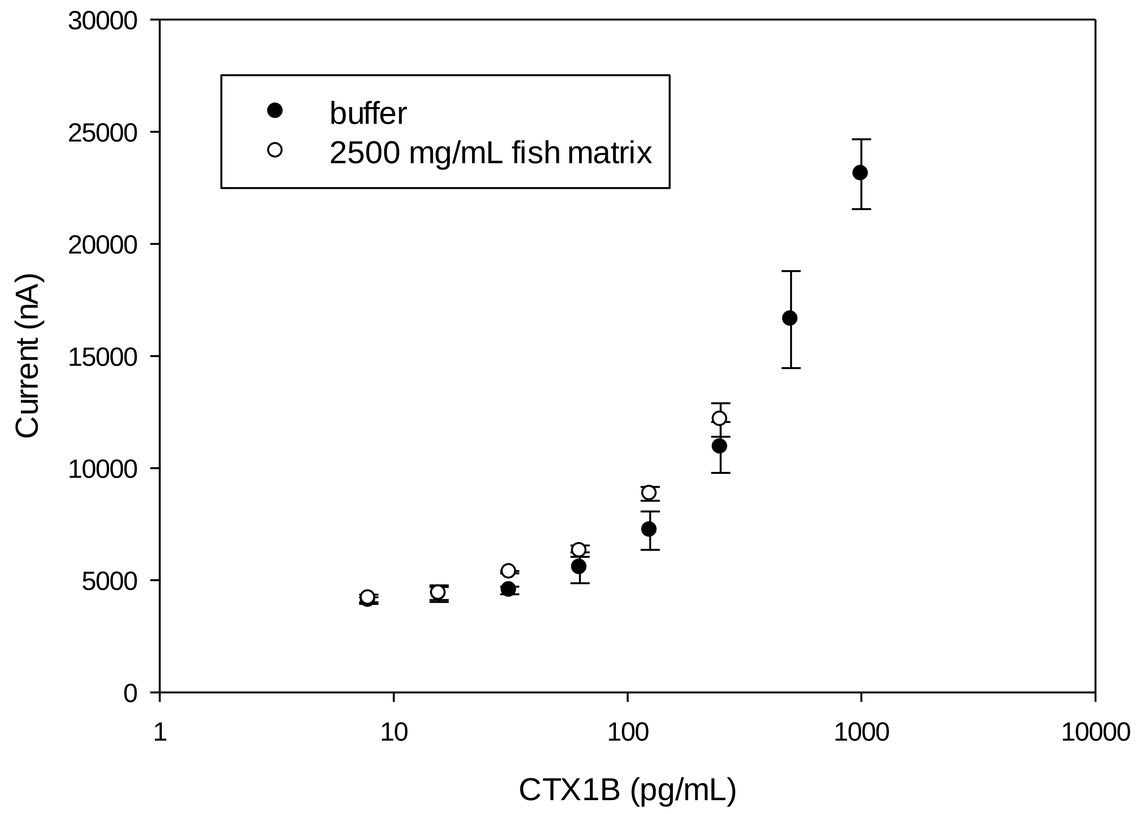
Introduction

- **Ciguatoxins (CTXs)** are potent lipophilic **marine toxins** responsible for **Ciguatera Fish Poisoning (CFP)**, the most common non-bacterial seafood-borne diseases worldwide.
- The importance of CTXs in seafood safety and their **emerging** occurrence in locations far away from the (sub)tropical areas where they were considered endemic, highlight the need for **rapid**, **simple** and **cost-effective analytical methods**.
- A **portable electrochemical immunosensor** for the detection of CTXs is presented. A **sandwich** configuration is adopted: on the one side, two different capture antibodies able to recognise the left wing of **CTX1B** and **54-deoxyCTX1B** and the left wing of **CTX3C** and **51-hydroxyCTX3C** are immobilised on **multi-walled carbon nanotube (MWCNT)-modified electrodes**. On the other side, a biotinylated antibody which binds to the right side of these four congeners is used as a detector antibody. **PolyHRP-streptavidin** is used as an enzymatic label for signal amplification and detection.
- Amperometric measurements are recorded with a small and ready-to-go **potentiostat** inserted in a **smartphone**, providing ***in situ*** measurements.

Smartphone-based electrochemical



CTX1B calibration curve

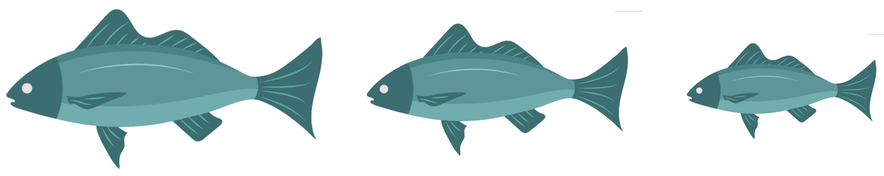


Limit of detection (LOD) = 10.44 pg CTX1B equiv./mL

✓ **No matrix effects at 2500 mg/mL fish matrix**

Effective LOD (eLOD)= 0.004 µg CTX1B equiv./kg fish matrix

Analysis of naturally contaminated fish samples



In progress...

Results will be compared with those obtained by cell-based assay (CBA) and liquid chromatography coupled to mass spectrometry (LC/MS).

Conclusions

- A portable electrochemical biosensor for the detection of CTXs has been developed, allowing the detection of **CTX1B** at levels **below the 0.01 µg/kg guidance level** proposed by the US Food and Drug Administration (FDA).
- The use of carboxyl-functionalised **MWCNT**-modified electrodes allows the covalent immobilisation of the two capture antibodies on the electrode, providing an **enhanced active area** and improving **electron transfer**.
- The immunosensor is being applied to the analysis of naturally contaminated **fish samples**. The use of two different capture antibodies in the sandwich configuration will allow the detection of at least **four CTX congeners**. Results will be compared with other analytical methods. The different recognition principles between analytical techniques should be considered when comparing the results.
- This alternative **low-cost**, **easy-to-use**, **rapid** and **portable** analytical tool can clearly contribute to address the significant challenges faced for the reliable and accurate detection of CTXs at the point of need.

Acknowledgements

The authors acknowledge financial support from the Ministerio de Economía, Industria y Competitividad, the Agencia Estatal de Investigación (AEI) and the Fondo Europea de Desarrollo Regional (FEDER) through the CIGUASENSING project (BIO2017-87946-C2-2-R) and from the European Food Safety Authority through the EuroCigua Project (GP/EFSA/AFSCO/2015/03). The authors also acknowledge support from CERCA Programme/Generalitat de Catalunya.