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Article

Inspecting Histamine Isolated from Fish through a Highly Selective Molecularly Imprinted Electrochemical Sensor Approach

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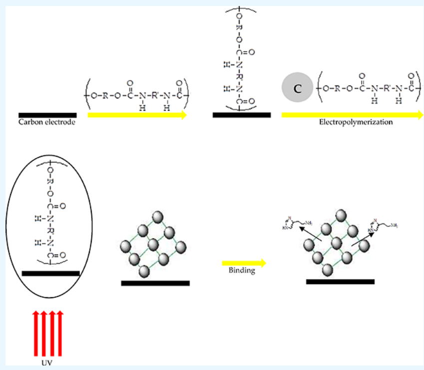
ABSTRACT: Numerous analytical approaches have been developed to determine histamine levels in food samples due to its health consequences. Consuming histamine over the Food and Drug Administration (FDA)-regulated 50 mg kg^{-1} limit would result in chronic toxicity. Consequently, the present study discusses a novel electrochemical approach to evaluate histamine levels in fish products via a molecularly imprinted polymer (MIP) on an electrode surface. The film was produced with electropolymerized polyurethane (PU), which maintained the histamine compound. Fourier-transform infrared (FTIR) spectroscopy was applied to verify the MIP manufactured in this study. The capability of the polymer was measured by assessing its electron shifts with cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS). Differential pulse voltammetry (DPV) was also employed to validate the sensing method. The MIP/screen-printed electrode (SPE) and non-imprinted polymer (NIP)/SPE recorded a linear response ranging from 1 to 1000 nmol L^{-1} at the 1.765 and 709 nmol L^{-1} detection limits. The sensing technique was subsequently utilized to determine the histamine levels in selected samples at room temperature (25 °C). Generally, the sensor allowed the accurate and precise detection of histamine in the fish samples. Furthermore, the approach could be categorized as a simple technique that is low-cost and suitable for on-site detections.



1. INTRODUCTION

Food safety has become a pressing issue that must be appropriately handled, given that food could be contaminated easily.[1] The World Health Organization (WHO) reported on 2000−2020 that one in 10 people suffers from food poisoning, while almost half of a million have died from food poisoning.[2] In Southeast Asia, particularly in Indonesia and Malaysia, food poisoning has resulted in 22.8 million cases of diarrhea and 37,600 thousand fatalities. Consequently, food security and monitoring are imperative.[3]

Aquatic foods have been most related to security issues considering the massive consumption of aquatic food products in Southeast Asia.[4] Physicochemical reactions in food commonly occur during storage. The reactions are influenced by several factors, such as heat, light, packaging process, and moisture. Furthermore, food adulteration might alter food content, which might lead to health threats.[5]

Aquatic food products offer high nutritional values that benefit humans. Nonetheless, aquatic nourishments contain high oil and fat levels compared to land-dwelling animals, which could lead to obesity, diabetes, and cardiovascular problems.[6] Consequently, nutrition experts suggested fish as the best choice as it is low in fat and rich in protein. Moreover, fish consumption serves various merits to the human body.[7]

Decarboxylation turns fish muscles into biogenic amines, which is a concern. Histamine is the most popular biogenic amine and thus has been the attention of numerous researchers. The presence of histamine in the bloodstream could result in several adverse effects, including histamine poisoning, a type of food toxicity. The symptoms of histamine poisoning range from mild to moderate to high risk and are even life-threatening.[8]

Food poisoning from histamine is commonly related to several aquatic animals, including sardines, mackerels, tunas, anchovies, and herrings. Accordingly, several countries have regulated the consumption of histamine-containing fish. For example, the Food and Drug Administration (FDA) in the United States of America (USA) only allowed 50 mg kg^{-1} of histamine intake, whereas a limit of 100−200 mg kg^{-1} has been set by the European Union (EU).[9] Consequently, developing a

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