Food Safety: Physical, Chemical And Microbiological Hazards Present In Food

Introduction

Background

On 7th June 2019, Public Health England (PHE), The Food Standards Agency (FSA) and other technical food related scientific agencies in the United Kingdom were investigating the source of listeria infections linked to prepacked sandwiches. At the time of this investigation 6 people had been hospitalised due to serious illness from listeriosis. By 14th June 2019, there were nine (9) confirmed cases of listeriosis and the death toll had risen to 5 people. On 26th June 2019, the multi-agency group had confirmed 9 cases linked to the said sandwiches with at least 5 deaths. The Public Health England reported observing, on average, 166 cases of Listeriosis annually (2008 – 2018) resulting in an average of 46 deaths every year from 2010 to 2016. ("Listeria cases being investigated," 2019).

On 18th December 2018 Aljazeera news reported on its website of more than 100 hospitalised and 15 people killed in India after ingesting monocrotophos, a highly potent neurotoxic pesticide. Laboratory analysis had shown the presence of this neurotoxic pesticide in food and vomit samples. The same pesticide had been linked to the deaths of 23 school children in the state of Bihar in India in 2013 according to the same report by Aljazeera (Aljazeera, 2018).

In 2019, eleven (11) have passed since the famous melamine food poisoning of infants, yet it's painful memories may live on in thousands of families whose children fell ill and 6 mothers who lost their children to an otherwise preventable food safety breach. According to the BBC report, three hundred thousand children were taken ill and 6 died after consuming milk adulterated with melamine (BBC News, 2010).

Globally, an average of 600,000,000 incidents occurred in 2010 from various food borne diseases resulting in an average of 420,000 deaths (WHO, 2015) and an estimated economic loss of USD 51 billion in the United States alone in 2011 (Scharff, 2012) not counting the social and emotional pain caused by these incidents to the lives of living loved ones.

Recent years have seen much advancements in every aspect of human life especially in fields as information and communication technology, e-commerce, manufacturing and service. These advancements may have also resulted in busier lifestyles, especially in urban areas which are the major hubs for these advancements.

There seem to have been a steady trend towards obtaining an increasing proportion of nutrition needs in the form of ready-to-eat foods from sources outside the home such as street foods, fast food and various restaurants. Technologies such as online ordering systems with delivery-to-location options has made it an even more convenient option to obtain nutrition. In urban cities in Ghana, especially in the capital city of Accra, many food establishments like Papaye, Frankies,…and other are leading the way in presenting consumers with these convenient

Hazards present in food may be naturally inherent in the food, due to physiological, chemical or biochemical degradation of food materials or may be due to contamination with physical, chemical or biological agents or a combination of these.

Dramatic increase in the number and complexity of food products available in today's society, together with other factors such as novel processing technologies, emerging food-bourne pathogens, falling hygiene and sanitation standards in some communities has resulted in an increased interest in food safety.

According to the Food and Agriculture Organization of the United Nations (FAO), of the 4 percent of the 250 000 to 300 000 known edible plant species, 150 to 200 are used by humans.

Literature Review

Food safety seems to be a topic of much discussion in the political, economic, cultural and consumer circles in recent times. Consuming safer foods has become the priority on many consumers as the food supply chain becomes more complex and control of food safety hazards becomes even more complicated. Diets have expanded from basic staples such as potatoes, wheat, rye, maize, rice and yams among others to very specialised processed foods containing many ingredients.

Among the food safety hazards, microbiological hazards remain the most dominant in terms of likelihood of occurrence and severity when it occurs.

This literature review seeks to understand studies conducted in food safety practices in ready-to-eat food establishments around the globe, studies on food safety hazards in general and more specifically the nature of microbiological hazards related to ready-to-eat foods.

The Global Nature Of Food Safety Concerns

The Food and Agriculture Organisation of the United Nations defines food safety as the absence, or safe, acceptable levels, of hazards in food that may harm the health of consumers. It further categorises food borne hazards as microbiological, chemical or physical in nature and are often invisible to the plain eye; bacteria, viruses or pesticide residues are some examples. (The Food and Agriculture Organization of the United Nations (FAO), 2019). In recent years emphasis on allergens as a food hazard has become more prominent hence expanding the FAO definition further hence allergens as a food hazard may be grouped with chemical hazards or as a standalone hazard since it requires different control measures than chemicals in general.

The Centre for Disease Control and Prevention suggests researchers have identified as many as 250 food borne diseases caused by various bacteria, viruses and parasites any of these could cause anything from mild discomfort to even death of the consumer. (Centers for Disease Control and Prevention, 2018)

Evidence from a WHO report suggests that concerns about food safety have skyrocketed in more affluent societies. The report however notes that the real tragedy of foodborne diseases is more predominant in the developing world. The WHO report on Estimates of the Global Burden

of Foodborne Diseases suggests 31 main food hazards caused as many as 420 - 960 million (95% UI) foodborne illnesses and resulted in 310,000 - 600,000 (95% UI) deaths in 2010 (World Health Organization (WHO), 2015).

With these alarming figures relating to food consumption and health, it makes sense consumers and policy makers are experiencing an elevated interest in food safety in a global food supply chain that is getting longer and more complex, and a failure in food safety at any link in this chain, from the environment, through primary production, processing, transport, trade, catering or in the home, can have significant health and economic consequences (Copenhagen, 2015)

Klaus G. Grunert in an article titled “Food Quality and safety: consumer perception and demand” published in the European Review of Agricultural Economics suggests food quality and safety have been highly topical for the past 10 years; in the public debate, in food policy, in industry, and, last but not least, in research (Grunert, 2005).

In Ghana, Benjamin et al in their study of reported foodborne diseases in selected communities within the Greater-Accra Region of Ghana showed that home-made food and street vended food were the major sources of suspected etiological food, recording 49.01% and 34.87% of the cases respectively (Osei-tutu & Kolson, 2018). This is expected as it seems the trend towards consumption of street-vended and restaurant foods tends to increase with the increasing sophistication in urban living. If demand for street-vended and restaurant foods continue to increase, issues related to food safety may increase as well unless there in an intervention towards managing food safety hazards in these foods.

Acknowledging the realities and consequences of food safety on the global health system and economy, on the 20th of December, 2018, the United Nations General Assembly adopted a resolution proclaiming a World Food Safety Day, starting in 2019 on every 7th June, to celebrate the myriad benefits of safe food (FAO, 2018). The approach of a world food safety day seems to be a global recognition of the importance and value of safe food in the lives of everyone to the extent that the UN web article introducing the first world food day suggests food safety is key to achieving many of the Sustainable Development Goals (United Nations, 2019). The article suggests safe food is linked to food security, reducing preventable food-borne diseases, promoting sustainable patterns of food production and consumption, and promoting partnerships among government, food industries, producers and consumers.

It is worth noting, in contrast to the above, that twenty (20) years ago the importance of food safety was not fully appreciated by many public health authorities (Kaferstein & Abdussalam, 1999). This may have been due to less understanding of the nature of food safety hazards, it’s impact on global economies and how to control these hazards. Interestingly, the same bulletin published by the WHO projected a likely increase in attention given to food safety as public interest in such food safety issues as transgenic foods, toxic chemicals in food, food irradiation and many others was on the ascendancy at the time of publication some twenty (20) years ago.

Global concerns about food safety seem to revolve around the presence of certain hazards in food and understanding the nature and sources of these hazards may be key to developing practices to prevent, eliminate or reduce these hazards to safe levels.

Safety Hazards Present In Food

The FAO ‘Code of Practice’ on General Principles of Food Hygiene defines ‘a food hazard as a biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect. (The Food and Agriculture Organization of the United Nations (FAO), 2003)’

The American Society for Food Safety (now ASQ) defines a hazard simply as ‘anything that could cause harm to a consumer using the product (Surak & Wilson, 2014)’

Food safety hazards can be classified into a number of categories to account for the nature of the hazard (Batt, 2016). Traditionally food safety hazards have been classified as physical, chemical or biological in nature.

Physical Hazards Present In Food

Physical hazards in food will include those ‘tangible’ objects that may cause harm to the consumer. Surak and Wilson note two kinds of objects or physical materials that can be physical hazards; (1) part of a product that forms a part of a raw material but is meant to be completely or partially removed during the production process to avoid harm to the consumer and this will include bones in meat and; (2) objects or physical materials that are not designed to be part of the finished product but are inadvertently introduced into the product during the production process (Surak & Wilson, 2014). The latter includes hard plastics, metals, stones and glass.

Physical hazards account for a lesser proportion of food safety hazards likely to result in long term illness or death (World Health Organization (WHO), 2015) and while physical hazards in food are typically unlikely to cause long term illness nor death, physical hazards have been the result of long term deformation and subsequent legal issues for restaurants resulting in loss of profits and trust among consumers. On 22nd January 1995, Donald C. Porteous, Jr. was dining at the St. Ann's Cafe & Deli in Louisiana USA. While he was eating an oyster po-boy he bit into a pearl, broke a tooth and cracked it all the way down the shaft. In the court case “DONALD C. PORTEOUS, JR.v.ST. ANN'S CAFE & DELI AND LAFAYETTE INSURANCE COMPANY,” ruling was initially made in favour of the Plaintiff but the decision of the district court and the court of appeal was reversed by the Louisiana Supreme Court in favour of the defendant ‘dismissing the plaintiff's suit with prejudice and at his cost’ based on a lack of evidence against a breach of due diligence. The lower courts had erred in applying common law foreign-natural test which the Supreme Court found inappropriate for the circumstance. (Louisiana State University, 1998).

Notwithstanding the final ruling, it appears years of such legal clashes due to physical hazards in food could result in loss of sales and profits, loss of time, and less confidence in the ready-to-eat food industry to provide safe foods.

Chemical Hazards In Food

Chemical hazards in food are more diverse in nature compared to physical hazards and seem to have a more significant short to long term adverse effect on food consumers. Batt, 2016 notes that chemical hazards include pesticides and other chemicals that might be applied or carried on raw materials, as well as chemicals used in the food manufacturing process including cleaners and sanitizers. Batt as well includes any nonviable hazard such as proteins that might

be allergens to some subset of the population as chemical hazards. Batt however does not include in his definition chemicals such as acrylamides that are formed because of the processing of certain foods under high temperatures.

The Centre for Food Safety on the Government of Hong Kong includes a more extensive categorization of chemical hazards found in food. These hazards are;

- Certain food additives that are intentionally added to achieve certain technological function during the processing of foods which fall under several categories as acids, acid regulators, antioxidants, flavours, humectants, preservatives and thickeners among others.
- Environmental pollutants such as heavy metals (lead, cadmium, mercury) and dioxins.
- Chemicals formed during certain food processing or cooking conditions such as acrylamide.
- Residues of agricultural chemicals resulting from previous application of pesticides and veterinary drugs during production and storage of food crops and animals.
- Some naturally produced toxins by microbes or sea animals such as aflatoxins in peanuts and ciguatoxin in coral fish.
- Some naturally present components of food, which may cause adverse reactions under certain conditions, e.g. phytohaemagglutinin in inadequately cooked pulses and beans, allergic substances in peanuts and milk, etc (Yau, 2018)

Chemical hazards in food may have acute implications in nature, usually from toxins such as Allergens as a chemical hazard is one that seems to be less known but gaining more importance as globally (Tang & Mullins, 2017).

Microbiological Hazards In Food

Of the three categories of hazards typically mentioned in the literature, biological hazards seem to have the fastest and highest impact on consumers in terms of causing disease and especially direct deaths attributed to the hazard. Out of thirty-one (31) identified food hazards of major concern by the WHO during the estimation of the global burden of foodborne diseases, three of them were attributed chemicals namely dioxins, cyanide and aflatoxins while the remaining twenty-eight (28) were biological in nature (World Health Organization (WHO), 2015).

Illness from microbiological contamination may result from disease caused by the pathogens when they invade and cause physical damage to body tissues or by producing and releasing specific toxic substances in the host body that disrupt key body processes.

Common Microbiological Hazards In Food

Of the 250 known pathogens that can cause various food-borne, a selection of these seem to show up in most literature relating to ready-to-eat fast foods. In their study of Microbiological assessment of ethnic street foods of the Himalayas, Kharel et al isolated 15 pathogens from 10 common ethnic street foods. The study isolated bacteria from the genus Lactococcus, Lactobacillus, Enterococcus, Bacillus, Escherichia, Enterobacter, Salmonella, Staphylococcus aureus and Shigella (Kharel, Palni, & Tamang, 2016).

Eslami et al conducted a study of microbiological contamination in three (3) ready-to-eat foods; pizza, frankfurters and sausages in the city of Ilam. Of the 270 samples of ready-to-eat foods tested for five (5) bacteria species, “27.77% was contaminated with Escherichia coli, 21.48% with Staphylococcus aureus, 13.33% with Shigella sonnei, 14.44% with Salmonella. Arizona, and 5.9% with Enterococcus faecalis. (Eslami, Gholami, Nargesi, Rostami, & Avazpour, 2017)”

Another study on the ready-to-eat foods in Tabuk city isolated Salmonella, Staphylococcus aureus, Escherichia coli and other coliforms in hamburger, shawarma, pizza and salads (Darwish, 2018).

Interestingly, one study conducted to verify the microbiological quality of meals in a school deferred catering service between 2011 and 2015 never detected Salmonella spp. nor Listeria monocytogenes in 620 samples of cooked meals analysed over the period (Petruzzelli et al., 2018). This result seems to be inconsistent with other works mentioned above. However, the findings of Petruzzelli et al. may have been the result of the fact that the school meals are not exposed to open environments where there could be higher levels of exposure to microorganisms after cooking compared to street foods that are sold in various less controlled and more open environments capable of less sanitation and hence higher exposures to contamination. Another explanation may be that the school meals are sampled at a time closer to cooking which, relatively, will result in less time for contamination and subsequent multiplication of microorganisms.

Microbiological Hazards In Fast Foods

In their study of foodborne pathogens of fast food and ready-to-eat Foods in Tabuk city and evaluating hazard for food quality, Darwish assessed samples for aerobic plate count, Salmonella, Staphylococcus aureus, Escherichia coli and coliforms from four fast foods namely hamburger, shawarma, pizza and salads. The mean counts of selected bacteria were expressed as Log10 colony forming units per gram of samples. In this study, for aerobic plate counts, salad recorded the highest mean Log10 cfu per gram of 5.9, followed by beef shawarma which recorded 5.6 cfu per gram of sample, then chicken shawarma of 5.3 cfu per gram of sample while pizza seem to generally record the lowest mean cfu per gram of sample. Sausage pizza recorded 3.6 cfu per gram of sample and margarita pizza the lowest mean cfu per gram of 3.4 (Darwish, 2018). From an empirical standpoint the results are expected as salads and shawarma tend to undergo little or no heat treatment prior to serving for consumption while at the same time have high water activities. Pizza on the other hand will undergo some extensive heat treatment during the baking which will potentially destroy most microorganisms. Interestingly Salmonella was detected in salads, beef and chicken shawarma, beef and chicken hamburgers but in none of the four varieties of pizza. Again, this may be the result of heat treatment during baking.

Whilst Darwish’s study seeks to address food pathogens of fast food and ready-to-eat food, the study methods sampled food products from the restaurants and does not consider time lag from preparation to consumption in cases where food is taken away or delivered to the consumer especially considering that this is becoming a major trend in the global food supply chain.

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