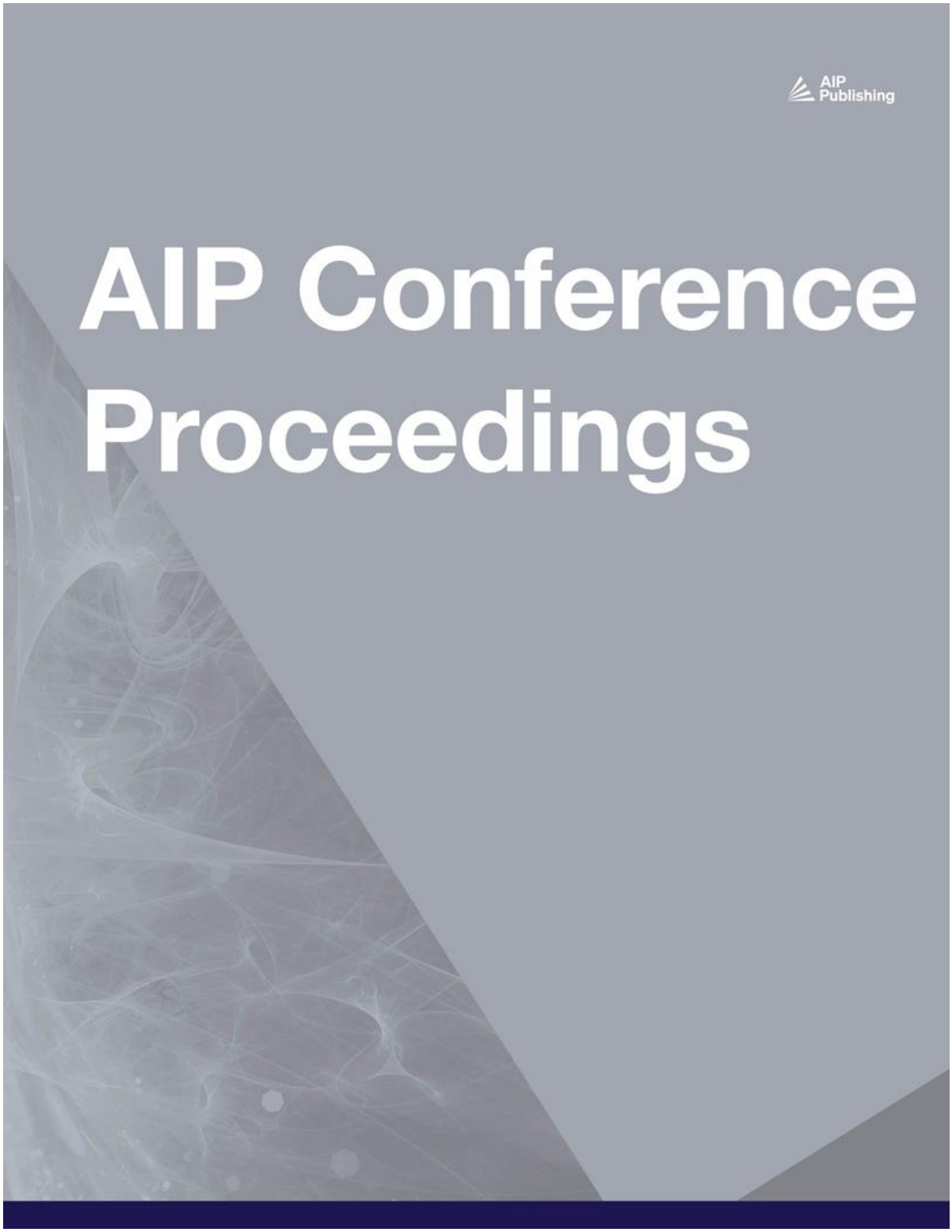
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# Preface: Proceedings of the 7th International Symposium on Applied Chemistry 2021

This present Proceedings contains the papers presented at the 7th International Symposium of Applied Chemistry (ISAC) 2021, held on 28-30 September 2021 at the Research Center for Chemistry, The National Research and Innovation Agency (BRIN), Puspiptek-Serpong. This is already the seventh consecutive annual symposium started in 2015, organized by the Research Center for Chemistry, The National Research and Innovation Agency (BRIN). This conference aims to gather academics, scientists, and professionals from several disciplines of applied chemistry.

This year, the theme of ISAC is "*Applied Chemistry Breakthrough for A Better Future*", where the scientific program consisted of plenary and parallel sessions with the following topics: Environmental and Analytical Chemistry, Clean Energy Production Technology, Food Processing Technology, Green Process and Chemical Engineering, Material and Catalysis, Natural Product and Medicinal Chemistry, and Pharmaceutical Technology and Drug Delivery System.

During the process, the acceptance of the manuscript was around 90%. More than one hundred papers have been received to be considered to be presented at ISAC 2021, and one hundred one articles were published in the American Institute of Physics (AIP) Conference Proceeding. The manuscripts selection was based on the international peer review with independent reviewers. Fifty-six expert referees were involved in reviewing the submitted papers.

Hence, we would like to thank:

- The scientific reviewers who helped to maintain the publication quality and provide thoughtful recommendations to the authors;
- The distinguished keynote speakers Dr. Jahangir Kamaldin (Universiti Sains Malaysia, Malaysia), Dr. Anna Phelan (University of Queensland, Australia), Dr. Tjandrawati, M. Es. Sc. DU (The National Research and Innovation Agency (BRIN), Indonesia), Firman Kurniawansyah, Ph.D (Sepuluh Nopember Institute of Technology, Indonesia);
- PT. Era Mitra Perdana, PT. Horiba, PT. Berca Niaga Medika, PT. Dynatech for sponsoring and supporting this symposium;
- The Organizing Committee of ISAC 2021.

We also grateful for all supports and suggestions that came to us. We are looking forward to the 8th International Symposium on Applied Chemistry that will be held in 2022.

*Dr. Muhammad Al Muttaqii*

*Chair/Chief Editor*

*7th International Symposium on Applied Chemistry (ISAC) 2021*

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# Determination of histamine using chemical sensor based on amperometric technique using screen-printed polyurethane electrode (SPPE) compared to HPLC equipped fluorescence detector

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**Muhammad Abdurrahman Munir, Khairiah Haji Badri, Lee Yook Heng, et al.**

# Determination of Histamine Using Chemical Sensor Based on Amperometric Technique Using Screen-printed Polyurethane Electrode (SPPE) Compared to HPLC Equipped Fluorescence Detector

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**Abstract.** For a long time, the presence of histamine in foods related to food poisoning owing to inappropriate storage of food. Histamine is generally used as an indicator of food safety. This study used HPLC to analyze histamine which was very accurate yet time-consuming and used many organic solvents which are not good for the environment. Therefore, the purpose of this work is to develop a non-enzymatic electrochemical technique to detect histamine using screen–printed polyurethane electrode (SPPE) in phosphate buffer solution (PBS) at pH 7.5, SPPE showed a very low oxidation potential of histamine at +0.31 V (*vs*. Ag/AgCl) avoiding perturbations from other amines such as cadaverine, putrescine and aniline. The developed method offered a satisfactory selectivity, detection limit at 0.17 $\mu mol \cdot L^{-1}$ and linear range at $10^{-4}$ – 1 $mmol \cdot L^{-1}$ for histamine detection. In addition, the proposed method was successfully applied to detect histamine with concentrations at 0.01 and 0.1 $mmol \cdot L^{-1}$ in fish mackerel and canned fish with recovery values ranging from 94 and 103%, respectively. Amperometric detection of histamine in fish samples using screen-printed polyurethane electrode was applied and compared with HPLC and presented high promise to be applied as an inexpensive and effective tool for food safety surveillance.

## INTRODUCTION

Histamine is one of the biogenic amines easily found in food that containing protein. Protein is arranged from several amino acids, including histidine. The cause of allergy-related to histamine concentration in the bloodstream is very substantial or known as histamine poisoning. Nevertheless, histamine is also entangled in the secretion of $H_2SO_4$, immune system and neurotransmission [1]. Histamine is also a well-known mediator of inflammation released from mast cells and basophils [2]. Therefore, the Food and Drug Administration (FDA) has released a serious warning not to consume foods containing histamine more than 50 $mg \cdot kg^{-1}$. Furthermore, consuming foods containing histamine beyond FDA regulation causing adverse impacts such as perturbation of digestive and respiratory systems and can cause death for some serious cases [3].

This compound can be shaped by breaking down the histidine. The breakdown can be done with two pathways, first by conversion to glutamic acid that can degrade the histidine to uronic acid and the second way is the loss of COO- in histidine structure catalyzed by the specific enzyme to produce histamine [4 – 7] as shown in Figure 1. The

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decarboxylation of histidine occurs inside foods due to the improper storage conditions that causing bacteria to grow and metabolize decarboxylase. After histamine is produced, it is not straightforward to extricate histamine even by employing heating and freezing techniques due to its marvelous stability [8 – 10]. Therefore, the determination of histamine is imperative and should be done by the food industry immediately because the concentration of histamine can increase rapidly as the inappropriate storage time is prolonged. Hence, a handy and rapid sensor for histamine analysis in foods is entailed for healthy consumption among consumers [11 – 12].

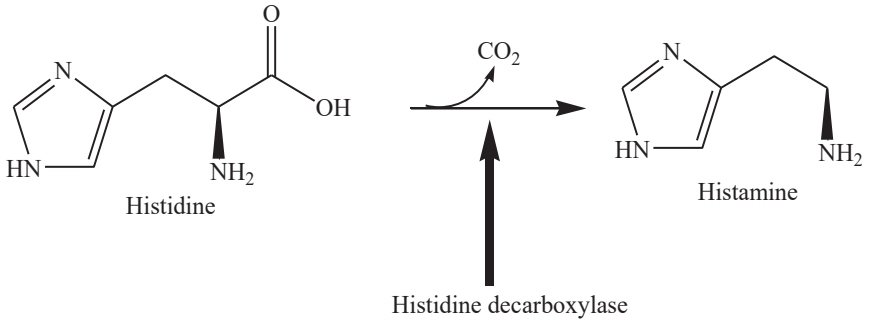


**FIGURE 1**. Decarboxylation process of histidine (Adapted: Huang et al. 2018 [8]).

**FIGURE 2**. The SPPE that applied as a working electrode.

Sundry developed and established laboratory analytical approaches had been employed for decades to detect histamine for fish freshness purposes such as high-performance liquid chromatography [8], thin-layer chromatography [13], gas chromatography [14], capillary electrophoresis (CE) [15], colorimetric assay [3, 16], fluorometric assay and enzyme-linked immunosorbent assay (ELISA) [17 – 18]. Albeit these methods demonstrate a satisfactory selectivity and sensitivity, yet these methods have various boundaries. For instance chromatography techniques (HPLC and GC) require a derivatization action before being analyzed using both methods due to lack of chromophore and volatility of histamine. These techniques also require too many preparations, sumptuous, and use many organic solvents that can harm the environment. Most importantly, they are not portable and require an analytical expert to be practically employed in fishery enterprises and market supervision [5]. Hence, it is a huge challenge for researchers to continuously evolve a new approach for histamine detection to surmount these issues.

Identifying histamine using an electrochemical sensor equipped with the biological receptor or recognized as a biosensor shows a preferable choice owing to have better selectivity, sensitivity, rapid, cheap and portable compared to other methods mentioned before. The application of biological receptors such as enzymes and antibodies has been studied and reported [19 – 25]. Nevertheless, this technique has various drawbacks that have been reported by several studies, such as time-consuming, complicated procedures and enzymes price. Furthermore, several reports studied the performance of electrochemical electrodes for histamine detection by modification of working electrodes using various materials such as graphene, lithium, platinum, gold and carbon nanotube (CNT) [26 – 28]. However, the cost of these materials has become an imperative issue that researchers should handle. Thus, an electrochemical method that uses inexpensive and easily available materials such as polymers to modify electrodes should be built immediately [29 – 31].

Nowadays, screen-printed electrodes (SPEs) modified with conducting polymer have been developed for various electrochemical sensing. SPE becomes the best solution owing to its frugal manufacture, tiny size, able to produce on a large-scale and can be applied for on-site detection [5]. On the other hand, conducting polymers (CPs) become an alternative to modifying the screen-printed electrodes due to their electrical conductivity, able to capture analyte by chemical/physical adsorption, and large surface area. Those properties make CPs as a very appealing material from electrochemical perspectives [32]. Such advantages of SPE encourage us to construct a new electrode for histamine detection. No research reported on the direct electrochemical oxidation of histamine using a screen-printed electrode modified by polyurethane. Therefore, this research is the first to develop a new electrode for direct quantitative analysis of histamine using SPPE without any conducting materials and biological receptors, as shown in Figure 2.

To achieve the ultimate goal and preclude the application of chromatography techniques, we present a simple and inexpensive analytical method as a resolution for histamine detection in this manuscript. The electrochemical measurements were carried out using SPPE in phosphate buffer solution (PBS). The electrochemical was studied and optimized using cyclic voltammetry (CV) and differential pulse voltammetry (DPV). Under the optimized