FOOD QUALITY CONTROL AND STUDY OF CRITICAL CONTROL POINTS ENSURING FOOD SAFETY

“THERE IS NO FOOD SECURITY , WITHOUT FOOD SAFETY”

- SANA SIDDIQUI

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Abstract

Food safety is of utmost importance in the food industry. The main reason is the susceptibility of the products to microbiological, physical and chemical hazards. Hazard analysis critical control point (HACCP) is a systematic approach, the aim of which is to determine the hazards related to food, to identify critical control points (CCP), and to put them under control. For the food industry, the HACCP program is currently recognized as the best approach to control food safety.

The application of the Hazard Analysis and Critical Control Points (HACCP) system is rapidly progressing. The term is well known for food safety management, health care and all those areas that dealor focuses on food safety as the primarily object.

Food safety regulations are scientific discipline describing the handling preparation, and storage of food in ways that prevent foodborne illness and make it suitable for consumption. This includes a few examinations that should be followed to avoid potentially severe health hazards. There are 5 basic steps to food safety:

1. Receive – food products received should always be checked for Temperature, Quality, Genetically Modified Products, Allergens, And Quantity.
2. Sanitize - fruits and vegetables should be sanitized properly, hands, counters, and cooking utensils.
3. Store - all items should be segregated to avoid any cross-contamination and stored at proper temperatures. Allergens should always be separated and clearly labelled.
4. Cook –internal temperature of the food should reach above 75˚C in general. Cooked food should not stay out for more than 2 hours.
5. Chill –it should be blast chilled right away.

In the present study, food safety knowledge and attitude of 50 consumers from two different categories of food service establishments (FSEs) were assessed. Results revealed that most consumers (60%) eating at various FSEs were young, in the age group of 18–35 years. Some of the consumers could identify the carriers for foodborne diseases such as cholera, food poisoning and jaundice, but most of them did not know about the carriers of typhoid,

gastroenteritis and amebiosis. Some of the consumers just have vague information about food safety from family and friends as per what has been practiced since by them. Most consumers had a positive attitude toward food hygiene as healthy eating is the norm of life in the present scenario. Most consumers believed that government intervention has helped in improving the quality offoods sold across the country due to the regular hygiene visits by the municipality. A lot of better-educated food handlers believed that adherence to norms on the personal hygiene of the food handler should be made compulsory, and that training of persons in food service is essential to ensure the quality of food and food safety. In conclusion, various sources of information should be used to increase consumer awareness on food safety.

Chapter 2

Introduction

The burden of food-borne diseases though preventable remains huge contributing to worldwide morbidity. The WHO estimates that each year, unsafe food makes at least two billion people, representing about one- third of the global population ill worldwide. The Simple prevention techniques could significantly reduce this burden of diseases which can cause serious illness or death [1-3]. Food-borne diseases claim more lives and are reported very often in health facilities.When two or more people get the same illness from the same contaminated food or drink, the event is called a **foodborne illness outbreak**. FDA investigates outbreaks to control them, so more people do not get sick in the outbreak, and to learn how to prevent similar outbreaks from happening in the future. Food - borne diseases are widespread and growing public health problems, both in developed and developing countries [4]. The global incidence of food-borne diseases is difficult to estimate, but it has been reported that in 2005 alone, 1.8 million people died from food-borne illnesses [5]. The high prevalence of diarrhea diseases in many developing countries corresponds to food safety issues.Though most food-borne diseases are sporadic and often not reported, food-borne disease outbreaks may take on massive proportions of the population risk. For example, in 1994, an outbreak of *Salmonellosis* due to contaminated ice cream in the U.S.A affected an estimated 22,400 persons [8]. Similarly, in 1988, an outbreakof hepatitis A, resulting from the consumption of contaminated clams affected some 30,000 individuals [9,10].The various efforts at reducing food-borne diseases include enforcement of laws on food safety,health education and more importantly, the use of hazard analysis and critical control point (HACCP) principles [11,12].The most recent food outbreak occurred in June 2021.

Difference between Food Safety and Food Hygiene

Often times some persons use Food Safety and Food hygiene interchangeably, but the two are not exactly the same.The term '**Food Safety**' encompasses all the important practices that businesses must follow to ensure food is fit for consumption while **'Food Hygiene'** is one of these important practices, which means it's a subcategory of 'food safety**'.**Because food hygiene falls under the umbrella term **'Food Safety'**, Food Hygiene itself does not include all the other key areas of food safety. This is an important difference to be aware of, particularly when applying food management procedures to your premises. Food safety refers to an entire

system of managing risks. Meanwhile, food hygiene refers to an individual set of practices for controlling only one aspect.Knowing this will help you better determine what level of knowledge people in your business require and how to apply all the necessary controls**.** This, in turn, can help you make a more informed decision about improving your business's practices and what additional training you may need.An understanding of Food Safety is always recommended for everyone in food-related roles, so they can contribute to other essential areas. However, they won't need the same level of knowledge as those in management positions about other aspects of food safety.

Major foodborne illnesses and causes

Foodborne illnesses are usually infectious or toxic in nature and caused by bacteria, viruses, parasites or chemical substances entering the body through contaminated food or water. Foodborne pathogens can cause severe diarrhoea or debilitating infections including meningitis. Chemical contamination can lead to acute poisoning or long-term diseases, such as cancer. Foodborne diseases may lead to long-lasting disability and death. Examples of unsafe food include uncooked foods of animal origin, fruits and vegetables contaminated with faeces, and raw shellfish containing marine biotoxins.

Bacteria:

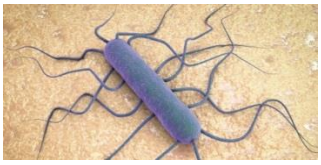
- ***Salmonella, Campylobacter, and Enterohaemorrhagic Escherichia coli*** are among the most common foodborne pathogens that affect millions of people annually – sometimes with severe and fatal outcomes. Symptoms are fever, headache, nausea, vomiting, abdominal pain and diarrhoea. Examples of foods involved in outbreaks of salmonellosis are eggs, poultry and other products of animal origin. Foodborne cases with *Campylobacter* are mainly caused by raw milk, raw or undercooked poultry and drinking water. *Enterohaemorrhagic Escherichia coli* is associated with unpasteurized milk, undercooked meat and fresh fruits and vegetables.

Salmonella

E.coli

Campylobacter

- ***Listeria*** infection leads to miscarriage in pregnant women or death of newborn babies. Although disease occurrence is relatively low, listeria's severe and sometimes fatal health consequences, particularly among infants, children and the elderly, count them among the most serious foodborne infections. *Listeria* is found in unpasteurised dairy products and various ready-to-eat foods and can grow at refrigeration temperatures.



Listeria

- ***Vibrio cholerae*** infects people through contaminated water or food. Symptoms include abdominal pain, vomiting and profuse watery diarrhoea, which may lead to severe dehydration and possibly death. Rice, vegetables, millet gruel and various types of seafood have been implicated in cholera outbreaks.

Antimicrobials, such as antibiotics, are essential to treat infections caused by bacteria. However, their overuse and misuse in veterinary and human medicine has been linked to the emergence and spread of resistant bacteria, rendering the treatment of infectious diseases ineffective in animals and humans. Resistant bacteria enter the food chain through the animals (e.g. *Salmonella* through chickens). Antimicrobial resistance is one of the main threats to modern medicine.

Vibrio Cholerea

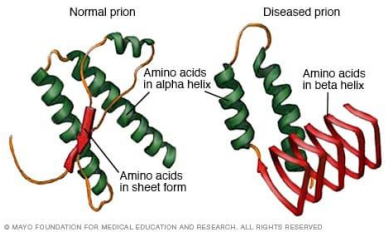
Viruses: *Norovirus* infections are characterized by nausea, explosive vomiting, watery diarrhoea and abdominal pain. *Hepatitis A* virus can cause long-lasting liver disease and spreads typically through raw or undercooked seafood or contaminated raw produce. Infected food handlers are often the source of food contamination.

Hepatitis A

Parasites: Some parasites, such as fish-borne trematodes, are only transmitted through food. Others, for example tapeworms like *Echinococcus spp*, or *Taenia solium*, may infect people through food or direct contact with animals. Other parasites, such as *Ascaris, Cryptosporidium, Entamoeba histolytica* or *Giardia*, enter the food chain via water or soil and can contaminate fresh produce.

Tenea Solium

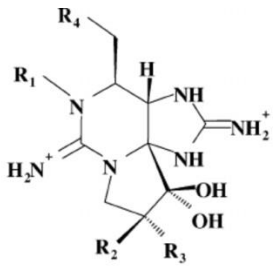
Prions: Prions, infectious agents composed of protein, are unique in that they are associated with specific forms of neurodegenerative disease. Bovine spongiform encephalopathy (BSE, or "mad cow disease") is a prion disease in cattle, associated with the variant Creutzfeldt-Jakob Disease (vCJD) in humans. Consuming bovine products containing specified risk material, e.g. brain tissue, is the most likely route of transmission of the prion agent to humans.



Prions

Chemicals: Of most concern for health are naturally occurring toxins and environmental pollutants.

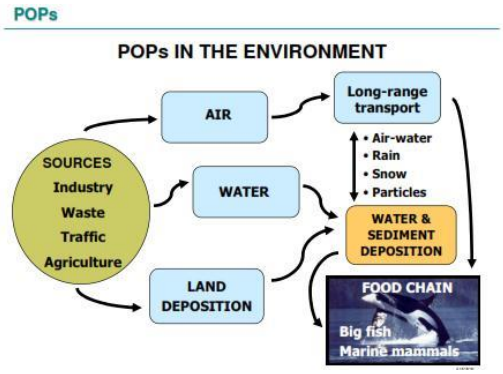
Naturally occurring toxins include mycotoxins, marine biotoxins, cyanogenic glycosides and toxins occurring in poisonous mushrooms. Staple foods like corn or cereals can contain high levels of mycotoxins, such as aflatoxin and ochratoxin, produced by mould on grain. A long-term exposure can affect the immune system and normal development, or cause cancer.



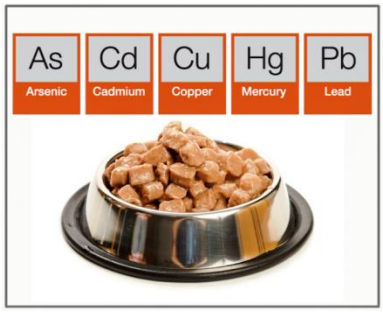
			Carbamate	N-Sulfocarbamoyl	Decarbamoy
R_4:			$-O-C(=O)-NH_2$	$-O-C(=O)-NHSO_3^-$	$-OH$
R_1	R_2	R_3			
H	H	H	STX	B1 (GTX5)	dcSTX
H	H	OSO_3^-	GTX2	C1	dcGTX2
H	OSO_3^-	H	GTX3	C2	dcGTX3
OH	H	H	NEO	B2 (GTX6)	dcNEO
OH	H	OSO_3^-	GTX1	C3	dcGTX1
OH	OSO_3^-	H	GTX4	C4	dcGTX4

Example of a naturally occurring toxin found in found in dinoflagellates and bivalve shellfish.

- **Persistent organic pollutants (POPs)** are compounds that accumulate in the environment and human body. Known examples are dioxins and polychlorinated biphenyls (PCBs), which are unwanted by-products of industrial processes and waste incineration. They are found worldwide in the environment and accumulate in animal food chains. Dioxins are highly toxic and can cause reproductive and developmental problems, damage the immune system, interfere with hormones and cause cancer.



- **Heavy metals** such as lead, cadmium and mercury cause neurological and kidney damage. Contamination by heavy metal in food occurs mainly through pollution of air, water and soil.



Date Posted (MM/DD/YYYY)	Reference	Pathogen	Product(s) Linked to Illnesses (if any)	Total Case Count
6/9/2021	1027	*Salmonella* Weltevreden	Shrimp	6
4/28/2021	24	*E.coli* O145:H28	Not Identified	16
4/21/2021	23	*Salmonella* Duisburg and *Salmonella* Urbana	Cashew Brie	7

3/17/2021	18	Acute Non-viral Hepatitis	Alkaline Bottled Water	16
2/17/2021	15	*Listeria monocytogenes*	Hispanic-style fresh and soft cheese	13
2/17/2021	14	*E.coli* O157:H7	Not Identified	22
1/13/2021	10	*Salmonella* Miami	Not Identified	65

The study was situated within the context of HACCP.

Chapter 3

Overview

1. **Food Safety System**

   Food Safety refers to handling, preparing and storing food in a way to best reduce the risk of individuals becoming sick from foodborne illnesses. Food safety is a global concern that covers a variety of different areas of everyday life. The principles of food safety aim to prevent food from becoming contaminated and causing food poisoning. This is achieved through a variety of different avenues, some of which are:

   - Properly cleaning and sanitizing all surfaces, equipment's and utensils
   - Maintaining a high level of personal hygiene, especially hand-washing
   - Storing, chilling and heating food correctly with regards to temperature, environment and equipment
   - Implementing effective pest control
   - Comprehending food allergies, food poisoning and food intolerance

Key elements of Food Safety:

- **Ensuring everyone follows good food hygiene practices:** This includes personal hygiene, safe handling of food, preventing cross-contamination, cleaning procedures, allergen control, safe storage of food, and cooking temperatures.
- **Implementing appropriate food management systems:** This refers to the overarching system that keeps food and the premises safe and hygienic. The main aspect is **HACCP**, but it also refers to record keeping, labelling, traceability, supply and delivery, and staff training.
- **Maintaining hygienic premises:** The maintenance of the building is another key aspect of risk prevention. This includes the general cleanliness and upkeep of the building, having an appropriate layout, suitable lighting, ventilation, pest control, and waste management

Understanding the difference between Pre Requisite Program (PRP), Operational Pre Requisite Program (OPRP) & Critical Control Point (CCP):

If you are a food safety practitioner you will no doubt have heard of and may even be confused by the terms PRP, oPRP and CCP.

During the intervening decades since the “launch” of HACCP, numerous food safety standards, codes of practice, and regulatory directives have adopted the principles of HACCP, and, in the process, put forth their own unique interpretation on how exactly these principles are affected.

The purpose of risk assessment and management:

When we speak of HACCP, risk assessment and determination of control measures is an aspect which many people may find difficult, if not mystifying, on occasion.

To put it simply, the basic principle is to install within the process and operation some control measures which are appropriate for the specific hazards and the risk they pose to the final consumer.

HACCP requires you to identify these potential hazards and then determine the significance of these hazards by applying risk assessment techniques, the output of which is a measure of risk which then allows us to put in place appropriate control measures, such as PRP, 0PRP, and CCP.Over the decades, various standards have attempted to define how risk assessment is carried out and how to determine control measures.

In the process they have introduced their own unique terms, language, scope, methodology and workflows, and while some of these have been good, much of this work has served only to confuse people causing HACCP plans which are unnecessarily complex and hinder the effective management of food safety.

In the context of food safety, the International Standards Organization (ISO) has defined a control measure as an action or activity that can be used to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

This definition is general and can be used to describe virtually any action, step, activity, job, task, process or procedure which has the intention of addressing a food safety hazard.

As we look closer at the main food safety standards we can see that control measures become categorized.

Categories of Control Measures:

1. <u>Critical Control Point (CCP)</u>

The CCP is perhaps the most commonly known of all the control measures, and the ISO defines it as a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

This definition is similar to the general definition of a control measure, however, a CCP differs as it relates specifically to a step in the process such as cooking, cooling, or freezing, and not a general activity or action.

A CCP differs from a control measure as it relates specifically to a step in the process, and not a general activity or action. ISO also states that a CCP is a step at which control can be applied, which means that if a 'CCP' is unable to apply control, it cannot be considered a CCP.

In scenarios where control is subjective and cannot be measured accurately, this may be problematic as control is not able to be enforced.If a CCP is unable to apply control, it cannot be considered a CCP.Finally, another factor relating to CCPis the risk posed by the hazard should the control not be exercised.

For instance, if *salmonella* were to be present in cooked meat, it would pose a significant risk to the consumer if cooking were not carried out to the required temperature and time specification.In this situation, control is a critical step and is designed and enforced specifically to control the hazard.

2. Prerequisite Program (PRP)

Defined by ISO as the basic conditions and activities necessary to maintain a hygienic environment throughout the food chain which are suitable for the production, handling and provision of safe end products and safe food for human consumption.

There are wide variety of PRPs depending on the particular product and process.

They are often described in certain sectors of the industry as Good Agricultural Practice (GAP), Good Veterinarian Practice (GVP), Good Manufacturing Practice (GMP), Good Hygienic Practice (GHP), Good Production Practice (GPP), Good Distribution Practice (GDP), and Good Trading Practice (GTP).

Examples of PRP's in a food manufacturing environment would be:

- construction and layout of buildings and associated utilities
- lay-out of premises, including workspace and employee facilities

- supplies of air, water, energy and other utilities
- supporting services, including waste and sewage disposal
- the suitability of equipment and its accessibility for cleaning, maintenance and preventative maintenance
- management of purchased materials (e.g., raw materials, ingredients, chemicals and packaging), supplies (e.g., water, air, steam and ice), disposals (e.g., waste and sewage) and handling of products (e.g., storage and transportation)
- measures for the prevention of cross-contamination
- cleaning and sanitizing
- pest control
- personnel hygiene

PRP's are usually general to the process and not focused on any particular step in the process.Failure of a PRP does not necessarily lead to an immediate and imminent food safety riskGenerally, time and repeated failure are required to create a critical change in the safety of the product.Stated another way, they usually manage more general and lower risk hazards.

3. Operatiopnal Pre Requisite Program (OPRP)

As a concept of control, it was introduced by the ISO in their food safety management standard ISO 22000 and is defined as a control measure identified by the hazard analysis as essential in order to control the likelihood of introducing food safety hazards and/or the contamination or proliferation of food safety hazards in the product(s) or in the processing environment.

What is striking about this control measure and its definition is the almost universal confusion users have in differentiating it from CCP's and PRP's.The variation in the focus of the control measures appears to be based on a subtle difference in the description of hazards and risks.In my day-to-day, I speak with others who have found it difficult to understand the nature of oPRP's.To try and clarify what exactly an oPRP is, it has been described as a specific action relating to the process, and, while not being critical for food safety, it is essential in reducing the likelihood of a specific hazard occurring.For example, a cooking step in a process may be critical to controlling the risk of a specific pathogen surviving such as E. coli.

This is an intrinsic step for producing a cooked product and its removal from the process is not possible and therefore it's correct to say that control is critical.Essentially, this means that the control applied at this step can be considered critical and is, therefore, a CCP.

Alternatively, metal detection in the same process is also designed to reduce the likelihood of a hazard reaching the consumer and arguably could be considered a CCP as well.However, the key difference is that it is not an intrinsic step required for the production of safe cooked ham.It can be removed from the process and a company can practically still produce relatively safe products.

Nonetheless, its presence may be deemed essential to reducing the likelihood of the hazard and therefore an oPRP.It is important to realize that this is simply one possible definition of an oPRP which provides some working understanding.After specific hazards are identified at a process step, a risk assessment is required to determine if the hazard is significant or not.

If significant hazards are identified then a decision tree is required to help determine if the hazard requires control and, if so, should they be controlled as a CCP, PRP or oPRP.Significance describes those hazards which present a real risk of impacting on the consumer.It may be said that significance is essentially an expression of risk.In food safety, risk is a measure of the combined severity of impact from a hazard and its probability of occurrence. In its simplest form risk is expressed as being High, Medium or Low.

Below is an example of a 5 x 5 risk assessment model along with a risk rating which uses Safefood 360° to demonstrate.

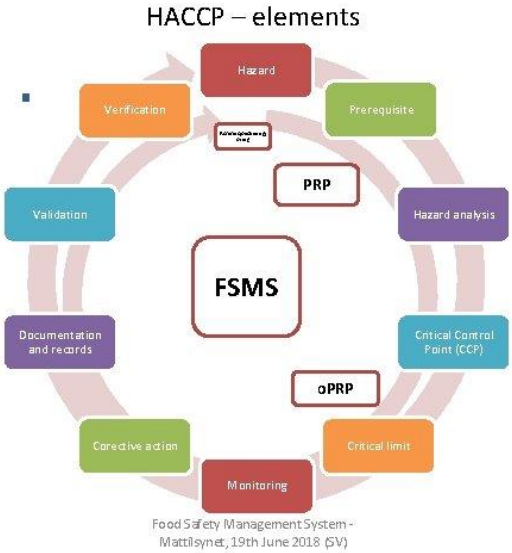
Risk rating

RISK	FROM	TO	COLOR	DESCRIPTION	SIGNIFICANT?
LOW	1	4		LOW RISK(1-4)	NO
MEDIUM	5	14		MEDIUM RISK (5-14)	YES
HIGH	15	25		HIGH RISK(15-25)	YES

1.1 The HACCP System

General Principles and Definitions:

HACCP is a preventive system for production of safe food products. It is based on technical and scientific principles applicable to every step of the food production chain, from growing/breeding activities, to production and distribution systems, to the moment the food reaches the final consumer (ICMSF 1991). HACCP systematic analysis identifies raw materials and processed foods that may contain toxic substances or agents of FBDs, or that are potential sources of contamination. It may also determine the possibility that microorganisms survive or grow during food production, processing, storage, and preparation (ICMSF 1991). HACCP was developed by Pillsbury Company, after a request from the National Aeronautics and Space Administration in the 1960s, to ensure the safety of foods used in the American space program (Bauman 1990) [23,24].HACCP is a management system in which food safety isaddressed through the analysis and control of biological,chemical, and physical hazards from raw material production,procurement and handling, to manufacturing,distribution and consumption of the finished product[13,14]. HACCP is designed for use in all segment of foodindustry from growing, harvesting, processing, manufacturing, distributing, and merchandising to preparing food forconsumption. Prerequisites programs such as CurrentGood Manufacturing Practices (CGMPS) are essentialfoundation for the development and implementation ofsuccessful HACCP plans.



HACCP is based on seven principle [15].:

1. Conduct a hazardous analysis:

The purpose of a hazardous analysis is to develop a list of hazards which are likely to cause injury or illness if they are not controlled. Points to be considered in this analysis can include: skill level of employees; transport of food; serving elderly, sick, very young children, immune-compromised; volume cooling; thawing of potentially hazardous foods; high degree of food handling and contact; adequacy of preparation and holding equipment available; storage, and method of preparation. The next step is to determine if the factors may influence the likely occurrence and severity of the hazard being controlled. Finally, the hazards associated with each step in the flow of food should be listed along with the measures necessary to control the hazard.

2. Determine Critical Control Points (CCP's):

A critical control point is any step in which hazards can be prevented, eliminated or reduced to acceptable levels.For each hazard that requires control, control points shall be reviewed to identify those that are critical. This requires a logical approach and may be facilitated by use of a decision tree. Critical control points (CCPs) shall be those control points which are required in order to prevent or eliminate a food safety hazard or reduce it to an acceptable level. If a hazard is identified at a step where control is necessary for safety but the control does not exist, the product or process shall be modified at that step, or at an earlier step, to provide a control measure. CCP's are usually practices/procedures which, when not done correctly, are the leading causes of foodborne illness outbreaks. Examples of critical control points include: cooking, cooling, re-heating, holding. To determine CCP's ask the following questions:

- At this step in preparation can food become contaminated and/or can contamination increase?
- Can this hazard be prevented through corrective action(s)?
- Can this hazard be prevented, eliminated or reduced by steps taken later in the preparation process?
- Can you monitor the CCP?
- How will you measure the CCP?
- Can you document the CCP?

3. Establish Critical Limits:

A critical limit ensures that a biological, chemical or physical hazard is controlled by a CCP. Each CCP should have at least one critical limit. Critical limits must be something that can be monitored by measurement or observation. They must be scientifically and/or regulatory based. Examples include: temperature, time, pH, water activity or available chlorine.

4. Establish Monitoring Procedures:

Monitoring is a plan which includes observations or measurements to assess whether the CCP is being met. It provides a record of the "flow of food" through the establishment. If monitoring indicates that the critical limits are not being met, then an action must be taken to bring the process back into control. The monitoring system should be easy to use and meet the needs of the food establishment, as well as the regulatory authority. It is important that the job of monitoring be assigned to a specific individual and they be trained on the monitoring technique.

5. Establish Corrective Actions:

If the criteria for a CCP is not being met, some type of corrective action must be taken. They must meet the standards established in Step 3, must be based on facts for normal working conditions and be measurable. Corrective actions may range, for example, from "continue cooking until the established temperature is reached" to "throw out the product," depending on the severity of the situation.

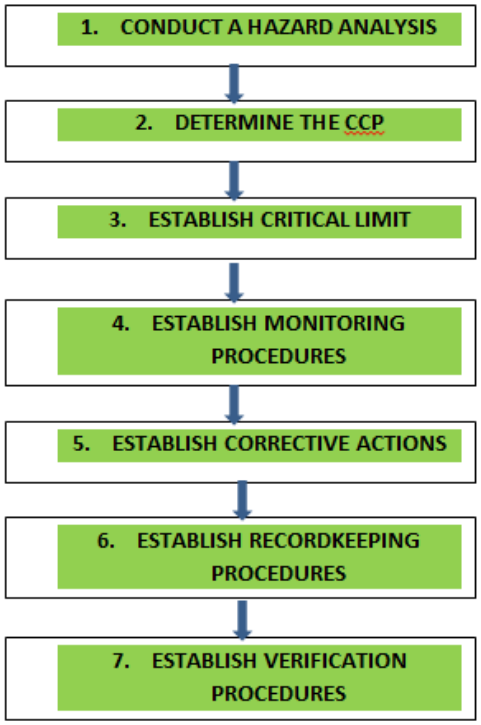
HACCP plans should include the following: who is responsible for implementing the corrective action and what corrective action was taken. They should be established in advance as part of the HACCP plan.

6. Establish verification procedures:

These procedures are activities, other than monitoring, that determine the validity of the HACCP plan and that the system is operating according to the plan. An important aspect of verification is to determine if the plan is scientifically and technically sound. Also, that all the hazards have been identified and that, if the HACCP plan is properly implemented, these hazards can be effectively controlled. Verification can be accomplished by expert advice and scientific studies and observations of the flow of food, measurements and evaluations. Another means of verification is an onsite review of the established critical limits. Each CCP will have one independent authority. This verification step provides an opportunity to make modifications to the plan if necessary.

7. Establish record-keeping and documentation procedures:

Record-keeping and documentation procedures should be simple to complete and include information that illustrates that the established standards are being met. Employees need to be trained on the record-keeping procedures and why it is a critical part of their job. Examples of records include time/temperature logs, checklists, forms, flowcharts, employee training records, and SOP's.



Food safety system based on these principles of HACCP have been applied in food processing plants, retailfood stores and food services operations [16]. HACCP havebeen universally accepted by government agencies and the food industry around the world [17,18]
as effective tool to ensure food safety. The production ofsafe food products require that the HACCP system is builtupon a solid foundation of prerequisite programs. Each
segment of the food industry must provide the conditionnecessary to protect food while it is under their control.**HACCP** is a systematic approach to the identification, evaluation,
and control of food safety hazards based on theseseven principles [19].It is important to note that, the success of a HACCP. system depends on the type of organization [20], educatingand training management and employees on the importanceof their role in producing safe foods.

This also includes information on the control of food-borne hazardsat all stages of the foodchain.

Also, specific training on working instructionsand procedures that outline the tasks of employees inmonitoring each aspect of HACCP should be organizedfor people involved in food preparation. Management offood industry must provide adequate time for thoroughеducation and training and provide personnel with materialsand equipment necessary to perform these tasks.Effective training is an important prerequisite to successfulimplementation of a HACCP [21,22].

The HACCP system has its own terminology: –

Hazard: unacceptable biological (growth or survival of microorganisms), chemical (pesticides, antibiotics, heavy metals, cleaning products), or physical (pieces of glass, metal, or other materials) contamination, rendering the food unfit for consumption.

Severity: magnitude of the hazard or of the consequences to the health of consumers. Diseases may be classified, in terms of severity, as lethal, chronic, or mild.

Risk: probability that the hazard will occur. Risk levels may be high, moderate, or low, and may vary according to the situation.

Critical control point (CCP): a place, practice, procedure, or process that may be controlled to prevent, eliminate, or reduce the hazard to acceptable levels.

Critical limit: physical (e.g., time, temperature), chemical (e.g., pH), or biological (e.g., sensorial, microbiological) attribute or value determined for each CCP, which indicates that the operation is controlled.

Monitoring: measurement of time/temperature, pH, or acidity, or visual observation of CCPs in order to assess whether critical limits are met; if they are not met, the CCP is not controlled and corrective actions are necessary.

Corrective action: immediate and specific procedures to be followed whenever critical limits are not met.

Verification: additional tests and/or review of monitoring records in order to confirm whether the HACCP plan is working as designed. Verification may cause some of the steps of the process to be changed in order to ensure food safety.

Decision tree: logical sequence of questions that enable the identification of a raw material, step in the process, or ingredient as a CCP.

Factors influencing the incidence of food-borne diseases:

Food-borne diseases have occurred ever since the beginning of human existence. The drastic increase in the cases is the consequence of different factors which are either inter-related or complex. These factors include:

(a) Food supply system:
- Mass production and distribution, leading to opportunities for contamination and larger foodborne disease outbreaks.
- A longer food chain leads to contamination, survival, and growth.
- Rapid increase in the food service establishments where the food handlers do not have the necessary hygiene training.

(b) Health and demographic situations:
- Population growth.
- Rapid growth in the vulnerable population.
- Increase in the number of individuals with poor health and lack of nutrition.
- Boom in population in the areas with no proper sanitation infrastructure and clean water supply.

(c) Lifestyle and social human behavior:
- Increase in the number of individuals eating out instead of home cooked food.
- Increase in travel has also resulted in the exposure of unsafe food.
- Lack of training and knowledge of food handling.
- Rush of small establishments to make high profit with lower investments results in comprising with the food quality making it unsafe for human consumption.
- Busy lifestyle often forces to make wrong decision for food.

(d) Environmental conditions:
- Pollution
- Climatic changes
- Ecological system, that is diminishing fresh water and adequate food supplies

Potentials of HACCP to prevent foodborne illness:

For sure the HACCP system provides the food industry and the public health authorities a powerful tool to combat foodborne illness.

- It should be realized that presently the greatest potential of HACCP system lies in the prevention of the large outbreaks.
- HACCP has been developed some 30 years ago and it has taken a toll in the following years. It has been a great tool for food safety and has been internationally recognized as a reference for food safety assurance.
- The system is implemented to major large and medium sized food industries, however more focus on its implementation should take care of. It is voluntarily adopted along with the GMP.
- This system has helped the major public health authorities to recognize hazardous practices and maintain good hygiene.
- Implementation of HACCP system is needed to prevent food contamination and in assisting those that need improving their food safety standards.

Impact of HACCP on Food Safety:

Data from the World Health Organization show that, in 2005, 1.8 million people died of gastroenteritis caused by contaminated food and water (World Health Organization 2007). In spite of the technological progress in food production and control, the occurrence of these diseases has recently increased, even in developed countries. The food hazards causing such fatal diseases are generated throughout the journey of the food. Today the food chains are becoming global and cosmopolitan, and so are the food hazards. The hazards present at one place are spreading rapidly at the other place by the global imports and exports of food products. However such food hazards can be restricted and the foods can be made free of the hazards by implementing HACCP from the collection of the raw materials to the final processing of the food product by means of monitoring the CCPs.

It can be understood in a manner that one of the major CCP in the manufacturing of milk products is pasteurization of milk and by successful monitoring of this CCP, numerous pathogens can be reduced hence reducing the diseases. Factors related to the supply chain, demographic situation, lifestyle, health system infrastructure, and the environmental conditions of each country influence the prevalence, increased frequency, and consequences of these diseases. When all these facts are taken into account, HACCP is an important tool in modern quality management in the food industry, ensuring the integrity of the product, preventing FBDs, and protecting the health of the consumer.

Further the implementation of HACCP successfully reduces the transmission of diseases to the employees working in the food plants by reducing the risk of zoonosis by adoption of better personal safety methods.

Impact of HACCP on Environment:

As the HACCP lays emphasis on “Clean Production”, therefore, it ensures the use of every single resource whether it may be water, energy or any raw material in an efficient way leading to manufacture of a priced commodity and letting out less harmful and meager waste products. Good managemental and good operational practices had a positive thrust on better storage capability of the food item, reduction in losses, discard of residues, redesign of products and production processes, and minimal and efficient use of raw material and energy thereby ensuring an overall boon to the environment. The new technologies are being used under the HACCP system which had provided an excellent scenario of decreased wastes which may pollute the environment in any form and focuses on efficient food production.

How to certify to HACCP:

We make the HACCP certification process simple. After we have received your application, we appoint a client manager who will guide you and your business through the following steps

1. **Gap analysis:**

   This is an optional pre-assessment service where we take a closer look at your existing food safety management system and compare it with HACCP requirements. This helps identify areas that need more work before we carry out a formal assessment, saving you time and money.

2. **Formal assessment:**

   This happens in two stages. First we review your organization readiness for assessment by checking if the necessary HACCP procedures and controls have been developed. We will share the details of our findings with you so that if we find gaps regarding your data security, you can close them. If all the requirements are in place, we will then assess the implementation of the procedures and controls within your organization to make sure that they are working effectively as required for certification.

3. **Certification and beyond:**

   When you have passed formal assessment you will receive an HACCP certificate, which is valid for three years. Your client manager will stay in touch during this time, paying you regular visits to make sure your system doesn't just remain compliant, but that it continually improves.

1.2 GMPSystem

It is a **system** for ensuring that products are consistently produced and controlled according to quality standards. It is designed to minimize the risks involved in any pharmaceutical production that cannot be eliminated through testing the final product. GMP covers all aspects of production from the starting materials, premises and equipment to the training and personal hygiene of staff.

They ensure that ingredients, products and packaging materials are handled safely and that food products are processed in a suitable environment. GMPs address the hazards associated with personnel and environment during food production. They provide a foundation for any food safety system.

Company's responsibility is to determine the most effective and efficient quality process**.**

Table 1: General Requirements For Food Safety Assurance In Food Industry.

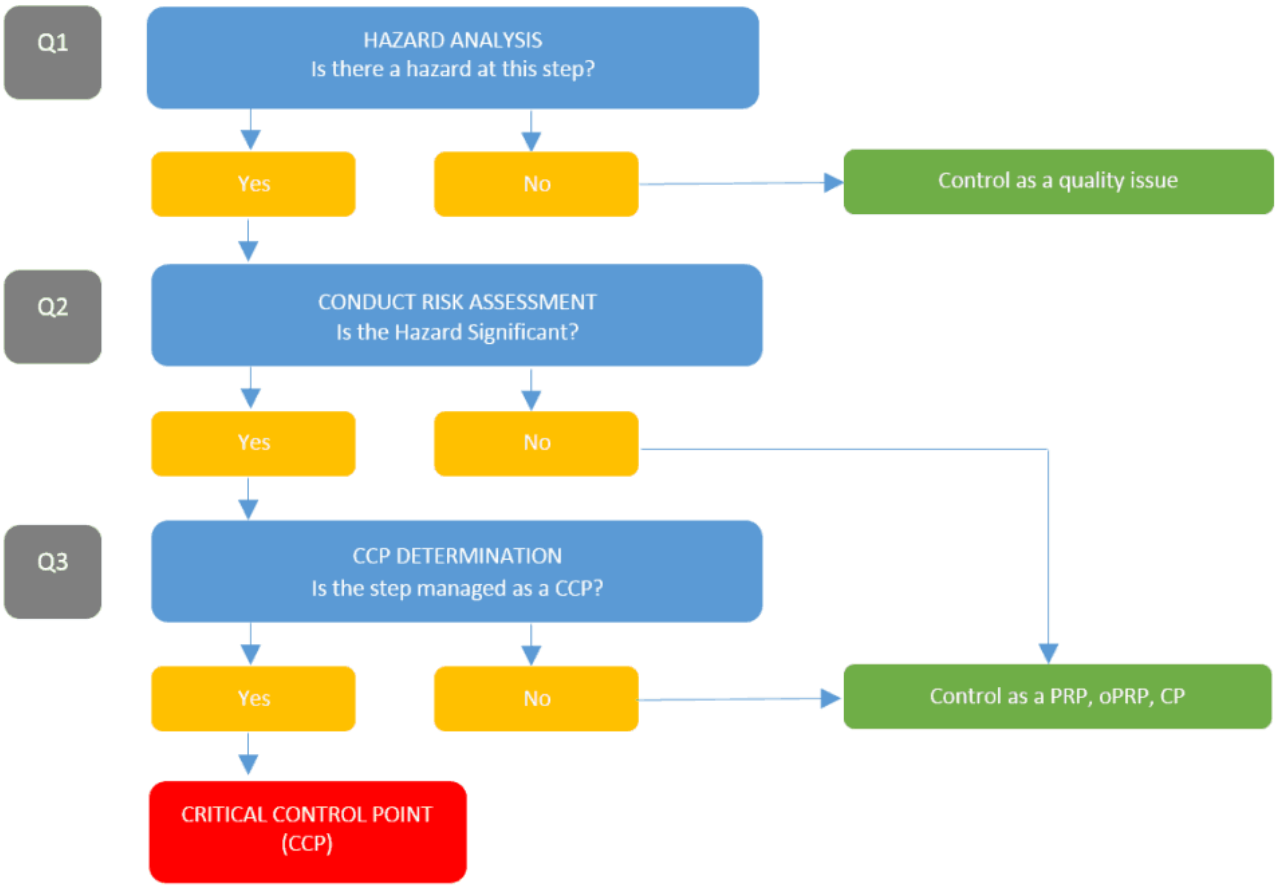
Staff	Create an appropriate organizational framework, describe the key positions, train the workers, develop behavioral and attitude competencies, supervise personal hygiene and health.
Self-Inspection	Perform internal audits, check compliance and corrective actions etc.
Quality Control	Apply good practices in the laboratory, apply sampling techniques, validate the analytical method, inspect the process, maintain, check and calibrate the measuring and monitoring devices.

Processing	Validate the process, prevent cross-contamination during manufacture, purchase good raw material, ensure the quality of the process for immediate, bulk or end product, comply legal labelling requirements, ensure good quality of end product, traceability should present.
Customer complaints	Handle the complaints, document the withdrawals and recalls, analyze the root cause.
Warehousing	Warehousing involves 3 activities (receiving, storage and Shipping) that are included in a quality control program.
Regulations	Apply mandatory requirements, follow contractual requirements.

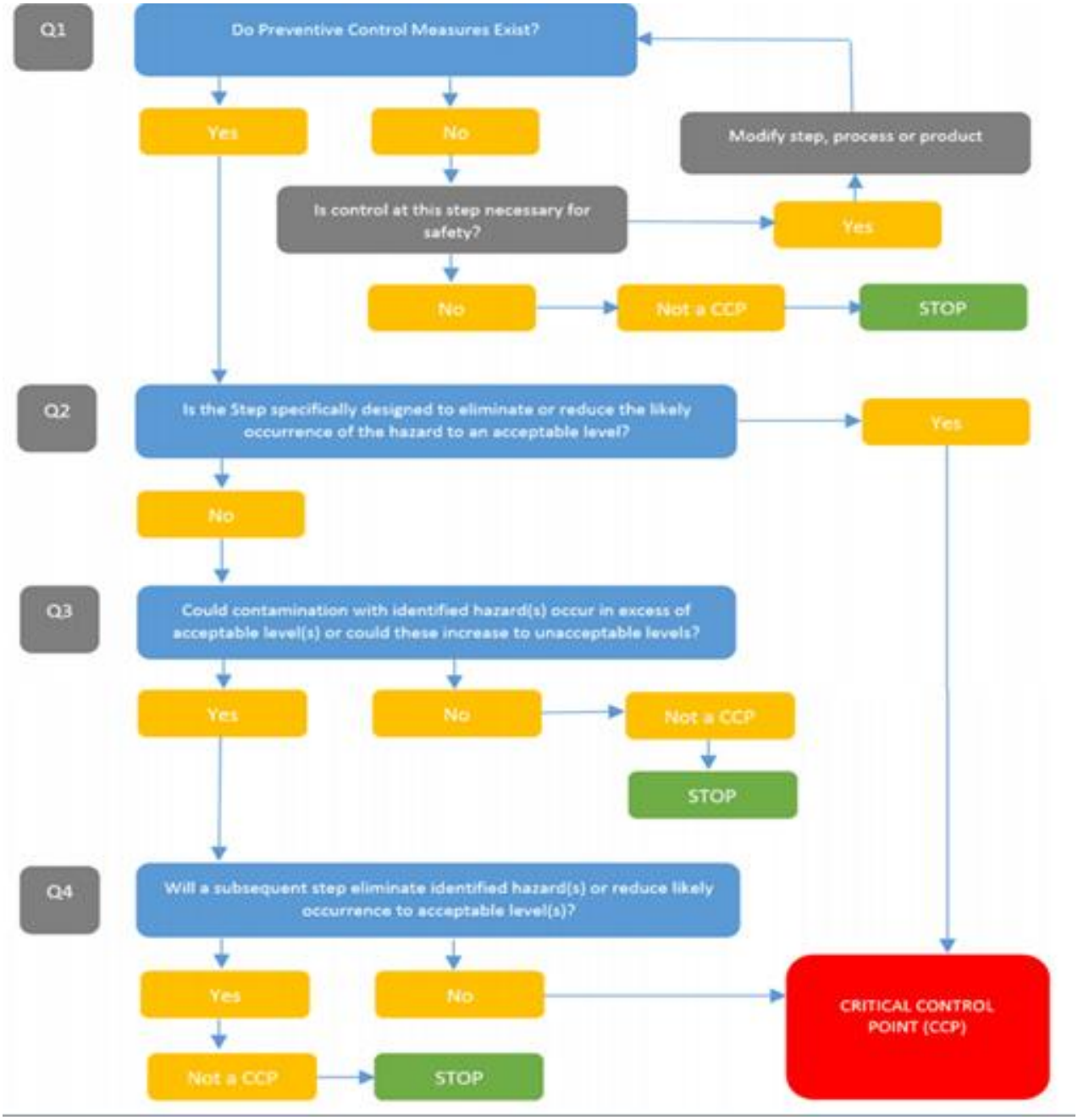
Table2: Decision Tree

Decision Tree A decision tree is used to determine critical control points once a hazard analysis has been performed on the food	
Question 1	Does this step involve a hazard of sufficient likelihood of occurrence and severity to warrant its control?
Question 2	Does a control measure for the hazard exist at this step?
Question 3	Is control at this step necessary to prevent, eliminate, or reduce the risk of the hazard to consumers?

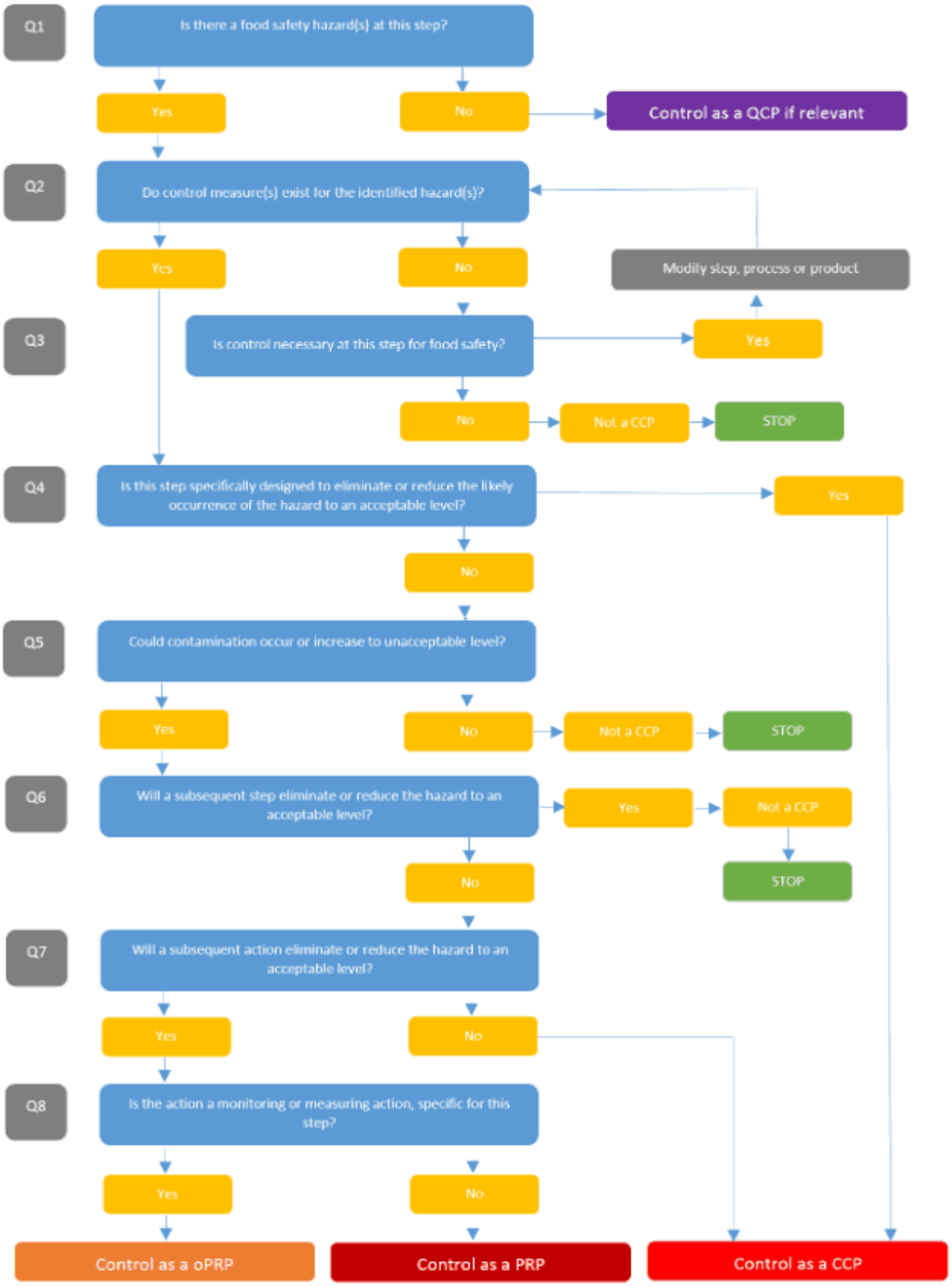
SIMPLE DECISION TREE



CODEX DECISION TREE



ROBUST EXAMPLE



1.3. Food Distribution Systems

Physical flows and storage of products from the final production point to the customer or end user is known as distribution management process (34)**.** After procuring agricultural raw materials, food manufacturers process those before further distribution. The processing step includes ranging from simple packaging of fresh produce to extensive cooking or preservation operations. General conditions according to the HACCP Guide for Good Sanitary Practice in transportation are as follows.

1) Means of transport have to be constructed in a way to enable efficient cleaning and disinfection; they must be physically separated in order to prevent contamination.
2) Needs to be at a specific temperature level, have to ensure proper temperature control

1.4. Food Safety

The food distribution system was shown in **Figure 2**. Food safety generally refers to the prevention of illnesses resulting from the consumption of contaminated food.

Figure 2

1.5. Food Quality

Food quality is not only refers to the physical properties of food products, but also on the way the product is perceived by the final consumer (35). This includes microbial aspects, texture and flavor. Quality assurance dominates the process of production, distribution and the costs for

certification, auditing. It also evokes responses like technological innovation to create higher efficiency and reduce costs. New technological developments such as time-temperature integrators or indicators can be used to improve temperature monitoring throughout the distribution system (36). This allows improved shelf life estimation of food products e.g. Pork, poultry and fish chains (37.). The most important quality monitoring systems in the food industry are: Global Food Safety Initiative (GSFI), International Food Standard (IFS), International Organization for Standardization (ISO), Safe Quality Food (SQF) and British Retail Consortium (BRC). The aim of these norms is to help the retailers to ensure safety of their products and food quality monitoring

Table 3: Pre- Requisite Program In Food Industry.

Prerequisite Programs	
Facilities	Establishment should be located, constructed and maintained according to sanitary design principles. There should be linear product flow and traffic control to minimize cross contamination from raw to cooked materials
Supplier Control	Each facility should assure that its suppliers have in place effective Good Manufacturing Practices (GMP) and food safety programs. These may be the subjects of continuing supplier guarantee and supplier HACCP system verification.
Specifications	There should be written specifications for all ingredients, products, and packaging materials.
Production Equipment	All equipment should be constructed and installed according to sanitary design principles. Preventive maintenance and calibration schedules should be established and documented
Cleaning and Sanitation	All procedures for cleaning and sanitation of the equipment and the facility should be written and followed. A master sanitation schedule should be in place
Personal Hygiene	All employees and other persons who enter the manufacturing plant should follow the requirements for personal hygiene
Training	All employees should receive documented training in personal hygiene, Good Manufacturing Practices (GMP), cleaning and sanitation procedures, personal safety, and their role in the HACCP program.

Chemical Control	Documented procedures must be in place to assure the segregation and proper use of on-food chemicals in the plant. These include cleaning chemicals, fumigants, and pesticides or baits used in or around the plant.
Receiving, Storage and shipping	All raw materials and products should be stored under sanitary conditions and proper environmental conditions such as temperature and humidity to assure their safety and wholesomeness.
Traceability and Recall	All raw materials and products should be lot-coded and a recall system in place so that rapid and complete traces and recalls can be done when a product retrieval is necessary
Pest Control	Effective pest control programs should be in place.
Standard Operating Procedures	Sanitation practices and procedures must be in place, along with procedures for receiving, storage and shipping

1.6 Awareness

This section of the literature review is devoted to a discussion to clarify the term "awareness" and how it is measured in this study. To begin the discussion awareness is often equated to consciousness. "We have some control over the contents of our consciousness. We can focus our awareness; we can pay attention to certain stimuli" (44). Students often choose to direct their attention to specific information, particularly when they are listening to a lecture for the purpose of passing a test. In the food handlers' situation, the test is a certifying instrument and in this case attention to the material is heightened. Motivation can be high for the test-takers to go beyond awareness to understanding when their jobs depend on passing the test. Studies in 1953 by Hovland, Janis, and Kelley and a study in 1968 by McGuire described a five step

process that delineated the sequence for change in attitude to occur. The steps are the following:

1) Attention (noticing)
2) Comprehension (understanding)
3) Yielding (acceptance)
4) Retention (remember)
5) Action (implement)

This study equates the first step, "attention," with the definition of "awareness." The trainees in this study paid "attention" to the information because it meant continued employment and financial stability. Another way to look at the definition is through the eyes of an instructional designer that differentiates between the concept level and the application level. The Awareness of 25 concept level can be described as recall of facts presented by the trainer without using analysis. The second level is the application level, which an instructional designer incorporates into the majority of lesson designs. At this level information is presented, practiced and analyzed. The instructional designer would define "awareness" at the recall or first level (45). HACCP is a recently developed system; therefore, the researcher did not find awareness surveys on this topic. Awareness surveys have been used in other industries to address safety issues. The survey was designed to obtain data on the attitudes, level of commitment and awareness of mine personnel towards safety issues from over 2000 survey participants. This study found that respondents were not satisfied with the amount of safety training. (46). Another study entitled, "Is Education the Missing Link in Ergonomics," was conducted to ascertain keyboard operators' awareness. A questionnaire assessed three groups of participants prior to training and after. The results of the study showed that awareness of ergonomic controls needed to be increased (47). The Hazard Analysis Critical Control Point topic was selected for this study because of the tremendous "growth" pressures that are affecting the food industry and the need for increased awareness of food safety issues by employees. The combination of rapid growth in the food service industry without adequate training and subsequent Awareness of 26 implementation are situations that create an environment for increased food-borne illness. The following chapter will describe an overview of the study including the purpose, methodology, target population, and questionnaire items.

Purpose:

The purpose of this study is to identify the awareness of HACCP exhibited by food handlers who received their training at Goodwill Consultancy Dubai. The findings may provide preliminary

data, which the college administration will analyze to determine the need to increase HACCP training.

Methodology/Procedures:

This study examines awareness of Hazard Analysis Critical Control Point (HACCP) system by food service/food processing personnel who responded to a six-item Questionnaire. The questionnaires were distributed to trainees at the completion of an eight-hour food handler class that was conducted between Feb 2021 to April 2021. This method of distribution was decided upon so that the responses would be indicative of the attitudes of majority of the population surveyed. This decision was based on the fact that if the participants received their questionnaire in the mail it could skew the results, since a limited number of participants would return the survey with only the most focused individuals replying. This methodology of surveying the entire class and asking them to return the questionnaire before leaving, gave an opportunity to increase the response rate for a more accurate picture of HACCP awareness. It also minimized the potential effect of time lapse on trainees' recall the concepts. The following timeline is a guide for the activities of the study. HACCP compliance is currently required of food processors of seafood, poultry, egg, and meat.

Overview of Target Population:

The questionnaires for this proposal were disseminated to one hundred individuals after they completed an eight-hour food handlers' class. The researcher does not personally know the participants. The following charts give a broad overview of the intense interest in this class, not only by the English-speaking population, but by Arabic and Hindi as well. The following demographics indicate the number of individuals that enrolled in the food handlers' eight-hour class at Goodwill Consultancy during the 2021-2021 academic year.

Questionnaire:

The questionnaire included the following questions:

1. Did you increase your knowledge ofsanitary practices as a result of your Food Handler training?
2. Did your instructor discuss HACCP in your class?
3. The primary purpose of HACCP is to practice sanitation principles?
4. A log of daily cleaning of restrooms is a mandatory element of HACCP?
5. Hand washing is a critical control point?

6. Would you recommend this training for others?

Survey Questions to Determine Awareness:

Who: Approximately all the individuals who have completed the eight hour "food handler" training at goodwill consultancy were included in the study. This is a small sample when compared to the numbers of food handlers in the United Arab Emirates. The majority of participants of this study include entry-level employees, but managers are included as well.

What: A six-item questionnaire was developed so that respondents had only two choices of response either "Yes" or "No". The researcher expected a return rate of greater than 75%, since the questionnaire was distributed at the conclusion of the food handler class; but the actual return rate was 69%.

How it was Measured: Descriptive statistics are used to summarize participant awareness. Since the goal of this study is to establish a baseline measure of awareness, no further analysis is necessary

Analysis of Data: One hundred surveys were distributed and sixty-nine were collected. This is a return rate ofsixty-nine percent (69%). The high return rate can beattributed to the fact that the survey's were distributed at the end ofthe class along withthe class evaluation and collected the same day.

Results- Statistical: The results are as follows for all questions, but only question three, four and fivepertain to the evaluation ofHACCP awareness.

Questionnaire - Awareness of HACCP by Food Handler Trainees

Questionnaire- Awareness of HACCP by Food Handler Trainees				
SN	Questions	Yes	No	No Response
1	Did you increase your knowledge ofsanitary practices as	100%	0%	

	a result of your Food Handler training?			
2	Did your instructor discuss HACCP in your training?	99%	1%	
3	The primary purpose of HACCP is to practice sanitation principles?	76%	24%	
4	A log of daily cleaning of restrooms is a mandatory element of HACCP?	70%	28%	2%
5	Hand washing is a critical control point?	77%	23%	
6	Would you recommend this training for others?	98%	2%	

Chapter 4

Food Safety Management System:

HACCP represents an integrated system of food safety control in all the phases of its production and distribution (**Figure 3**). It was developed in the USA in 1960 as a help in food preparation for astronauts, and is also one of the first systems for food safety control widely accepted in food processing. There are two main components to HACCP: Hazard Analysis (HA) and Critical Control Points (CCP). Hazard Analysis (HA) is a risk analysis with which dangers at every stage of production and delivery and it evaluates the levels of those dangers and how they affect human health. Critical Control Points (CCP) in the food chain are those points which enable complete prevention or elimination of risks or at least reduction of risks onto an acceptable level, as well as their control to ensure food safety. Five branches of food industry demanding the implementation of the HACCP system are production, processing, storage, transport, distribution.

The first safety is security of food source (food security), important in the underdeveloped countries, while the second safety is the one related to the sanitary correctness (food safety). One of the elements of the food safety relates to the legislation enforcement and food control, and is performed by the system of rapid information on food for humans and animals RASFF (Rapid Alert System for Food and Feed) which enables rapid flow of information about new risks. Product changes are often reduced by temperature-controlled storage and distribution, which, however, normally require a significant amount of energy, there by negatively affecting the environmental impact of the products (38,39) discussed the challenges the cold storage and distribution sector faces with respect to environmental concerns and increasing electricity costs. Nowadays, systems that are originally designed to control food safety (e.g. HACCP) are also used to increase the product quality throughout the supply chain (40**).** This also concerns nutritional quality, as can for instance be seen in the recent development of the nutritional control points (NCP) concept **(**41). This is based on the HACCP system, and can be used to identify the critical points in production and distribution systems related to nutritional product changes and eventually help to increase nutritional quality.

Figure 3

Handle Foods Safely

Although most healthy people will recover from a foodborne illness within a short period of time, some can develop chronic, severe, or even life-threatening health problems. In addition, some people are at a higher risk for developing foodborne illness, including pregnant women, young children, older adults, and people with weakened immune systems (such as transplant patients and individuals with HIV/AIDS, cancer, or diabetes). To keep your family safer from food poisoning, follow these four simple steps:

1. Clean,
2. Separate,
3. Cook,
4. Chill.

1. CLEAN

Wash hands and surfaces often

- Wash your hands with warm water and soap for at least 20 seconds before and after handling food and after using the bathroom, changing diapers, and handling pets.
- Wash your cutting boards, dishes, utensils, and counter tops with hot soapy water after preparing each food item.
- Consider using paper towels to clean up kitchen surfaces. If you use cloth towels, launder them often in the hot cycle.
- Rinse fresh fruits and vegetables under running tap water, including those with skins and rinds that are not eaten. Scrub firm produce with a clean produce brush.
- With canned goods, remember to clean lids before opening.

2. SEPARATE

Separate raw meats from other foods

- Separate raw meat, poultry, seafood, and eggs from other foods in your grocery shopping cart, grocery bags, and refrigerator.
- Use one cutting board for fresh produce and a separate one for raw meat, poultry, and seafood.
- Never place cooked food on a plate that previously held raw meat, poultry, seafood, or eggs unless the plate has been washed in hot, soapy water.
- Don’t reuse marinades used on raw foods unless you bring them to a boil first.

3. COOK

Cook to the right temperature

- Color and texture are unreliable indicators of safety. Using a food thermometer is the only way to ensure the safety of meat, poultry, seafood, and egg products for all cooking methods. These foods must be cooked to a safe minimum internal temperature to destroy any harmful bacteria.

- Cook eggs until the yolk and white are firm. Only use recipes in which eggs are cooked or heated thoroughly.
- When cooking in a microwave oven, cover food, stir, and rotate for even cooking. If there is no turntable, rotate the dish by hand once or twice during cooking. Always allow standing time, which completes the cooking, before checking the internal temperature with a food thermometer.
- Bring sauces, soups and gravy to a boil when reheating.

4. CHILL

Refrigerate foods promptly

- Use an appliance thermometer to be sure the temperature is consistently 40° F or below and the freezer temperature is 0° F or below.
- Refrigerate or freeze meat, poultry, eggs, seafood, and other perishables within 2 hours of cooking or purchasing. Refrigerate within 1 hour if the temperature outside is above 90° F.
- Never thaw food at room temperature, such as on the counter top. There are three safe ways to defrost food: in the refrigerator, in cold water, and in the microwave. Food thawed in cold water or in the microwave should be cooked immediately.
- Always marinate food in the refrigerator.
- Divide large amounts of leftovers into shallow containers for quicker cooling in the refrigerator.

HACCP HAND WASHING GUIDELINES

Hazard:

Toilet paper slips and tears, and a person can get 6 log pathogens on fingertips.

Control:

When coming from the toilet, do the double wash with a nail brush for a 6 log reduction by dilution.

1. Nail brush friction, detergent, and water (45 to 110ºF), 3 log reduction

2. Second wash, no nail brush, 2 log reductions

3. Paper towel dry, 1 log reduction

Validation:

1. Contaminate fingertips 7 log with non-pathogenic *E. coli*

2. Double fingertip wash, 6 log reduction

3. Petrifilm™ recovery E. coli <10 total

HACCP FOOD RECEIVING AND STORAGE GUIDELINE

Hazard:

Pathogens from raw food can cross-contaminate ready-to-eat food.

Control:

•Raw food: time and temperature not CCP; washing or cooking makes food safe

•Ready-to-eat food on top

•Air flow: 50 feet per minute holding; 1,000 feet per minute cooling;41ºF, 7 days; 45ºF, 4 days; 50ºF, 2.5 days;70ºF, 18 hours; 110ºF, 4 hours

•Humidity 70% to prevent mold growth; 95% to prevent drying of fruits and vegetables

Validation:

Instant mashed potatoes with *E. coli* in a container; Store, measure temperature, measure growth.

HACCP FOOD CONTACT SURFACE WASHING GUIDELINE (cutting boards, knives)

Hazard:

Campylobacter jejuni from chicken (1,000 to 10,000 on surface) and *Vibrio* from seafood

Control:

1. With warm water running over the cutting board into a disposal, scrub with a brush for a few seconds; 3 log reduction by dilution

2. In the pot and pan sink, scrub again; 2 log reduction by dilution

3. Rinse to remove soap

4. Sanitize, air dry

Validation:

1. Put 7 log E. coli on the cutting board

2. Wash and sanitize

3. Swab 8 square inches,<10 E. coli

HACCP WASHING AND BLANCHING FRUITS AND VEGETABLES GUIDELINE (VEGETATIVE BACTERIA)

Hazard:

Raw fruits and vegetables are contaminated in the pores of the surface.

Chemicals do not affect pathogens in the surface.

Control:

The bacteria must be removed by brush friction or water turbulence.

The following reduces bacteria, parasites, and viruses about 2 log by dilution.

1. Trim.

2. Wash in turbulent water. Transfer to 2nd sink.

3. Rinse in turbulent water, 2nd sink.

4. Spin dry.

Chemicals can be used in a 3rd sink, but have a limited effect, 1 log. Blanch fruit or vegetable in 160ºF water, 1 minute, for a 5 log reduction.

Validation:

Put *E. coli* on food and measure before and after treatment, using *E. coli* Petrifilm™.

HACCP FOOD PASTEURIZATION GUIDELINE (VEGETATIVE BACTERIA)

Hazard:

Pathogens contaminate raw meat, fish, and poultry.

Control:

Salmonella is the target pathogen. Reduce *Salmonella* 5 log. (Assumes the food is contaminated with about 1,000 / gram, and must be reduced by 1 per 100 grams.)

Validation:

• Contaminate with non-pathogenic E. coli. Take sample before heating, 5 log reduction.

HACCP FOOD HOT HOLD GUIDELINE (SPORE CONTROL)

Hazard:

• The surface of food with a center temperature of 140ºF in a steam table exposed to air with a relative humidity of 50% will be about 117ºF because of evaporative cooling.

• *Clostridium perfringens* will grow<125ºF.

Control:

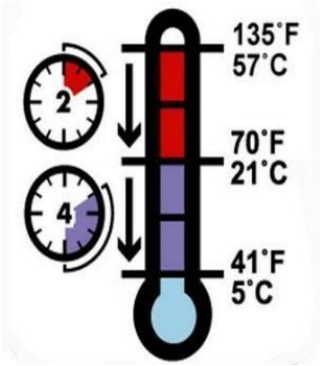
Keep food covered; keep high humidity, >90%, above food; or cover food with something like a butter sauce or cheese.

Validation:

• Make a pan of instant mashed potatoes with cooked ground beef on the surface.

• Measure temperature. Hold in a steam table for 4 hours. Measure *Clostridium perfringens*.

HACCP FOOD COOLING GUIDELINE (SPORE CONTROL)



Hazard:

Clostridium botulinum, Bacillus cereus, and Clostridium perfringens spores will germinate and multiply if cooling is too slow between 125 and 80ºF.

Control:

• Cool fast enough between 120 and 80ºF to prevent outgrowth of spores

Pre-cool at room temperature.

• Blast cooler 1,000 feet per minute air, 38ºF, 2-inch pan, 6 hours.

• Ordinary refrigerator 50 feet per minute air, 2-inch pan, 15 hours

Validation: Cool hamburger to 160 ºF to pasteurize the food and activate the spore. Put in a test container

• Cook hamburger to 160ºF to pasteurize the food and activate the spore. Put in a test container.

• Cool. Take a center sample before and after cooling. Determine if there is growth using Petrifilm™.

Process Step	Identification of Hazards	Hazard Analysis/Risk Analysis	PRP / OPRP/ CCP		Q1	Q1A	Q2	Q3	Q4	CCP (Y/N)	Reason For Decision
Purchase	**Biological:** Contamination with pathogens & spoilage micro organisms **Chemical:** Presence of toxic chemicals eg. Pesticides in fruits and veg. Antibiotics in meat, fish Excessive levels of additives. **Physical:** Presence of foreign bodies. (insect,plastic,stones etc.)	Likelihood – 1 Severity – 3 Risk – 3 Likelihood – 1 Severity – 2 Risk – 2 Likelihood – 3 Severity – 1 Risk - 3	CP CP CP	Use of Approved Suppliers only						No No No	All purchases are made from approved suppliers. This can eliminate or reduce hazard to a safe level.
Receiving	**Biological:** Contamination with pathogens & spoilage micro organisms **Chemical:** Presence of toxic chemicals eg. Pesticides in fruits and veg. Antibiotics in meat, fish Excessive levels of additives. **Physical:** Presence of foreign bodies. (insect,plastic,stones etc.)	Likelihood – 1 Severity – 3 Risk – 3 Likelihood – 2 Severity – 3 Risk – 6 Likelihood – 1 Severity – 3 Risk – 3	CP OPRP CP	Controlled by SOPs at receiving. Suitable Packaging. Staff Hygiene and SOP training Temp. Control Chilled 5 and below Frozen -18 and below Delivering with not proper temp to be rejected.						No No No	The chances of contamination at receiving is low as the items are purchased from approved suppliers & received in packed condition by trained staff. Minimal chances due to strong SOP and further can be reduced while cooking. All purchases are made from approved suppliers. Raw material deliveries are closely inspected and rejected if needed.

				Use of Approved Suppliers only. Raw material inspection.							
Washing/ Sanitization	**Biological:** Survival of pathogens & spoilage micro organisms **Chemical:** Presence of toxic chemicals on fruits and vegetables due to excessive use of sanitization chemical **Physical:** Presence of foreign bodies. (insect,plastic,stones etc.)	Likelihood – 3 Severity – 3 Risk – 9 Likelihood – 1 Severity – 3 Risk – 3 Likelihood – 1 Severity – 1 Risk - 1	CP CP CP	Controlled by SOPs Staff Hygiene and training Cleaning and disinfection of food contact surfaces. Using proper concentration sanitizing chemicals. Proper washing as per manufacturers instruction Separate storage of chemicals Staff Hygiene and training	Y		Y			Yes No No	Fruits and vegetables are used also for raw consumption. If not washed properly (concentration, contact time) the hazard will reach the consumer. There will be no subsequent steps to reduce it to safe level. Minimal chance if strong SOP and carrying out manufactures instructions. Training the staff on SOP.

Dry Storage	**Biological:** Contamination with harmful microorganisms through faeces, urine and contact of pest. **Multiplication** of molds, yeast due to improper storage conditions. **Chemical:** Contamination with toxic chemicals eg. Pesticides chemicals etc **Physical:** Presence of foreign bodies like insect, plastic, stones, pest droppings	Likelihood – 1 Severity – 3 Risk – 3 Likelihood – 1 Severity – 2 Risk – 2 Likelihood – 1 Severity -2 Risk – 2 Likelihood – 1 Severity -1 Risk – 1	CP PRP CP CP	Good building proofing and maintenance. Good housekeeping practices. Integrated pest control. Food shall be covered and protected. Maintain cool dry condition. Monitor relative humidity and stock rotation. Chemicals shall be labelled and stored separate from food. Good building proofing and maintenance. Good housekeeping practices. Integrated pest control. Food shall be						No No No No	Minimal chances due to strong SOP during storage and pest control practices. Very less chances of microbial multiplication due to temp &RH control & stock rotation. Minimal chances due to separate storage of chemicals and proper labelling. Minimal chances due to strong SOP during storage and pest control practices.

				covered and protected .							
Chilled Storage	**Biological:** Contamination with pathogens & spoilage micro organisms **Multiplication:** of pathogenic and spoilage microbes **Chemical:** Presence of toxic chemicals eg. Cleaning and sanitizing chemicals **Physical:** Presence of foreign bodies from the food handler(hair, nailetc.) or from storage or utensil (nuts, blots)	Likelihood – 1 Severity – 2 Risk – 2 Likelihood – 3 Severity – 3 Risk – 9 Likelihood – 1 Severity – 3 Risk – 3 Likelihood – 1 Severity – 1 Risk - 1	CP CP CP CP	Food covered and protected , segregated from the raw and high risk items, training of the staff on SOP and Hygiene. Temp control chilled items below 5 Proper washing as per manufacturers instruction Separate storage of chemicals Staff hygiene &SOP Training Preventive Maintenance program	Y		N	Y	N	No Yes No No	Minimal chances due to strong SOP during chilled storage Fruits, vegetables, RTE, dairy are used also for raw consumption. There will be no subsequent steps to reduce it to safe level. Minimal chance if strong SOP and carrying out manufactures instructions. Minimal chances due to strong SOP during chilled storage .
Frozen Storage	**Biological:** Contamination with pathogens & spoilage micro	Likelihood – 1 Severity – 1 Risk – 1	CP	Food covered and protected						No	Minimal chances due to strong SOP during frozen storage

	organisms **Multiplication:** of pathogenic and spoilage microbes **Chemical:** Presence of toxic chemicals eg. Cleaning and sanitizing chemicals **Physical:** Presence of foreign bodies from the food handler(hair, nailetc.) or from storage or utensil (nuts, blots)	Likelihood – 2 Severity – 3 Risk – 6 Likelihood – 1 Severity – 3 Risk – 3 Likelihood – 1 Severity – 1 Risk - 1	OPRP CP CP	, segregated from the raw and high risk items, training of the staff on SOP and Hygiene. Temp control chilled items below -18 Staff hygiene &SOP Training Proper washing as per manufacturers instruction Separate storage of chemicals Staff hygiene &SOP Training Preventive Maintenance program						No No No	Least bacterial growth at frozen condition. Minimal chance if strong SOP and carrying out manufactures instructions. Minimal chances due to strong SOP during frozen storage
Thawing	**Biological:** Contamination with pathogens & spoilage micro organisms **Multiplication:** of pathogenic and spoilage microbes as	Likelihood – 1 Severity – 2 Risk – 2 Likelihood – 2	CP OPRP	Raw foods should be thawed in a separate area to prevent cross						No No	Minimal chances due to strong SOP during thawing storage Fruits, vegetables, RTE, dairy are used also for raw

	well as toxin production. **Chemical:** Presence of toxic chemicals eg. Cleaning and sanitizing chemicals **Physical:** Presence of foreign bodies from the food handler(hair, nailetc.) or from storage or utensil (nuts, blots)	Severity – 3 Risk – 6 Likelihood – 1 Severity – 3 Risk – 3 Likelihood – 1 Severity – 1 Risk - 1	CP CP	contamination with high risk foods. Rapid thawing not exceeding 72 hours and 5C Proper washing as per manufacturers instruction Separate storage of chemicals Staff hygiene &SOP Training Preventive Maintenance program						No No	consumption. There will be no subsequent steps to reduce it to safe level. Minimal chance if strong SOP and carrying out manufactures instructions. Minimal chances due to strong SOP during chilled storage .
Frozen Storage	**Biological:** Contamination with pathogens & spoilage micro organisms **Multiplication:** of pathogenic and spoilage microbes **Chemical:** Presence of toxic chemicals eg. Cleaning and	Likelihood – 1 Severity – 1 Risk – 1 Likelihood – 2 Severity – 3 Risk – 6 Likelihood – 1 Severity – 3	CP OPRP CP	Food covered and protected, segregated from the raw and high risk items, training of the staff on SOP and Hygiene.						No No No	Minimal chances due to strong SOP during frozen storage Time and temperature control during thawing can prevent the multiplication of harmful bacteriaand toxin products to dangerous levels for high risk food.

	sanitizing chemicals **Physical:** Presence of foreign bodies from the food handler(hair, nailetc.) or from storage or utensil (nuts, blots)	Risk – 3 Likelihood – 1 Severity – 1 Risk - 1	CP	Temp control chilled items below -18 Staff hygiene &SOP Training Proper washing as per manufacturers instruction Separate storage of chemicals Staff hygiene &SOP Training Preventive Maintenance program						No	Cooking can also eliminate bacteria. Minimal chance if strong SOP and carrying out manufactures instructions for chemical usage. Minimal chances due to strong SOP during thawing.
Preparation	**Biological:** Contamination with pathogens & spoilage micro organisms **Multiplication:** of pathogenic and spoilage microbes **Chemical:** Chemical residue of	Likelihood – 1 Severity – 3 Risk – 3 Likelihood – 1 Severity – 2 Risk – 2	CP CP CP	Segregated from the raw and high risk items, training of the staff on SOP and Hygiene. Color coding of utensils. Exclude staff with infectious disease. Proper						No No No	Minimal chances due to strong SOP during preparation. Minimal chances due to time-temperature control during preparation.

	sanitizing chemicals **Physical:** Presence of foreign bodies from the food handler(hair, nailetc.) or from storage or utensil (nuts, blots)	Likelihood – 1 Severity – 2 Risk – 2 Likelihood – 1 Severity – 1 Risk - 1	CP	cleaning of food contact surfaces. High risk food not to exceed ambient temp for more than 20 min. Hazardous Raw food not to exceed ambient temp for more than 45 min Proper washing as per manufacturers instruction Separate storage of chemicals Staff hygiene &SOP Training Preventive Maintenance program						No	Minimal chance if strong SOP and carrying out manufactures instructions. Minimal chances due to strong SOP during preparation .
Cooking/ Baking	**Biological:** Contamination with pathogens & spoilage micro organisms	Likelihood – 1 Severity – 1 Risk – 1	CP	Food protected from contamination. Staff hygiene	Y		Y			No Yes	Minimal chances due to strong SOP during cooking Undercooked

	Survival: of pathogenic and spoilage microbes **Chemical:** Presence of toxic chemicals due to incorrect use of utensils. **Physical:** Presence of foreign bodies from the food handler(hair, nail etc.) or from storage or utensil (nuts, blots)	Likelihood – 3 Severity – 3 Risk – 9 Likelihood – 1 Severity – 2 Risk – 2 Likelihood – 1 Severity – 1 Risk - 1	CCP CP CP	&SOP Training Clean and disinfect food contact surfaces. Critical limit 75. Food should be cooked thoroughly to ensure the core tempt has reached above 75 . Baking min 180. Usage of food grade stainless steel equipment and utensils for cooking. Staff hygiene &SOP Training Preventive Maintenance program visual inspection.						No No	food shall result in incomplete destruction of harmful bacteria. No subsequent steps to reduce it to safe level Minimal chance if strong SOP during cooking. Minimal chances due to strong SOP and control measures during cooking
Cooling	**Biological:** Contamination with pathogens & spoilage micro organisms	Likelihood – 1 Severity – 2 Risk – 2	CP	Food protected from contamination.						No	Minimal chances due to strong SOP and control measure during cooling.

	Multiplication: of pathogenic and spoilage microbes as well as toxin production. **Chemical:** Not expected to occur **Physical:** Presence of foreign bodies from the food handler(hair, nailetc.) or from storage or utensil (nuts, blots)	Likelihood – 3 Severity – 3 Risk – 9 Likelihood – 1 Severity – 1 Risk - 1	CCP CP	Staff hygiene &SOP Training Clean and disinfect food contact surfaces. Rapid cooling (blast chiller)and refrigeration. Blast chiller cooled food below 5 in less than 1.5 hours or 20C/ 2hrs, room tempt then 5C/4 chiller. Staff hygiene &SOP Training Preventive Maintenance program	Y		N	Y	N	Yes No	Slow cooling leads to multiplication of harmful bacteria that survived during cooking and germination of bacteria spores. No subsequent steps to reduce it to safe level Minimal chances due to strong SOP and control measure during cooling .
Packing	**Biological:** Contamination with pathogens & spoilage micro organisms **Multiplication:** of pathogenic and spoilage microbes	Likelihood – 1 Severity – 2 Risk – 2 Likelihood – 1 Severity – 2 Risk – 2	CP CP	Food covered and protected, segregated from the raw and high risk items,						No No	Minimal chances due to strong SOP and control measure during packing. Minimal chances due to tempt-time control during packing.

	Chemical: Contamination with toxic chemicals **Physical:** Presence of foreign bodies from the food handler(hair, nailetc.) or from storage or utensil (nuts, blots)	Likelihood – 1 Severity – 1 Risk – 1 Likelihood – 1 Severity – 1 Risk - 1	CP CP	training of the staff on SOP and Hygiene. Color coding of utensils. Exclude staff with infectious disease. Proper cleaning of food contact surfaces. Temp – time control during paking of high risk items not to exceed ambient temp for more than 30 mins Use of Approved Suppliers only Staff hygiene &SOP Training Preventive Maintenance program						No No	All suppliers are approved. Minimal chances due to strong SOP during packing.
Cold hold/ storage	**Biological:** Contamination with pathogens & spoilage micro organisms **Multiplication:** of	Likelihood – 1 Severity – 2 Risk – 2 Likelihood –	CP CCP	segregated from the raw and high risk items, training of the	Y		N	Y	N	No Yes	Minimal chances due to strong SOP and control measure during cold hold/storage.

	pathogenic and spoilage microbes. **Chemical:** Not expected to occur **Physical:** Presence of foreign bodies from the food handler(hair, nailetc.) or from storage or utensil (nuts, blots)	3 Severity – 3 Risk – 9 Likelihood – 1 Severity – 1 Risk - 1	CP	staff on SOP and Hygiene. Proper cleaning of food contact surfaces Temp control: chilled fppd below 5. Staff hygiene &SOP Training Preventive Maintenance program						No	No subsequent steps to reduce it to safe level Minimal chances due to strong SOP and control measure during cold hold .
Cold serve	**Biological:** Contamination with pathogens & spoilage micro organisms **Multiplication:** of pathogenic and spoilage microbes **Chemical:** Not expected to occur **Physical:** Presence of foreign bodies from the food handler(hair, nailetc.) or from storage or utensil (nuts, blots)	Likelihood – 1 Severity – 3 Risk – 3 Likelihood – 2 Severity – 3 Risk – 6 Likelihood – 1 Severity – 1 Risk – 1	CP OPRP CP	Food covered and protected, segregated from the raw and high risk items, training of the staff on SOP and Hygiene. Color coding of utensils. Exclude staff with infectious disease. Proper cleaning						No No No	Minimal chances due to strong SOP and control measure during cold serve. Minimal chances due to tempt control during cold serve. Minimal chances due to strong SOP during cold serve.

				of food contact surfaces. Temp control serve food below 5 Staff hygiene &SOP Training Preventive Maintenance program							
Hot hold	**Biological:** Contamination with pathogens & spoilage micro organisms **Multiplication:** of pathogenic and spoilage microbes. **Chemical:** Not expected to occur **Physical:** Presence of foreign bodies from the food handler(hair, nailetc.) or from storage or utensil (nuts, blots)	Likelihood – 1 Severity – 1 Risk – 1 Likelihood – 3 Severity – 3 Risk – 9 Likelihood – 1 Severity – 1 Risk - 1	CP CCP CP	Food protected from contamination. training of the staff on SOP and Hygiene. Proper cleaning of food contact surfaces Critical limit 60. Food shall be In hot hold above 60. Staff hygiene &SOP Training Preventive	Y		N	Y	N	No Yes No	Minimal chances due to strong SOP and control measure during hot hold. No subsequent steps to reduce it to safe level Minimal chances due to strong SOP and control measure during hot hold .

				Maintenance program &visual inspections							
Hot serve	**Biological:** Contamination with pathogens & spoilage micro organisms **Multiplication:** of pathogenic and spoilage microbes **Chemical:** Not expected to occur **Physical:** Presence of foreign bodies from the food handler(hair, nail etc.) or from storage or utensil .	Likelihood – 1 Severity – 3 Risk – 3 Likelihood – 2 Severity – 3 Risk – 6 Likelihood – 1 Severity – 1 Risk – 1	CP OPRP CP	Food covered and protected , segregated from the raw and high risk items, training of the staff on SOP and Hygiene. Color coding of utensils. Exclude staff with infectious disease. Proper cleaning of food contact surfaces. Temp control serve hot food at 60 or above. Staff hygiene &SOP Training Preventive Maintenance program						No No No	Minimal chances due to strong SOP and control measure during hot serve. Minimal chances due to tempt control during hot serve. Minimal chances due to strong SOP during hot serve.
Transportation &	**Biological:** Contamination with	Likelihood – 1	CP	Food covered						No	Minimal chances due to strong

hot delivery	pathogens & spoilage micro organisms **Multiplication:** of pathogenic and spoilage microbes **Chemical:** Not expected to occur **Physical:** Presence of foreign bodies from the food handler(hair, nail etc.) or from storage or utensil .	Severity – 1 Risk – 1 Likelihood – 2 Severity – 3 Risk – 6 Likelihood – 1 Severity – 1 Risk – 1	OPRP CP	and protected , training of the staff on SOP and Hygiene. Proper cleaning of food contact surfaces. Temp not less than 60. Food carriers pre-heat &maintain at 60. Staff hygiene &SOP Training Preventive Maintenance program & visual inspection						No No	SOP and control measure during transportation and delivery Minimal chances due to tempt control during transportation and delivery Minimal chances due to strong SOP during transportation and delivery
Transportation & chiller delivery	**Biological:** Contamination with pathogens & spoilage micro organisms **Multiplication:** of pathogenic and spoilage microbes **Chemical:** Not expected to occur **Physical:** Presence of foreign bodies from the	Likelihood – 1 Severity – 1 Risk – 1 Likelihood – 2 Severity – 3 Risk – 6 Likelihood – 1	CP OPRP CP	Food covered and protected , training of the staff on SOP and Hygiene. Proper cleaning of food contact surfaces. . Cooling						No No No	Minimal chances due to strong SOP and control measure during transportation and delivery Minimal chances due to tempt control during transportation and delivery Minimal chances due to strong

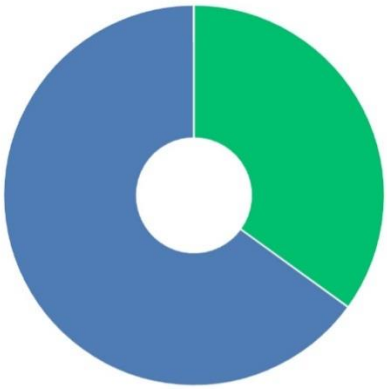
	food handler(hair, nail etc.) or from storage or utensil .	Severity – 1 Risk – 1		system in the truck is turned 1 hr before loading and maintained below 5 or put sme ice bags. Staff hygiene &SOP Training Preventive Maintenance program							SOP during transportation and delivery

Sampling of Data:

Methods and Materials used:

A study was conducted to determine the awareness and adherence to a food safety policy (HACCP) among selected group of 40 individuals living in United Arab Emirates. The study involved the use of structured questionnaire administered in form of a survey to respondents. The study population consisted of food services staff, chefs,cooks,selected food vendors and local buyers.

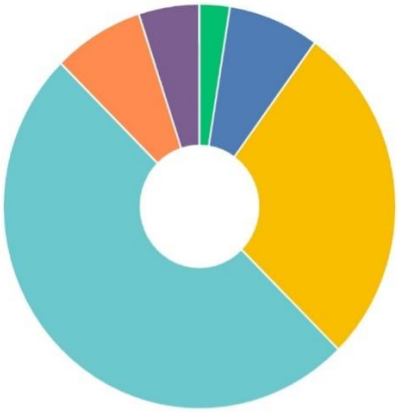
1. What is your gender?



Answered: 40 Skipped: 0

Male	35%	14
Female	65%	26

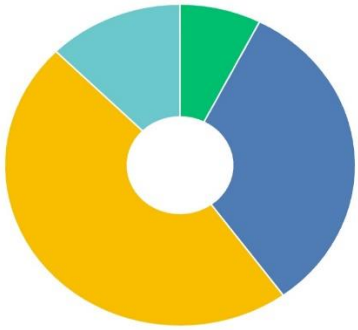
2. What is your Age?



Answered: 40 Skipped: 0

Under 18	2.5%	1
18-24	7.5%	3
25-34	27.5%	11
35-44	50%	20
45-54	7.5%	3
55-64	5%	2

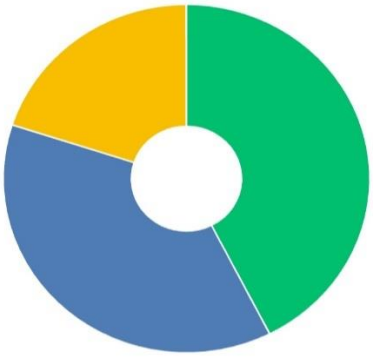
3. How often you eat out?



Answered: 40 Skipped: 0

Every day	7.5%	3
A few times a week	32.5%	13
About once a week	47.5%	19
Once a month	12.5%	5

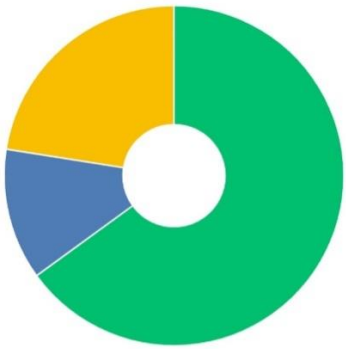
4. How do you evaluate food quality?



Answered: 40 Skipped: 0

Smell	42.5%	17
Apperance	37.5%	15
Price	20%	8

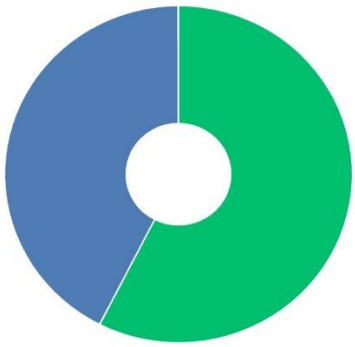
5. While buying food product, what do you look for the most?



Answered: 40 Skipped: 0

Hygiene Standards	65%	26
Product Pricing	12.5%	5
Food Brand	22.5%	9

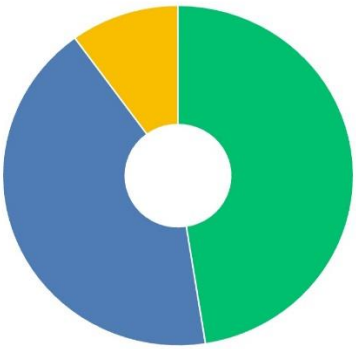
6. Do you read labels on food products, while buying?



Answered: 40 Skipped: 0

Always	57.5%	23
Sometimes	42.5%	17
Never	0%	0

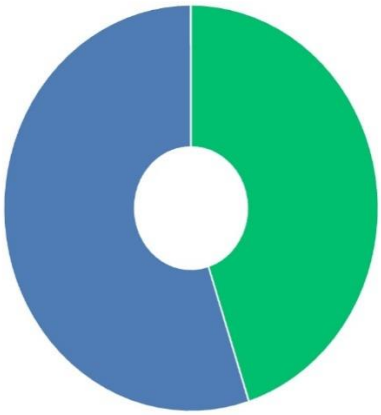
7. Do you ever check the hygiene grading of the food establishment, before buying or ordering food?



Answered: 40 Skipped: 0

Always	47.5%	19
Sometimes	42.5%	17
Never	10%	4

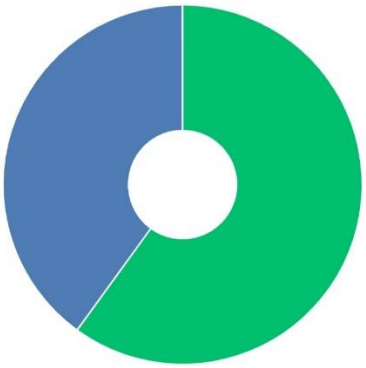
8. Have you ever suffered from food poisoning?



Answered: 40 Skipped: 0

Yes	45%	18
No	55%	22

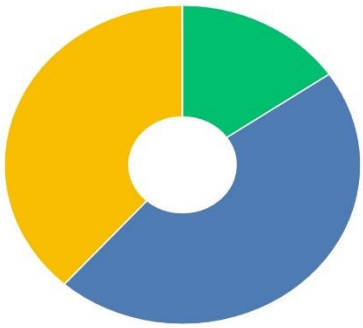
9. Are you aware of food borne pathogens (diseases) and their severity?



Answered: 40 Skipped: 0

Yes	60%	24
No	40%	16

10. What do you do with the left over food?



Answered: 39 Skipped: 1

Discard it	15.38%	6
Store it as per instructions	46.15%	18
Just keep it in the refrigerator	38.46%	15

Results: The above study shows that not all have an understanding of hygiene and food safety.

Only 25% of the respondents are completely aware of the food safety. To make them aware of the food safety measures a webinar was done which included the following areas:

Chapter 5

HACCP Implementation for a ready to eat food:

1.Case study of Hummus:

The food safety study of hummus isin two parts: the first focus, addresses food safety issues related to product formulation whiles the second focus is a study targeted at evaluating the impact of consumer knowledge and food handling practices in food safety. The first part of this study was a challenge study to evaluate the shelf life of four industrially produced refrigerated hummus formulations. The introduction of new products and the expansion of existing product lines, may lead to unforeseen food quality and safety challenges for food industries, especially in recent times where foods that were once indigenous to a particular society, is now being eaten by a wide range of people. This new trend is a result of increased global migration, leading to increased food diversity in communities, which are becoming more cosmopolitan. This shift in the diversity of populations is constantly impacting and driving continually changing trends in the food industry. As consumers continue to demand ready to eat, fresh and safe traditional foods that can be purchased in supermarkets, it has become necessary to prepare foods that were once made traditionally on a small scale, industrially for commercial and retail purposes. Food industries meet this demand, both on a small and large scale because of improvements in the processing, preservation and packaging of many traditional products that

have been achieved, despite the rudimentary processing of traditional foods due to the use of simple equipments, lower energy input, and the availability of resources.

Preliminary steps of the hazard analysis critical control point system:

Hazard analysis critical control point system requires some preliminary steps to be taken into consideration before the implementation of the seven principles. Determination of product properties, process flow charts, plant layout and process descriptions as preliminary steps will be very helpful in the HACCP implementation.

1.1 Product characteristics

Raw materials, and ingredients, were specified for the identification and the assessment of food safety hazards including biological,chemical and physical characteristics.

Traditionally hummus was cooked and consumed domestically as an appetizer together with Arabic bread, but in recent times it is also being produced and packaged in 100 g to 300 g “press-to-seal” plastic packages for sale commercially (25). Hummus traditionally a widely eaten Middle Eastern delicacy, served as a relatively cheap source of protein in the diet, but in recent times though, hummus is being eaten globally (25).

1.2 Preparation and serving of hummus

Hummus is usually made using these ingredients: chickpeas (Cicer arietinum L), tahina (an oily viscous liquid derived from milled dehulled roasted white sesame seeds), garlic, lemon juice or citric acid and salt (25). Traditionally the chickpeas were steeped overnight, and then softened by boiling with sodium bicarbonate (25). The soft cooked chickpeas are then cooled and then mixed with tahina (tahini) and other ingredients (garlic, lemon juice or citric acid and salt) to obtain the basic smooth hummus mix (25, 26). Hummus traditionally is normally served off plates or dishes but in recent times commercially produced hummus may be served straight out of the packaging or tub. Often hummus is served with a topping of a special dressing made of

lemon juice, ground pungent green capsicum and garlic, as well as olive oil and, occasionally, chopped parsley (25). The average nutrient content of a 100 g edible serving of hummus consists of 49.5, 9.6 and 19.7 g of water, protein and fat, respectively and 300 Kcal energy (25).

1.3 Food Safety Concerns; hummus spoilage

a) General Microbial Spoilage

A consumer's perception of the occurrence of visible food spoilage which makes foods unacceptable, according to Day, 1999, is when the visible characteristics of the foods such as the appearance, flavor, smell and texture changes (27). The most widely used and effective preservation techniques, currently used to prevent or delay food spoilage include temperature, pH, and water activity (aw) reduction, as well as heat application (28). Food preservation is highly improved when techniques are used to alter these factors to produce a synergistic effect. Microbial spoilage of chilled foods is very diverse and may be a result of the type of microorganism present, the nature of the food substrate and the effect of temperature on the food, subsequently different microorganisms may adapt to changes in condition and nutrient levels in order to survive in the foods (27).

b) Spoilage by Yeast and Molds

The survival, growth and metabolism of yeast and molds in ecosystems such as food, are regulated by interconnected strain and species interactions, which may involve interactions with bacteria cells and other fungi (29). Fungal infestations are of major concern in the food and agricultural industry globally and may start right in the field, particularly in the tropics where humidity is high (generally > 80%) and hence mold growth is favored (31). This occurrence may lead to very huge economic losses, because most food products either processed or fresh e.g. fresh fruits, berries, marmalades, juices, 6 cereals and grains, are susceptible to yeast and mold contamination and growth after harvesting (30, 31). With the recent surge of product

development in the food industry coupled with food safety concerns, associated with opportunistic infections involving yeast and molds, as well as other adverse effects of yeast infection in humans, interest in understanding the survival and growth of yeast in foods has been heightened (29).

c) Effect of Temperature on Food Spoilage

Food spoilage is influenced by temperature because most biochemical activities are either slowed down at reduced temperatures or speeded up at increased temperatures (32). Elevated temperatures enhance food spoilage, by altering the biological mechanisms in the food, which may lead to enzyme or protein denaturation and a subsequent increase in solute concentration, which may subsequently cause changes in pH and ionic strength of the medium (food) (32). Subsequently the application of reduced temperatures (refrigeration) during food storage has become a widely accepted method of storing minimally processed foods as a means of controlling and decreasing the progression of biochemical and microbial degradation in the food. Low temperature is effective in preserving chilled foods because it either totally inhibits the growth of microorganisms in the foods and or reduces subsequent growth of these microbes by prolonging the lag phase (27). Day, 1999, observed that at reduced temperatures, approaching the least possible growth temperature for a microorganism, the vulnerability of the microorganism to the effects of the preservative attributes of the food like acidity (pH) and water activity (aw) is enhanced (27). Food safety in industrial production takes precedence over other food quality issues in the production of chilled 7 foods and foods in general, this is important because although chilled foods may appear wholesome it may still contain large numbers of pathogens and toxins (27).

d) Effect of pH on Food Spoilage (Low pH and Weak Acid Synergy)

The pH of the food influences the microbial, as well as enzymatic activity of the food and subsequently influences the rate and type of food spoilage observed for a particular food (28).

An extensively used combination preservation technique is to enhance the effect of an antimicrobial acid within the food by lowering the pH of the food (28). Many useful food preservatives fall into this category and thus provide the synergistic effect that produces a low pH, mild acid environment (food), capable of inhibiting some microbial growth in the food (28). There are two modes of action for the functionality of these antimicrobial acids which include inorganic preservatives, sulphite, nitrite and the weak organic acids. As the lipophilicity of organic acids increase, its effectiveness as a preservative is enhanced; e.g. an increasing order of lipophilicity and subsequently effectiveness is: acetic, propionic, sorbic, benzoic (28). The second important aspect of the mode of operation of these acids, are their dissociation constants, their undissipated forms are the most lipophilic and are the ones that easily diffuse through the membrane of the microbe, this is influenced by the pH value and the dissociation constant (pK) and together these determine the amount of the undissipated acid remaining (28). The scope of pK values of the usual weak organic acid preservatives span 4.2 for benzoic to 4.87 for propionic acid, hence at higher pH values their activity is greatly diminished (28). In the microbial cell cytoplasm these undissipated acids dissociate, producing hydrogen ions and their accompanying anions 8 because most microbes in foods maintain an internal pH higher than that of their environment (28). Additional energy is required by the cell to export the additional hydrogen ions produced through the above mechanism (28). Hence in an attempt to maintain an elevated internal pH, cell growth is limited, till the required additional energy is obtained, to enable the pH of the cytoplasm to finally decline to unfavorably low levels limiting progressive cell growth (28). Gould et al., 1996, thus concluded that the simultaneous decrease of pH plus the availability of weak acid preservatives in a food, will lead to higher energy requirements by the microbial cells in the food and subsequently limit the effective generation of ATP by these cells, resulting in their growth retardation and a subsequent decline in microbial food spoilage (28).

1.4 Refrigeration

a) Shelf Life Extension via Refrigeration (Low Temperature Storage)

Reactions that lead to spoilage of foods are of primary concern in evaluating shelf life extension possibilities in foods, especially in minimally processed foods such as hummus. Some preservation techniques are targeted at regulating several forms of spoilage that may occur; these may be physical, chemical,enzymatic or microbiological (28). Essentially, though the most important or prime focus of shelf life experiments in all cases is to control and reduce the growth of microorganisms (28). Numerous new trends in food preservation and processing emerged in the past decade, but “Freshness”, was identified as one of the most important trends in food preservation in the food industry to have occurred in the past decade (33).

b) Preservation by Mild Thermal Processing and Cold Storage

Mild thermal processing in addition to vacuum packaging of foods, held at well-regulated low temperatures lead to the deactivation of less heat labile vegetative microflora and spores of psychotropic bacteria that could thrive at reduced temperatures (28). This mild thermal processing destruct the cold-growing fraction of possible spoilage microflora, this fractional destruction together with the low oxygen tension conditions created via vacuum packaging guarantees premium food quality (28). This process can lead to extended product shelf life (more than 3 weeks), when products are stored at temperatures under 3° C, although gradually slow growth of psychotropic bacteria such as strains of Bacillus and Clostridium may result in spoilage with time (28). To achieve food safety, thermal processing at 90°C for 10 minutes is necessary to guarantee the deactivation of spores of the coldest-growing pathogenic spore formers such as psychotropic strains of *Clostridium botulinum* (28).

c) Recommended Steps to Achieve Microbial Safety

In Foods Day (1999), recommended these general principles to be applied in achieving microbial safety in chilled foods: primarily food safety may be achieved if only high quality raw

materials are used, and this is made possible if the microbial status of all raw materials is known (27). There is also the need for proper documentation (clearly defined procedures), monitoring and control of all processing stages coupled with the documentation and monitoring of the temperature and time of chilled storage, transport and display of products in retail is key (27). Food safety may also be achieved if temperatures are controlled throughout, especially, that of raw material handling and if possible extending the temperature control to home refrigeration by consumers (27). Day, 1999 also cite the fact that hygienic practices carried out throughout the entire food process may also ensure the minimization of microbial growth (27). These recommendations may be achieved via the implementation of good manufacturing practices such as Hazard Analysis and Critical Control Points (HACCP) as well as strict adherence to legislative regulations on food safety.

HACCP Implementation for Raw food

2. Case Study of Seafood

Fish and shellfish, just like milk, baked goods, fruits, vegetables, and groceries of all types, are subject to the Food, Drug, and Cosmetic Act, administered by the U.S. Food and Drug Administration (FDA). The FDA inspects seafood processing plants to ensure compliance with sanitation and food safety regulations, monitors seafood products for conformance to regulations governing pesticides and other contaminants, and maintains extensive surveillance of imported seafood products at their port of entry. In 1997, the FDA Office of Seafood

announced a mandatory fish inspection program that is based on the Hazard Analysis Critical Control Point (HACCP) system. Under this system, seafood is monitored at critical points in its journey from sea to consumer to ensure quality and safety. The FDA also updated the Model Food Code, which is designed to help state and local governments prevent food-borne illness. The code incorporates HACCP principles and outlines practices for safe food handling at the retail level. There are several other programs in place to ensure the safety of our seafood. For example, state agencies monitor water quality in shellfish-growing areas to make sure the waters meet the safety standards for the safe harvest of shellfish.

How Does HACCP Make Seafood Safe?

All parts of the seafood processing operation are examined for hazards including raw materials, ingredients, processing steps, storage, and distribution. Hazards include disease causing organisms, toxins, environmental contaminants (such as pesticides), chemicals (cleaners, sanitizers, lubricants, etc.), and physical hazards (wood, metal, and glass). For each hazard, a critical control point is identified where the potential food safety problem is controlled. Records are kept at each critical control point so inspection agencies can be certain the HACCP system is operating to provide safe food. As an extra measure of safety, certain sanitation activities also must be conducted and documented. Under the FDA regulations, all seafood processors are required to operate under the HACCP program. All imported seafood is also covered. Overall, the message to consumers about seafood is good. The vast majority of seafood in the marketplace is safe, and most hazards can be eliminated or prevented by proper handling and thorough cooking. This is where the consumer plays a major role. By learning the proper guidelines for buying, handling, storing, and preparing seafood, you can help ensure that there are no holes in the seafood safety net [42]

The Consumer's Role

1. Buying Seafood

1.1 Buying Fresh Seafood

What should you know in order to purchase high-quality seafood? First, it's important to buy seafood from reputable dealers—those with a known record of safe handling practices—and avoid roadside stands. And since seafood is highly perishable, purchase it last. Make sure the raw juices from seafood do not drip on other foods, especially those that will be eaten without further cooking. (Bacteria in the raw juices can cause cooked foods to spoil, and since these foods are already cooked, there won't be any chance for the bacteria to be destroyed.) You can avoid cross-contamination in your shopping cart by enclosing individual packages of seafood in plastic bags. Note that the word "fresh" refers to seafood that has not been frozen. Yet "frozen" does not have a bad connotation. Frozen seafood can be superior in quality to fresh seafood, so base your purchase on product quality. (Products labeled "fresh frozen" indicate the seafood was frozen while it was fresh, in many instances within hours of harvest. If fishery products were frozen and thawed for retail sale they should be labeled "previously frozen.") How can you determine the quality of fresh seafood in the store? First, look at the display. All fresh seafood should be held as near to 32 °F as possible, which is maintained by refrigeration and/or ice.

The U.S. Food and Drug Administration currently recommends that pregnant or breastfeeding women and children under age 12 should eat 2 to 3 servings (8 to 12 ounces) of a variety of different kinds of fish and shellfish each week. There is a large variety of different types of fish and shellfish in the marketplace. The most frequently consumed items, including shrimp, salmon, canned light tuna, flatfish, tilapia, oysters, crab, pollock, catfish, clams, scallops, lobster and basa or swai, all have low mercury levels.

The FDA recommends that pregnant or breastfeeding women and young children should not eat four kinds of fish, Shark, Swordfish, King mackerel and Tilefish from the Gulf of Mexico, because they contain higher levels of mercury. Consumption of canned "white" or albacore tuna

and fresh tuna steaks should be limited to 6 ounces per week because they can have slightly more mercury.

If you eat fish caught by family and friends in your local lakes, rivers, and coastal areas you should check for any sportfish consumption advisories issued in your state. If no advice is available, eat up to 6 ounces (one average meal) per week of fish you catch from local waters, but don't consume any other fish during that week. Advisories are available from local and state health departments and the U.S. Environmental Protection Agency.

Whole Fish. Whatever the variety of the whole fish they have certain characteristics that indicate freshness. They should have bright, clear, full eyes that are often protruding. As the fish loses freshness, the eyes become cloudy, pink, and sunken. The gills should be bright red or pink. Avoid fish with dull-colored gills that are gray, brown, or green. Fresh fish should be free of loose or sloughing slime. The flesh should be firm yet elastic, springing back when pressed gently with the finger. With time, the flesh becomes soft and slips away from the bone. The skin of a fresh, whole fish should be shiny with scales that adhere tightly. Characteristic colors and markings start to fade as soon as a fish leaves the water, but the skin should still have a bright, shiny appearance (See below figure).

Whole fish: bottom fish is older eyes are clouding over. (Source: Florida Sea Grant).

Fish Fillets or Steaks. Note that fillets and steaks should have firm, elastic flesh and a fresh-cut, moist appearance, with no browning around the edges. Fillets separate if they are left too long in the case. The flesh should be almost translucent—as if you can almost see through it. There should be little evidence of bruising or reddening of the flesh from retention of blood. Prepackaged steaks and fillets should contain a minimum of liquid. Fish fillets stored in liquid deteriorate quickly (See below figure).

Shellfish. They may be sold live, cooked, or fresh-shucked. Each form and species has different quality signs to examine. The shells of live clams, oysters, or mussels should look moist and be tightly closed. If the shells gape slightly, have your retailer tap them. If the shells do not close, do not purchase them. Do not purchase live shellfish with cracked shells. The bottom shell of an oyster should be well cupped—a sign that the oyster inside is plump and well formed. The “neck” or “snout” of soft-shelled clams should show movement. The meats of fresh-shucked clams, oysters, or mussels should be plump and covered with their liquor. Their liquor should be clear or slightly opalescent (slightly milky or light gray) and free of shell or grit. There should be no strong odor.

Raw Scallop. Scallops are not usually sold live because they are highly perishable. Typically scallops are shucked at sea shortly after capture. On occasion, day boats will bring whole

scallops to market or local restaurants. Fresh scallop meats have a firm texture and a distinctly sweet odor. A sour or iodine smell indicates spoilage. The smaller bay and calico scallops are usually creamy white, although there may be some normal light tan or pink coloration. The larger sea scallops are also generally creamy white, although they may show some normal light orange or pink color.

Live Crab. Live crabs and lobsters should show leg movement, and the tail of lobsters should curl tightly underneath the body and not hang down when the lobster is picked up. Lobsters and crabs will not be very active if they have been refrigerated, but they should move at least a little bit.

Raw Shrimp. Raw shrimp meat should be firm and have a mild odor. The shells of most varieties are translucent with a grayish green, pinkish tan, or light pink tint. The shells should not have blackened edges or black spots—this is a sign of quality loss. Cooked shrimp meat should be firm and have no disagreeable odor. The color of the meat should be white with red or pink tints. Tiger shrimp have bluish colored shells with black lines between the segments of the shell (these are not black spots).

Squid. When buying whole squid, look for eyes that are clear and full. The skin should be untorn and the meat very firm. The skin of fresh squid is cream colored with reddish brown spots. As squid ages, the skin turns pinkish and the flesh will yellow.

Caviar. The unopened jar or tin of caviar can be stored in the refrigerator up to two weeks. An opened jar or tin of caviar can be stored in the refrigerator, covered, for no longer than two or three days. Most varieties of caviar should be kept refrigerated in the coldest part of the refrigerator, never frozen, with the exception of Salmon caviar, as it best preserved frozen.

1.2 Consumer Handling and Storing Fresh Seafood

The storage life of seafood depends on how well you take care of it, whether it is a whole fish or a live oyster. When your seafood purchase arrives home, store it in the coldest part of your refrigerator at a temperature as close to 32 °F as possible. Many home refrigerators operate at 40 °F; therefore, fish will lose quality faster.

Fish. Fish bruises easily, so lift a whole fish with both hands and avoid holding it by the tail. Pack dressed fish on ice in the refrigerator. Seal fillets or steaks in plastic bags or containers; then cover them with ice in trays or pans. Empty the melt water regularly and add more ice as necessary. Fish that is not prepackaged should be washed under cold, running water and patted dry with an absorbent paper towel. The fish should then be wrapped in moisture-proof paper or plastic wrap, placed in a heavy plastic bag, or stored in an air-tight, rigid container until ready for cooking. The shelf life of fish depends on the variety and its quality at time of purchase. In general, you should use fish quickly—within one to two days.

Shellfish. Handling and storage guidelines vary according to the variety of shellfish you purchase.Store live shellfish in a shallow dish covered with damp towels or moistened paper towels. Never put live shellfish in water or in an air-tight container where they could suffocate and die.Scrub live oysters, clams, and mussels with a stiff brush such as a vegetable brush just prior to shucking or cooking.Mussels and clams in the shell (live) should be used within two to three days; oysters in the shell, from seven to 10 days. Some shells may open during storage. If so, tap them. They will close if alive; if not, discard them.Store shrimp, squid, and shucked shellfish in a leak-proof bag, plastic container, or covered jar. Squid and freshly shucked clams have a shelf life of one to two days. Shrimp and scallops have a shelf life of about two to three days. And freshly shucked oysters have a shelf life of five to seven days.

Live lobsters and crabs should be cooked the same day they are purchased. Store cooked whole lobsters or crabs in rigid air-tight containers and use them within two to three days.

Cooked, picked lobster or crabmeat may be stored in a sealed moisture- proof plastic bag or air-tight plastic container for three to four days. Pasteurized crabmeat can be refrigerated for up to six months before opening; use it within three to five days after opening.

Leftovers. Taking care of leftovers is a critical food handling step and is often where errors can occur, sometimes resulting in food-borne illness. To prevent a problem at this step, wash hands before handling leftovers and use clean utensils and surfaces. Refrigerate or freeze leftovers in covered, shallow (less than 2 inches deep) containers within two hours after cooking. Leave air space around containers to allow circulation of cold air and to help ensure rapid, even cooling. When preparing seafood for later use, refrigerate or freeze it immediately after cooking in covered, shallow containers. Refrigerators and freezers are designed to compensate for the addition of a few temporarily hot foods without allowing other foods to warm up. Refrigerate leftovers within two hours when the temperature in the food serving area is below 90 °F and within one hour when the temperature of the air is 90 °F or above. Date leftovers so they can be used within a safe time. Before serving, cover and reheat leftovers to 160 °F. Soups, sauces, and other “wet” foods should be reheated to a rolling boil. If in doubt, throw it out. Discard outdated, obviously spoiled, or possibly unsafe leftovers in a garbage disposal or in tightly wrapped packages (42)

3. Buying Frozen Seafood

Commercially frozen fish is quickly frozen at its peak freshness and the consumer can now find a wide choice of top-quality and wholesome seafood in the freezer case. When properly thawed, frozen fish is comparable to fish that was never frozen. Both exhibit the qualities of freshness described previously. Frozen fish and shellfish should be packaged in a close-fitting, moisture-proof package. Select packages from below the load line of the freezer case. Look for packages that still have their original shape and the wrapping intact with little or no visible ice. Seafood

should be frozen solid with no signs of freezer burn, such as discoloration or drying on the surface, and have no objectionable odor. The same guidelines apply for frozen prepared seafood, such as crab cakes, breaded shrimp, or fish sticks. Do not allow the package to defrost during transportation.

3. Storing Frozen Fish

After shopping, immediately store commercially wrapped frozen seafood in your freezer. Put it in the coldest part of the freezer, at a temperature as close to −20 °F as possible. As with other frozen foods, avoid prolonged storage by planning your purchases, keeping in mind “first in, first out” Commercially frozen seafood can be stored in the freezer for six to 12 months depending on the type of fish and the amount of fat it contains. Freezing fish at home should be reserved for those times when you end up with more than you can immediately eat, such as after a fishing trip or if someone cancels for dinner. Freezing fish or shellfish in the home or commercial freezer will not improve quality; it only maintains the quality of the food at the time it is frozen.

To freeze seafood at home, start with a high-quality and carefully handled product. Fish should be cleaned first under cold water and then patted dry. Wrap with plastic wrap, excluding as much air as possible. Then overwrap your fish with freezer paper or aluminum foil. There are also specially designed plastic bags for use in the freezer. These may also be used for fish. Carefully seal all packages and label with contents, amount, and date. Place the packages in the coldest part of the freezer where the cold air can circulate around them, freezing them quickly. Shellfish such as shucked clams, oysters, or mussels can be frozen in rigid air-tight plastic containers. Be sure the meats are covered with their liquor and there is a 1/2-inch space between the liquid and the container lid to allow for expansion. Scallops may be frozen in plastic freezer bags. Be sure to exclude air and seal tightly or pack scallops tightly in covered freezer containers. Frozen, shucked shellfish can be stored for three to four months. Most shrimp available in the market has been previously frozen. Be sure shrimp has not been frozen if you

plan to freeze it. Refreezing shrimp under non- commercial conditions can significantly affect the flavor and texture, and, in some cases, may make the shrimp unsafe to eat when thawed.

The National Fisheries Institute has developed a seafood storage guide for fresh and frozen products. This guide indicates optimal shelf life for seafood products held under proper refrigeration or freezing conditions. Temperature fluctuations in home refrigerators will affect optimal shelf life, as will opening and closing refrigerators and freezers often. Although these storage times ensure a fresh product for maximum refrigeration storage life at 32 °F, the consumer should plan on using seafood within 36 to 48 h for optimal quality. To determine the approximate storage time for species not listed, ask your retailer which category (lean, fat, shellfish, breaded, or smoked) the seafood falls within and refer to the guide.

4. Thawing

It is not always necessary to thaw seafood before cooking, depending on how it will be prepared. If thawing is not necessary, simply double the cooking time. But if your recipe calls for coating, rolling, or stuffing, or if the fish is in a block, you will need to defrost it to facilitate handling. Plan ahead; defrost the fish overnight in the refrigerator. This is the best way to thaw fish to minimize loss of moisture. A one-pound package will defrost within 24 h. Never defrost seafood at room temperature or with hot or warm water. Bacteria on the surface will begin to multiply and cause spoilage. If you forget to take your seafood out of the freezer ahead of time, place it in the sink under cold, running water. A one-pound package will defrost in approximately one hour. You may also use your microwave oven to partially thaw your fish. Use the lowest defrost setting, which is usually 30 percent of normal power levels, and follow the manufacturer’s instructions for time based on amount of fish. (A pound of fillets defrosts in five to six minutes.) The fish should feel cool, pliable, and slightly icy. Be careful not to overheat it and begin the cooking process. Foods defrosted in the microwave oven should be cooked immediately after thawing. When thawing frozen fish that comes in a vacuum-sealed package,

remove it from the package, cover, or wrap, and thaw it under refrigeration immediately before use. Do not thaw product while it is still inside the vacuum-sealed package.

5. Preparation—Keeping It Clean

Finally, it's time to prepare your seafood! But before you begin, remind yourself of these important sanitary guidelines developed by the U.S. Department of Agriculture Food Safety and Inspection Service. Be sure the food preparation area and all surfaces and utensils that will touch food are clean. Always wash your hands with soap and warm water for at least 20 s before beginning food preparation, before working with new food or new utensils, after finishing food preparation, before serving food, and after going to the bathroom. Do not let juices from raw finfish, shellfish, meat, or poultry come into contact with other foods. Wash cutting board, utensils, counter, sink, and hands with hot, soapy water immediately after preparing raw seafood, meats, or poultry. Also, use a fingernail brush to clean under nails and cuticles. Keep dishwashing sponges and cloths clean. Use cutting boards that are easy to clean—plastic, acrylic, or rubber composition are good choices. Wooden boards may look pretty, but they should only be used for cutting breads because they are porous and difficult to clean thoroughly. Don't taste any food of animal origin (meat, poultry, eggs, fish, or shellfish) when it's raw or during cooking. Serve your cooked seafood on clean plates. Never put it back on the plate that held the raw product.

6. Cooking—General Rules

Cook fish and shellfish thoroughly. Fish is cooked when it begins to flake and/or loses its translucent (raw) appearance and turns opaque. Cook fish until it reaches an internal temperature of 140–145 °F for 15 s. Follow processor's directions when preparing frozen, packaged seafood products such as frozen, breaded fish portions. Seafood is usually baked in a moderate to high oven temperature (425 °F). Do not use recipes that call for cooking without a

reliable and continuous heat source. Avoid interrupted cooking—completely cook fish and shellfish at one time. Partial or interrupted cooking often produces conditions that encourage bacterial growth. Cooking Shellfish. Be careful not to overcook shellfish. So often shellfish are in small pieces and can easily be overcooked, becoming tough, dry, and flavorless. Some shellfish, such as canned clams or cooked, picked crabmeat and surimi products (imitation shellfish), are already cooked when purchased. In this case, heat the precooked shellfish or surimi product to the desired temperature without cooking further. Scallops and shrimp turn firm and opaque when cooked. It takes from three—five minutes to boil or steam one pound of medium-sized shrimp and three-four minutes to cook scallops. Shucked shellfish, such as clams, mussels, and oysters, become plump and opaque when cooked. The FDA recommends that shucked oysters be boiled or simmered for at least three minutes, fried in oil for at least three minutes at 375 °F, or baked at 450 °F for at least 10 min. Steam clams, mussels, and oysters in the shell for four-nine minutes from the start of steaming. Use small pots to steam shellfish. If too many shells are cooking at once, it's possible the centers won't cook thoroughly. Discard any clams, mussels, or oysters that do not open during cooking. Closed shells indicate they may not have received adequate heating. Boiled lobsters or steamed crabs turn bright red. Allow 10–12 min per pound of lobster, starting to time when the water returns to a boil. Steam crabs 25 min when two to three dozen, depending on size, have been placed in a large crab pot.

a) Microwave Cooking

Microwave ovens heat food surfaces rapidly. However, time must be allowed for the heat to penetrate to the center of the food. Take the following steps to ensure that food cooks thoroughly and evenly in the microwave oven. Cover the food to hold in moisture and facilitate even cooking. Glass cookware, glass ceramic cookware, and waxed paper are safe for microwave cooking. Plastic wrap may be used to cover containers, but should not touch the

food. Before using other types of containers or wraps, check to be sure that they are approved for use in the microwave oven. Unapproved materials may melt, burn, or contain chemicals that can migrate into food during cooking. When following microwave oven cooking instructions on product labels, remember that ovens vary in power and operating efficiency. If you're unsure of your oven's capability, try the following test.

b) Time to Boil Test. From a container of half ice and half water, measure exactly one cup of water (no ice) into a glass measuring cup. Place the cup in the center of the microwave oven. Heat on high for five minutes until the water begins to boil. If the water begins to boil in less than three and a half minutes, consider your oven "high power;" if longer, the oven is "low power." When using a recipe that states a heating time of six to eight minutes, the "high-power" oven will microwave in the shorter time (or six minutes) while the "low-power" oven will take the longer time (or eight minutes).

If the microwave oven doesn't have a turntable, turn the entire dish several times during cooking. Be sure to stir recipes such as casseroles or soups. Allow seafood cooked in the microwave oven to stand for the recommended time. This is necessary to complete the cooking process. Check for doneness before serving.

7. Serving Seafood

Seafood can be a delicious addition to your daily meal routine and for special occasions such as buffets, picnics, and bag lunches. To ensure the safety of your seafood, follow the sanitary guidelines listed in the Preparation section of this guide.

Buffets. When serving for a buffet, serve hot food from chafing dishes or warming trays that maintain the internal temperature of the food at 140 °F or above. For cold foods, nestle the serving dish into a bed of crushed ice. Small platters for replenishing the serving table should be prepared ahead and stored in the refrigerator (at 40 °F or below) or kept warm in the oven (at a

setting of 200–225 °F). Discard any foods that have been held at room temperature for more than two hours. Fresh food should not be added to a serving dish or platter containing foods that have already been out for serving.

Picnics and Lunches. When going on a picnic or traveling with food, keep all perishables in a cooler with ice or freeze-pack inserts until serving time. Make sure the food is cold or frozen to the touch before placing it in a cooler or cold thermos. When packing a “bag lunch” that will be eaten within several hours, placing ice cubes in a re-sealable bag or a small freeze-pack insert in an insulated bag should be all that is necessary to keep the food cold. Be sure to put the cooler or lunch bag in the coolest place possible. Don’t leave it in the direct sun or in a warm car.

Extra Care for Special Seafood

Seafood is highly perishable and in many cases requires certain precautions when handling for home use. Some seafood products require extra care either because they are more vulnerable to bacteria that can cause food-borne illness or they have unusual characteristics because of the way they are processed. This section provides additional information on handling some “extra care” products.

Smoked Seafood. Most of today’s smoked seafood products are lightly smoked to enhance flavor and not to prolong shelf life. Smoked seafood should be refrigerated at all times and stored no longer than four or five days. In the store, smoked seafood should be displayed in a refrigerator case, but not directly on ice. It should not be in direct contact with fresh seafood. Some other things to look for when buying smoked seafood include a firm, springy texture, glossy surface, smoky odor, no traces of dried blood or viscera, and no traces of salt crystals. For longer storage, smoked seafood can be frozen for two to three months.

Surimi Seafood. Surimi is the raw material with which imitation seafood is made. Surimi is prepared under strict controls at sea or onshore. Freshly caught Alaskan pollock is filleted, minced, washed, and strained to yield a concentrated fish paste. Small quantities of salt, sugar, and/or sorbitol are added to stabilize the protein during frozen storage. Next, the surimi is processed into food products by blending it with binders such as starch or egg white. Real shellfish, a shellfish extract, or artificial shellfish flavoring is added to make it taste like shellfish. Then it is formed into the desired shape and texture and cooked. Surimi products should look like the cooked form of the fish and shellfish they are meant to resemble. Since they are fully cooked, add these products to your recipe in the last minutes of cooking, leaving just enough time to heat through. When buying imitation seafood, look for opaque off-white body meat and red, cooked-shellfish color on the surface. If the surimi product is frozen, there shouldn't be crystals in the package—they indicate freeze-thaw problems. When thawed, these products should be moist and firm, not wet and soft. Do not buy products with off odors (sour, fermented, or sulfur smells). This indicates spoilage. It is wise to read the ingredient statement on the label if you are allergic to any fish or shellfish. Surimi seafood should be stored in the refrigerator for no longer than 14 days (follow the manufacturers "use by date" if present on unopened package), or frozen for 9–12 months. (See the seafood storage guide.) Remember, this product is fully cooked. Use sanitary handling techniques to prevent cross-contamination with raw seafood and meat.

Value-Added Seafood. Value-added seafood includes battered and breaded seafood, smoked seafood, dried fish, precooked seafood entrees, fresh minced clams, pre-seasoned fish fillets (such as farm-raised catfish), and others. All these products are semi-prepared and refrigerated or frozen to save you steps when preparing meals at home. Keep in mind the safe handling guidelines, cleanliness, and proper storage and cooking temperatures, and always read the label and follow the manufacturer's directions, especially as new products are developed and reach the marketplace.

To use refrigerated, prepared seafood safely, when purchasing it, make sure the seafood is cold. Also check the “sell by” or “use by” date on the package. Read the label and follow storage and cooking or heating instructions carefully. Use these products within the recommended length of time. When freezing these products, do so as soon as possible after purchase.

Marinades. Follow these guidelines when you use marinades to flavor fish and shellfish. If your recipe calls for basting cooked fish or shellfish with marinade, reserve a portion of it for this before combining the marinade with the raw seafood. Marinate seafood in the refrigerator in a glass or plastic container. Marinades often contain acidic liquids such as wine, lemon juice, or vinegar, which react with metal. Avoid cross-contaminating other foods by thoroughly cleaning any utensils, bowls, or surfaces the marinade comes in contact with after it is combined with raw seafood. Do not save marinades that have been combined with raw seafood, unless they will be immediately cooked in a sauce. Bring the marinade to a rolling boil before adding any other ingredients. Then cook the sauce to at least 160 °F.

The Final Edge of the Safety Net

The most important considerations in safe handling of seafood at home are cleanliness, temperature, and time. Keep your hands, preparation area, and utensils clean. Avoid cross-contamination. Never let raw seafood come in contact with cooked seafood or other raw or cooked foods. Be aware of temperatures—of the air, of your refrigerator and freezer, of cooking, too. Use the temperature guide in this publication. And be aware of time—the clock starts when fish and shellfish leave the water. Finally, to keep your seafood safe, buy high-quality products and just like they say in the industry, keep it clean, keep it cool, and keep it moving! By following these rules, you can feel confident in holding up your edge of the seafood safety net.

3. Case Study for Unpasteurized eggs

Fresh eggs, even those with clean, uncracked shells, may contain bacteria called *Salmonella* that can cause foodborne illness, often called “food poisoning.” FDA has put regulations in place to help prevent contamination of eggs on the farm and during shipping and storage, but consumers also play a key role in preventing illness linked to eggs. Protect yourself and your family by following these safe handling tips when buying, storing, preparing, and serving eggs—or foods that contain them.

What is *Salmonella*?

Salmonella, the name of a group of bacteria, is a common cause of food poisoning in the United States. Most people infected with *Salmonella* develop diarrhea, fever, abdominal cramps, and vomiting 12 to 72 hours after infection. Symptoms usually last 4 to 7 days and most people get better without treatment. However, in some people, the diarrhea may be so severe that they need to be hospitalized. In these patients, the *Salmonella* infection may spread from the intestines to the blood stream, and then to other body sites and can cause death unless the person is treated quickly with antibiotics. Certain people are at greater risk for severe illness and include children, older adults, pregnant women, and people with weakened immune systems (such as transplant patients and individuals with HIV/AIDS, cancer, and diabetes).

1) Buying

You can help keep eggs safe by making wise buying decisions at the grocery store.

- Buy eggs only if sold from a refrigerator or refrigerated case.
- Open the carton and make sure that the eggs are clean and the shells are not cracked.
- Store promptly in a clean refrigerator at a temperature of 5°C or below. Use a refrigerator thermometer to check.
- Store eggs in their original carton and use them within 3 weeks for best quality.

2) Storing

Proper storage of eggs can affect both quality and safety.

- Use hard-cooked eggs (in the shell or peeled) within 1 week after cooking.
- Use frozen eggs within 1 year. Eggs should not be frozen in their shells. To freeze whole eggs, beat yolks and whites together. Egg whites can also be frozen by themselves.
- Refrigerate leftover cooked egg dishes and use within 3 to 4 days. When refrigerating a large amount of a hot egg-containing leftover, divide it into several shallow containers so it will cool quickly.

3) Preparing

Wash hands, utensils, equipment, and work surfaces with hot, soapy water before and after they come in contact with raw eggs and raw egg-containing foods.

- Cook eggs until both the yolk and the white are firm. Scrambled eggs should not be runny.
- Casseroles and other dishes containing eggs should be cooked to 160° F. Use a food thermometer to be sure.
- For recipes that call for eggs that are raw or undercooked when the dish is served — like Caesar salad dressing and homemade ice cream — use either shell eggs that have been treated to destroy Salmonella, by pasteurization or another approved method, or pasteurized egg products.

4) Serving

Follow these serving guidelines for eggs and egg dishes.

- Serve cooked eggs (such as hard-boiled eggs and fried eggs) and egg-containing foods (such as such as quiches and soufflés) immediately after cooking. Cooked eggs and egg dishes may be refrigerated for serving later but should be thoroughly reheated to 165° F before serving.
- Never leave cooked eggs or egg dishes out of the refrigerator for more than 2 hours or for more than 1 hour when temperatures are above 90° F. Bacteria that can cause illness grow quickly at warm temperatures (between 40° F and 140° F).
- For party planning, keep hot egg dishes hot and cold egg dishes cold:
- Keep egg dishes refrigerated until time to serve.
- Serve small platters of reheated egg dishes at a time to ensure the food stays at the proper temperature. Replenish as needed, or at least every 2 hours.
- Keep cold egg dishes on ice if they are going to stay out longer than 2 hours.

5) Transporting

For picnics, pack cooked eggs and egg dishes in an insulated cooler with enough ice or frozen gel packs to keep them cold. Transport the cooler in the passenger compartment of the car, not in the much warmer trunk. At the picnic area, put the cooler in the shade if possible and keep the lid closed as much as you can.

For school or work, pack cooked eggs with a small frozen gel pack or a frozen juice box.

4. Case Study of Dairy Products

Milk

Grade A milk is carefully produced, processed and packaged in order to protect the safety of the consumer. Grade A milk must be pasteurized to be sold by retailers in interstate commerce. Raw milk is usually pasteurized either by low temperature pasteurization in which the milk is heated to 145 °F or higher for at least 30 minutes, or by high temperature pasteurization in which the milk is heated to 161 °F or higher for at least 15 seconds and then quickly cooled. Pasteurization destroys disease-causing bacteria and extends the shelf life of milk. However, pasteurized milk can readily spoil and could cause foodborne illness if not properly protected and handled.

Maintaining the Safety of Milk: Refrigeration is the single most important factor in maintaining the safety of milk. By law, Grade A milk must be maintained at a temperature of 45 °F or below. Bacteria in milk will grow minimally below 45 °F. However, temperatures well below 40 °F are necessary to protect the milk's quality. It is critical that these temperatures be maintained through warehousing, distribution, delivery and storage.The cooler refrigerated milk is kept, the longer it lasts and the safer it is. As the product is allowed to warm, the bacteria grow more rapidly. Properly refrigerated, milk can withstand about two weeks' storage.Infants, pregnant women, the elderly and the chronically ill (such as those undergoing cancer treatments and individuals with AIDS, diabetes or kidney disease) are most at risk from serious illness due to

eating any unsafe food. These individuals and those who care for them must be especially careful to handle milk safely.

Fresh Fluid Milk: Fresh milk is categorized mainly by the amount of butterfat it contains. In November 1997, the FDA announced a new rule for milk labeling that helps consumers clarify the difference between 1- and 2-percent milk and reinforces the fact that skim milk is fat-free. Under the new rule, 2-percent milk is renamed reduced fat; 1-percent milk is renamed low-fat; and skim milk is called fat-free or nonfat, although it may contain up to 0.5 grams of fat in a one cup serving.

Buying Fresh Fluid Milk: When selecting milk at the store, make sure it is properly displayed and pay close attention to the date on the label. All fresh fluid milks should be stored at temperatures below 40 °F and should not be stacked high in the display cases. If stored above 40 °F, milk will begin to develop signs of spoilage, including sour odor, off-flavor and curdled consistency. Remember that milk should be taken from the store and quickly placed in your refrigerator at home so that the temperature does not rise above 40 °F. Once you have purchased milk and refrigerated it promptly, it should retain its fresh taste for one to five days beyond the “sell-by” date if kept at the proper temperature. If it spoils before the date expires, this indicates it was not handled properly, and it should be returned to the store for a refund.

Storing Fresh Fluid Milk: Milk should not be left out at room temperature. Pour milk to be used into a serving container and return the original container to the refrigerator. Do not return unused milk that has been sitting out to its original container where it could contaminate the remaining milk. Milk can be stored frozen at 0 °F for up to three months and will be safe to drink if it is thawed in the refrigerator, although it does not retain its smooth texture.

Concentrated or Dried Milks

Evaporated & Evaporated Skimmed Milk: This type of milk has about 60 percent of the water removed. It may be fortified with vitamins A and/ or D. Store cans of evaporated milk in a cool, dry place. It is shelf-stable, but once opened it should be treated as fresh fluid milk, kept refrigerated and used within several days.

Sweetened Condensed Milk: This is the milk that results from the evaporation of half the water and the addition of sugar in amounts sufficient for preservation. It is stored like evaporated milk.

UHT Milk: Ultra-high temperature (UHT) milk is regular fluid milk that is packed in an airtight, sterilized, cardboard container. The product is treated by flash sterilization at 290 °F (twice the temperature of normal pasteurization). This high temperature kills all bacteria or microorganisms. The milk is then packed into sterilized containers and is shelf-stable for six months. After six months, the flavor and color begin to change and the product thickens. It is still safe, but may not produce the desired effect in a recipe. Once the package of UHT milk is opened, it is treated like fresh fluid milk and used within several days.

Cream

Cream has a very high fat content of between 18 and 40 percent butterfat compared to around 3.25 percent in whole milk. The rich, yellow color associated with cream comes from the carotene in the fat. The type of cream is determined by its fat content.

Half-and-half is a combination of milk and cream with a butterfat content of about 11 percent.

Light cream has between 18 and 30 percent butterfat and may be called coffee or table cream.

Light whipping cream has between 30 and 36 percent butterfat and can be whipped into solid form, although it tends to be less stable than heavy whipping cream.

Heavy cream or whipping cream contains 36 to 40 percent butterfat.

Pressurized whipped cream is sold in aerosol cans and is made from a mixture of cream, sugar and chemical stabilizers.

Sour cream is made by adding a lactic acid culture to sweet cream. Sour cream usually contains between 18 and 20 percent butterfat.

Reduced-fat sour cream has skim milk added to lower the fat content.

Storage: Store cream at 40 °F or below in its original container in the refrigerator. Do not leave cream at room temperature, and do not mix warm cream with cream that has been kept refrigerated. Use fresh, pasteurized cream within one to five days of the “sell-by” date.

Butter

Butter is made from the sweet or soured cream of cow’s milk by agitation or “churning.” After churning, the mass of butter is washed and salted. It is worked to distribute the salt and remove extra water. To be sold in stores, butter must contain at least 80 percent milk fat. Water and milk solids make up the other 20 percent. Salt and coloring may be added if desired. Some unsalted butter is sold as sweet butter, but most people prefer the salted product.The USDA grade label on the butter carton or wrapper means the butter has been tested for quality by a government grader and has been produced under sanitary conditions. The highest possible grade is AA. Grade AA butter is delicate and sweet-flavored with a creamy texture and good spreadability. Most butter sold is grade AA or A. Because of its high fat content, butter contains many calories and therefore should be used sparingly in the diet.

Storage: Storing butter properly, lengthens the shelf life so it can be used over a longer period of time. To prevent a type of spoilage called rancidity, protect butter from heat, light and air by storing it covered in the refrigerator. Rancid butter has an unpleasant taste and smell.

Butter absorbs odors from other foods rapidly. To prevent flavor changes, keep butter wrapped in moisture- and vapor-proof material or in tightly covered containers. For refrigerator storage,

leave butter in its original wrapper. Opened portions of butter should be refrigerated in a covered dish. Butter can be stored for up to two weeks at refrigerator temperatures (below 40 °F). Higher temperatures cause off-flavors and unpleasant odors to develop. Butter should not be stored in the butter keeper (set at warmer temperatures) on the refrigerator door longer than two days. For ease in spreading, remove butter from the refrigerator 10 to 15 minutes before using it for holding longer than two weeks, butter should be frozen. To store butter in the freezer, wrap it in moisture- and vapor-proof freezer packaging material to keep the butter from absorbing odors from other foods and to prevent freezer burn. Butter in its original carton can be overwrapped. Butter in one-pound blocks can be cut into smaller portions, repackaged and frozen for future use. If properly wrapped and held at 0 °F or lower, butter will keep well in the freezer for six to nine months. Thaw butter in the refrigerator.

Yogurt

The natural sugar in milk is converted to lactic acid by means of a bacterial culture producing the creamy, pleasantly tart yogurt. Yogurt is pasteurized to destroy disease-causing microorganisms. Fat and calorie content will differ depending on whether whole, low-fat or fat-free milk is used and whether fruit or sweeteners are added. The label will give the specific information for each yogurt.

Storage: Yogurt may be kept well covered in the refrigerator for seven to 10 days past the “sell-by” date. If it is kept longer, it will develop a stronger taste. Freezing yogurt is not recommended because of the variable results in texture.

Hazards identified in the milk and cheese processing steps andCorrective measures

Processing step	Hazard			Control measures
	Microbial	**Physical**	**Chemical**	
Receiving of Milk	Unhygienic contacts, Salmonella, Staphylococcus	Extraneous matter	Starch	Implementation of GMP, OPRP, Effective filtering
Cooling (OPRP)	Unhygienic contacts	Extraneous matter	Not usually	Effective cleaning of cooling tanks, implementation of GMP
R.O treatment	Faecal, Coliforms	Heavy metals, calcium, Hardness of water	Not usually	Filter changing and effective cleaning of membrane filtration
Standardization	Unhygienic contacts	Extraneous matter	Not usually	Effective cleaning
Pasteurization CCP	Unhygienic contacts, Salmonella, Staphylococcus	Extraneous matter	Not usually	Implementation of GMP, proper pasteurization
Poly packing (UV)	NON working of	Extraneous matter	Not usually	Monitoring of UV light

	UV light			
Cold Storage	Unhygienic contacts	Extraneous matter	Not usually	Effective cleaning, pest control
Crate washing (OPRP)	Not properly washed	Extraneous matter	Not usually	Effective crate washing with tested water
Dispatch	Not usually	Extraneous matter	Not usually	Effective cleaning and maintenance of hygienic conditions

Table: Hazard Analysis of Milk Processing

Processing step	**Hazard**			**Control measures**
	Microbial	**Physical**	**Chemical**	
Receiving of Milk	Unhygienic contacts	Extraneous matter	None	Implementation of GMP
Standardization	Unhygienic contacts	Extraneous matter	None	Implementation of GMP
Pasteurization	Unhygienic contacts Improper pasteurization	Not usually	None	Proper pasteurization

Cooling	Unhygienic contacts	None	None	Implementation of GMP
Coagulation by 1% citric acid	Unhygienic contacts	None	Adulterants	Proper verification of citric acid quality from a certified buyer
Draining of whey	Unhygienic contacts	Extraneous matter	Not usually	Effective cleaning Implementation of GMP
Milk solids filled in blocks and pressed by weight	Unhygienic contacts	Extraneous matter	Not usually	Implementation of GMP
Cutting into pieces	Not usually	Metal Dust	Not usually	Implementation of GMP and use of metal detector
Dipped in chilled water at 4°C	Unhygienic contacts	Extraneous matter	Not usually	Implementation of GMP
Draining of water	Unhygienic contacts	Not usually	Not usually	Implementation of GMP

Packed into desired weight and stored at 4°C	Unhygienic contacts	Pests	Not usually	Implementation of GMP Packing under UV light
Dispatched in chilled condition (OPRP)	Unhygienic contacts	Extraneous matter	Not usually	Strict control of conditions during dispatch

Table: Hazard Analysis of Cheese Processing

It can be concluded that that application of HACCP system can improve the quality of pasteurized Milk and cheese by control of critical points The pre-requisites programs (GMPs) and the operational pre-conditional programs that form the sturdy pillars of a stout and sturdy HACCP plan must be made mandatory to ensure good quality and hygiene in the plant as well as product the direct application of HACCP is difficult in industries that are not producing food products. But for industries that are associated with the food production industry the implementation of HACCP provides familiar value. The lessening of identified CCP number is necessary since it will ensure the safety of food products for consumption and safety of the consumer (48).

Chapter 6

Discussion

Food safety is integral to the Sustainable Development Goals.

When food is not safe, human development simply cannot take place. In its plan of action for people, planet and prosperity, the 2030 Agenda calls for everyone, in particular the poor and the vulnerable, to have access to safe, nutritious and sufficient food all year round. It pledges to ensure healthy lives and promote well-being, which are essential to sustainable development.

Unsafe food takes a huge toll on human health and the economy. Every year more than 600 million people fall ill and 420 000 die from eating food contaminated with bacteria, viruses, parasites, toxins or chemicals. Unsafe food accounted for 33 million disability-adjusted life years in 2010. As for the economic price tag, unsafe food costs low- and middle-income economies alone about US$ 95 billion in lost productivity annually and can curtail trade.

Food safety is everyone's responsibility.. Widespread collaboration and contributions of all actors across the food supply chain, underpinned by robust governance, agreed international standards and harmonized regulations, are essential to food safety. Good nutrition requires safe food. Unsafe food prevents the suitable uptake of nutrients and renders it unsuitable for human consumption and can lead to long-term growth delays in children. Poor nutrition makes people more susceptible to diseases. It is a vicious cycle that must be broken. Sustainable Development Goal 2, which is about ending hunger, achieving food security, improving nutrition and promoting sustainable agriculture, can only be achieved when food is safe for people to eat.

Food standards help to safeguard public health at large. Harmonized international food standards ensure that food is safe, healthy and of good quality, and can be safely traded between countries or passed on along a food value chain, enabling all players to comply with requirements elsewhere. International standards shield countries and companies from discretionary national trade barriers. We need to keep pace with the rapidly changing food

systems. Production and processing methods and technologies continue to transform trade, changing the way food moves from farm to fork. It is essential to ensure that the many economic, social and environmental factors driving these changes contribute to our ability to achieve Zero Hunger for a global population that is projected to reach almost 10 billion by 2050.

Food Safety Is Science-Centered

The availability of agreed decision-making tools facilitates an inclusive and transparent process for food safety decisions, based on a broad set of factors rather than a single consideration. Making sound strategic decisions is the primary responsibility of food safety risk managers, who must weigh multiple criteria and sometimes complex risk interactions. Decisions often require balancing food safety priorities with resources, following multiple policy recommendations and selecting the most appropriate intervention to minimize risks. To be effective in building strong food safety programmes, food safety risk managers need to influence high-level decisions Strengthening controls of food safety threats, plant and animal pests and diseases for agricultural productivity and trade. Also in determining appropriate action, decision-makers often need to consider the consequences relating to more than one risk factor, for example, the multiple impacts on public health, trade, food access and security. Science is central to the work of quality along the supply chain. In close collaboration with WHO, FAO provides neutral and independent scientific advice as the essential basis for the international food safety standards, guidelines and codes of practice established by the Codex Alimentarius Commission, and for supporting the development of modern food control systems by national authorities such as whole genome sequencing for epidemiological surveillance for foodborne pathogens. In developing high quality globally relevant scientific advice, consideration is given to the entire food production chain as appropriate as well as all relevant and accessible data. Regular updates are made to the methods and approaches used to ensure consistency with the most recent developments.

Chapter 7

Conclusion

HACCP is a proactive plan developed to prevent and reduce the incidents of food safety hazards. By monitoring and detecting potential problems throughout an entire process, identification of hazards and application of corrective measures can be implemented immediately. HACCP enables companies to apply prevention and detection methods to their specific application(s), giving them the freedom to adopt new techniques and technologies more rapidly. A successful HACCP plan is built upon a firm commitment from upper management with well-trained and motivated employees actively involved in the process. Under HACCP, responsibility for ensuring food safety is now appropriately placed on the food manufacturer or distributor. Adoption of this plan will result in the reduced likelihood of hazards and assure consumers that the products they consume are as safe as science and technology allow.

Overall tools for use in an integrated approach to the management of food safety are described in this report. They comprise the use of elements of Good manufacturing Practice (GMP) that are specifically concerned with the general design and operation of hygienic premises and equipment and with the hygiene of personnel, GMP requirements associated with hygiene form the basis for the operation of a hygienic food operation. Food Safety, HACCP and other Quality management

System looks for hazards or anything that could go wrong regarding product safety and implements controls subsequently to ensure that the product will not cause harm to the consumer. Food products go through every stage of the supply chain (production, storage and sales). The document gives the interrelationship between risk analysis (i.e., risk assessment, risk management and risk communication) and HACCP.

The advantages of HACCP are not limited. It can be implemented at any part of the globe due to its compatibility and suitability as the food production is proportional to the population. The surging population demands the better food products which ensure decreased susceptibility of people to food borne diseases and better health. The effective plan of HACCP is given by WHO and it should be followed by every food processing unit for manufacturing of clean foods. However, HACCP will only become effective when its principles are correctly and broadly applied in all stages of the food production chain from farm to fork. Food borne diseases only occur when there are failures in implementation or limited application of HACCP, mainly in small companies. Curbing certain loopholes in the implementation of the HACCP principles assure the clean food production.

HACCP is a tool that guides food safety personnel to ensure the quality of the food is safe and what needs to be done for that is done. Its successful implementation requires an understanding of its principles and a commitment to its implementation.

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Annexures

A1 Goods Receiving And Rejection Monitoring Record

A2 Daily Fruits And Vegetables Sanitization Record

A3 Thawing Temperature Monitoring Record

A4 Chiller Temperature Monitoring Record

A5 Freezer Temperature Monitoring Record

A6 Dry Storage Temperature - Humidity Monitoring Record

A7 Cooling Temperature Monitoring Record

A8 Internal Coking – Baking Temperature Monitoring Record

A9 Daily Hot- Holding Temperature Monitoring Record

A10 Cold Holding Temperature Monitoring Record

A11 Good Transportation- Distribution Temperature Monitoring Record

A12 Receiving And Service Holding Temperature Monitoring Record

A13 Delivery Vehicle Cleaning And Temperature Monitoring Record

A14 Personal Hygiene Checklist

A15 Traceability And Recall Record

A16 Training Attendance Record

A17 Food Sampling Monitoring Record

A18 Waste Oil Disposal Record

A19 HACCP Internal Audit Checklist

A20 Weekly Calibration Log

Sample Form	Goods Receiving/Rejection Monitoring Record	Issue date: OPRP/SP/RE- Rev. No: Written by: Hygiene Officer

The temperature controls of receiving high risk foods - Chilled items 1- 5 ºC and Frozen items, ≤ -18 ºC
Dry Items- Ambient Tempt

Date	Invoice number	Supplier	Product	Temp ºC food	Temp ºC Vehicle	Production date	Expiry date	Accept/ Reject	Corrective action taken for rejected items

(critical limits- chilled items above 8 ºC Frozen items – less than -15 ºC)

Verified By Hygiene officer:

Sample Form	Daily Fruits and Vegetable Sanitization Record	Rev date: HACCP/OC/RE-Rev-No. Written by: Hygiene Officer

Date	Food item	Contact Time(mins)	Chlorine Level Monitoring/ Reading (ppm)	Checked by

Concentration of the disinfecting chemicals as per below;

Contact time: 3 Minutes (for all skin types)

Milsan Dilution Ratio 1:100 (1L of Chemical in 100L of Water)

Verified by Hygiene Officer:

Sample Form	Thawing Temperature Monitoring Record	OPRP/OC/RE- Rev. No: Written by: Hygiene Officer

Temp: ≤5 ^{0}C

Duration: 72 hrs. Max

Items	Temp.	Date In	Temp.	Date Out	Production date	Expiry date	Remarks

Verified By Hygiene Officer:

Sample form	Chiller Temperature Monitoring Record (critical limit 7°C and more for more than 2 hours) **Temp. Limit ≤ 5 ºC**	**Issue date:** **HACCP/OC/RE-** **Rev. No.** **Written by: Hygiene Officer**

Month: **Area:** **Chiller No:** **Type:** _____

Dates	02:00-03:00	06:00-07:00	10:00-11:00	14:00-15:00	19:00-20:00	23:00-00:00	Checked By	Remarks
01	°C	°C	°C	°C	°C	°C		
02	°C	°C	°C	°C	°C	°C		
03	°C	°C	°C	°C	°C	°C		
04	°C	°C	°C	°C	°C	°C		
05	°C	°C	°C	°C	°C	°C		
06	°C	°C	°C	°C	°C	°C		
07	°C	°C	°C	°C	°C	°C		
08	°C	°C	°C	°C	°C	°C		
09	°C	°C	°C	°C	°C	°C		
10	°C	°C	°C	°C	°C	°C		
11	°C	°C	°C	°C	°C	°C		
12	°C	°C	°C	°C	°C	°C		
13	°C	°C	°C	°C	°C	°C		
14	°C	°C	°C	°C	°C	°C		
15	°C	°C	°C	°C	°C	°C		
16	°C	°C	°C	°C	°C	°C		
17	°C	°C	°C	°C	°C	°C		
18	°C	°C	°C	°C	°C	°C		
19	°C	°C	°C	°C	°C	°C		
20	°C	°C	°C	°C	°C	°C		
21	°C	°C	°C	°C	°C	°C		
22	°C	°C	°C	°C	°C	°C		
23	°C	°C	°C	°C	°C	°C		
24	°C	°C	°C	°C	°C	°C		
25	°C	°C	°C	°C	°C	°C		
26	°C	°C	°C	°C	°C	°C		
27	°C	°C	°C	°C	°C	°C		
28	°C	°C	°C	°C	°C	°C		
29	°C	°C	°C	°C	°C	°C		
30	°C	°C	°C	°C	°C	°C		
31	°C	°C	°C	°C	°C	°C		

Verified By Hygiene Officer:

Sample form	**Freezer Temperature Monitoring Record** (critical limit -15◦C and less for more than 30 hours) **Temp. Limit ≤18.0 ºC**	**Issue date:** **OPRP/OC/RE-** **Rev. No:** **Written by: Hygiene officer**

Month: **Area:** **Deep Freezer No:** **Type:** _____

Dates	02:00-03:00	06:00-07:00	10:00-11:00	14:00-15:00	19:00-20:00	23:00-00:00	Checked By	Remarks
01	°C	°C	°C	°C	°C	°C		
02	°C	°C	°C	°C	°C	°C		
03	°C	°C	°C	°C	°C	°C		
04	°C	°C	°C	°C	°C	°C		
05	°C	°C	°C	°C	°C	°C		
06	°C	°C	°C	°C	°C	°C		
07	°C	°C	°C	°C	°C	°C		
08	°C	°C	°C	°C	°C	°C		
09	°C	°C	°C	°C	°C	°C		
10	°C	°C	°C	°C	°C	°C		
11	°C	°C	°C	°C	°C	°C		
12	°C	°C	°C	°C	°C	°C		
13	°C	°C	°C	°C	°C	°C		
14	°C	°C	°C	°C	°C	°C		
15	°C	°C	°C	°C	°C	°C		
16	°C	°C	°C	°C	°C	°C		
17	°C	°C	°C	°C	°C	°C		
18	°C	°C	°C	°C	°C	°C		
19	°C	°C	°C	°C	°C	°C		
20	°C	°C	°C	°C	°C	°C		
21	°C	°C	°C	°C	°C	°C		
22	°C	°C	°C	°C	°C	°C		
23	°C	°C	°C	°C	°C	°C		
24	°C	°C	°C	°C	°C	°C		
25	°C	°C	°C	°C	°C	°C		
26	°C	°C	°C	°C	°C	°C		
27	°C	°C	°C	°C	°C	°C		
28	°C	°C	°C	°C	°C	°C		
29	°C	°C	°C	°C	°C	°C		
30	°C	°C	°C	°C	°C	°C		
31	°C	°C	°C	°C	°C	°C		

Verified By Hygiene Officer:

Sample form	Dry Storage Temperature & Humidity Monitoring Record	Issue date: PRPS/OC/RE- Rev. No: Written by: hygiene officer

Month & Year:

Date	Temperature (9am)	Humidity (9am)	Temperature (6pm)	Humidity (6pm)	Checked by Store Keeper	Remarks
	20-25 ºC	60 to 65 %	20-25 ºC	60 to 65 %		
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
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31						

Verified By Hygiene Officer:

Sample Form	Cooling Temperature Monitoring Record	Issue date:
		HACCP/OC/RE- Rev. No:
		Written by: Hygiene Officer

Location:…… **Section:……**

Key: Ice bath- Decrease temp. from above 60 °C to 21 °C in a maximum of 2 hours & from 21 °C to 5 °C in a maximum of 4 hours. Use sanitized probe thermometer to check the temperatures.

Date	Food Item	Cooling Start				Cooling End		Checked by(PIC)	Corrective Action/Remarks
		Ice Bath/Room temperature				Chiller			
		Initial		After 2 hour		After 4 hour			
		Time	Temp.	Time	Temp.	Time	Temp.		

Verified by Hygiene Officer

Sample Form	Internal Cooking/Baking Temperature Monitoring Record	Issue date: HACCP/OC/RE- Rev. No: Written by: hygiene officer

Date: _____ **Section:** _____

Final cooking - core temp >75°C / Final Baking – core temp >90 °C

Start Time	End Time	Cooking/Baking			Prod. Date of the item used	Expiry Date of the item used	Corrective actions if any
		Item	Internal tempt	Time >30 sec.			

Verified By Hygiene officer:

Sample Form	**Daily Hot Holding Temperature Monitoring Record**	Rev date: HACCP/OC/RE Rev. No. Written by: Hygiene Officer

Date: _____ **Section:** _____

Temperature/Time Requirement = Hot Holding Temp. > 60 ^{O}C, maximum 4 hours for food service					Checked by (Section Cook)	Corrective Action
Hot Items	Receiving		Closing/Dispatching			
	Temp (^{o}C)	Time	Temp (^{o}C)	Time		

Verified By Hygiene Officer

Sample Form	Cold Holding Temperature Monitoring Record	Issue date: HACCP/OC/RE- Rev. No. Written by: hygiene officer

Date: _____ **Section:** _____ **Type of Food:** **Cold** ☐

Required Temperature Cold Food / Less than 5 ^{O}C Holding Time: 4 hours maximum					Checked by (Section Cook)	Corrective Action
Items	**Temp.**	**Start Time**	**Temp.**	**End Time**		

Verified By Hygiene Officer

Sample Form	Good Transportation / Distribution Practices Temperature Report	Issue date:
		OPRP/TC/RE- Rev. No:
		Written by: Hygiene Officer

Date: _____ Time: _____ Van Type: _____

SN	Food Type	Departure Temperature	Arrival Temperature
HOT ITEMS			
COLD ITEMS			

Supervisor Signature: _____ Departure Time: _____

Arrival Time: _____ Location In charge Sign: _____

Verified by Hygiene Officer: _____

Sample Form	Delivery Vehicle Temperature & Cleaning Monitoring Record	Issue date:
		PRPS/TC/RE- Rev. No.
		Written by: Hygiene Officer

DATE	VEHICLE DISPATCHING DETAILS		VEHICLE ARRIVAL DETAILS		DRIVER SIGNATURE	VEHICLE CLEANING DETAILS		LOCATION	REMARKS
	DELIVERY (°C)	TIME	ARRIVAL (°C)	TIME		CLEANING DATE	DRIVER SIGN		
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
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31									

***The Transportation Supervisor has to verify the delivery vehicle chiller temperature and cleanliness are satisfactory.**
****The delivery vehicle temperature shall be maintained below 5 °C.**
*****The delivery driver should indicate the vehicle cleaning date & put signature next to the vehicle cleaning date.**

Verified by Hygiene Officer:

Sample form	Cedar Tree Hospitality	Issue date:
	Personal Hygiene Inspection Checklist	PRPS/PH/RE-, Rev. No.
		Written by: Hygiene Officer

Key: Non compliances shall be represented by entering the reason (select the corresponding letter from below):
H: Hands not clean. N: Nails dirty & not short. V: Visible cut, boils or septic spots.
I: Infections like severe cold, diarrhoea etc.
J: Wearing jewellery. P: Strong perfume smelling. L: Long hair or not covered or not shaved. S: Smoking. C: Untidy clothing.

Month & Year:

Date		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Remarks
#	Employee Name																																
Remarks if any:																																	

Verified by Hygiene Officer:

Sample Form	Traceability & Recall Record	Issue date:
		PRPS/TB/RE- Rev. No:
		Written by: Hygiene Officer

Recall Description: Actual ☐ **Mock** ☐

Name	Designation	Recall Team	Signature	
			Starting	Closing
		Recall Team Leader		
		Member		
		Member		

Date: ..... **Starting Time:** ..... **Closing Time:** .....

Product Name:

Dispatch /Serving Station: Hot ☐ Cold ☐

Problem in the Product: _____

_____

Outlet where product was on display: 1) 2)

Dispatch / Serving Temperature found satisfactory: Yes ☐ No ☐

The same product was in hot cabinet for refilling: Yes ☐ No ☐ NA ☐

Hot cabinet temperature was ok (if above answer is yes): Yes ☐ No ☐ NA ☐

The same product was in chilling unit for refilling: Yes ☐ No ☐ NA ☐

Chilling unit temperature was ok (if above answer is yes): Yes ☐ No ☐ NA ☐

Did product passed through cooking process: Yes ☐ No ☐

Cooking Temperature was ok (if above answer is yes): Yes ☐ No ☐ NA ☐

Did product passed through chilling process: Yes ☐ No ☐

Chilling Temperature was ok (if above answer is yes): Yes ☐ No ☐ NA ☐

Did product passed through reheating process: Yes ☐ No ☐

Reheating Temperature was ok (if above answer is yes): Yes ☐ No ☐ NA ☐

Did product passed through defrosting process: Yes ☐ No ☐

Defrosting process was controlled (if above answer is yes): Yes ☐ No ☐ NA ☐

Shelf life of major ingredients used in the product was ok: Yes ☐ No ☐

Major ingredients (used in the product) were received in acceptable condition: Yes ☐ No ☐

Major ingredients (used in the product) were received from nominated suppliers: Yes ☐ No ☐

Temperature of major ingredients (used in the product) at the time of receiving was according to food safety standards: Yes ☐ No ☐

Root cause of problem in the Product: _____

_____

Corrective action taken for problem rectification: _____

_____

Preventive action taken to avoid recurrence of problem rectification: _____

_____

_____

Recall Team leader

Sample Form	Training Attendance Record	Issue date: PRPS/HR/RE- Rev- No. Written by: Hygiene Officer

External: ❑ **Internal: ❑** **Date:**

Trainer: **Training Topic:**

SN	Participant's Name	Designation	Signature	Results	
				Effective	Not Effective

Trainer signature:…….

Note: after reviewed on floor level, the effectiveness will be judged and marked accordingly into the given column. If it was found not effective, the same participant will attend the upcoming session on the same area.

Assessment: _____

Assessed By: _____ **Date:** _____

Reviewed by	Verified by
Hygiene Officer	*Team leader*

Sample Form	Internal Audit Checklist	Issue date:
		PRPS/AU/RE-
		Rev. No:
		Written by: Hygiene Officer

Audit Date: **Time:** **Audited by:**

No	Standard/Requirement	SCORE		Auditor Comments (if any)	Action Taken or Required	Closed Out Date	Responsible Person
		C	NC				
MANAGEMENT RESPONSIBILITY							
1	Has a food safety management system been developed?						
2	Does the food safety management system cover all food operations (processes)?						
3	Does the organization have a food safety policy?						
4	Are food safety objectives been set and are measurable?						
5	Has a multidisciplinary Food Safety team been formed?						
6	Have the organization appointed a Food Safety team leader and defined the responsibilities and authorities?						
7	Does the organization define the responsibility and authority of the Food safety team?						
8	Is the knowledge of the food safety team suitable and appropriate? (Check training, qualifications, experience etc.)						
9	Is the internal and external communication controlled and has responsibility defined? Is the communication effective?						
10	Does the company have emergency preparedness and response procedures in place?						
11	Is a Management Review meeting carried out yearly or when required? Is it effective?						
BUILDING FACILITIES							
12	Are walls and floors in good						

	condition?						
13	Is drainage adequate?						
14	Is ventilation adequate?						
15	Are processes (e.g. raw & ready to eat) properly separated with date labelling to avoid cross contamination?						
16	Is the layout of equipment, facilities and processes suitable and appropriate?						
17	Are storage conditions are clean and adequate for keeping goods? (E.g. packaging materials, food, cleaning chemicals etc.)						
18	Do the cleaning and disinfection programs ensure that the all parts of the equipment are sufficiently cleaned do they ensure the cleaning equipment is also kept cleaned and disinfected?						
PERSONAL HYGIENE							
19	Employees wear proper clothing – clean uniform, hairnet, shoes etc.						
20	Fingernails are short, unpolished, and clean						
21	Jewellery is limited to small ear ring and plain ring.						
22	The ready to eat food preparation staff wear disposable gloves						
23	Fresh cuts or bandages on hands are completely covered while handling food						
24	Adequate hand washing, sanitizing and drying facilities are available – warm water, anti-bacterial soap, disposable paper towels etc.						
25	Hands are washed routinely and thoroughly using proper hand-washing procedures						
26	Does the organization have adequate toilet facilities and is the condition acceptable						
27	Does the organization have changing room facility and is						

	the condition acceptable, clean and provided with lockers						
28	Smoking is observed only in designated areas away from food handling areas						
29	Eating, drinking, or chewing gum are observed only in designated areas away from work areas						
30	Personnel with infections such as infected/septic cuts or wounds, skin infections, communicable diseases are restricted						
31	Employee illnesses are documented						
PEST CONTROL							
32	Does the organization have a pest control plan/system?						
33	Does the organization have a pest control contract with approved pest control company?						
34	Are rodent, bird and insect prevention facilities suitable and appropriate?						
35	Are doors, windows and other facilities in good condition?						
36	Does the organization maintain the pest control records such as contract copy, service report and bait map?						
PACKAGING MATERIAL STORAGE							
37	Are packaging materials stored in good condition - clean, arranged, covered?						
38	Are the packaging materials being protected from contamination?						
39	Are lights adequately protected? (Glass)						
CLEANING CHEMICAL STORAGE							
40	Are these toxic compounds stored separate to raw materials, ingredients and packaging materials?						
41	Are these toxic compounds clearly labelled for identification?						
42	Are there handling/usage						

	instructions available?						
CLEANING & SANITIZATION							
43	Does the condition of food contact surfaces meet the requirement of hygiene? (Equipment, facilities etc.)						
44	Does the organization have cleaning plans?						
45	Have the results of cleaning been monitored using cleaning monitoring record?						
46	Have the results of cleaning been monitored and verified for effectiveness? (E.g. microbiological swab analysis)available?						
CUSTOMER COMPLAINT & RECALLS							
47	Does the organization have a procedure to deal with all consumer and customer complaints, product recalls?						
48	Have the responsibility and authority for handling customer complaints and recalls been defined?						
49	Have these complaints been documented?						
50	Have these complaints analysis been utilized for verification of the system?						
51	Has the organization a clear system for product identification of product to ensure traceability?						
EQUIPMENT MAINTENANCE & CALIBRATION							
52	Does the organization have maintenance plans for the critical equipment's chillers, freezer, ovens, delivery vehicle chillers, freezer, hot holding unit etc.?						
53	Are the equipment's such as chillers, freezer, oven, probe thermometers, delivery vehicle chillers, freezer, hot holding unit etc. are calibrated by the manufacturer or during installation?						
54	Is the equipment's maintenance such as filter replacement for water filters are doing as						

	manufacturer instructions?						
TRAINING							
55	Have they developed a training procedure for identifying training needs and training personnel?						
56	Does the organization have training plans?						
57	Does the organization verify the effectiveness of training?						
DOCUMENTATION AND RECORD KEEPING							
58	Does the organization follow procedure to manage system documents?						
59	Have documents been properly approved by authorized personnel before issue?						
60	Is the documentation controlled?						
61	Has the organization obtained related codes, standards, legislation and regulation to the food product?						
62	Does the organization control document changes? Are all documents current?						
63	Are the records accessible?						
64	Are the HACCP records clearly identified?						
65	Are the records retained in the proper conditions to prevent damage, deterioration or loss during retention period?						
66	Is contingency plan present?						
67	Does the organisation have the documentation with context to ISO 22000-2018?						
68	Has the organisation done risk assessment?						
69	Does the organisation understand the needs and expectations of its customers?						
70	Is the food safety policy and objectives available?						

71	Is the food safety policy and objectives been communicated across the staff?						
72	Is the internal and external communication established?						
73	Has all steps been verified?						
74	Is the emergency team, recall team and FSMS team available?						
75	Has the responsibilities been communicated?						

Auditor's Signature and stamp

Sample Form	**Food Sampling Monitoring Record**	Date:
		PRPS/PQ/RE-
		Rev/Iss.No:
		Written By: Hygiene Officer

Location/Area:…… **Date:……..**

Key: Food sample should be kept in the freezer (-18°C) for 48 hours then discarded.

Food Item	Meal	Sample Date	Deposition Date	Signature	Corrective Action

Checked by **Verified by Hygiene Officer**

Sample Form	**Receiving and Service Holding Record**	PRPS/PQ/RE
		Rev/Iss.No:
		Written By: Hygiene Officer

Location:_____ **Date:**_____

SR	HOT FOOD (>60°C)	Receiving Temp	Receiving Time	Temp after 1 hour	Temp after 2 hours	Temp after 3 hours	Temp after 4 hours	Remarks	Checked By
SR	COLD FOOD (<5°C)	Receiving Temp	Receiving Time	Temp after 1 hour	Temp after 2 hours	Temp after 3 hours	Temp after 4 hours	Remarks	Checked By

Verified by Hygiene Officer:

Sample Form	Waste Oil Disposal Record	Date:
		PRPS/PQ/RE-
		Rev/Iss.No:
		Written By: Hygiene Officer

Date	Waste Oil Received (Location Name)	Quantity Received as Waste Oil	Checked by	Remarks

Verified by Hygiene Officer:

Sample Form	Weekly Calibration Log	Date:
		PRPS/PQ/RE-
		Rev/Iss.No:
		Written By: Hygiene Officer

Date:

SN	Thermometer	Temperature reading in Boiling water (100°C) Tolerance -/+ 2		Temperature reading in Ice (0°C) Tolerance -/+ 2		Corrective Action (if any)	Verified By
		Master Thermometer Reading	Daily Used Thermometer Reading	Master Thermometer Reading	Daily Used Thermometer Reading		
1							PIC
2		100°C		0.0°C			PIC
3		100°C		0.0°C			PIC
4		100°C		0.0°C			PIC
5		100°C		0.0°C			PIC

Date:

SN	Thermometer	Temperature reading in Boiling water (100°C) Tolerance -/+ 2		Temperature reading in Ice (0°C) Tolerance -/+ 2		Corrective Action (if any)	Verified By
		Master Thermometer Reading	Daily Used Thermometer Reading	Master Thermometer Reading	Daily Used Thermometer Reading		
1							PIC
2		100°C		0.0°C			PIC
3		100°C		0.0°C			PIC
4		100°C		0.0°C			PIC
5		100°C		0.0°C			PIC