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Bacteriological Analysis of Street Foods in Dipolog City

Kristine Gladys E. Jambre [1] & Maria Jyl P. Lagorra [2]
[1]Jose Rizal Memorial State University, Dipolog Campus
[2]Jose Rizal Memorial State University, Dipolog Campus
E-mail: kristinegladysjambre@jrmsu.edu.ph

Abstract — This study determined the presence of microbes in street foods and evaluated the sanitation practices of street vendors in compliance to Sanitation Standard Operating Procedures. Data were analyzed using descriptive analysis. Multi-dimensional scaling using S17 Bray Curtis similarity with application of similarity profile was used to show visual representation of dissimilarities among microbial density with respect to type of food item and accompanying compliance to sanitary practices. A total of 30 food samples categorized as non-alcoholic beverages and ready to eat foods were collected and examined for total coliform, Escherichia coli, molds and yeasts as well as Salmonella detection. Result showed contamination of test parameters in all food samples. Majority of the vendors lacked awareness on sanitation in food preparation, processing or handling. The result of the study served as basis in the implementation of DOST IX's project with the Dipolog City Barbecue Vendors Association entitled Rebranding of Dipolog City Boulevard Barbeque Vendors and Operators, the DOST way.

Keywords — Microbes, Street Foods, Food Handlers, Sanitation Standard Operating Procedures, Microbial Analysis, Pathogens, Potential Health Hazards, Consumers

I. Introduction

Cultural evolution is real. The changes taking place in people's lifestyles have caused the habit of eating outside to evolve. In today's modern world, people prefer to buy foods that are usually sold on the streets (Sezgin and Sanlier, 2016). These foods are highly demanded both by the sellers and consumers because of their tastes, easy availability, low cost, cultural and social heritage connection and being nutritional (Barro et. al., 2002; Buscemi et. al., 2011; Kok and Balkaran, 2014; Sezgin & Sanlier, 2016).

Street vending plays an important role in meeting the food requirements of urban dwellers in many cities and towns of developing countries (Birgen et. al., 2020). It feeds millions of people daily with a wide variety of foods that are relatively cheap and easily accessible (Tambekar et. al., 2008; Eromo et. al., 2016). We can see more of them in crowded places like churches, schools and the market and boulevard area. More and more people are drawn towards consuming these convenient and cheaper alternatives for nutrition. It can be noted that a lot of Dipolognons too have adopted the new culture of eating street foods. In recent years, there has been a noticeable increase in the number of street food vendors in the city. The traditional processing methods that are used in preparation, inappropriate holding temperature and poor personal hygiene of food handlers are

some of the main causes of contamination of street-vended foods. Consumers who depend on such foods are more interested in its convenience and usually pay little attention to its safety, quality and hygiene (Nicolas et. al., 2007; Tambekar et. al., 2008; Eromo et. al., 2016).

It has been found in majority of cases that these food stalls are not fit from hygienic point of view. A lot of these street food stalls do not follow the Sanitation Standard Operating Procedures that are prescribed to protect the consumers from potentially deadly food borne illnesses. Due to a lack of basic infrastructure such as water connections and refrigeration, the sanitary quality at these venues may be compromised, becoming a public health risk to the consumer. Risk factors at these locations could affect food safety at critical points such as purchasing, which includes criteria used in the selection of raw materials. Other critical points involve hygienic practices utilized during transport of products to the vending site, and the preparation of mixed ingredients, as well as cooking, storing, serving, sanitizing and waste management practices (Costarrica and Morón, 1996, Donkor et al., 2009, FAO, 2009b, Rane, 2011, WHO, 1996, US Food and Drug Administration, 2014; Cortese et. al., 2016).

The hygienic aspects of vending operations are a major source of concern for food control officers. For example, stands are often crude structures, and running water may not be readily available. Also toilets and adequate washing facilities are rarely available. The washing of hands, utensils, and dishes is often done in buckets or bowls. Disinfection is not usually carried out, and insects and rodents may be attracted to sites where there is no organized sewage disposal. Finally, food is not adequately protected from flies and refrigeration is usually unavailable (Mensah, et. al., 2002).

With this in mind, we conducted a microbial study of different types of street foods being sold in the city to test whether these foods are fit for consumption and not contaminated with potential pathogens. Also, we performed an ocular inspection at the physical locations of the food stalls to evaluate the sanitation practices of street vendors in compliance to Sanitation Standard Operating Procedures (SSOP). We also conducted a Focus Group Discussion with the food handlers and the sanitation personnel to discuss matters concerning sanitation.

Literature Review

Perdigon, et.al, 2006 stated that every person must eat and drink to sustain life, but life will be shortened or the quality of a person's health will suffer if food or water contaminated with a food borne pathogen or its toxin has been consumed. No one in either developed or developing countries is spared from contracting food borne diseases and they can occur anytime, anywhere as long as careless food handlers, consumers, and the food establishments give the pathogens favorable conditions for growth and survival. Maintenance of a sanitary environment is health-promoting and will help boost tourism and businesses.

Food, water and environment safety should be observed by every member of the food chain, from top management to the worker and from the farmer to the consumer. Individuals can

make a difference: A trained individual can prevent food borne water borne illness and even spare life (Perdigon, et. al., 2006).

The USFDA Food Code has addressed the structural design of food establishments and equipment as well as acceptable operational practices. These major interventions in the Food Code include: 1) demonstration of knowledge by the person-in-charge (usually food safety manager certification training) 2) employee health facilities 3) no bare hand contact with ready-to-eat food (good hand washing practices, utensils and glove use) 4) time and temperature control and 5) the use of consumer advisory information regarding consumption of raw or undercooked food. Three purposes for establishing SSOPs are: to protect your products from contamination from microbiological, chemical, and physical hazards. To control microbial growth that can result from temperature abuse and to ensure that procedures for maintaining equipment are in place. Sanitation Standard Operating Procedures (SSOP) should also include SSOPs to Maintain Equipment, SSOPs to Control Microbial Growth in Foods, SSOPs to control and monitor facilities for hand washing, sanitizing and toilet facilities (Perdigon, et. al., 2006).

According to the Department of Health's Revised Guidelines on Current Good Manufacturing Practice in Manufacturing, Packing, Repacking, or Holding Food (2004), the advent of globalization has opened new competition for local industrial manufacturer in the world as well as in the domestic markets. Emphasis on product quality and safety has gained significant importance in order for local manufacturers, including those in the food manufacturing sector, to be able to compete well and profit under a globalized economy. This is the basis of their guidelines. SSOPs used by Perdigon et. al. (2006) are all itemized in the Revised Guidelines on Current Good Manufacturing Practice in Manufacturing, Packing, Repacking, or Holding Food. These SSOPs are adapted by both BFAR and BFAD as adopted also from USFDA.

Coliform bacteria include a large group of many types of bacteria that occur throughout the environment. They are common in soil and surface water and may even occur on your skin. Large numbers of certain kinds of coliform bacteria can also be found in waste from humans and animals. Most types of coliform bacteria are harmless to humans, but some can cause mild illnesses and a few can lead to serious waterborne diseases (Swistock & Sharpe, 2016).

Coliform bacteria are often referred to as "indicator organisms" because they indicate the potential presence of disease-causing bacteria in water. The presence of coliform bacteria in water does not guarantee that drinking the water will cause an illness. Rather, their presence indicates that a contamination pathway exists between a source of bacteria (surface water, septic system, animal waste, etc.) and the water supply. Disease-causing bacteria may use this pathway to enter the water supply (Swistock & Sharpe, 2016).

The presence of E. coli in foods is undesirable because it indicates poor hygienic conditions which have led to contamination or inadequate heat treatment. The presence of E. coli in water indicates recent fecal contamination and may indicate the possible presence of disease-causing pathogens, such as bacteria, viruses and parasites. Ideally E. coli should not be detected and as

such a level of < 3 per gram (the limit of the most probable number test) has been given as the satisfactory criteria for this organism (Aijaz, 2001).

Foods should be free of Salmonella as consumption of food containing this pathogen may result in food borne illness. The presence of this organism indicates poor food preparation and handling practices such as inadequate cooking or cross contamination. Consideration may also be given to investigating the health status of food handlers on the premises who may have been suffering from salmonellosis or asymptomatic carriers of the organism (Aijaz, 2001).

Yeast and mold are organisms of great importance to the food industry. These two species are very different from bacteria, which are more commonly associated with food borne illness. Hundreds of yeast and mold species have been isolated from foods and due to their ability to grow over a wide spectrum of environmental conditions very few foods are entirely safe from fungal spoilage (Wilkins, 2014). Both yeasts and molds cause various degrees of deterioration and decomposition of foods. Occasionally, a food appears mold-free but is found upon mycological examination to be contaminated. Several food-borne molds, and possibly yeasts, may also be hazardous to human or animal health because of their ability to produce toxic metabolites known as mycotoxins (Tournas, et al., 2001).

II. Methodology

Sampling Area

This study was conducted in Dipolog City's Boulevard, public market and City Plaza areas. These are the areas where the most number of customers can be found as these are densely populated. The food establishments strategically placed themselves where they can be accessible to customers who are on the go, who want readily available food at a considerably low price. Dipolog City's Boulevard poses the most health risks as hundreds of customers, young and old, visit and buy from these establishments on a daily basis as this area is one of the most visited tourist spot in the city.

Collection of Samples

A total of 30 randomly collected food subjects of non-alcoholic beverages of at least 500 mL each sample and ready to eat foods of at least 250g per sample specifically fried chicken, barbeque, tempura, chicken proven, lumpia, bola-bola, kwek-kwek (ready to eat foods) and mango shake, fruit juice and buko juice (non-alcoholic beverages) samples were randomly and aseptically collected. The samples were kept in sealed containers and then transported using a sealed ice box to maintain low temperature. These samples were refrigerated before analysis to prevent microbial growth.

Microbiological Analysis

Microbiological analyses were performed at the laboratory of the Department of Science and Technology's Regional Standards and Testing Laboratory Region 7 where the samples were tested for Escherichia coli, Salmonella,total coliform count, and molds and yeast presence following the protocol used by the Food and Drug Administration (FDA) set by the Bacteriological Analytical Manual 8th ed., Online 1998 Rev., Chapters: 4 (Escherichia coli and the coliform bacteria); Chapter 18 (Yeasts, Molds and Mycotoxins); Chapter 5 (Salmonella). The surface colony count technique (cfu/g)/(cfu/mL) was used to estimate the microbial count. Testing was done three times to ensure reliability of the resulting data.

III. Results and Discussion

Table 1. Enumeration of total pathogenic bacteria

CONTAMINANT	NON ALCOHOLIC BEVERAGE					READY TO EAT FOODS				
	Sampling 1 16-Nov-2018	Sampling 2 28-Nov-2018	Sampling 3 19-Mar-2019	Mean (cfu/ml)	Reference Values	Sampling 1 16-Nov-2018	Sampling 2 28-Nov-2018	Sampling 3 19-Mar-2019	Mean (cfu/g)	Reference Values
Total Coliform	1.1×10^3	2.6×10^4	7.3×10^5	2.5×10^5	1 cfu/ml	1.3×10^2	0	1.8×10^2	1.0×10^2	10 cfu/g
Escherichia coli	3.7 x 10	0	0	1.2 x 10	0 cfu/ml	0	0	0	0	0 cfu/g
Mold and Yeast	1.2×10^4	2.6×10^4	5.9×10^4	2.1×10^5	1 cfu/ml	1.6×10^3	1.2×10^3	1.6×10^3	1.5×10^3	10^2 cfu/g
Salmonella	0	0	0	0	0 cfu/ml	0	0	0	0	0 cfu/g

*Reference values are based on the acceptable levels set by the Food and Drug Industry for total coliform count, Escherichia coli count, mold and yeast count for both food categories such as ready to eat foods and non-alcoholic beverages.

Table 1 reflects the occurrence of high bacterial loads in non-alcoholic beverages at 2.5 x 105 cfu/ml for total coliform count and 2.1 x 105 cfu/ml for molds and yeast, both above the acceptable levels for non-alcoholic beverages. The presence of these microbes in food can be linked to a number of factors such as improper handling and processing, use of contaminated water during washing and dilution, cross contamination from rotten fruits and vegetables, or the use of dirty processing utensils like knife and trays (Bryan et al., 1992; Khalil et al., 1994; Das et al., 2010). Rajan et al. (2017) obtained an alarming amount of Total Bacterial Count (TBC), Total Coliform Count (TCC), yeast and molds, Escherichia coli, Bacillus cereus, Salmonella and Staphylococcus aureus on seven popular street foods.

The results of the microbial analysis show a higher contamination rate for non-alcoholic beverages compared to the ready to eat food samples. Bacterial growth is hampered when subjected to high temperature thereby proliferation is not possible for foods which have gone through the process of cooking.

The number of contaminated samples was alarming. All of the (9) non-alcoholic beverage samples were all tested positive for molds and yeast and 13 out of 21 ready-to-eat food samples contaminated with the same microbes. The higher rate of mold and yeast count in non-alcoholic

beverages may be attributed to its contents such as dairy products like milk as well as fruits that may encourage growth of these disease carrying organisms (CDC, 2018). It is also possible that leftover fruits that are not refrigerated are still used on the next day of business and not thrown out to avoid contamination. Several food-borne molds, and possibly yeasts, may be hazardous to human or animal health because of their ability to produce toxic metabolites known as mycotoxins. Certain foodborne molds and yeasts may also elicit allergic reactions or may cause infections (USFDA, 2001).

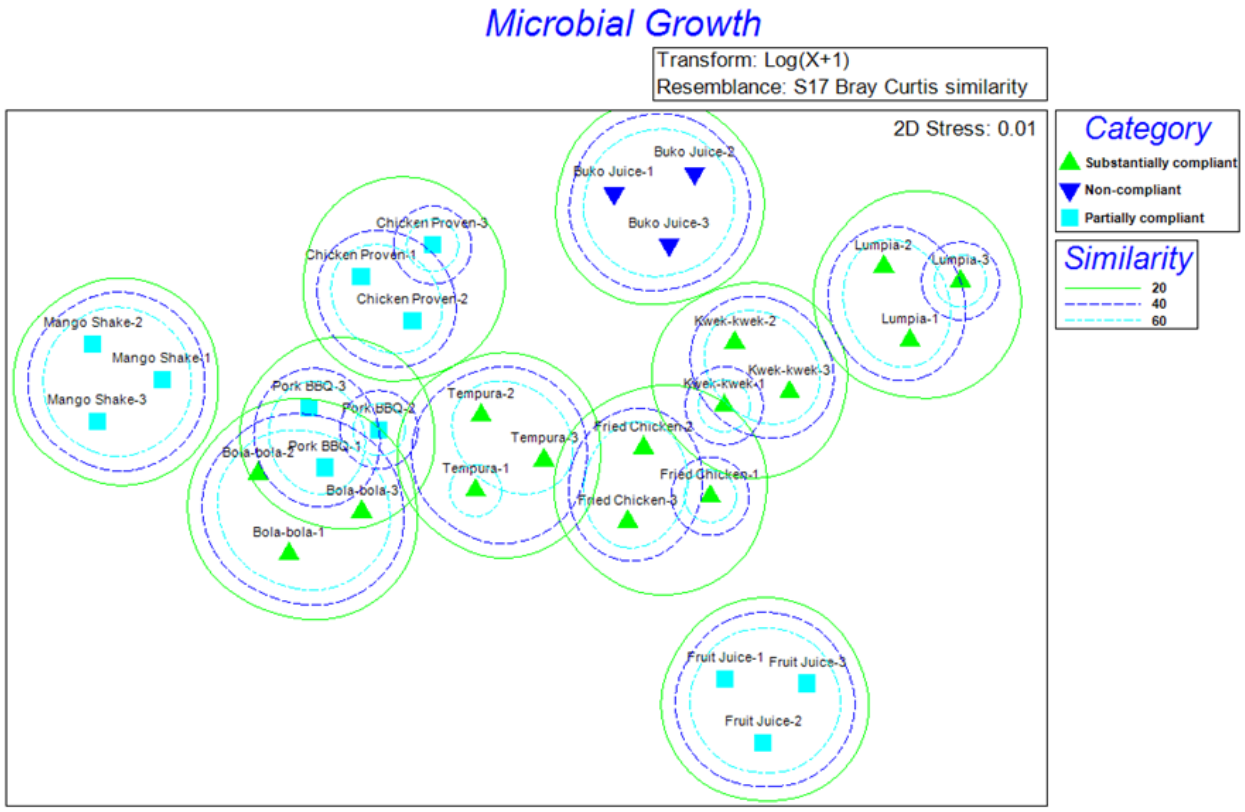

Figure 1. MDS result showing microbial growth influenced by the food item and the accompanying practices or compliance to sanitary practices.

Total coliform count has the second highest number of contaminated samples with (8) out of the (9) non-alcoholic beverages being contaminated and (5) out of 21contaminated for ready-to-eat food samples. Coliforms are groups of microorganisms that can be found in soil, water, as well as gut of animals. Coliform count is a hygienic indicator and high level of coliform counts generally indicates unsanitary condition of poor hygiene practices during or after food production (Centre for Food Safety, 2017). Water used plays a vital role for this type of contamination. Dirty water may contain coliform bacteria that may indicate fecal contamination. This can be due to usage of dirty water as raw ingredient or the ice used. This can also be due to contamination from unhygienic food handling of the food handlers during any of the eight steps of food process. Escherichia coli is one of the few bacteria which can clearly indicate fecal contamination in food and water.

Detection of E. coli was minimal with only one of the 30 samples being contaminated. If coliform is detected, the risk of contracting water-borne and food borne illness is increased. If a lab detects only total coliform bacteria, the source is probably environmental and fecal contamination is unlikely. However, if environmental contamination can enter the system, pathogens could get in too. It is important to find and resolve the source of the contamination (DOH, 2016). It can be noted that all of the street foods vended are uncovered, exposing them to air contaminants as well as pests (flies, cockroaches, etc.) that are microbe carriers, responsible for the contamination or cross contamination. There are no pest control programs that are in place. Pests and animals are very visible in the area. Flies hover around the uncooked barbecue. Dogs and cats are roaming around even at the preparation area.

IV. Conclusion

Therefore, based on the results of the microbial analysis and ocular inspection, it can be concluded that the food handlers and food establishments are non-compliant to Standard Sanitation Operating Procedures thereby putting the consumers at risk for contracting food borne illnesses.

Although the Philippine government has already enacted Presidential Decree No. 856/Code on Sanitation of the Philippines to prescribe sanitation requirements for food establishments for the protection of consumers, however, there is a gap in implementing these laws. Therefore, the alarming level of health risk leads to an urgent need for the city government of Dipolog to strictly implement the code of sanitation. Constant monitoring and evaluation needs to be performed by the Sanitation Department to ensure full compliance to these existing laws.

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