

ASSESSMENT OF LEVELS OF EXPOSURE TO BIOGENIC AMINES – A GAMBIA CASE STUDY

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ABSTRACT

Biogenic amines (BAs) have been reported in a variety of foods namely, fish, milk, yogurt, beef and chicken. Their amounts are usually increased during controlled or spontaneous microbial fermentation of food or in the course of food spoilage. Biogenic amines are basic nitrogenous compounds with important metabolic and physiological significance in living organisms. They also pose some hazards to human health when consumed in quantities beyond their legal limits. Protein containing foods are the main precursors from which BAs are synthesized. A lot of amino acid containing foods are being consumed in The Gambia with no equipped laboratory to assess the levels of BAs. This work involved the study of the factors which enhance the formation of BAs through use of questionnaires, observation and testing (temperature). This research aimed at assessing the level of exposure to biogenic amine contamination by consumers in The Gambia. It was found that the level of biogenic amines may not be beyond their toxic levels in fish, milk and yogurt, but there is a probability of it being high in meat due to lack of proper means of preservation and quiet higher in imported chickens because of the duration of time it takes to get it to final consumers. [*African Journal of Chemical Education—AJCE 10(1), January 2020*]

INTRODUCTION

Amines are derivatives of ammonia. There are different types of amines as there are different modes of classifying them; types include, aliphatic monoamines, diamines among others. Amino acid decarboxylation is responsible for the synthesis of amines in foods. Decarboxylation has to do with the removal of the carboxylic acid group (-COOH) on the amino acid by enzymatic reactions. Enzymes that take part in such reactions are known as decarboxylase enzymes. Amines formed by this process are known as biogenic amines, BAs.

BAs are toxic substances and are responsible for many diseases in man and animals which are associated with the ingestion of food; food from plant and animal sources. The action of microbes on food during aging and storage results in the formation of biogenic amines. Some BAs which result from this process are: histamine, putrescine, cadaverine, tyramine, tryptamine, β -phenylethylamine, spermine and spermidine. Whenever they are produced, it is always as a mixture. There is a specificity to the production of these BAs: histamine is produced from histidine; cadaverine from lysine; putrescine from three amino acids: glutamine, arginine and agmatine. Depending on the food, some BAs occur in more quantity than others. Certain foods are known to contain more of some biogenic amines than others. Examples of foods which contain BAs include, fish, fish products, meat products, eggs, cheeses, fermented vegetables, soy bean products, beers and wines. Conditions that lead to the production of the BAs: free amino acids, (proteinous foods), presence of micro-organisms that can decarboxylate amino acids. Mishandling of food, (during storage and processing) also leads to the production of BAs[1,2]. Any food which ferments would produce BAs in the process of fermentation. Conditions that favour the decarboxylation of amino acids must favour the production of the enzymes necessary for the reaction that would produce the BAs. However, it is possible to find high levels of

histamine, a biogenic amine, in foods before they begin to appear spoiled. So, the fact that food looks good does not mean that it is. According to a study carried out by Shalaby, even high temperature treatment, (heating) does not significantly reduce the amount of BAs found in foods that have been subjected to deliberate or accidental bacterial contamination. In other words, if food is bad, heating it does not make it edible.

BAs are also responsible for the typical and characteristic taste of mature foods . The taste of food becoming stale is due to BAs. BAs are responsible for food poisoning. The amount of BAs present in foods, fruits and vegetables provides an index for measuring food quality.

In the tropics fish are caught in temperatures more than 20°C. These conditions make it easy for bacteria containing decarboxylase enzymes to act on fish if not refrigerated immediately. At temperatures between 0°C and 5°C bacterial growth ceases, however, enzymic activity continues to produce more BAs.

Consumption of food containing BAs leads to food poisoning, food borne disease, scombroid poisoning and tyramine toxicity, (results from cheese). Even poultry and farm animals can be poisoned from eating food containing BAs. This was reported by C.A. den Brinker *et al* in 2003[3].

Certain conditions limit the production of BAs in foods. These include; pH, salt concentration and temperature. These could be exploited as a way of ensuring better storage conditions.

Symptoms resulting from the consumption of large amounts of BAs in foods are: headache, nausea, hypo – or hypertension, cardiac palpitation and in severe cases, intra-cerebral haemorrhage and death [4]. What percentage of reported illnesses in hospitals in The Gambia is

due to the accumulation of BAs resulting from food consumption? If the population is educated on the effect of BAs, then may be the government would spend less on health care.

On the other hand, some BAs, are not that toxic; they play vital roles in the body. They are involved in growth of cells, tissues and organs. Their role in this respect is as cofactors in several biochemical reactions associated with cellular activities and proliferation. Other important roles include regulation of body temperature, stomach volume, stomach pH and brain activity. BAs are considered as very important food micro-components during periods of intensive tissue growth; infant gut maturation. In order for this biological function to be performed, the BAs must be present in little quantity. Their use in this respect is strongly influenced by certain physiological conditions. A complication of this is that the presence of certain BAs in little quantity leads to the production of other BAs in large quantities. Further to this, the body also produces its own BAs. Different parts of the body contain different amounts of BAs. The amount produced depends on body metabolism [5,6,7,8].

How much BAs are present in foods which are sold in The Gambia? Are their levels safe for consumption? The aim of this study is to assess the level of exposure to biogenic amine contamination by people who reside in The Gambia and suggest possible ways of improving handling. This study focuses on the most-widely consumed proteinous food in The Gambia: fish, milk, yogurt, beef and chicken.

METHODOLOGY

This study involved no laboratory exercise. The method used to gather information was through questionnaires and site visits. Fishermen, fish vendors or retailers, slaughter men, meat vendors and yogurt vendors were engaged with questionnaires related to the handling of their

products. This study focused on fish, milk, yogurt, beef and chicken; these are widely-consumed in The Gambia. Further to this, the researchers were interested in the accumulation of biogenic amines in these foods *vis-a-vis* to the way they are handled. Each set of questionnaires were printed in excess and the administered ones are herein referred as successful questionnaires.

Table 1 **Number of successful questionnaires for each sample group.**

Sample Group	Number of successful questionnaires
Fish vendors	316
Fishermen	35
Slaughter-men	16
Meat vendors	70
Yogurt vendors	61

Scope of Study

This study focused on fish, milk, yogurt, beef and chicken. Certain localities in The Gambia are known as fishing communities; these are places where fishermen go to fish and people usually go there to buy fish. The questionnaires were administered at these fishing sites: Banjul, Bakau, Tanji, Sanyang Village, Gunjur and Kombo Kartong. For yogurt, fish retailers and meat vendors, all fish landing communities plus Latrikunda, Kunkujang, the Sinchus, the Yundums, Busumbala, Brikama and Abuko were visited to gather data. The questionnaires were limited to the areas mentioned above due to the fact such activities are mostly centered there. The provincial parts of The Gambia feed on fish transported by Lorries or pickup trucks mostly from Tanji, Gunjur and Kartong. In the rural areas of The Gambia, fish, meat and yoghurt consumed are purchased from all the afore-listed areas. The Gambia is a relatively small country: 800km long and about 400km wide; the data gathered in this study is more-or-less representative of the country.

RESULTS AND DISCUSSIONS

With reference to Table 1, the data collected was analyzed and correlated with factors affecting biogenic amines formation in food samples. These factors have been referred to earlier.

□ **Yogurt**

Yogurt is locally known as “*Sow Yawour*”. Yogurt is from the fermentation of milk powder as stated by our respondents. The duration for this fermented process range from 12 – 14hrs as indicated from the data. Yogurt making involves dissolving the powdered milk in water accompanied by stirring for about 15 – 20 minutes and addition of warm water. This work found out that the fermentation process is always aided by the addition of already fermented yogurt. Only a single vendor acknowledged the addition of a colouring agent which is labelled “Ideal”. Yogurt is preserved by refrigeration using electricity. The unsteady supply of electricity in these areas often leads to spoilage of yogurt as stated by our respondents. Furthermore, vendors claimed making limited amounts of yogurt which they will sell within a day to avoid prolonged selling.

From this, it is suspected that a moderate amount of biogenic amines are present in yogurts sold in the visited communities.

□ **Meat**

The meats involve in this study were beef, pork, mutton, chevon and imported chicken legs. From slaughter men, most of their animals are fed on grasses, cereals and other plant products. Butchered meat is immediately delivered to meat vendors as claimed by slaughter men. Meat vendors or retailers confirmed keeping meat consignment for about 3 – 4 days with refrigeration and the use of iced-cold water as their only available preservation methods. This is not really reliable. The meat vendors consulted during the administering of the questionnaires

complained of erratic electricity supply in their communities. This, they said, disturbs the quality of the meat. Some literature cited in this article confirmed that the longer meat has been kept, the higher its biogenic amine content. Most of the vendors were seen hanging meat in the open and adding salt to keep away flies; all these promote the formation BAs. From the observed handling and preservation method, it could be suspected that there is high amount of biogenic amine concentration in meats sold in The Gambia especially imported chicken legs which sometimes spend up to 12 months in stores. This concentration maybe not necessarily be beyond the legal limits of BAs.

□ **Fish**

The fishermen engaged in this work are those who supply fish to Gambian markets. They spend between 12 – 18 hours in the sea. These fishermen depend on weather conditions for departure and use no preservation methods. It takes nothing less than an hour to offload; some even said it can take up to 6 hours depending on magnitude of their catch and ability of the wholesalers to buy. Fish vendors involve wholesalers and retailers. Fish wholesalers buy from fishermen on the bank of the river. Wholesalers embark on mass preservation mostly refrigerating; some others preserve by smoking or salting or sun drying. They spend between 2 – 3 days to exhaust a consignment of fish. Fish retailers sell to consumers. These retailers use the same preservation methods as the wholesalers. They also keep a fish consignment between 1 – 2 days. The long chain of distribution established in the fish business delays the fish reaching the final consumers. This study found out that most of the fish preserved by salting and sun drying are those that can no more be consumed directly. Exposure is a key factor; all those found selling in markets displayed their fish in the open air. This enhances microbial accessibility. The researchers in this work also found out that most of those who store fish in scrap refrigerators

add normal salt which they believe make iced-cold water stay longer. Some studies cited in this work confirmed that such substances promote the formation of biogenic amines.

CONCLUSION

Biogenic amines play very important roles in human physiology which this paper emphasizes. Although, the suspected levels of biogenic amines in the foods samples involved in this study may not necessarily be beyond their legal limits except for imported chicken legs. These imported chicken legs can spend up to 12 months in the country before reaching final consumers. Twelve months is more than enough for all the precursor amino acids to be converted to biogenic amines.

Even these food samples can be considered safe for consumption today, greater care should be taken in handling them. The food authority can also do more to reduce the risk is biogenic amines contamination by conducting regular screening of those involved in selling such food samples.

The information in this work is not from a laboratory and therefore not enough for strong conclusions. Thus, there is need for laboratory test to determine the amount of biogenic amines in the samples involved in this study and others such as beer, imported canned milk, bread etc.

RECOMMENDATIONS

After looking into the factors influencing the formation of biogenic amines and the handling of food containing the precursors, the following have been recommended.

- The importation of chicken legs should be banned in the country. The food authority should do more to ban chicken leg importation.

- The general public should be sensitized on the proper handling of meat, fish and yogurt and other BA precursor food samples. This sensitization should include the occurrence, physiological roles and toxic effects of high biogenic amine consumption.
- The food authority of the country, Food Safety and Quality Agency, should establish a fully equipped laboratory that will be sophisticated enough to conduct proper analysis of food samples containing biogenic amine precursors.

IMPLICATIONS FOR CHEMICAL EDUCATION

There is a need for people who sell imported chickens to sell them quickly so as to avoid buildup of biogenic amines. Further to this, hoarding of such foods should be avoided; it may make economic sense, but not medical sense; health-wise. Sellers of imported chickens and meat should be educated on the need to not hoard such foods.

Biogenic amines are a public health concern; proper handling of food should be taught in classrooms so as to educate students on the implications of improper handling.

Students should be taught to avoid consuming protein foods that are known to be stale. Furthermore, even if such food is not stale, but known to have been kept long, its consumption should be discouraged because of possible buildup of biogenic amines.

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