Al-Quds University
Deanship of Graduate Studies
Faculty of Public Health

Food Safety in the West Bank: Bacterial Contamination of Foods Served in Restaurants

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Dedication

TO

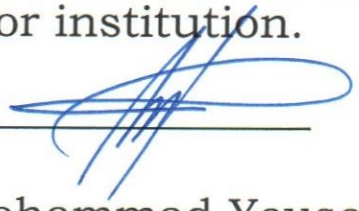
MY DEAR WIFE, BROTHERS AND

SISTERS FOR THEIR ENCOURAGEMENT,

WITH LOVE AND RESPECT

Declaration

I certify that this thesis submitted for the degree of Master in the result of my own research, except where otherwise acknowledged, and that this thesis (or any part of the same) has not been submitted for a higher degree to any other university or institution.

Signed 

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ABSTRACT

Data of microbial food examinations recorded between 1996-2002 at Environmental Health Department, Ministry of Health were analyzed and studied for the microbial contamination in order to assess the role of different kinds of food in food poisoning occurrence. Food samples were collected from all districts of the West Bank. Most food samples were gathered from the major cities. A total of 3373 samples of different raw and ready to eat foods were gathered from restaurants. Hommous and raw cheese constituted 25 % and 16% of food samples, respectively. According to the Palestenian Standards, 27.5% of tested samples were contaminated. The percentage of contaminated samples were 57.7 % in food samples collected from restaurant, 16.5 % in food industries and 16.6 % of different food types collected from the market. *Salmonella* was detected in 13 food samples; most of them were raw meat collected from Jenin district.

الخلاصـــة

تقوم هذه الدراسة الى معرفة نسبة التلوث في الأغذية التي يتناولها الناس وتأثيرها على الصحة العامة مقارنة بحالات التسمم التي تحصل بين متداولي الأغذية .

ان المعلومات المعطاه عن الأغذية المفحوصة هي من سجلات دائرة صحة البيئة في وزارة الصحة سنة 1996 – 2002 أي خلال سبعة سنوات من العينات التي جمعت من جميع محافظات الضفة الغربية وهي عشر محافظات . وهذه العينات كانت من الأغذية المستوردة ، والمصنعة محليا ، والمطاعم ، الا أن التركيز في هذه الدراسة كان على العينات التي جمعت من المطاعم وهي 3373 عينة من المواد الأولية والمواد الجاهزة ، وخاصة المطاعم الشعبية ومحلات الحلويات . فمثلا هناك حوالي 25% من العينات كانت من الحمص الجاهز للأكل ، و 16% من الجبنة البيضاء ومن محلات بيع الكنافة . وجميع هذه العينات فحصت ميكربيولوجيا .

وحسب المواصفات الفلسطينية فان نسبة التلوث بشكل عام في جميع العينات المفحوصة هي 27.5% . بحيث كانت نسبة التلوث في عينات المطاعم 57.5% ومن المصانع المحلية حوالي 16.5% ومن العينات التي جمعت من السوق ومنها المستوردة 16.6%.

لقد وجدت السالمونيلا في 13 عينة من اللحوم الطازجة ومعظمها جمعت من محافظة جنين .

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CHAPTER ONE

1. INTRODUCTION

1.1. Statement of the problem:

The aim of this study is to determine the severity of food poisoning in the West Bank. To do so food factories, restaurants, markets throughout the West Bank produce and serve popular foods that can be made at home also, were targeted and samples were collected and tested for microbiological contamination.

1.2. Significance:

There are restaurants which serve foods that are cheep and liked by almost everyone, visited by a large number of the population which would give us a good indication of how safe is the food served, and how severe is the problem of food poisoning.

How this will be of use to the population? Safety and good hygienic conditions of these restaurant will have an impact on the control FP,FI

1.3. Objectives:

The objectives of the study include estimating the degree of contamination of popular foods, the safety of foods, the hygienic

practices of food handlers, the spreading of food borne illness in the West Bank, and proposing some solutions to the problems inflicted by the food industry.

1.4. Target groups:

Parameters studied were Total Plate Count, Total Coliforms, and Fecal Coliforms, *Salmonella Staphyloccocus aureus* and Yeasts and Molds. Samples were collected from food factories, restaurants, and the market and tested for microbiological contamination. Internationally-recognized methods will be utilized to collect and test the samples such as Food and Drug Administration (FDA), Association of Official Analytical Chemists (AOAC), French Standard Institute (AFNOR), and World Health Organization (WHO).

1.5. Limitations:

1-One of the limitations of this study is that it will not cover all kinds of foods consumed by the Palestinian population, but covers only some of these foods.

2- Another limitation is that this study will show that there is a problem of food poisoning, but it will not show the severity of this problem.

3- Data collected was based on a design determined by other researchers, which limit the type of data analysis discussion.

CHAPTER TWO

2. LITERATURE REVIEW

Food poisoning is an illness caused by eating contaminated food. Incidents of food borne disease in the West-Bank are on the average of about 571 cases annually caused by microbiological contamination reported by Preventive Medicine Department-Ministry of Health Table (1). These numbers reported only from governmental hospitals. No real numbers of cases are reported because not everyone affected visits a doctor, and doctors in the private sector do not keep records and do not report these cases. Some cases may not be recognized as food borne illness, but it is generally believed that in developed countries less than 10%, or even only 1% of cases of food borne illnesses ever reach official statistics (WHO). Food borne diseases were estimated to cause approximately 76 million illnesses, 325,000 hospitalizations, and 5,000 deaths in the United States annually (1). In England, for example, there are about 80,000 cases per year, and incidence of food borne disease in Venezuela 140 cases per 100,000 populations (2).

2-1. Definition of Terms

Food poisoning is an illness caused by consuming contaminated food. The symptoms are usually vomiting, diarrhea and abdominal pain.

Vomiting and diarrhea are the body's method of disposing of harmful substances from the digestive tract thus preventing them from getting into the blood stream.

In a few types of food poisoning, the poisons enter the blood stream, causing illness in the body generally, with a wide variety of symptoms.

Foodborne Disease: A Foodborne disease is considered to be any illness associated with by which the causative agent is obtained by the ingestion of food.

Chemical food poisoning is considered to be an illness caused by the consumption of food containing microbial toxins or chemical poisons. Food Poisoning caused by bacterial toxins is called food intoxication, whereas, that caused by chemicals that have gotten into food is referred to as chemical poisoning.

Illnesses that are not caused by bacterial by products, such as toxins, but through ingestion of infectious microorganisms, such as bacteria, viruses or parasites, are referred to as food infections .

2-2. Causes of food poisoning:

2-2-1. Bacteria:

The vast majority of all food poisoning cases are caused by bacteria. The food is poisonous because it has been contaminated by pathogenic bacteria, and/or their toxins.

2. **Viruses**:

Viruses are infective microorganisms with dimensions that range from 20-300 nm or about 1/100 to 1/10 the size of a bacterium. Viruses are transmitted to food by workers who are carriers. An infected food handler can excrete the organism through the feces and respiratory tract infection.

Transmission occurs through coughing, sneezing, touching a runny nose, and contaminated hands after leaving the toilet. A virus that has caused a major increase in outbreaks in restaurants during the past 10 years is hepatitis (1). The most likely foods to transmit viral illnesses are those handled frequently and those that receive no heating after handling such as sandwiches, salads and desserts.

Viruses require living tissue for growth and therefore will not multiply in food; the food is merely a means of transport into the human body.

They are destroyed by temperatures reached in normal cooking.

Viral food poisoning is usually transmitted by food which has not been cooked properly or has been mishandled after cooking by a food carrier.

- Infectious hepatitis (A) can be transmitted through food that has not been handled in a sanitary manner. A major source of hepatitis is raw shellfish from polluted water

- **Chemical food poisoning**:

The food is poisonous because it has been contaminated by chemicals during the growth, preparation, storage or cooking of the food. Most cases of chemical food poisoning are caused by carelessness in the home or industrial establishments, as cleaning material, insecticidal spray, pesticides, food additives and packaging materials.

4. Physical hazards:

Food can be contaminated with foreign material that could be a physical hazard to the consumer such as, pieces of glass which pose an obvious risk of cutting the consumer's mouth or doing even-greater damage if it is swallowed. Sharp stones, pieces of metal, bone or wood can cause similar problems.

Any hard object can damage teeth and an even wider range of other, often apparently innocuous; objects can cause choking when swallowed (2).

2-2-5. Vegetable food poisoning:

Certain plants naturally contain substances which are poisonous to human beings for example, toad stools, hemlock, deadly nightshade, rhubarb leaves, and potatoes.

2-2-6. Mycotoxins:

Mycotoxins : Mycotoxins are compounds or metabolites that are toxic or have other adverse biological effects on humans and animals. They are carcinogens and are produced by a wide range of moulds. The acute diseases caused by mycotoxins are called mycotoxicoses .

Bullerman (1979) reported that in large doses they are acutely toxic, causing severe liver damage with intestinal and peritoneal hemorrhaging, resulting in death (3). Molds that are capable of producing mycotoxins are frequent contaminants of food commodities. Major producing microorganisms are *Aspergillus flavus*, and *A. parasiticus*.

Potential foods involved: cereal, grains, flour, bread, cornmeal, popcorn, and peanut butter.

2-2-7. Molds :

They are characterized by their display of a variety of colors and are generally recognized by their mild and fuzzy cotton like appearance. Molds generally withstand greater variations in pH than bacteria and yeasts, and can frequently tolerate greater temperature variations. Molds thrive best at

or near a pH of 7.0, a range from 2-8 can be tolerated. Molds thrive better at ambient temperature than in a colder environment, even though growth can occur bellow 0°C. When the water activity goes below 0.90 molds are likely to grow. Bacteria and yeasts grow more effectively and normally when the water activity 0.90 or higher. Although any food can be invaded by mold growth. Grains, nuts, vegetables, and fruits are susceptible to mold contamination prior to harvesting and during storage. Molds may spread throughout the food processing chain. Molds have an absolute requirement for oxygen. Because molds are difficult to control, food processors have encountered spoilage problems. In the past, 6000 cases of ready-to-eat pudding were recalled because of mold contamination (4).

2-2-8. <u>YEASTS</u>:

Are generally unicellular. They differ from bacteria in their burger cell sizes and morphology.

The generation time of yeasts is slower than that of bacteria with a typical time of 2-3 hours in food.

Like molds, yeasts can be spread through the air or by other means and can be found on the surface of foodstuffs.

Yeasts prefer a water activity of 0.90 – 0.94 but can grow below 0.90.

These microorganisms grow best in intermediate acid range, a pH of 4.0 – 4.5.

2-3. Factors affecting growth of microorganisms in food:

In order to grow and multiply in food, microorganisms require six factors (conditions) which are called (FATTOM), that is, Food, Acidity (pH), Temperature, Time, Oxygen availability, and Moisture (1).

2-3-1. Food: Like all living things bacteria need food, it's the most important condition needed for bacterial growth. Most bacteria prefer foods that are high in protein and moisture like meats, poultry, seafood, dairy products, and cooked rice, beans and potatoes.

2-3-2. Acidity (pH): The pH symbol is to designate the acidity or alkalinity of a food. The scale for measuring pH ranges from 0-14. A pH of less than 7.0 indicates the food is acidic. Very acidic foods (pH of 4.5 or below); will not normally support the growth of disease-causing bacteria.

A pH above 7.0 indicates the food is alkaline. Most bacteria prefer a neutral environment (pH of 7.0) but are capable of growing in foods that have a pH in the range of 4.6-7. Since most foods have a pH of

less than 7.0, we have identified the range where harmful bacteria grow best (on4.6-7.0). Many of the foods manufactured in food establishments have a pH in this range.

2-3-3. Temperature: All bacteria do not have the same temperature requirements for growth. Psycrophilic (cold loving): Bacteria grow within a temperature range of (0-21°C). These microorganisms are

especially trouble some because they are capable of growing at both refrigerated and room temperature.

Most psycrophilic bacteria are spoilage organisms, but some can cause disease.

Mesophilic (middle range): Bacteria grow at temperature between

21°C to 43°C with most rapid growth at human blood temperature (37°C). Thermophilic bacteria: Bacteria that grows best at temperature above 43C°. Most Thermophilic bacteria are spoilage organisms.

Temperature and time are the most critical factors affecting the growth of bacteria in foods. Most diseases causing bacteria can grow within a temperature range of (5 to 60C°). This commonly referred to as the food "temperature danger zone".

2-3-4. <u>Time</u>: Under ideal conditions, bacterial cells can double in number every 15 to 30 minutes.

• Clostridium perfringens bacteria can double every 10 minutes (5). For most bacteria, a single cell can generate over 1 million cells in 5 hours. Because bacteria have the ability to multiply rapidly, it does not take long before many cells are produced.

A rule of thumb in the food-service industry is that bacteria need about four hours to grow to high enough numbers to cause illness. This includes total time that a food is between 5 and 60 C°.

2-3-5. <u>Oxygen availability</u>: Bacteria differ from one another in their requirements for oxygen. Aerobic bacteria must have oxygen in order to grow. Anaerobic bacteria cannot survive when free oxygen is present because it is toxic to them. Anaerobic bacteria grow well in vacuum packaged foods or canned foods also in the middle of cooked food masses where oxygen is not available. Facultative anaerobics forms of bacteria can grow with or without free oxygen but have a preference. Most food borne disease-causing microorganisms are facultative anaerobes.

2-3-6. <u>Moisture</u>: Like most other forms of life, moisture is an important factor in bacterial growth. For bacterial growth not determined as percentage of moisture or water by volume, but rather it is the amount of water available for bacterial activity which is expressed as water activity with the symbol a_w , which is measured on a scale from 0-1. Water activity is a measure of the amount of water that is not bound to the food and is therefore available for bacterial growth. Disease-causing bacteria can only grow in foods that have a water activity of 0.85 or higher.

2-4. Major groups of bacteria:

Bacteria are unicellular microorganisms. Bacteria produce pigments ranging from variations of yellow to dark shades, such as brown or black. Certain bacteria have pigmentation of intermediate colors red, pink, orange, blue, green, or purple. Bacteria cause food discoloration, especially among foods with unstable color pigments, such as meat. Some species of bacteria also produce spores, some of which are resistant to heat, chemicals, and other environmental conditions. Many of these spore-forming bacteria are thermophilic microorganisms. That produces a toxin which causes food borne illness.

Food borne illnesses continue to be a major public health problem in the developed and developing countries (5). Current statistics for food borne illness in various industrialized countries show that up to 60% of cases may be caused by poor food handling techniques, and by contaminated food served in food service establishments (1).

All these items are prepared by the restaurants under certain health conditions supervised by Environmental Health Department, M.O.H.

Food Factories: samples were collected from 123 food factories in the West-Bank table 2 for microbiological analyses for public health issues.

The Market: Samples were collected randomly from the market and include grocery stores, hospitals, schools, other institutes, and imported food items.

Viruses require living tissue for growth and therefore will not multiply in food. The food is merely a means of transport into the human body.

2-4-1. Coliform Group:

Specific groups of bacteria or individual species are commonly used to provide evidence of poor sanitary practices, inadequate processing or post-process contamination of foods. These organisms are commonly referred to as indicator organisms (6).

The coliform group contains all aerobic and facultatively anaerobic, gram negative, non-spore forming rods able to ferment lactose with the production of acid and gas at 32°C or 35°C within 48 hours (15).

The genera include:

1. *Klebsiella* - may be found in feces and in the environment;
2. *Escherichia* - found always in human and other animal feces;
3. Enterobacter – found in feces and in the environment.
4. Serratia-found in environment.

Coliforms can be classified into those of fecal or non-fecal origin (15). The fecal coliform group is reffered to as organisms that grow in the gastrointestinal tract of humans and of the warm blooded animals and includes members of 3 genera: Escherichia, Klebsiella, and Enterobacter (7).

When *E.coli* content nearly 95% of the coliforms in feces and are universally present in the feces of warm blooded animals at densities of 10^8 - 10^9 per gram, it can be concluded that it would be always present in any fecal contamination (8).

In addition to its role as indicator of fecal contamination, E.coli is one of the most commonly used index organisms for Salmonella (8). It's presence in food particularly meat, meats products and fresh vegetables is used as indication of fecal contamination (9) and as indication of non-hygienic conditions or practices during production, processing or storage (10).

The numbers and types of microorganisms present in or on a food product may be used to judge the microbiological safety and quality of

that product (1).In examination the presence of fecal coliform should be taken to indicate a lack of cleanliness, not of safety. The safety of food can be assessed only by testing for the presence of pathogens (11).

The most frequent microorganisms associated with food poisoning are:

2.4.2. *Staphylococcus aureus*:

Staphylococcus aureus causes toxic food poisoning. Growing and multiplying in food stored at a warm temperature, it produces a toxin (a poisonous substance). When the food is swallowed the toxin irritates the stomach lining causing vomiting. The incubation period is therefore relatively short and the main symptom is vomiting.

Incubation period: 1-7 hours.

Duration of illness: 6-24 hours.

Symptoms: vomiting, sometimes abdominal pain and diarrhea.

Staphyloccocus aureus: The primary sits is the human skin, anterior nostrils, and nares are the most consistent area from which this organism can be isolated (12). The nasal carriage of *S.aureus* results easily in transfer of the bacteria to the hand. Food handlers harbouring enterotoxigenic strains of *S.aureus* constitute a potential source of contamination of food via the hands.

According to the Preventive Medicine Department of the Ministry of Health, the outbreaks resulted from *S.aureus* is the first major food poisoning in Palestine.

In 1982, in the United States there were 28 outbreaks responsible for 669 cases Staphyloccocal food poisoning contaminated meats, vegetables, creamy foods etc (13). The Association of European Airlines reported that there were eight Staphyloccocal outbreaks between 1947-1999, which includes 290 cases of passengers from different items of food (14).

S. aureus is frequently present in the human nose and throat and on the skin of healthy people. Food poisoning causing *S.aureus* usually come from those which have been contaminated by the food handler after they have been cooked and are then eaten cold or after a mild reheating process.

S. aureus is able to grow at higher concentration of salt than the other food poisoning bacteria e.g.(local) white cheese.

With ideal temperature and high contamination levels, Staphylococci can multiply enough to cause food poisoning without noticeable changes in color, flavor or odor. *S.aureus* organisms are destroyed by heating at 66°c for 12 minutes, but the toxin requires heating for 30 minutes at 131°c. Therefore the normal cooking time and temperature for most foods will not destroy the enterotoxin.

2-4-3. Salmonellosis:

The genus *Salmonella* was named in 1900 after the American Veterinarian Dr. Salmon who was the first to describe a member of the group, *Salmonella cholerasius* (3).

Symptoms: Fever, headache, abdominal pains, diarrhea and vomiting.

Salmonella are non-spore-forming organisms, and readily killed by heat.

These bacteria present in foods of animal origin, for example poultry, meat, unpasteurized milk, eggs. *Salmonella* is a member of the normal flora of intestines. Food handlers can contaminate food if they do not wash their hands after a visit to the toilet.

Salmonellosis is considered a food infection because it results from the ingestion of the numerous species of living *Salmonella* organisms. These microorganisms grow and produce an endotoxin (a toxin retained within the bacterial cell) that causes the illness.

The incubation period is relatively long: 12-36 hours.

Duration of illness: 1-8 days.

In Palestine, the Preventive Medicine Department M.O.H thought that the outbreaks occurred from restaurants and houses meals, a second major food poisoning. Recently, in 2002 an outbreak occurred in Hebron, where 51 cases of food poisoning were reported after consumption of soup and meat in a restaurant, in Ramadan.

An estimated 3400 human cases of Salmonella infection occurred in 1974 as a result of temperature abuse of egg containing potato salad served at an outdoor barbecue (3). In 1997, the consumption of mayonnaise in school cafeteria has led to a large Swidish outbreak of *Salmonella enteritidis* (3). A Salmonella food poisoning outbreak occurred in Riyadh, Saudi Arabia in 1980 where 12 persons out of 21 who attended a home dinner were affected and 6 of these required the care of a physician (23). In 1985, 16284 cases and 7 deaths were documented when pasteurized milk became recontaminated with *Salmonella typhimurium* strain (3). In Scotland, 224 outbreaks of Salmonellosis associated with poultry meat were reported between 1980-1985. In total, 2245 person were affected, 12 of whom died (12). The largest-ever outbreak of foodborne Salmonellosis occurred in Chicago area in 1985, with 16284 confirmed cases (25).

A high incidence of Salmonellosis have been reported in infants living on the Island of Guam (1115 cases/100,000 infants in 1993), the organism has been introduced on the foot wear of family members (27).

Until 1988, poultry meat was considered the major source of Salmonella food poisoning in Britain (29).

In 1989, *Salmonella enteritidis* was responsible for at least 49 food borne outbreaks and 13 deaths in United States, in which raw shell eggs

and unpasteurized liquid egg products were the food vehicles in the majority of outbreaks (16).

In England and Wales, Salmonella infection account for more than 80% of cases reported for food borne diseases in 1981-1983 (17, 18, 19).

The Association of European Airlines reported that 15 outbreaks infected approximately 4000 passengers on aircraft between 1947-1999 by contaminated food served on the planes (14).

2-4-4. <u>Clostridium perfringens food borne illness</u>:

Clostridium perfringens is an anaerobic, endospore former that produces a variety of toxins as well as gas during growth. It is the cause of gas gangrene.

These microorganisms and their endospores have been isolated in many foods especially among red-meats, poultry and sea food. Also, from vegetable coated with soil, or dust. People working in the kitchen may cross contaminate foods after using the toilet and not washing their hands.

Incubation period: 8-22 hours.

Duration of illness: 12-24 hours.

Symptoms: Abdominal pains and diarrhea; the patient rarely vomits.

Some endospores of this microorganism are killed in a few minutes at 100c°, whereas others require from 1-4 hours at this temperature for complete destruction.

2-4-5. Botulism :

Botulism is a true food poisoning that results from the ingestion of the toxin produced by *Clostridium botulinum* during its growth in food. This microbe is anaerobic, endspore-forming, gas-forming bacterium that is found primarily in soil. There are currently eight different botulinum toxins.

Death occurs in approximately 60% of the cases from respiratory failure.

Incubation period : 12-48 hours.

Symptoms : impaired swallowing, speaking, respiration, and coordination, dizziness and double vision.

The toxin is relatively heat – labile, but the bacterial endospores are very heat resistant. Thermal processing at 85c° for 15 minutes inactivate the toxin.

To completely destroy *C. botulinum* endospores , 100C°/360 min or 120C°/20 min, is required.

2-4-6. Bacillus cereus: Is an endospore-forming organism it is an aerobe and therefore requires oxygen for growth.

Bacillus cereus usually causes toxic food poisoning. It can grow and multiply in food stored at a warm temperature, and it produces a toxin .

When the food is swallowed the toxin irritates the stomach lining causing vomiting.

Incubation period: 1-5 hours

Duration: 6-24 hours

Symptoms: Vomiting, abdominal pains, occasionally diarrhea.

The endospores of *B.cereus* are brought into the kitchen on cereals, particularly rice, corn flour and spices.

The endospores of *B. cereus* are not easily destroyed by heat and will survive most cooking processes. They do not multiply but if the food is cooked slowly or kept warm for some time before serving, they will germinate producing vegetative bacteria which multiply rapidly at this temperature and produces a very heat-resistant toxin.

2-4-7 Fecal Coliform(E.coli)

Facultative Gram negative organism: It causes what is called travelor's food poisoning.

Escherichia coli is a heterogeneous species comprising many different strains, the vast majority of which are not pathogenic (7).

Most of strains are considered to be part of the normal microbial flora of the gastro-intestinal tract of man and other warm-blooded animals. However, certain strains are pathogenic and cause characteristic diarrheal symptoms such as *E.coli O157:H7* which was first isolated in 1975 in the USA (20).

Since then have been recognized as major food borne pathogens, and have caused several large outbreaks world wide. In 1982, *E.coli*

O157:H7 has been recognized as a causative agent of haemorrhagic colitis in the USA, Canada, and the United Kingdom (21, 22).

Symptoms : Hemorrhagic colitis, hemolytic uremic syndrome with 5-10% acute mortality rate, abdominal pain, vomiting, anemia thrombocytopenia, acute renal injury with bloody urine, seizures, pancreatitis.

Foods usually involved: Ground beef, dairy products, raw beef, water, apple cider, mayonnaise.

Following the investigation of two outbreaks of illness that were associated with consumption of hamburger from fast-food restaurant chain (23,24,25). Since then more than 12 similar outbreaks have been reported in the USA (23). In October,1988, an outbreak of *E.coli O157:H7* hemorrhagic colitis occurred among students attending a Minnesota School. The outbreaks were caused by consumption of the processed meat patties (26). Recently more than 8000 children (including seven fatalities), in 43 of 47 total Japanese prefectures, were shown to excrete *E.coli O157:H7* after consuming the midday school meat (27).

In the U.K the number of 0157:H7 infection has risen from handful in the early 1980 to approximately 650 in 1994 (28). In 1996, a large outbreak of verotoxin producing *E.coli O157:H7* infection occurred among students in several Japanese schools and day-care caterers.

The outbreaks affected 9451patients and caused 12 deaths and were thought to be caused by contaminated lunches (29). The association of European Airlines (AEA), reported three outbreaks associated with meals served on aircraft in 1947-1999, with 71 passengers affected by eating salad contaminated with *E.coli O157:H7*(14)

2-5 Category of Risks:

Components of restaurants meals can be placed into four risk categories:

Dangerous, high risk, medium and low-risk items (30).

Dangerous: Salmonella, meat, poultry.

- High-Risk: Products which are intensively handled after heat treatment such as Hommous salad (garbanzo peas) and meat after cooking.

- Medium –Risk: A minimum of handling after heat treatment, such as sausage, rice and pasta.

- Low-Risk: acidified food below pH 4.5 such as fresh fruits, canned fruits, bread.

Food handlers are a potential source of pathogenic micro-organisms.

A person known or suspected to be suffering from a disease likely to be transmitted through food or any person afflicted with infected wounds, skin infections or sores should not be allowed to work in contact with any unpacked foods.

2-6. Microbiological Limits:

Microbiological limit values are used to ensure the safety and quality of foods, Which inturn elevates consumer confidence (83). The Ministry of Health usually has its own standard, but WHO standards will be used as needed.

Table 2 describes the microbiological limit values for food items used by M.O.H.

Table 2 Microbiological limit values for food items used for restaurants meals according to the M.O.H. standard

Food items	Total Count	Total Coliform	Fecal Coliform	*Staph aureus*	Salmonella	Yeast&Molds
Homous	10^6	1000	100	50	0	100
Arabic Salad	NA	100	100		0	
Vegetable Salad	10^6		100	1000	0	100
Other Salads (as Mayonnaise)	1000	100	NA	NA	0	50
Raw Falafel	10^6	1000	1000	1000	0	NA
Tahina	5.10^4	100	100	100	0	100
Mutabal	NA	1000	100	1000	0	1000+100
Raw Meat	10^6	NA	NA	NA	0	NA
Cocked Meat	10^4	NA	NA	1000	0	NA
Other Foods (as Sausage)		NA	NA	NA	0	NA
Raw Knafa Dough	10^4	1000	100	1000	0	NA
Raw Cheese		1000	100	100	0	NA
Cocked Knafa	10^4	100	NA	50	0	NA
Other Sweets (as Baklava)	NA	NA	NA	NA	0	NA
Peanut	NA	10	NA	100	0	100

* Not applicable = NA

6. Bakdoonsieh (Tahina): Which is made up of a mixture of parsley and tahina (a sesame seed extract that is high fat content). Number of samples 153.
7. Egg Plants (Metabal): Which is made up of egg plants mashed in Tahina with lemon and salt. Number of samples 50.
8. Cooked Meat: Red meat or poultry as shawerma, kebab, chicken on grill etc. Number of samples 110.
9. Raw Meat: Red meat or poultry prepared for cooking. Number of samples 92.
10. Other foods: some kinds of foods such as eggs, sausage etc. Number of samples 66.

The most famous sweets are:

Kinafa and Baklava and their contents:

1. Kinafa : Which is made up of locally made white cheese and kinafa dough, and a highly concentrated sugar syrup. Number of samples 35.
2. Raw kinafa dough: Especially for making kinafa . Number of samples 140.
3. Raw white cheese, locally made by Palestinan farmers. Number of samples 531.
4. Other sweets: Such as Baklava which is made up of dough and peanut, and others. Number of samples 303.

5. Peanut: Used for Kinafa and other sweets. Number of samples 82.

Illness in various industrialized countries show that up to 60% of cases may be caused by poor food handling techniques, and by contaminated food served in food service establishments.

All these items are prepared by the restaurants under certain health conditions supervised by Environmental Health Department, M.O.H.

Food Factories: samples were collected from 123 food factories in the West-Bank Table 2 for microbiological analyses for public health issues.

The Market: Samples were collected randomly from the market and include grocery stores, hospitals, schools, other institutes, and imported food items.

3.2 . **Ministry of Health policies concerning food Control Legislation**:

1. Food-borne diseases including food poisoning should be notified by all health providers to the Palestinian Health Authority.

2. Food poisoning including food borne diseases outbreaks should be immediately notified within 24 hours by telephone and/or by fax by Public Health Law .

3. Food-borne diseases including food poisoning and ourbreaks are treated free of charge including hospitalization.

4. Food-borne diseases, food poisoning, and ourbreaks should be immediately investigated in order to have early diagnosis, control and prevention.

3.3. **Prevention and Control Measures**:

1. Food and water are randomly routinely screened by samples collection from the local producer, importers, and food handlers.
2. Samples transportation, conservation, screening, and results dissemination are scheduled by Palestinian Ministry of Health – Environmental Health Department.
3. Samples collected from food handlers are treated free of charge, for Public Health consideration.
4. Training : Frequent training courses are organized for Environmental Health Inspectors, Public Health Laboratory Technicians, and Preventive Medicine Physicians and Nurses in order to upgrade their knowledge for preventive and control purposes of food-borne diseases.

3.4. **Coordination** :

1. Routine and frequent coordinaly meeting with Ministries, UN, Universities and other organizations involved in food prevention and control.

2. Coordination with W.H.O concerning the implementation of the adopted W.H.O policies, as recommendations in addition to exchange information through W.H.O bullettins and reports.

3. Participation in intercountry or global meeting concerning food-borne disease.

4. National Environmental Health Committee was established for consultancy purposes.

3.5. **Sample collection**

Samples were collected for routine test of microbiological quality for public health issue by Environmental Health Inspectors to determine the situation of food safety and take actions by law, as a goal of Ministry of Health at primary care of people.

17143 samples were collected between " 1996-2002" , from food establishments such as :

(i) Imported food from stores of importers and super-markets, which is divided into two sources; international imports, and Israeli products. Quality control is very difficult, because wide and uncontrolled border, and political situation.

(ii) Food Factories: A total of food factories in the West-Bank 123, were inspected and quality control was checked for both hygienic conditions, and collecting samples for laboratory analyses particularly dairy and meat

products more than other products. In addition, samples were collected from all kinds of factory products.

(iii) The market which means imported and local products, as super markets, street vendors, schools, hospitals, hotels and other institutions.

(iv) Restaurants: The inspectors of Environmental Health Department inspect the establishment for , storage of raw materials, food preparation areas, refrigeration equipment, general cleanliness, general hygiene of workers and collect samples, almost, weekly.

Environmental Health Department of the Primary Health Care and Public Health Administration of the MOH is the bodies that carry quality control of food in the West Bank area.

It is divided into five division :

1. Food Quality Control Division
2. Water Quality Control Division
3. Sewage and Solid Waste Division
4. Vector Control Division
5. Crafts and Licensing.

There are about 70 inspectors for Environmental Health in the West Bank. These inspectors are in charge of quality control of the food industry restaurants, grocery stores and cafeterias. They are responsible of applying health rules issued by the MOH and making sure that these

institutes abide by these rules, after which a certificate is issued for them to carry on with the business.

Samples were collected for laboratory analyses at 0-4C, in clean and dry containers and transported on a weekly basis, and tested by the Central Public Health Laboratories, a body of the MOH in Ramallah.

3.6. **Food handling staff** :

Ministry of Health requires all food handlers in the food industry and restaurants to pass an annual physical tests. This policy was changed since 1998, because a study carried out by WHO recommended that the cost of this physical test is very high for the MOH to handle. In addition, the study shows that discovering food poisoning organism carriers is very rare.

Frequent microbiological tests on hands are useful to control hand hygiene. According to De Witt and Karnpelmacher (1988), 8% of food handlers showed high numbers ($> 10^5$/hand) of Enterobacteriaceae and S.aureus on their hands (31).

A sample unit consists of a minimum of 100 grams.

The inspectors used sterile plastic cups of 200 gram, the same spoon in which the worker of restaurants using, so the samples must be from the same dish which people were served from.

Dry Samples: Randomly collected from many places of a sample unit of 100gr. And kept in plastic containers.

3.7. **Receiving samples at the laboratory** :

As soon as samples arrive at the laboratory, time of collection and temperature are checked within 4 hours of receipt, samples are examined immediately or kept in the refrigerator before examination for 24 hours of collection. Samples are divided into three groups:

Frozen samples should be received frozen, and the temperature should be below 0C preferably -10C .

Refrigerated samples should be received refrigerated with temperature between 0-4C .

Dry and canned samples should be received at ambient temperature which is between 15-25C .

A lable is put on the sample that includes the following information :

- Sample code number (laboratory number).
- Date of reception.
- Type of sample.
- Tests required.

3.8. Determination of Total Aerobic count in dairy and general food products:

Add 50g. or 50ml of test sample to 200ml peptone water (Merck, USA), Blend in a stomacher for one minute at medium speed. Make -1 to – 6 dilutions in saline. Make duplicate plates of plate count agar medium of each dilution by spread plate technique, and incubate plates for 72 hours at 30C. Count. Colonies and calculate the total aerobic microorganism per gram or milliliter of sample, as follows:

$$N = \frac{\sum C}{[(1 \times n_1) + (0.1 \times n_2)] \times d}$$

Where N is the number of colonies per ml or gr.

$\sum C$ = Sum of all colonies on all plates counted.

n1 = Number of plates in first dilution counted.

n2 = Number of plates in second dilution counted.

d = Dilution from which the first counts were obtained (32)

3.9 Detection of total coliforms in dairy and general food products:

Procedure: Add 50 g or 50 ml of test sample to 200 l peptone water, then blend in a stomacher for one minute at medium speed. Make -1 to -3 dilution s in saline. Make duplicate plates on Violet Red Bile Lactose (Merck, USA) (VRBL) or EMB.

Medium of each dilution spread plate technique, then incubate for 4 hours at 30°C. Count colonies with diameter greater than 0.5 mm. And calculate the number of total Coliforms per gram or milliliter of sample.

Subculture on BCP (Merck, USA) and incubate for 4 hours at 30°C.

Quality control: Both positive and negative organism control such as E. coli, Klebsiella, Proteus and others, and negative media controls were included with each batch of samples.

Confirmation: Kligler test, ONPG, Methyl Red, Voges-Proskauer, Citrate, Lactose fermentation and Glucose fermentation.

3.10 Determination of Fecal Coliforms in Dairy and general food products

Procedure: Add 50g. or 50 ml of test sample to 200 ml peptone water. Blend in a stomacher for one minute at medium speed, Make -1 to -3 dilution's in saline. Make duplicate plates on VRBL or EMB medium of each dilution by spread plate technique. Incubate for 18 - 24 hours at 44 °C, Count Red colonies with diameter greater than 0.5 m. and calculate the number of Fecal Coliforms per gram or milliliter of sample.

Subculture on EMB plates to confirm E. coli.

Quality control: Both positive and negative organisms controls such as *E. coli, Klebsiellla, Proteus*, and others and negative control should be included with each batch of samples.

Confirmation tests: Indol, ethyl Red, Voges-Proskauer, Citrate, Catalase, Oxidase, Glucose and Lactose fermentation (32).

3.11. **Detection of *Staphylococcus aureus* in General Food Products**.

Procedure: Add 50g. or 50ml of sample to 200ml of peptone water, Blend in Stomacher for one minute at medium speed. Make -1to -4 dilutions in Saline. Make duplicate plates of each dilution by spread plate technique. Plates should be Baird-Parker agar incubated for 18-48 hours at 37C. Count Black colonies with clear zone around, and calculate the number of bacteria in 1.0g or 1.0ml of sample. Inoculate Brain Heart infusion broth and incubate for 24 hours at 37C, to confirm with coagulase test.

Quality control: Both positive and negative organism controls and negative media controls were included with each batch of samples.

Confirmation tests: Mannitol hydrolysis, Coagulase test (32).

3.12. **Detection of Salmonella in General Food Products** :

Procedure: Add 25g. of test sample to 225ml, of peptone water or selenite cystine broth, Blend in stomacher for one minute at medium speed and, incubate for 16 hours at 37C.

Isolation of Salmonella :

Add 0.1ml of culture (peptone water) to 10.0ml of Rappaport medium, (Meid) and incubate for 24 hours at 42C.

Selenite Medium (Merck, USA): Add 2.0ml. of culture (peptone water) to 20.0ml. of selenite cystine medium and incubate for 24 hours at 37C.

Quality control: Both positive and negative organism controls and negative media controls were included with each batch of samples.

Confirmation tests: Biochemical identification and serological identification (32).

Bizmuth Sulfite Plates: Inoculate 0.1ml of rappaport medium or selenite cystine medium onto bismuth sulfite plates for 24 hours at 37° C. Look for black colonies.

3.13. **Detection of Yeasts and Molds in General Food products**:

Procedure: Add 50g or 50ml of test sample to 200ml peptone water, Blend in a stomacher for one minute at medium speed, Make -1 to- 4 Make duplicate plates on YGC medium (Merck, USA) dilutions in saline of each dilution by spread plate technique, per incubate at 22-25°c for at least 5 days. Count colonies at 3.4, and 5 days. Examine colonies under microscope to differentiate between yeasts and Molds, and do Gram stain for yeasts.

Quality Control: Both positive and negative organism controls and negative media controls were included with each batch of samples.

Confirmation tests: Microscopic examination, Gram stain. Biochemical tests for Yeasts Growth at 37C, Capsule stain , Spore stain , Urease. Biochemical tests for Molds.

CHAPTER FOUR

4. RESULTS

3.1. Distribution of Food Samples

A total of 3373 samples of different raw and ready to eat foods were reported from the records of Environmental Health Department, Ministry of health, during 1996 to 2002. Samples were gathered by Environmental Health inspectors from restaurants in the main cities in 10 districts of the West Bank. The majority of samples (838 = 24.8 %) were Hommous.

About two third of food samples were collected from three districts of West Bank namely Ramallah, Jenin and Bethlehem. Most of these food samples (60 %) were ready to eat foods. Table (2) describes the number of samples collected from each district of the West Bank.

3.2. Total Aerobic Count

A total of 2803 food samples accounting 83.1 % of the collected samples were examined for the total number of aerobic count (Table 3). The maximum value reported was 10^{13} Colony forming unit (CFU) in raw falafel sample collected from Ramallah district during hot season (September 22, 2001), whereas the minimum was 10 CFU in different kinds of food samples.

Table 2. Distribution of the different types of food samples by the districts of West Bank during 1996-2002

District	Ready to eat foods										Raw foods					
	Hommous	Arabic Salad	Vegetable Salad	Other Salad*	Tahaina	Metabal	Cocked Meat	Other foods**	Cocked Knafa	other sweets***	Raw Falafel	Raw Meat	Raw Knafa dough	Raw cheese	peanut	**Total**
Jenin	192	11	6	3	2	-	77	12	12	74	1	71	4	224	34	**723**
Nablus	35	6	39	8	13	3	-	4	-	41	9	-	25	38	18	**239**
Tulkarm	50			3	6	5	2	4	-	4	1	2	20	57	10	**164**
Qalqilia	98		2			-	-	2	5	17	-	-	3	27	15	**169**
Salfit	66	8	12	4	1	5	-	1	-	3	9	-	1	1	-	**111**
Ramallah	152	76	72	67	65	11	26	11	9	53	83	5	65	115	-	**810**
Jericho	91	34	8	25	14	10	2	19	-	7	43	-	1	16	3	**273**
Beithlehem	117	59	58	142	50	13	2	11	2	55	66	13	4	30	-	**622**
Hebron	12		10	5	2	2	-	1	7	49	15	1	14	22	2	**142**
Jerusalem	25	6	58	6		1	1	1	-	-	18	-	3	1	-	**120**
Total (%)	**838 (25)**	**200 (6)**	**265 (8)**	**263 (8)**	**153 (5)**	**50 (2)**	**110 (3)**	**66 (2)**	**35 (1)**	**303 (9)**	**245 (7)**	**92 (3)**	**140 (4)**	**531 (16)**	**82 (2)**	**3373 (100)**

* Includes Turkey and French salads
** Includes Turkey and French salads
***Includes Baclava and Black forest

Table 3. Numbers and percentages of acceptable and unacceptable samples for each kind of food according to total aerobic count.

Food Sample	No. of Samples	Tested Sample	PSL*	Match PSL (%)	Not Match PSL (%)
1. Hommous	838	835	$< 10^6$	544 (65 %)	291 (35 %)
2. Arabic Salad	200	NA**	NA	NA	NA
3. Vegetable Salad	265	264	$< 10^6$	184 (70 %)	80 (30 %)
4. Other Salad	263	260	$< 10^3$	63 (24 %)	197 (76 %)
5. Raw Falafel	245	244	$< 10^6$	52 (21 %)	192 (79 %)
6. Tahaina	153	153	$< 5*10^4$	51 (33 %)	102 (67 %)
7. Metabal	50	NA	NA	NA	NA
8. Raw Meat	92	83	$< 10^6$	54 (65 %)	29 (35 %)
9. Cocked Meat	110	110	10^4	45 (41 %)	65 (59%)
10. Other foods	66	NA	NA	NA	NA
11. Raw Knafa dough	140	19	$< 10^4$	3 (16 %)	16 (84 %)
12. Raw cheese	531	NA	NA	NA	NA
13. Cocked Knafa	35	24	$< 10^4$	17 (71 %)	7 (29 %)
14. other sweets	303	NA	NA	NA	NA
15. peanut	82	NA	NA	NA	NA
Total	3373	1992	NA	1013 (51 %)	979 (49 %)

* Palestinian Standard limits

** Not Applicable

4.3. Total Coliform

About 70 % of the collected samples were examined for the contamination with total coliform, these species of *Enteriobacteriaceae* were detected in raw and ready to eat food samples. Table (4) shows that the majority of examined food samples were contaminated with coliform bacteria. The least percentage of contamination was 14 % in Cocked Knafa samples.

3.4. Fecal Coliform

A total of 2506 samples of different kinds of foods were examined for the presence and the number of fecal coliform bacteria. Only 18 samples were free from fecal coliform bacteria, the mean of fecal coliform bacteria in all samples was more than one million.

About 50 % of ready to eat food samples were found contaminated with more than 1000 *E. coli.* On the other hand 50 % of raw food samples have more than 5700 *E. coli.* Table (5) shows the percentiles of contamination for ready to eat and raw food samples.

Raw falafel samples have the highest contaminated percentage of contamination with *E. coli.* Ninety percent of tested samples have more than 1000 *E. coli.* It is followed by Arabic Salad which have 90 % of samples contaminated with more than 100 E. coli. Table (5) shows the mean, standard deviation and percentiles for all food samples together and for each type of food separately.

Table 4. Numbers and percentages of acceptable, and unacceptable samples from each kind of food according to the total Coliform

Food Sample	No. of Samples	Tested Sample	PSL*	Match PSL (%)	Not Match PSL (%)
1. Hommous	838	838	$<10^3$	327 (39 %)	511 (61 %)
2. Arabic Salad	200	200	$<10^2$	15 (8 %)	185 (92 %)
3. Vegetable Salad	265	NA**	NA	NA	NA
4. Other Salad	263	263	$<10^2$	129 (49 %)	134 (51 %)
5. Raw Falafel	245	245	$<10^3$	21 (9 %)	224 (91 %)
6. Tahaina	153	153	$<10^2$	40 (26 %)	113 (74 %)
7. Metabal	50	50	$<10^3$	29 (58 %)	21 (42 %)
8. Raw Meat	92	NA	NA	NA	NA
9. Cocked Meat	110	NA	NA	NA	NA
10. Other foods	66	NA	NA	NA	NA
11. Raw Knafa dough	140	NA	NA	NA	NA
12. Raw cheese	531	530	$<10^3$	257 (48 %)	273 (52 %)
13. Cocked Knafa	35	35	$<10^2$	30 (86 %)	5 (14 %)
14. other sweets	303	NA	NA	NA	NA
15. peanut	82	82	10	32 (39 %)	50 (61 %)
Total	3373	2396	NA	880 (37 %)	1516 (63 %)

*Palestinian Standard limits
NA** Not Applicable

Table 5. Shows the percentiles of fecal coliform of ready to eat and raw food samples collected form restaurant.

Type of Food	No of fecal coliform (=0)	Percentiles						
		5	10	25	50	75	90	95
Raw food	2	10	10	10	$5.7 * 10^3$	$1.0 * 10^5$	$1.0 * 10^6$	$2.0 * 10^6$
Ready to eat	16	10	10	10	$1.0 * 10^3$	$2.5 * 10^4$	$1.0 * 10^5$	$5.6 * 10^5$

Table 6: Numbers and percentages of acceptable, and unacceptable samples for each kind of food according to Fecal Coliform.

Food Sample	No. of Samples	Tested Sample	PSL*	Match PSL (%)	Not Match PSL (%)
Hommous	838	825	0	138 (17 %)	687 (83 %)
Arabic Salad	200	199	0	53 (27 %)	146 (73 %)
Vegetable Salad	265	258	0	124 (48 %)	134 (52 %)
Other Salad	263	262	0	59 (23 %)	203 (77 %)
Raw Falafel	245	239	$<10^2$	72 (30 %)	167 (70 %)
Tahaina	153	145	0	39 (30 %)	106 (70 %)
Metabal	50	50	0	14 (28 %)	36 (72 %)
Raw Meat	92	79	$<10^2$	14 (18 %)	65 (82 %)
Cocked Meat	110	109	0	30 (28 %)	79 (72 %)
Other foods	66	44	0	13 (30 %)	31 (70 %)
Raw Knafa dough	140	17	0	7 (41 %)	10 (59 %)
Raw cheese	531	120	50	80 (67 %)	40 (33 %)
Cocked Knafa	35	10	0	7 (70 %)	3 (30 %)
other sweets	303	122	0	85 (70 %)	37 (30 %)
peanut	82	27	0	18 (67 %)	9 (33 %)
Total	3373	2506	-	753 (30 %)	1753 (70 %)

*Palestinian Standard limits

4.5 *Salmonella sp.*

Out of the 2937 samples examined for Salmonella 13 food samples were contaminated, most of them were raw meat that collected from Jenin district (Table 7). The number of tested samples for each type of food were shown in table (8).

Table 7. Distribution of salmonella contamination in food samples collected from restaurants.

Food Sample	District				Total
	Hebron	Beithlehem	Ramallah	Jenin	
Hommous	1	1	1	0	3
Raw Meat	0	0	0	7	7
Raw cheese	0	1	0	2	3
Total	1	2	1	9	13

4.6 Staphylococcus sp.

A total of 2399 food samples accounting 71 % of all collected samples were examined for the total number of *Staphylococcus sp.* The maximum value reported was $3.2 * 10^7$ in raw cheese sample, whereas about 3.4 % (82 of 2399) of samples were free from *Staphelococcus sp.* table (9).

Table 8. Numbers and percentages of acceptable, and unacceptable samples for each kind of food samples collected from restaurants according to Salmonella.

Food Sample	No. of Samples	Tested Sample	PSL*	Match PSL (%)	Not Match PSL (%)
Hommous	838	835	0	832 (99.6%)	3 (0.4 %)
Arabic Salad	200	199	0	199 (100%)	0 (0 %)
Vegetable Salad	265	262	0	262 (100%)	0 (0 %)
Other Salad	263	257	0	257 (100%)	0 (0 %)
Raw Falafel	245	238	0	238 (100%)	0 (0 %)
Tahaina	153	145	0	145 (100%)	0 (0 %)
Metabal	50	50	0	50 (100%)	0 (0 %)
Raw Meat	92	91	0	84 (92 %)	7 (8 %)
Cocked Meat	110	110	0	110 (100%)	0 (0 %)
Other foods	66	49	0	49 (100%)	0 (0 %)
Raw Knafa dough	140	27	0	27 (100%)	0 (0 %)
Raw cheese	531	514	0	511 (99.5%)	3 (0.5%)
Cocked Knafa	35	16	0	16 (100%)	0 (0 %)
other sweets	303	120	0	120 (100%)	0 (0 %)
Peanut	82	27	0	27 (100%)	0 (0 %)
Total	3373	2940	-	2927	13

*Palestinian Standard limits
NA** Not Applicable

Table 9. Numbers and percentages of acceptable, and unacceptable samples for each kind of food samples collected from restaurants according to of staph aureus

Food Sample	No. of Samples	Tested Sample	PSL*	Match PSL (%)	Not Match PSL (%)
Hommous	838	837	< 50	818 (98 %)	19 (2 %)
Arabic Salad	200	NA**	NA	NA	NA
Vegetable Salad	265	262	$< 10^3$	260 (99 %)	2 (1 %)
Other Salad	263	NA	NA	NA	NA
Raw Falafel	245	243	$< 10^3$	239 (98 %)	4 (2 %)
Tahaina	153	146	$< 10^2$	142 (97 %)	4 (3 %)
Metabal	50	50	$< 10^3$	50 (100 %)	0 (0 %)
Raw Meat	92	NA	NA	NA	NA
Cocked Meat	110	110	$< 10^3$	108 (98 %)	2 (2 %)
Other foods	66	NA	NA	NA	NA
Raw Knafa dough	140	138	$< 10^3$	120 (87 %)	18 (13 %)
Raw cheese	531	520	$< 10^2$	434 (83 %)	86 (17 %)
Cocked Knafa	35	29	< 50	28 (97 %)	1 (3 %)
Other sweets	303	NA	NA	NA	NA
Peanut	82	64	$< 10^2$	62 (97 %)	2 (3 %)
Total	3373	2399	NA	2261 (94%)	138 (6 %)

*Palestinian Standard limits
NA** Not Applicable

4.7. Yeast and Mold Contamination

A total of 1638 food samples were examined for the total number of yeasts and molds. Only one sample and 11 samples of raw and ready to eat food, respectively, were free from yeast and molds. About 50 % of food samples were contaminated with more than 2000 of yeast and molds. Table (10) shows contamination of food samples with yeast and molds according the Palestinian standard.

Table 10: Numbers and percentages of acceptable, and unacceptable samples for each kind of food collected from restaurants according to Yeast and Mold.

Food Sample	No. of Samples	Tested Sample	PSL*	Match PSL (%)	Not Match PSL (%)
Hommous	838	830	$< 10^2$	600 (72 %)	230 (28%)
Arabic Salad	200	NA**	NA	NA	NA
Vegetable Salad	265	264	$< 10^2$	31 (12 %)	233 (88 %)
Other Salad	263	261	50	79 (30 %)	182 (70 %)
Raw Falafel	245	NA	NA	NA	NA
Tahaina	153	153	$< 10^2$	33 (22 %)	120 (78 %)
Metabal	50	50	$< 10^3$	24 (48 %)	26 (52 %)
Raw Meat	92	NA	NA	NA	NA
Cocked Meat	110	NA	NA	NA	NA
Other foods	66	NA	NA	NA	NA
Raw Knafa dough	140	NA	NA	NA	NA
Raw cheese	531	NA	NA	NA	NA
Cocked Knafa	35	NA	NA	NA	NA
other sweets	303	NA	NA	NA	NA
peanut	82	80	$< 10^2$	15 (19 %)	65 (81 %)
Total	3373	1638	-	782 (48 %)	856 (52 %)

*Palestinian Standard limits
NA** Not Applicable

4.8. Distribution of collected food samples

Over the period of this study, about half the food samples did not match the Palestinian standard. The following Table (Table II) shows the distribution of contaminated samples by year.

Tables 12-19 show a comparison between the percentage of different kinds of contaminated food samples collected from restaurants, food industries and market during 1996-2002.

Table 11. Distribution of contaminated samples taken from restaurants by year.

Year	Percentage of contaminated samples
1996	60 %
1997	52.4 %
1998	56.7 %
1999	56.5 %
2000	59.0 %
2001	60 %
2002	56 %
Average	**57.7 %**

Table 12: Distribution of food samples collected from the West Bank during 1996.

District	Total number of samples	Contaminated	Restaurants	Contaminated	Local industry	contaminated	Market	contaminated
Jenin	221	82	88	42	35	15	98	25
Nablus	328	107	106	65	130	25	92	17
Tulkarm	255	73	66	27	134	31	55	15
Qalqelia	89	55	51	34	21	15	17	6
Salfet	59	26	13	9	13	11	33	6
Ramalah	274	119	105	78	110	28	59	13
Jericho	118	30	16	10	97	17	5	3
Bethlahem	215	96	83	52	72	29	60	15
Hebron	386	108	32	19	307	82	47	7
Total	1945	696	560	336	919	253	466	107
Percentage of Contaminatia	-	35.7	-	60	-	27.5	-	23.2

A total number of samples 1945, were percentage of contaminate 35.7%. The highest contamination of food were from restaurant samples 60%.

Table 13: Distribution of food samples collected from the West Bank during 1997.

District	Total number of samples	Contaminated	Restaurants	Contaminated	Local industry	contaminated	Market	contaminated
Jenin	293	108	71	34	34	16	188	58
Nablus	343	60	13	5	170	27	163	28
Tulkarm	228	54	29	16	153	27	46	11
Qalqelia	80	44	41	31	6	3	33	10
Salfet	53	27	17	11	22	13	14	3
Ramalah	510	92	59	29	230	42	218	21
Jericho	163	43	14	12	73	18	76	13
Bethlahem	292	87	79	43	75	18	138	26
Hebron	486	93	47	13	245	47	194	33
Total	2448	608	370	194	1017	211	1070	203
Percentage of Contaminatia	-	24.8	-	52.4	-	21.5	-	19.0

A total number of collected sample 2448 were 24.8% contaminated the highest contamination were from restaurant 52%.

Table 14: Distribution of food samples collected from the West Bank during 1998.

District	Total number of samples	Contaminated	Restaurants	Contaminated	Local industry	contaminated	Market	contaminated
Jenin	506	210	155	92	3	0	350	118
Nablus	303	39	15	7	158	18	130	14
Tulkarm	260	50	34	26	173	19	29	5
Qalqelia	65	23	15	13	24	9	29	1
Salfet	47	18	16	11	13	6	18	1
Ramalah	436	46	21	11	161	24	256	11
Jericho	154	30	27	19	43	3	84	8
Bethlahem	456	133	194	95	143	24	119	14
Hebron	415	69	15	5	285	45	121	19
Total	2642	618	492	279	1014	148	1136	191
Percentage of Contaminatia	-	23.4	-	56.7	-	14.6	-	17.0

A total number of collected sample 2642 were 23.4% contaminated, the highest percentage contamination were from restaurant 56.7%.

Table 15: Distribution of food samples collected from the West Bank during 1999.

District	Total number of samples	Contaminated	Restaurants	Contaminated	Local industry	contaminated	Market	contaminated
Jenin	453	171	73	31	18	3	362	137
Nablus	280	47	3	2	132	16	145	29
Tulkarm	197	51	30	27	129	15	38	9
Qalqelia	102	38	27	16	27	13	48	9
Salfet	33	10	3	2	5	3	25	5
Ramalah	322	28	8	5	112	14	202	9
Jericho	146	29	23	18	48	5	75	6
Bethlahem	464	125	137	74	76	7	251	44
Hebron	450	122	41	20	280	48	129	54
Total	2447	621	345	195	827	124	1275	302
Percentage of Contaminatia	-	5.3	-	56.5	-	15	-	23.6

Table 16: Distribution of food samples collected from the West Bank during 2000.

District	Total number of samples	Contaminated	Restaurants	Contaminated	Local industry	contaminated	Market	contaminated
Jenin	470	134	132	69	33	6	305	59
Nablus	193	15	3	3	98	7	92	5
Tulkarm	155	45	14	9	101	23	40	13
Qalqelia	116	47	46	37	23	4	47	6
Salfet	27	14	12	10	7	3	8	1
Ramalah	406	73	102	58	174	13	130	2
Jericho	159	57	58	43	49	11	52	3
Bethlahem	366	79	101	62	95	7	170	10
Hebron	345	37	33	5	232	20	80	12
Jerusalem	0	0	0	0	0	0	0	0
Total	2237	501	501	296	812	94	924	111
Percentage of Contaminatia	-	22.4	-	59.0	-	11.6	-	12.0

Table 17: Distribution of food samples collected from the West Bank during 2001.

District	Total number of samples	Contaminated	Restaurants	Contaminated	Local industry	contaminated	Market	contaminated
Jenin	792	215	91	35	24	7	677	137
Nablus	213	90	139	69	30	8	44	15
Tulkarm	69	23	0	0	64	22	5	1
Qalqelia	23	5	6	4	8	1	9	0
Salfet	9	7	9	7	0	0	0	0
Ramalah	390	122	131	76	225	41	34	5
Jericho	212	75	82	59	76	8	54	8
Bethlahem	287	107	131	94	27	10	129	30
Hebron	138	16	3	3	93	8	42	9
Jerusalem	485	126	134	92	204	22	147	12
Total	2618	786	726	439	751	127	1141	220
Percentage of Contaminatia	-	300	-	60.0	-	17.0	-	19.3

Table 18: Distribution of food samples collected from the West Bank during 2002.

District	Total number of samples	Contaminated	Restaurants	Contaminated	Local industry	contaminated	Market	contaminated
Jenin	790	102	96	24	50	9	644	73
Nablus	121	16	8	3	80	11	33	8
Tulkarm	125	14	11	5	83	10	31	4
Qalqelia	47	21	21	15	10	3	16	3
Salfet	44	31	34	25	10	6	0	0
Ramalah	1021	273	251	155	579	82	191	10
Jericho	156	61	66	45	28	4	62	12
Bethlahem	185	55	80	50	12	3	93	5
Hebron	273	44	39	16	154	26	80	5
Jerusalem	340	40	44	27	118	14	178	4
Total	3102	657	650	365	1124	168	1328	124
Percentage of Contaminatia	-	21.0	-	56.0	-	14.9	-	9.3

Table 19: Total number of samples between 1996-2002,and the total number of Contaminated samples and the percentage.

Year	Total number of samples	Total no. Of contaminated	Restaurants	No. Of contaminated samples from restaurants	Local	No. Of contaminated samples from local	Market	No. Of contaminated from market
1996	1943	296	550	336	919	253	466	107
1997	2448	608	370	194	1017	211	1070	203
1998	2622	618	472	279	996	148	1120	191
1999	2447	928	345	195	827	124	1275	302
200	2207	501	470	296	812	94	924	111
2001	2478	786	586	439	751	100	1141	185
2002	3032	657	580	365	1124	131	1328	124
Total	17143	4794	3373	2104	6446	1061	7324	1223
Percentage of contamination	100 %	27.5%		57.7%		16.5%		16.6%

Table 20: Number of cases of food poisoning reported from all districts of the West Bank during 1996 – 2002.

year	No. of Cases										
	Hebron	Bethlehem	Ramallah	Jerusalem	Jericho	Nablus	Tulkarm	Salfit	Qalqelia	Jenin	Total
1996	297	33	15	0	34	83	92	38	30	105	727
1997	210	75	26	0	21	48	44	16	7	108	555
1998	114	45	9	0	5	78	59	26	0	160	516
1999	94	39	9	0	32	113	41	35	2	141	506
2000	125	59	170	0	36	51	77	48	45	118	729
2001	62	53	2	0	81	43	99	16	8	176	540
2002	134	35	15	2	29	13	79	5	13	99	424

During 1996-2002, a total number of 3997 cases (571 cases annually) of food poisoning were reported by preventive medicine department, ministry of health.

Candies, wafers and biscuits industries consists one third of food industries in the West Bank, table 22 shows the percentage of each kind of food industry.

Table 21. Kind and Numbers of Food Factories in the West Bank

Type of Industry	Number	Percent
Dairy Products	17	12.9
Meat Products	10	7.6
Cereal & Makarouni	8	6.0
Juices & Carbonated Cola	14	10.6
Candies Wafers Biscuits	41	31.0
Tahina	19	14.4
Canned Food	2	1.5
Ice Cream	4	3.0
Snacks	7	5.3
Chewing gum	2	1.5
Oils	2	1.5
Salada	2	1.5
Others	4	3.0
Total	132	100 %

CHAPTER FIVE

5. DISCUSSION

The collection of most samples from three districts, Ramallah, Jenin and Bethlehem, can be attributed to the large numbers of restaurants in these cities because the tourism activities in the main cities of these districts.

Out of fifteen kinds of food, five items were applicable for Total Aerobic Count (TAC) analysis. The highest degree of contamination with TAC was raw knafa dough 84 %, followed by Homous, Tahina ,and cooked meat. The percentage of contaminated food were 35%,67%,59% respectively. All these items are ready to eat foods, thus the presence of large number of different kinds of bacteria point to the probability of the occurrence of food poisoning and food spoilage.

Table 4, shows that 2396 sample were tested for colifrom bacteria. Sixty three percent of samples were unacceptable according to the Palestinian standard. Arabic salad contains the highest degree of contamination with total coliform 92%. Sixty one percent of Hommous samples were contaminated. Raw falafel was 91%, but this is not significant because raw falafel is not ready to eat food, since it is fried in hot vegetable oil (more than 250°C), which kill all microorganisms. Most of the restaurants that serve falafel are, actually, street vendors, and are easily affected by contaminated air, dust, sand, soil, and from the

movement of people and cars . So, the high percentage of contamination is attributed, mostly, to the location of these street vendors. This applies, also, for the high percentage of Arabic salad and tahina which are major constituents of sandwiches especially falafel sandwich.

Although total coliforms are not pathogenic organisms. Since they come from dust, soil, and plant remains, they are a good indicator of the presence of fecal contamination, if they are found in large numbers.

The high percentage of contamination of all kinds of samples by fecal coliforms, indicates that hygienic conditions are lacking, especially personal hygiene, which means that people handling food of these restaurants are not washing their hands properly after using the toilets. It also, indicates that contamination could be because of contaminated water that is used to wash or cook the food with. This is an indication of bad sewage system at these restaurants, or irrigation of vegetables using sewage water instead of clean water.

As mentioned 95% of fecal coliform is *E.coli* (8), which indicated that *E.coli* would be always present in any fecal contamination event, unlike Klebseilla, Enterabacter and Citrobacter.

The presence of *S.aureus* was low (6%) in average. However, its presence in processed foods shows contamination occurred by hands,

indicating inadequate personal hygiene among food handlers during the preparation of food. Cooked food can be contaminated by a colonized person during handling in the kitchen. The storage of contaminated food at an inappropriate temperature (7-46°C) could possibly have led to the multiplication of S. aureus and the formation of entorotoxins, which are very resistant to heat and will survive cooking even with some sterilization processes (33).

Because *S. aureus* is a poor competitor, it seldom causes problems with raw products. Heat-treated proteinaceous food items are good media for their growth. *S. aureus* cells are salt-tolerant (16 to 20 NaCl). Raw cheese (with 17% contamination) included in a hot knafa, may be a vehicle of outbreaks from our restaurants.

Raw cheese (17%) and raw knafa dough (13 %) considerably higher frequency of S. aureus, because they need more manual handling, so contamination could be via the hands. White cheese and Knafa drough are cooked together in a metal containers at enough temperature to kill all kinds of vegetative cells, but does not kill toxins produced by these micro organisms especially *S. aureus* enterotoxin.

Staphylococcus does not grow well in competition with other organisms and so is rarely found in unprocessed foods. It grows best in precooked foods.

Since most people are carriers of *Staphylococcus* in the nasal passages and on the skin (particularly in boils and infected wounds), reinfection of cooked food is common. Appreciable levels of toxin are only found after considerable growth of *Staphylococcus* had occurred.

The *Staphylococcus* organism is easily destroyed by heat but any toxin which the organism has produced in the food is not, being resistant to boiling temperature for up 60 minutes. It is thus possible to have food with no detectable presence of viable *Staphylococcus aureus* which is still able to cause staphylococcal food poisoning. It follows that staphylococcal enterotoxin is not destroyed by normal reheating processing.

Salmonella was present in raw meat 8 %, raw cheese 0.5 % and Hommous 0.4%. The source of contamination can be raw material, cross contamination via raw materials, surfaces, utensils and infected food handlers. Proper heat treatment is sufficient to destroy surface contamination. Usually it is found in poultry and turkey, red meat may also be contaminated but the prevalence of *Salmonella* is lower than in poultry (34).

In Nablus area contamination with *Salmonella* was 9.1% in poultry, 8% in beef, and 6.5% in Turkey (35). The incidence of salmonella can be harmful if meats eaten raw or medium raw, as is preference of some people (e.g.23-25% of USA population) (36). So meat should be cooked to reach

temperature 70°C in deep. In Arab countries, usually, they eat meat well cooked, with temperature reach above 70°C, which is enough to kill microorganisms.

The high percentage of contamination of raw meat by *Salmonella* indicates that the system of slaughtering is done without any control. In addition, it indicates that animals are fed contaminated feeds that transmit *Salmonella* to these animals.

Testing of samples of raw meat in 2003, show that 20 % of these samples are contaminated with *Salmonella* (Data not reported).

Table 10 show that the percentage of contamination by yeasts & molds was 52% Vegetable salad 88% , Tahina 78%, more significantly peanut 81%. This is an indication of uncontrolled environment conditions such as dust, soil, air, and ventilation at these restaurants.

Very few yeasts are dangerous to humans, and most of them are useful. Yeasts do not cause food poisoning but some types are capable of causing food spoilage, as acid foods with high sugar content (Tricket).

Molds do not normally cause food poisoning although some of them can produce mycotoxins.

Moulds present in grain or nuts which are stored in damp conditions produce mycotoxins which may cause cancer. Almost any food can be invaded by mold growth. Grain, nuts, vegetable and fruit are susceptible to mold contamination prior to harvesting and during storage. This mold may

spread throughout the food processing chain 6000 cases in USA of ready to eat pudding were recalled (1) because of mold contamination (4). During 1996 two manufacturers of fruit juice issued recalls on products contaminated with mold (4) .

Food Contamination:

Table 20 shows that the 27.5 % of total samples collected between 1996-2002 were contaminated, 57.7 % of samples collected from restaurants were contaminated, 16.5% of samples collected from local food industry were contaminated, and 16.6 % of samples collected from the market were contaminated. These numbers reflect high percentage of contamination, which is an indication of lack sanitary system everywhere in the country. It, also, reflects the lack of quality control system and understanding of the importance of food safety.

Contamination in the food industry represents 16.5% of all samples collected. Mainly, contamination comes from dairy products such as yogurt, cheese and labaneh, because they are very rich media for bacterial growth, handled more during preparation steps, and are not controlled very well during transportation. The second highest percentage of contamination found in the food industry is processed meat, particularly slices and sausages. This is due to cooking temperatures, personal hygiene, cutting, and packaging.

The samples collected from the market are distributed among all kinds of food. Contamination is specific to any kind of food, and does not discriminate between imported or locally manufactured products.

Table 21 shows that the number of food poisoning cases reported by the Ministry of Health. These numbers, actually, are not real, since they are only reported from public hospitals. The real number of food poisoning cases is reflected from high percentage of contamination found in the samples collected between 1996-2002. Since there is 57.7% of contaminated samples collected from restaurants, we can assume that there should be more reported food poisoning cases than what is mentioned in Table 21.

Recommendations

1. Increase the number of food inspectors by the ministry of Health and train them on food inspection.
2. Health education for food handlers about food safety.
3. Establishing licensing system for any restaurant that passes food safety requirements.
4. Updating of food law and legislation.
5. Encouraging food industry and restaurants to establish a quality control system, mainly, Hazard Analysis and Critical Control Points (HACCP).
6. Encourage food industry and restaurants to carry out laboratory testing for their products at certified laboratories.
7. Educational programs for the public about food safety and the causes of food poisoning and its dangers.

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