

Foodborne Illness Risk Factors in Institutional Foodservice: Utilizing Temperature Control as a Preventive Measure

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ABSTRACT

Foodborne illness has become a common and costly problem than previously which estimated by worldwide illness recently. It can be seen that most of the foodservice operations; commercial, non-commercial and institutional are trying very hard to avoid or minimize the occurrences of this problem in their establishment. This research was carried out to determine the most crucial factors that lead to foodborne illness in institutional foodservice operation which includes schools, universities, hospitals, child care center, military and prison services that based on the Food and Drug Administration (FDA) risks factors assessment. Among of all the risk factors, it has been identified that by controlling the temperature at all stages of food production and services, the minimization and reduction of bacteria growth can be achieved. As a result, the foodborne illness cases can be reduced. Thus, this research served as a platform to develop new food handling processes when preparing food and assist foodservice personnel in understanding the importance of temperature control to avoid foodborne illness.

KEYWORDS: Foodborne Illness, Institutional Foodservice, Risk Factors, Risk Assessment, Temperature Control.

INTRODUCTION

Institutional foodservice industry is a non-profit oriented operation that found in places such as schools, hospitals and child care centers, military and prison services. Currently, outsourcing can be seen as the popular choice of business model within the institutional foodservice industry. Outsourcing foodservice has become a new trend in national developments, especially in higher education centers nationwide. It can be defined as “the performance of transferring certain organization’s recurring internal activities and decision rights to outside providers, as stated in a contract” [1]. The trend of outsourcing is booming in various industries such as manufacturing, finance and legal sectors [2] where healthcare sector is dominated as the highest outsourcing growth [3]. It is reported that every one out of 5 schools is outsourcing its dining services [4].

In a broader sense, foodservice industry refers to all organizations where food is served outside the home [5]. Food and beverages service have become complementary to the operation, and surprisingly it contributes larger revenue proportion to the hotels where they operate for the profit. Though food and beverages are not the major products in the business, but they are also inclusive of foodservice operation as long as they serve food and beverages to customers [6]. This can be clarified by looking into the operation of hotels and hospitals, where the major operation of both is not serving food and beverage but serving hotel guests and patients. Food and beverages in hospitals relatively serve patients in special conducted menu that suitable with their health condition and not profit oriented operation.

Various cases and issues involving all aspects in foodservice have been reported especially in terms of foodborne illnesses. Foodborne illnesses, food poisoning and many phrases are used to represent the outbreak involving food and diseases. Numerous cases of foodborne related diseases were associated with outbreaks in institutions of Malaysia [7-10] with 62% of the episodes in schools, 17% in academic institutions and 8% accounted in community gatherings [11].

Hazardous substances in food can be classified into 3 groups which consist of physical hazards, chemical hazards and biological hazards. Many studies that involving these 3 elements are focus on identify and eliminate the risk. World Health Organization (WHO) has identified factors that promoting to disruptions which include inadequate temperature control, infected food operators, cross contamination, inadequate heat treatment, contaminated raw ingredients and contaminated source of water. In these recent years, foodborne outbreaks which caused by the contamination of fresh fruits and vegetables have become more common incidences of foodborne illnesses in industrialized countries [12]. The situation becomes worst when food is prepared in advance, and the temperature is not controlled properly which lead the bacteria to multiply and produce toxins. It is also supported by [13] that insufficient temperature for cooking and reheating fails to eliminate pathogens, as well as cross contamination due to poor personal hygiene amongst food handlers.

It is reported that a greater part of foodborne illnesses can be associated to five (5) risk factors; food from unsafe supplies, inadequate cooking, improper holding temperature, polluted equipment and weak personal hygiene [14]. Each of the risk factors mentioned earlier should be given extra attention as each has significant effects to foodborne illnesses. Among all risk factors

which associated to foodborne illnesses, inadequate time and temperature control of food had dominated 70% of these food poisoning outbreaks while the remaining percentage goes to cross contamination [15]. The temperature range established by many sources show that bacteria will grow at temperatures between 5°C -57°C which is called 'danger zone'.

Temperature also applies to cold food handling equipment's such as chiller and freezer. It is identified that overburdened refrigerator and chiller with frequent opening and closing of the chiller doors raise the temperature of the food inside. These mostly contribute to the multiplication of bacteria or pathogens in food items. Cooking and reheating food is tied together with temperature. Studies by [16] state that the temperature that should be applied to kill and eliminate harmful germs is about 70°C. However, for hospital patients that are more exposed to infections, the food temperature must be at 75°C to ensure all the foods are cooked thoroughly. Improving temperature control practices in institutional foodservice, especially in hospitals and health care is important to improve patients' health.

Poor food handling also causes foodborne illnesses. Foods that are ready to be served should not be stored at room temperatures in the 'danger zone' range as there is a tendency for bacterial growth. Food that is cooked in large batches, cooled and reheated is identified as a potential cause of foodborne illnesses. It is recommended that food must be cooked at higher temperatures to avoid the growth of harmful bacteria. For institutional foodservice especially in hospitals, temperature during plating and holding is crucial as they are responsible to serve large numbers of patients within a very short period of time.

The remainder of the paper is organised as follows. Section II elaborates the data and several methods used in the study. While section III reports the empirical results followed by conclusion in section IV.

LITERATURE REVIEW

Foodborne Disease

Foodborne disease can be described as illness generated by the utilization of food and water polluted with bacteria and/or their toxins, parasites, viruses or chemicals [17]. Additionally, foodborne illness can also be defined as a typical, routinely mild but sometimes deadly illness [18]. It is also related to the information on the symptoms, which include nausea, vomiting, abdominal cramps and diarrhoea that suddenly develop within 48 hours after engrossing a contaminated food or drink. Foodborne illnesses occur when people absorb food or water that has been contaminated with certain types of bacteria, parasites, viruses or toxins [19]. Furthermore, foodborne illness can be illustrated as food poisoning that develops when people consumed contaminated food with bacteria or other toxins with symptoms that include diarrhoea, vomiting and stomach cramps that typically start 4-36 hours after consuming contaminated food [20].

There were several bacteria that are associated with foodborne illness such as *Campylobacter*, *Clostridium Botulinum*, *Clostridium Perfringens*, *Escherichia Coli*, *Hepatitis A*, *Listeria*, *Rotavirus* and *Salmonella* [21]. A bacterium that is mostly present and is harmful in food such as poultry product is *Staphylococcus* or *Escherichia Coli* [19].

Conditions Support Foodborne Microorganisms' Growth

There must be desired conditions that help foodborne microorganisms to multiply. The 6 requirement conditions for bacteria to grow are food, acidity, time, temperature, oxygen and moisture. These conditions can be with a simple acronym F-A-T-T-O-M. Since many foods inherently contain microorganisms, it is important for food handlers to control the 6 conditions to prevent bacterial growth.

- **Food:** Pathogens are likely produced and multiplied in nutritious foods that contain high protein and carbohydrate. Food that is high in nutrients includes poultry, meat, fish, grains, legumes, eggs and dairy products.
- **Acidity:** For most bacteria, the optimum pH is around neutrality that is 7.0. Bacteria prefer conditions that are near pH 7.0, but they are also capable of growing in pH range of 4.6-7.0 [22].
- **Time:** Bacteria grow quickly and do not take a long time to multiply into numerous numbers of cells. In the food industry, it is well known that microorganisms that can cause foodborne illnesses will likely contaminate food that is held for 4 hours at room temperature. Within 4 hours, bacteria can grow into high numbers that lead to foodborne illnesses to the person who consumes the contaminated food [22].
- **Temperature:** Most foodborne microorganisms grow well and rapidly at desired temperatures between 5°C and 57°C (41°F and 135°F). This is frequently ascribed to as the "temperature danger zone" [13].
- **Oxygen:** Some foodborne bacteria require oxygen to grow, while others can grow without the presence of oxygen. Bacteria that grow much faster with the presence of oxygen at about 21% are known as aerobes. But for some bacteria, the presence of oxygen is like a toxin for them. These bacteria called anaerobe can grow well in vacuum packaged foods or canned foods where oxygen free [23]. There are also bacteria that can grow well in conditions with or without oxygen, which are categorized as facultative anaerobes.
- **Moisture:** The amount of moisture available in food for this growth is called water activity. If the water present in food is little or not available, it makes the bacteria growth slow or even prevented [24]. Bacteria desired a very high water availability to be able to grow rapidly. They require high water activity (Aw) that is between 0.99Aw and 0.94Aw.

Temperature Risk Factor

Great evidence discovered by several researchers such as [25, 26] found that temperature is one of the most frequent factors associated with foodborne illnesses. Both *Salmonella* and *Campylobacter* can contaminate fresh fruits and vegetables, as

highlighted by [27]. These bacteria are susceptible to warmth, and can be immolated by cooking or other heat treatment such as pasteurization. Usually, bacteria are easily contaminating food cooked in bulk and prepared in advance. Occurrence of foodborne illnesses is when foods are not chilled promptly and permit spores of the bacteria to cultivate and propagate. If subsequent re-heating of the food is not sufficient, the probability of bacterias to develop illness is higher. It is therefore crucial that correct temperature control is achieved throughout all stages of processing, transporting, retail display and domestic refrigeration in order to minimize microbial growth on food and prevent foodborne illnesses [28]. Information gathered during all stages help to understand and manage the pathogen-associated risks. Improper temperatures for refrigeration lead to unsafe food storage, food easily spoiled and contamination.

The implementation of tools to easily access and accurately monitor the process is a must. Examples of tools are thermometer and refrigerators with inner built thermometer to ensure that the equipment temperature is at a standard level to maintain the quality of the products inside and prevent microbial growth. This study is an approach to discover depth details on how temperature becomes the most important element to overcome and decrease the problem of foodborne illnesses, mainly in institutional foodservice. The study on temperature is important in order to increase the awareness and attention among the food operators. When the food operators understand the importance of temperature towards food safety, they will take an action to implement better monitoring procedure practices during food production process, not only at the holding phases but also from the early stages of production. Very few studies have been conducted in temperature control practices especially in institutional foodservice. Therefore, this research is carried out to determine the most crucial factors that lead to foodborne illness in institutional foodservice operation which based on Food and Drug Administration (FDA) risk factors assessment.

METHODOLOGY

The research method used for this study is content analysis through qualitative method. This is due to some information from various sources that are related to risk factor foodborne illnesses where temperature control factor are being explored, analysed, described and compiled together.

Content analysis requires researchers to undergone detail observation, especially during collecting reliable data from journals, books and articles that will be included as part of the research. All related studies were tabled out and compared to generate ideas. By having lots of reading and analysis of the selected journals and articles, the information gained can later be discussed and become evidence and support the research objectives. Apart from that, it offers more space to expand opinions and ideas.

From the various sources, the summary becomes the essential information that will become the root of the study. Grouping the journals and research papers according to their sections will help to provide better views and more coordination during the explaining and analysing process.

RESULTS AND DISCUSSION

Foodservice products contribute as one of the primary determinants for food poisoning [29]. The proportion of food poisoning generated by caterers and institutional foodservice provider is greater than in any other foodservice sectors, which indicate almost 70% of all bacterial foodborne illness outbreaks [16]. Within the 70% of these outbreaks, it is due to inadequate time and temperature control of food, while the remaining 30% is due to cross-contamination.

However, there are certain researchers who claimed that the most compelling mismanagement made by catering employees are not due to improper temperature control, but lack of personal hygiene practices; most significantly, the lack of competent hand cleaning. It is highlighted that a competent hand cleaning is crucial to restrain the spread of foodborne illness [30, 31]. In addition, food contamination by microbes usually occurs due to unsafe food handling processes such as cross contamination from floor surfaces and raw food. It cannot be denied that contaminated food, dirty food premises, poor hygiene status and unsafe food handling practices among food handlers can cause food poisoning [32].

Studies reported that around 12-80% of foodborne illnesses occurred as a result of weak food handling and hygiene practices [33, 34]. For instance, in review of 23 restaurant-associated Salmonella outbreaks in Minnesota USA between 1995 through 2003, about 12% of foodservice workers were tested positive for Salmonella. It concludes that contaminated employees contribute as a primary determinant of bacteria transference that lead to foodborne illnesses [35].

Most significant contributing factors that directly related to food safety concerns within retail and food service establishments are generally described as "foodborne illness risk factors" which namely food from unsafe sources, inadequate cooking, improper holding temperature, contaminated equipment and poor personal hygiene [36]. Four (4) factors had been identified as essential factors and guidelines in influencing foodservice operators to prepare safe food which consists of time pressure, equipment's and resource availability, food safety emphasis by management and co-workers as well as food safety education training [37]. Having food safety knowledge alone was inadequate to prevent foodborne illnesses [37]. In fact, employees must be encouraged to perform proper food safety procedures in order to prevent foodborne illnesses. However, it is a saddened scenario to discover that one-quarter of food service managers/ executives did not possess any formal qualifications, skills and experiences [38].

Study conducted by [39] found that 43% or 2,400 restaurants over 5581 restaurants in Florida earned infringement for their misbehaviours of temperature abuse particularly on inappropriate refrigeration equipment. In order to reduce the risk of

foodborne illnesses, one must remember that failure to cool food correctly and store them at appropriate temperatures that prevent microbial growth and failure to heat them sufficiently to kill microorganisms will lead them to multiply to the dangerous level. Microorganisms can be found growing in temperatures of around -10°C up to more than 100°C. Very few microorganisms can grow at temperature lower than 0°C, and none can grow properly in freezing temperature which is below -18°C [24].

Both raw and cooked foods are exposed to facilitate fast growth of bacteria. Food can become re-polluted especially after it has been refrigerated and air-cool. How long the food needs to be heated for it to be safe for human consumption is depends on how many organisms present in the particular food. The higher the number of microorganisms, the longer it takes to heat the food and kill them. In general, food should be cooked until it reaches at least 70°C. For patients in hospital, their foods should be cooked at least at 75°C due to their body condition that is not strong and have a weak body immunization. Food that is ready to be served to customers or patients must be stored at temperatures that above 60°C. A short cooking time and low cooking temperatures can lead to Salmonella and other organisms to survive. Additionally, it was found that individuals with confirmed cases of salmonellosis in foodborne illness normally neglected an ultimate temperature reading prior to consuming the products though instructions on product packaging required them to do so [35].

Generally, hospitals, nursing homes and healthcare settings serve meals in the ward itself from a bulk food trolley, or served in a central kitchen location with trolleys of plated meals delivered to the patient areas. The greatest challenge for most tray delivery services is in maintaining a safe and acceptable temperature of the foods. Normally, there are considerable distances between a central meal plating area near the kitchen and the ward areas. A time limit of 45 seconds was established during the process of plating of food and places it in heated storage before it is distributed to the patients [16]. Furthermore, it is assumed that all patients are supplied a particular meal within recommended time frame, normally one (1) hour period.

An efficient temperature control must be implemented starting from individuals who have direct contact with food such as food supplier, food receiving clerk and cooks. This is to ensure that not only the management or food controllers are responsible to monitor the staff and operation where they meet the standards and responsible to follow the right procedures, but also to let the staffs to be educated with the importance of implementing the right procedures to reduce the risk of foodborne illnesses. Therefore, they are able to perform good practice and stay focused on controlling food temperatures. Staphylococcal Enterotoxin is a major cause of food poisoning, which typically occurs after ingestion of different foods, particularly processed meat and dairy products. It is produced by Staph Aureus by improper handling and subsequent storage at elevated temperatures [40]. Additionally, employees' hands act as a primary determinants of contamination. Hence, good personal hygiene and good cleaning practices are crucial to prevent contamination.

In institutional foodservice, a food controller must regularly check the food production process by introducing proper temperature control to the staff. They required practical instruction, so that they will become clear of handling and practicing it. Food handlers are usually the main source of food contamination in food poisoning outbreaks. In addition, equipment and environmental surfaces can also be sources of contamination with Staph Aureus [41]. The management plays a significant role in the extent to which food handlers engage in safe food preparation practices [36, 37]. It is imperative that foodservice management knows the standards, provide their employees with the knowledge and skills, provide enough resources and materials that employees need in order to perform their jobs appropriately and consistently monitor compliance with the standards. It is crucial to assure that their targets can be achieved.

In institutional foodservice, preparation and holding the food is crucial to be controlled by the production due to high traffic and large batch and amount of production. The temperature danger zone, which are between 41°F (5°C) to 145°F (57°C) encouraged disease-causing pathogens to cultivate when food is kept at that temperature. The scenario become worst if food is kept at these temperatures for more than 4 hours and can lead to severe food borne illnesses. Hence, it is crucial to store hot and cold food at appropriate temperatures (hot at 145°F or higher, cold at 41°F or lower). Moreover, food's temperature should be monitor periodically or at least every 4 hours during storage and distribution [42].

Besides that, food handlers may need to serve a large number of people at a short period of time. This often requires food handlers to prepare food in advance or a few hours earlier. If the preparation of food procedure is strictly controlled and storage temperatures are at levels that do not allow bacterial growth, then the level of hazards can be adequately controlled [27]. The most common violation in institutional foodservice is leaving the food in the temperature danger zone for more than 4 hours. All steps within the food production or service process for which loss of control could result in an unacceptable risk of foodborne illnesses [43]. Both hot and cold foods need proper temperature control to avoid bacteria to grow and live in the food before consumption [44]. This also includes reheating process of food before consumption. The quality of the food were not only affected by non-standardization of temperature distribution, but also boost the arguments of food safety when microorganisms were not demolished in cold spots [45].

It is significant to have a better temperature control practice through the establishment of a complete instruction and guidelines. It will become easier for everybody especially those who are involved in food production to practice and achieve safer food to be consumed. An effective temperature control will also provide organizations with better and improved practices of preparing food. This is due to control the food temperature where other aspects also need to be considered during implementation such as time and hygienic aspects. In institutional foodservice, temperature control is hard to be implemented due to lack of monitoring and awareness amongst the food operators. By having complete and simple guidelines, it will become possible for them to implement the proper temperature control towards their production. Complete instruction and guideline can

also be a reminder to food handlers. Hence, they will realize food that is being prepared without proper handling may contribute to the risk of foodborne illnesses.

It is hope that from the research, the food providers in institutional foodservice will offer better response to the implementation of correct temperature and quality of food served. This is when many people realize that temperature plays an important role in preventing foodborne illness, they will eventually educate and deliver the knowledge to the people. The community will have better supervision on temperature control especially during selection of their meal. The number of foodborne illness cases will decline from time to time as more people are exposed and practice good temperature control of their food.

In addition, a good understanding of temperature control in institutional foodservice will increase awareness on preparing food by the food providers. This will result to safer food consumed by potential risk population which include patients, elderly and school children. As their immune system is at lower level, the food consumed will no longer become a worry to them since a good temperature control are implemented by the food operator. The food they consumed is safe and the possibility of foodborne illness to occur will decline.

Furthermore, the industry will enjoy better gains by the declining numbers of foodborne illness cases. This is where they have understood and take serious actions in maintaining a good temperature control in their food production. Besides that, more and more industry players will also adapt a good temperature control. They have realized the important of temperature control in minimizing and reducing the foodborne illnesses. Additionally, the food production personnel who are aware and educated in the importance of crucial temperature control in minimizing and reducing risk of foodborne illness will pay more attention and care during the process of food production. Attention given to ensure correct temperature is achieved and control until the food is ready to be served. So, when cases of foodborne illnesses decrease, industry will gain more profit and reduce the cost of hospital admission, lawyer's fee and also loss of prestige and reputation.

CONCLUSION

In conclusion, the research fulfilled the objectives to determine the most crucial factors that lead to foodborne illness in institutional foodservice operation. Various aspects in institutional foodservice have been analysed, and the major contributor to foodborne illness was identified which is temperature abuse. It is highlighted that by controlling the temperature at all stages of food production and service, the minimization and reduction of bacteria growth can be achieved. Moreover, controlling temperatures will also contribute to the satisfaction of customer. This is due to proper temperature control practices will fulfil customer expectation of fresh and safe cooked food either in hot or cold condition. On the other hand, temperature control can overcome other factors that contribute to foodborne illnesses.

Foodborne illnesses can be prevented with appropriate and serious attention given to the temperature control in improving the food safety practices. A complete and simple standard operation procedure and guidelines need to be placed on the wall or near the selected equipment such as food warmer, oven and microwave ovens to increase the awareness among food operators. This is crucial so that they will always become alert and pay more attention to temperatures during cooking, holding and reheating of food to reduce the risk of foodborne illnesses occurrence especially in institutional foodservice. Besides that, the implementation of temperature control should not only be practiced by institutional foodservice but also recommended for commercial foodservice. Commercial foodservice has larger and more competitors to fight in serving the best delicious food and safe from harm. By acknowledging the right temperature and right ways to keep the food in a proper temperature, the food operators can at least avoid or reduce the chances of food from being contaminated. This will encourage food operators in both sectors to be more conscious and aware of the importance of temperature control to reduce the risk of foodborne illnesses. However, support and monitoring by the management should also be done in order to achieve consistent and continuous level of food safety. For the future recommendation, this research can be tested empirically as it can serve as a guideline for foodservice establishments and cafeteria operators to prevent food-borne illnesses.

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