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Review Article

The Importance of Derivatizing Reagent in Chromatography Applications for Biogenic Amine Detection in Food and Beverages

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Biogenic amines (BA) are chemical compounds formed in foods that contain protein, allowing the foods to undergo a bacterial degradation process. Biogenic amines are labeled as toxic food because its consumption exceeding the FDA regulation (50 mg/kg) can be harmful to humans. Some countries also have regulations that prohibit the consumption of biogenic amines in high concentrations, especially histamine. The chromatography methods generally applied by researchers are liquid chromatography (LC) and gas chromatography (GC), where the use of a derivatization reagent is necessary to increase their sensitivity. This review is based on past and present studies about biogenic amine detection related to food samples. The rationale of this study is also to provide data on the comparison of the analytical approaches between LC and GC methods. Furthermore, the various approaches of biogenic amine determination and the most applied analytical methods have been reviewed.

1. Introduction

Food analysis has become a challenge in the food industry in ensuring the food distributed is safe for human consumption. There are many factors that require foods to be analyzed, such as contamination of food by bacteria, mishandling of food by humans, and food degradation due to environmental factors such as pH, temperature, and storage. Biogenic amines are compounds that can be easily found in food protein and should be analyzed because they can bring adverse effects. The appearance of biogenic amines in foods is generally influenced by bacteria contamination [1]. The review paper describes the importance of biogenic amine detection and the methods applied by some studies for biogenic amine detection in food and beverage samples.

2. Biogenic Amines

Biogenic amines (BA) are organic compounds with aliphatic, aromatic, and heterocyclic structures and formed by amino acid decarboxylation. The alpha-carboxyl group is removed from the amino acid compound causing the production of the following biogenic amines: histamine from histidine, cadaverine from lysine, tyramine from tyrosine, tryptamine from tryptophan, etc. [2, 3]. Figure 1 shows several biogenic amines that are generally found in food. Of all the biogenic amines, histamine is particularly found in the human body, albeit at a low and harmless concentration owing to the presence of diamine oxidase (DAO) and histamine-N-methyltransferase (HMT) to detoxify histamine. Histamine has the ability to increase blood capillary permeability as a side effect of an inflammatory response, while cadaverine can modify histamine from being nontoxic to toxic [5–7]. Foods contaminated with other compounds are safe for consumption after a heating process. Biogenic amines, on the contrary, can withstand heat and are not destroyed by high heat [8, 9].

However, bluefish, mahi-mahi, herring, and sardine known as nonscombroid fish species can also cause histamine poisoning [10]. Several organizations have different perspectives about histamine consumption. The Food and Drug Administration (FDA) regulation for histamine consumption allows histamine to be consumed at 5 mg/100 g of food. Meanwhile, the European Community released a

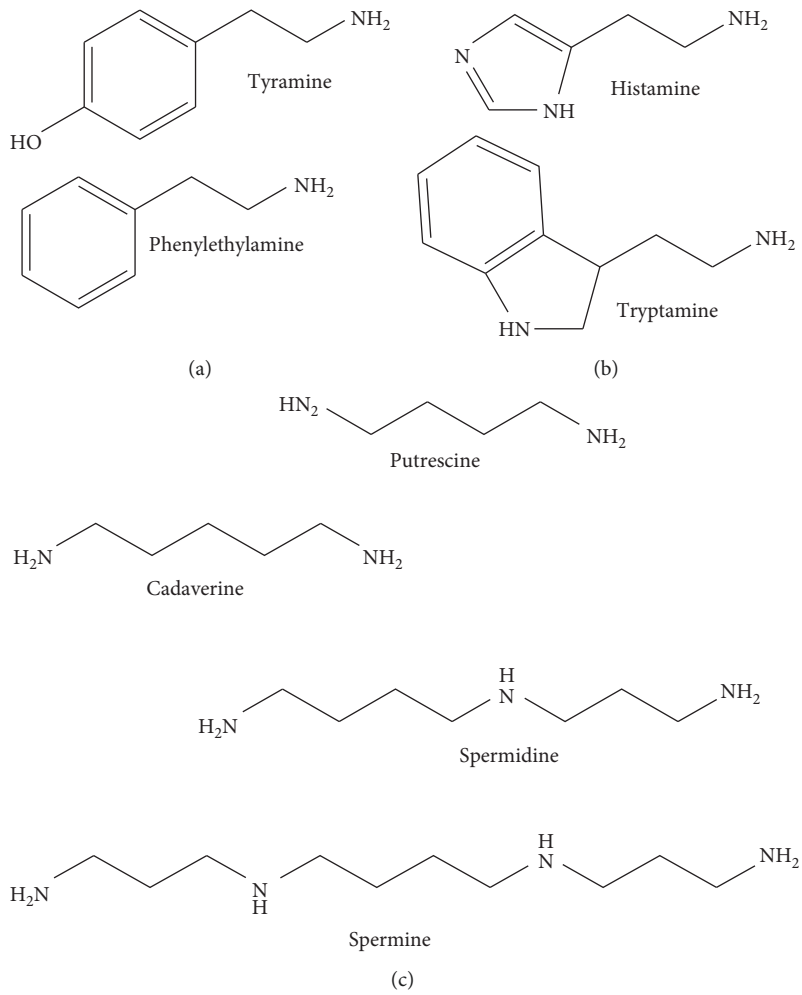

Figure 1: The main biogenic amines' chemical structures found in food and beverages ([4] with modifications): (a) aromatic structure; (b) heterocyclic structure; (c) aliphatic structure.

guideline for histamine content in foods and beverages to be lower than 10 mg/100 g of food. However, several studies showed histamine was given to humans orally at 67 and 180 mg per 100 g food without any sign of toxicity [9, 11]. Based on the issues presented above, it is imperative for the players of the food industry to monitor and measure the presence of biogenic amines in food, particularly histamine, to ensure food safety. Food researchers should take on the task of controlling and finding the best method to detect biogenic amines in food and beverages before distribution.

3. Biogenic Amine Detection by Chromatography Methods

Biogenic amine detection in foodstuff is crucial for the following reasons: to modify the current technique or develop new techniques to be applied by researchers or analysts in analyzing biogenic amines in various products from other countries that consume food protein regularly; to study the relationship between biogenic amine accumulation and the growth of bacteria inside foods; and to study their potential toxicity [12]. The analysis of biogenic amines in foods is not a straightforward process as biogenic amines' structures are very complex, and their presence in foods is sometimes very small (below 1 ppm). The appropriate extraction and purification methods must be selected with care [13]. Furthermore, to ensure the isolation of biogenic amines, the food samples must be treated very carefully. Sample clean-up is important in a biogenic amine extraction before an analysis using chromatography techniques is carried out. Common clean-up techniques applied are presented in Table 1. These include solid-phase microextraction (SPME), hollow fibre liquid-phase microextraction (HF-LPME), liquid-liquid extraction (LLE), and solid-phase extraction (SPE). Upon completion of a clean-up, the selected instruments can be used to perform an analysis. The use of solvents is important to ensure the successful extraction of biogenic amines. Some studies applied water and methanol to extract biogenic amines, but some studies also considered the use of acidic solvents such as perchloric acid, hydrochloric acid (HCl), or trichloroacetic acid (TCA) for their satisfactory accuracy and recovery.

Several studies reported the use of solvents for biogenic amine extraction, but all of them acquired different results.