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THE HYGIENIC STATUS OF THE FOOD HANDLERS
IN POLICE ESTABLISHMENTS IN KHARTOUM STATE
A thesis Submitted in partial Fulfillment for the
Requirement of MPEH Degree

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KHARTOUM 2006
Dedication

To my Mother, Father and colleagues
Acknowledgement

I am greatly in depted to my supervisor Dr. Sulieman. M. El Hassan for his invaluable guidance and closed supervision.

I thank the faculty of Veterinary Science and all the staff of the department of microbiology for the help they provided for me.
Abstract

This study was carried out to evaluate the hygienic status of the food handlers in Police establishments in Khartoum state, where one hundred food handlers were questioned in thirty police establishments. The questionnaire was analyzed and it showed low education at levels of the handlers where most of them had basic education, also it showed that some of the food handlers had bad habits of smoking and snuffing during work. Also there was no awareness in the behaviours in some cases like in case of sweating where most of them did nothing while sweating. Also this study found that the majority of the handlers (97%) use the normal air for drying utensils. Also most of the handlers (52%) had no medical certificates, and some of them (16%) had invalid certificates.

The observations recorded showed some of the food handlers (11%) dressed dirty clothes, and most of them (81%) and (73%) had no head cover nor protective clothes. Also some of the food handlers (22%) used the finger rings. The research found that the majority (94%) of the food handlers were in the age under 45 Years.

Twenty five swab samples had been collected from the hands in addition to 10 swab samples from the noses. Many types of bacteria had been isolated from these samples especially Streptococcus and Staphylococcus bacteria. *Staphylococcus species* isolated were, *S.aureus*, *S.scuiri*, *S.cohnii*, *S.xylosus*, *S.caseolyticus*, *S.lentus*, *S. schleiferi*, *S.capitis*.

There were three species of Streptococci isolated in this study which were *St.equinus*, *St. equisimilis*, *St.pyogenes*, *St salivarius*.
Some other pathogenic bacteria were isolated such as:

*Pseudomonas* spp, *Stomatococcus mucilaginosus*, *Morganella morganii*,
*Enterococcus galinarum*, *Enterococcus casseliflavus*, *Acentobacter* spp
and *Lactobacillus salivarius*.

This study revealed that food handlers are an important source of food
contamination in police establishments in Khartoum state.
ملخص الأطروحة

تم إجراء هذه الدراسة لتقديم الوضع الصحي بين العاملين في مجال تحضير الأغذية في محلات بيع الأغذية في مؤسسات الشرطة في ولاية الخرطوم. حيث تم استجواب مائة عامل أطعمة في ثلاثين مؤسسة شرطية. وقد تم تحليل الاستبيان والذي أوضح أن معظم العاملين في مستوى التعليم الأساسي. كذلك وجد أن بعض العاملين لهم عادات سئية مثل التدخين وتعاطي التمباك (الصخور) أثناء العمل. أيضاً هنالك عدم وعي أو إهمال في التصرف في بعض الحالات مثل حالة العرق حيث أغلبهم لا يفعل أي شيء أثناء العرق.

أيضًا أوضحت البحث أن أغلب العاملين (97%) يستخدمون الهواء الطبيعي في تحفظ الأطعمة. وقد وجد أن معظم العاملين (52%) ليس لديهم شهادات فحص طبي والبعض منهم (16%) لديه شهادات منتهية الصلاحية.

الملاحظات التي تم تسجيلها أوضحت أن بعض العاملين (11%) يرتدون ملابس متسخة وأغلبهم (81%) و(73%) لا يرتدون أغطية الرأس والملابس الواقية.

أيضًا اتضح أن بعض العاملين (22%) يرتدون الخواتم. وجد كذلك أن أغلب العاملين (94%) من ذوي الأعمار دون الخامسة والأربعون.

جمعت 25 مسحة قطن من اليد اليسرى، بالإضافة إلى عدد 10 مسحة قطن من الأئذان وقد تم عزل العديد من البكتيريا من هذه العينات خاصة البكتيريا السببية و العنقودية. البكتيريا العنقودية التي تم عزلها هي:


وهذه ثلاثة أنواع من البكتيريا السببية تم عزلها في هذه الدراسة وهي:

St.equinus , St. equisimilis , St.pyogenas , St salivarius
أيضا تم عزل أنواع أخرى من البكتريا الممرضة مثل:

*Pseudomonas spp, Stomatococcus mucilaginosus, Morganella morganii, Enterococcus galinarum, Enterococcus casseliflavus, Acentobacter spp* and *Lactobacillus salivarius*.

الدراسة توصلت إلى أن عمال الإغذية مصدر هام للتلوث في مؤسسات الشرطة في ولاية الخرطوم.
Contents

Dedication .................................................................................................................. I
Acknowledgment ...................................................................................................... II
Abstract ...................................................................................................................... III
Abstract in Arabic .................................................................................................... V
Contents ....................................................................................................................... VII
List of Figures ............................................................................................................. VIII
List of Tables .............................................................................................................. IX
Introduction ................................................................................................................ 1
Objectives ................................................................................................................... 2

Chapter one ................................................................................................................. 3
1. Literature Review .................................................................................................... 4
   1.1 Food Constituents ............................................................................................. 4
   1.2 Food contamination ......................................................................................... 4
   1.3 Food Spoilage .................................................................................................. 6
   1.4 Food poisoning ............................................................................................... 7
   1.5 Food Microorganism ....................................................................................... 9
   1.6 Parasites associated with food borne diseases ................................................ 14
   1.7 Viruses associated with food borne diseases .................................................. 15
   1.8 Food Hygiene ................................................................................................ 15
   Personal Hygiene ................................................................................................ 18

Chapter two ................................................................................................................. 20
2. Materials and Methods .......................................................................................... 21
   2.1 Data Collection ................................................................................................ 21
   2.3 Sterilization ..................................................................................................... 21
   2.4 Reagents and Indicators ................................................................................ 21
   2.5 Collection of blood for enriched media ......................................................... 22
   2.6 Preparation of Media .................................................................................... 22
   2.7 Culture of Specimens .................................................................................... 24
**List of Figures:**

<table>
<thead>
<tr>
<th>Figure</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Education</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>Health education</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>Smoking</td>
<td>31</td>
</tr>
<tr>
<td>4</td>
<td>Snuffing</td>
<td>31</td>
</tr>
<tr>
<td>5</td>
<td>Hands washing</td>
<td>32</td>
</tr>
<tr>
<td>6</td>
<td>Drying themselves</td>
<td>32</td>
</tr>
<tr>
<td>7</td>
<td>Behavior in case of injury</td>
<td>33</td>
</tr>
<tr>
<td>8</td>
<td>Drying utensils</td>
<td>33</td>
</tr>
<tr>
<td>9</td>
<td>Clothes keeping</td>
<td>34</td>
</tr>
<tr>
<td>10</td>
<td>Doctor visits</td>
<td>34</td>
</tr>
<tr>
<td>11</td>
<td>Medical certificates</td>
<td>35</td>
</tr>
<tr>
<td>12</td>
<td>Validity of medical certificates</td>
<td>35</td>
</tr>
<tr>
<td>Table</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>1</td>
<td>Appearance of clothes</td>
<td>37</td>
</tr>
<tr>
<td>2</td>
<td>Appearance of hair</td>
<td>37</td>
</tr>
<tr>
<td>3</td>
<td>Head cover</td>
<td>37</td>
</tr>
<tr>
<td>4</td>
<td>Protective coat</td>
<td>38</td>
</tr>
<tr>
<td>5</td>
<td>Finger nails</td>
<td>38</td>
</tr>
<tr>
<td>6</td>
<td>Using of finger rings</td>
<td>38</td>
</tr>
<tr>
<td>7</td>
<td>Age</td>
<td>39</td>
</tr>
<tr>
<td>8</td>
<td>Aerobic bacteria isolated from hands</td>
<td>41</td>
</tr>
<tr>
<td>9</td>
<td>Aerobic bacteria isolated from noses</td>
<td>42</td>
</tr>
<tr>
<td>10</td>
<td>Gram reaction and biochemical properties of Streptococci</td>
<td>43</td>
</tr>
<tr>
<td>11</td>
<td>Gram reaction and biochemical properties of Staphylococci</td>
<td>43</td>
</tr>
</tbody>
</table>
Introduction

Food is a necessary element for the functions of the body and without food the tissues of the body will be destroyed and the life will stop.

The hygiene of the food during it’s all processes from the farm to the mouth of the consumer is very necessary, and the food must be kept under well controlled conditions. Handling of the food is the most hazardous point so these must be a carefulness while handling.

The food handlers is one of the main resources of the food contamination and spoilage because they act as the ventricles for the microorganism from the surround environment to the food.

There must be a regular revision to those handlers to ensure that they are working according to the public health standards, and having adequate education in food hygiene field. Monitoring of the behaviors of the food handlers is very important and this is the responsibility of the managers and public health personel.

In most cases the appearance of the food handlers are reflect the hygienic status of the food they prepare so the food handlers are represent the address of the food establishment (Gibson).

The military areas always have closed community, and have specific job, according to this nature the food supply is come through specific channels.

It was observed that there were some food establishments inside these military areas have not been subjected to any sanitary procedures. The nature of the military community need a specific food control process
because this community have some jobs characterized by the hard work, these jobs need adequate nutrition and the food prepared for them must be subjected to an examination of personnel working in preparation of the food, so as to secure healthy food.

Because of the difficulty to access these military areas by the public health personnel according to its security nature, there must be away to control the food preparing establishment inside these military areas.

**General Objective:**

To evaluate the hygienic status of the food Handlers in Police establishments.

**Specific Objectives are:**

- To evaluate the personal hygiene of the food handlers.
- To evaluate the level of the health education of the food handlers.
- To evaluate the regular examination for the food handlers.
- To detect the bad behaviours during food processing.
- To detect the types of microorganisms carried by the food handlers on their bodies.
Chapter 1

Literature Review
1- Literature Review

The food

The food is defined as that which is necessary for the health and function of living things, the function of the food is to keep us alive and healthy (Birch, 1986).

1.1 Food Constituents

Common food is mixture of nutrients and essential dietary nutrients include, proteins, carbohydrates, fats, minerals, vitamins and water (Osee and Marion, 1970).

1.2 Food contamination

Food can be contaminated from many sources as:

1.2.1 From plants and fruits

The natural surfaces of plants usually include species of Pseudomonas, Alcaligenes, Flavobacterium, Micrococcus, Coliform and Lactic acid bacteria. So these fruits and vegetables must be well washed (Frazier and Westhoff, 1992).

1.2.2 Contamination from animals

Source of microorganism from animals include: The surface, respiratory tract and the gastrointestinal tract, also the hide, hoofs, and hair contain not only large number of microorganism from soil, manure, feeds, and water but also important kind of spoilage organisms (Frazier and Westhoff, 1992).

*Trichinella spiralis*, which cause Trichinosis is transferred by infected pork, and occasionally wild game (Barry and Raymond, 1973).
1.2.3 Contamination from soil

The soil contain the greatest variety of microorganisms of any source of contamination, not only numerous kinds of microorganism, but also large total numbers are present in fertile soil, like Bacillus anthrax, which can be survived in the soil for years (Frazier and Westhoff, 1992).

1.2.4 Contamination from water:

Natural water contain microorganisms from soil and animal or sewage. The food microbiologists interested in two aspects of water biology. The public health aspect and the economic aspect. The water used about food should be absolutely safe to drink. The main microorganism which can be found in water is E.coli, Shigella, Salmonella and Vibrio (Frazier and Westhoff, 1992).

1.2.5 Contamination from air:

Contamination of food from the air may be important for sanitary as well as economic reason (Frazier and Westhoff, 1992).

1.2.6 Contamination during handling and processing:

Contamination of foods from natural sources may take place before the food is harvested during handling and processing of food. Additional contamination may come from equipments coming in contact with food. The employees should be examined before employing them, and regularly after employing them (Frazier and Westhoff, 1992).

1.2.7 Microorganism on the skin

The surfaces of human and other animal are exposed to air, soil and water and there will always be possibility of contamination of food by direct contact with the animal surfaces. However the surface of the skin is not a favourable place for most microorganisms. Since it is usually dry and has low pH due to the presence of organic acid (Adams and Moss, 2000).
1.2.8 Microorganisms in the nose and throat

The nose and throat with the mucus membrane which line them represent even more specialized environment and are colonized by different group of microorganisms, which are usually harmless but may have potential to cause diseases, especially following extremes of temperature, starvation, overcrowding, or other stresses which lower the resistance of host and make the spread of diseases more likely in both human and other animals. *Staphylococcus aureus* is carried on the mucous membrane of the nose (Adams and Moss, 2000).

1.2.9 Mouth

There is a great variation in the number and type of organisms present in a healthy mouth. The mouth of the new born infant is not sterile at birth. It usually contains the same types of organisms that are present in mother's vagina at that time. (Elaine et al., 1973).

1.3 Food Spoilage

Food spoilage may cover all factors which will render food unsuitable for eating. This can be caused by natural chemical changes which impair the flavor, such as rancidity, or contamination by foreign materials such as chemicals, including sprays, insects, and pests, or breakdown of the food by microorganism.

Every housewife is familiar with common signs of food spoilage—milk which curdles, smells, and tastes, sour cheese which has a fury green covering of moulds, meat which first smells sour and later develops an obnoxious putrid smell and cooked vegetables which become slimy. She knows they have been kept too long and throws them away.

The reason is that bacteria or moulds have contaminated the food which has been moist and warm. The organisms have used the food
to feed upon, and in so doing have broken it down into simpler substance contaminated it with their waste products. The moulds growth in cheese is on the surface only and if the outer layer is removed the centre portion is satisfactory. With bacteriological spoilage, however, the whole food mass is usually affected (Barry and Raymond).

In causing spoilage, some bacteria form acids and gases, those which form gases other than hydrogen sulphide which is soluble, cause blown cans. The gases which are usually carbon dioxide and hydrogen, first destroy the vacuum normally present in a can. As the bacterial activity continues more gases is produced giving rise to positive pressure in the can. This may continue until the can splits under the pressure.

Spoilage of canned food due to under processing may be divided into three convenient groups. Firstly cans of normal outside appearance but with a marked decrease in pH of the contents: these are "flat sours" because the can ends are normal or flat, and the contents have become acid or sour, this is caused by bacteria which produce acids but not gas. Secondly, cans with distended ends, or blown cans, caused by gas formation by the bacteria. Thirdly, and much less frequently, "sulphur spoilage", in which the can is flat but the contents turn black, the bacteria form hydrogen sulphide which dissolve in the liquid in the can, and forms black compound with the substance of the tin plate. Small isolated patches of black often occur on the surface of solid meat pack (Barry and Raymond, 1973). Yeasts may be useful or harmful in food, yeast fermentation are involved in the manufacture of food like bread, bear, wine … etc. Yeasts were undesirable when they cause spoilage of some food like juices, syrups and honey (Frazier and Westhoff, 1992).
1.3.1 Bacteria associated with food spoilage

1.3.1.1 Bacillus stearothermophilus

It causes flat sour in non-acid packs such as vegetables. It is a facultative anaerobe which produces heat-resistant spores and is capable of growing at 70°C.

Bacillus group organisms usually form acids only from carbohydrates but gas formation in cured meat products has been found to be due to this group, and it has been shown experimentally that some Bacillus species are able to form gas in the presence of nitrate (Barry and Raymond, 1973).

1.3.1.2 Clostridia group

Cl. porotogenous is a mesophilic proteolytic species which causes putrefactive spoilage of meat products.

The most important thermophile anaerobe responsible for blown cans is Cl. thermoschwarzyticum. As its name suggests, this organism is very saccharolytic, forming large quantities of gas, and therefore blown cans, and spores are very heat resistant.

The type species causing blackening is Cl. nigrificans which is thermophile and produces hydrogen sulphide. This gas is soluble however, and so does not cause blown cans, but reacts with the metal of the container to form black compound (Barry and Raymond, 1973).

1.4 Food poisoning

1.4.1 Bacterial food poisoning

certain type of bacteria which can grow in food are the principal causitive agents of food poisoning. Symptoms arise in persons who have eaten contaminated food and may be due either to both infection or intoxication.
Infection results from the introduction of live disease-producing bacteria into the human gut. Between the ingestion of such bacteria and the onset of symptoms there is a period of delay called incubation period during which the pathogens proliferate in the body. The Salmonella group are example of infective bacterial types. They are, in fact, responsible for the majority of food poisoning outbreaks.

Intoxication results from the introduction of bacterial toxins (poisons) into the human gut. Food poisoning toxins are produced by types of bacteria different from those which cause infection, examples of toxin-producing bacteria types are some members of the Staphylococcus group, and also Clostridium botulinum. For the production of toxins it is necessary for such bacteria to multiply in food for some time before it is eaten. The food then carries the poison directly into the gut, therefore the onset of symptoms is very rapid, a few hours or less (Baray and Raymond, 1973).

1.4.1.1 Staphylococcal food poisoning

It is characterized by explosive vomiting and diarrhoea that occur 1-5 hours after the ingestion of contaminated food. *S. aureus* grow well in food but the ingestion of viable *S. aureus* is not necessary because the disease is caused by heat-and protease-stable enterotoxins.

The disease is self-limiting, with proper hydration, complete recovery occurs within 24-48 hours (Gabriel, 1997).

1.4.2 Toxins

Some bacteria form poisons or toxin which may be exotoxins or endotoxins, and these are of great importance when considering food poisoning. The exotoxins diffuse from the bacterial cell in the surrounding material and produce characteristic symptoms when ingested even in very small quantities.
Usually they are easily inactivated by heat. Botulism is caused by exotoxins.

The endotoxins are more resistant to heat and form an integral part of the cell. many pathogens, that is disease -producing bacteria, form toxins.

Whilst moulds, and yeast are able to spoil food by fermentation, discoloration or production of "off" flavors, their ingestion will not usually cause food poisoning as the bacteria are able to do .Cases have recently been reported, however of food poisoning in animals and poultry from peanuts that have been spoiled by Aspergillus flavus and a Penicellium .

1.5 Food Micro organisms

There were some microorganisms which were very important in food hygiene and safety.

1.5.1 Staphylococci

This type of bacteria have many species, but there were three of them commonly found in many cases of infection.

One of these is Staph aureus which is the main pathogen and responsible for pyogenic infection, and it identified by positive coagulase test. It's habitat is on the body surfaces and the nose, about 50%-75% of healthy people carry it, also it can be found in throat or gut. The second one is Staph epidermidis which is found on the skin .The third one is Staph saprophyticus which is similar to Staph epidermidis.

Staph aureus is an important pyogenic organism, causing pustules, boils, septicaemia, endocarditis, toxic food poisoning, toxic shock syndrome and skin exfoliation (Douglas and Morgan,1998).
Staphylococci are transmitted from person to person and upon transmission, the organism may become established as part of the recipients normal flora and later be introduced to sterile sites by trauma or invasive procedures, alternatively the organism may be directly introduced in to normally sterile site, such as by a surgeon or nurse during surgery.

Person to person spread of Staphylococci particularly those that have acquired antimicrobial resistance, most notably occurs in hospitals and presents substantial infection control problem (Betty et al., 2002). Staphylococcal poisoning is very fast, it may occur in half an hour or four hours after ingestion of the contaminated food, the microorganism may occur on the hands and in the nasal passages. The toxin is heat stable, it is not destroy by heat. Precooked food such as ham is most commonly involved in this types of food poisoning (Barry and Raymond, 1973).

A study was conducted by Samia. S (1998) in which, *S. aureus* and *S. sciuri* were isolated from food stuff.

Also there was a study conducted by Hanadi: E. (2006), she isolated six different species of Staphylococci from the food and hands of the food handlers.

**1.5.2 Streptococci:**

The germ Streptococcus includes large numbers of species some of which are frank pathogens, and other that are members of normal flora of the oropharynx and gastrointestinal tract, Disease associated with Streptococci range from dental plaque and trivial skin infection to life-threatening complications such as necrotizing fasciitis, toxic shock, rheumatic fever, and glomerulonephritis (Gabriel, 1997).
It include the causative agent of sore throat and scarlet fever, it is possible that food handlers with sore throat can infect the food (Osee and Marion, 1970).

Sore throat is caused by *Streptococcus pyogenes* when *Streptococcus galactiae* causes mastitis in caws (Frazier and Westhoff, 1992).

*Streptococci* is the most common bacterial cause of pharyngitis and tonsillitis. Symptoms of *Streptococcal* throat infection include malaise, fever, headache, and sore throat. A white exudates is visible in the pharynx, the tonsils are enlarged and erythematous, and swollen anterior cervical nodes may be present (Gabriel, 1997).

Barry and Raymond reported that Boissard and Fry (1953) investigated an outbreak of food poisoning in which forty-three soldiers out of 220 at risk were infected by *Streptococcus pyogenes* at an army camp near Cambridge. The first two men reported sick on Thursday morning with acute sore throats.

On the following day twenty-nine men reported sick and by the following day a total of thirty-eight men had reported. The same type of *strepotococcus pyogenes* was isolated from throat or nose of thirty-eight out of the forty-three cases.

1.5.3 *Salmonella*

*Salmonella* is a rod-shaped, motile bacterium; non motile exceptions are *S.galinarum* and *S.pullorum* non spore-forming and Gram-negative. There is a wide spread occurrence in animals, especially in poultry and swine the environmental source include water, soil, insects, kitchen surfaces, animals feces, raw meat, raw poultry, and raw sea foods.
Various *Salmonella species* have long been isolated from the outside egg shells, the present situation with *S. enteritidis* is complicated by the presence of the organism inside the egg in the yolk. Food other than eggs have also caused outbreak of *S. enteritidis* disease.

It is estimated that from 2 to 4 million cases of salmonellosis occur in the U.S annually, the incidence of salmonellosis appears to be rising both in the U.S and in other industrial nations.

In 1985, a salmonellosis outbreak involving 16,000 confirmed cases in 6 states was caused by low fat and whole milk from one Chicago diary. In August and September, 1985 *S. enteritidis* was isolated from employees and patrons of three restaurant of a chain in Maryland (F.D.A., 2006).

The Salmonella is the most frequent causative agent of food poisoning and about 1000 different types have been identified. The most common species of Salmonella found in food poisoning cases was *Salmonella typhimurium*.

The incubation period is from a few hours to several days the organism may be transmitted by the faeces and urine of infected person and by food or water. It also may be conveyed by flies and rodents (Barry and Raymond, 1973).

### 1.5.4 Vibrio

Vibrio is short Gram-negative rod and often curved. The genus is the most extensively characterized and medically important group within the family *vibrionaceae*. The genus includes more than 30 species that are commonly found in aquatic environments, in the past the importance of vibrios has been associated almost exclusively with the epidemic and pandemic cholera caused by a particular antigenic form of *V. cholerae* (David et al., 2002).
This genus of bacteria are widely distributed in fresh and salt water, soil, and in the alimentary canal of man and animals, some species are pathogenic to man like *Vibrio cholerae* which cause cholera (Frazier and Westhoff, 1992).

### 1.5.5 Shigella

The genus *Shigella* is subdivided on biochemical and serological grounds into four species: *Shigella dysenteriae*, *Shigella flexneri*, *Shigella boydii* and *Shigella sonnei*.

They are typical members of Enterobacteriaceae and are closely related to genus *Escherichichia*.

*Shigellae* are Gram-negative bacilli, they are non motile and non capsulated.

The severity of the clinical illness is to some extent associated with species involved.

*Shigella flexneri* and *Shigella boydii* groups may cause severe illness (David *et al.*, 2002).

Bacillary dysentery is caused by some species of *Shigella* of which there were three main types. *Shigella dysenteriae*, *Shigella paradysenterae* and *Shigella sonii*. The incubation period from a few hours to four days. It cause the summer diarrhoea. It usually spread very rapidly when it found in a fairly close community, and when spread by foods the contamination arise directly or indirectly from an infected person or carrier (Barry and Raymond, 1973).

### 1.5.6 Clostridium botulism

It caused a very serious form of food poisoning with very high fatality rate. The organism produces an exotoxins, the toxins attack the central nervous system, so causing paralysis and death usually after a few days.
The toxin is produced under anaerobic conditions such as canned food, the organism can grow and form toxins in case of insufficient heat in canned food (Barry and Raymond, 1973).

1.5.7 *Escherichia*

*E. coli* is the most prominent fecal coliform; Hence, we might expect that there is little different between *E. coli* and fecal Coliform (Hans and Frank, 1979).

*E. coli* is Gram-negative, motile non-sporing bacillus, morphologically identical with Salmonellae and on ordinary culture media their colonies are also very similar.

On MacCokey's medium *E. coli* strain yield rose-pink colonies due to fermentation of lactose in the medium.

The species are differentiated by biochemical reaction (Cruick Shank, 1975). For isolation of *E. coli*, good growth occurs into ordinary media. Media used are nutrient agar, blood agar, MacConkey agar and nutrient broth. Many strains especially the pathogenic ones are betahaemolytic on blood agar (Namita, 2003). Certain strain of *E. coli* cause enteric disease syndromes in the young of human and other vertebrate animals. In most of the outbreak of *E. coli* enteritis, the organisms are transmitted by water or person to person. Some outbreaks are food-borne (Georg, 1979).

Hoyle (1999) and Jennifer (2002) reported that there are hundred of different type, or strain, of *E. coli* some of which are harmful, but most of which are not. This genus is divided to many biotypes and serotypes some of which can be pathogenic to man (Frazier and Westhoff, 1992).
Frank (1996) stated that *E.coli* type of bacteria present as standard pathogen in the human intestinal tract so it used as an indicator of faecal contamination of food and water.

Food in food service establishments is frequently contaminated with *E.coli*. This organism was isolated from foods, kitchen, and from food handlers (Hank and Frank, 1979).

El Gazafey (2002) conducted a study in Alarabi market at Khartoum state, about forty-three Bueger samples were collected and examined for *E.coli*. The result indicated that 4.7% of samples have total count are more acceptable (102C-F-U./g).

1.5.8 *Bacillus cereus*

It is Gram–positive, facultatively aerobic sporeformer whose cells are large rods and whose spores do not swell the sporagium. Two recognized type of illness are caused by two distinct metabolites.

The diarrhoeal type of illness is caused by a large molecular weight portion, while the vomiting type illness is believed to be caused by a low molecular weight, heat-stable peptides. Confirmation of *B.cereus* as the etiologic agent in the food borne outbreak requires either:

1. Isolation of strains of the same serotypes from the suspected food and feces or vomitus of the patient, isolation of large number of *B.cereus* serotypes known to cause food borne illness from the suspected food and or from the feces or vomitus of the patient or.

2. Isolation of *B.cereus* from suspected food and determining their enterotoxigencity by serological or biological test (F.D.A, 2006).

1.5.9 *Moulds*

Moulds are multicellular filamentous fungi usually giving a fuzzy or cottony appearance when growing on food, they may be white,
dark, or various colours, spores produced by moulds usually asexually, in large numbers. Moulds are probably not harmful, however aflatoxin has been produced by certain types of moulds such as *Asperigillus flavus* (Osee and Marion, 1970).

### 1.5.10 Yeasts

Yeasts are non filamentous, unicellular fungi that are typically spherical or oval. Like moulds, yeasts are widely distributed in nature, they are frequently found as a white powdery coating on fruits and leaves, yeasts are capable of facultative anaerobic growth. Yeasts can use oxygen or an organic compounds as the final electron acceptor. Yeasts perform aerobic respiration to metabolize carbohydrates to carbon dioxide and water, they ferment carbohydrates and produce ethanol and carbon dioxide, this fermentation is used in the brewing, wine-making, and baking industries (Tortora *et al*., 2004).

There are species of yeasts that can be pathogenic for humans, the main two genera are Candida and Cryptococcus.

Candidiasis is the generic designation given to a wide spectrum of infections caused by many species of the genus Candida. The most common pathogenic species *C. albicans* which is an endogenous organism. Candida species are found wild, particularly *C. albicans* which is a common commensal. *C. albicans* is present in 40%-80% of healthy people as part of normal intestinal flora. Infection with *Candida* usually occur when a patient has some alteration in cellular immunity, normal flora, or normal physiology. Cryptococcosis is caused by *Cryptococcus neoformans*. Pigeons and chicken droppings are a common source of this yeast, infection is probably determined by resistance of the host as suggested by the fact that Cryptococcosis is frequently seen in immuno
compromised individuals. This infection may be subacute or chronic, and the disease has prolonged evolution of several months. The patient symptoms may initially include vision problems and headache, followed by progressive change in mental status lead to nuchal rigidity, coma, and death (Gabriel, 1997).

1.6 Parasites

1.6.1 *Entamoeba histolytica*

*E. histolytica* principally habitats the large intestine, and on occasion may invade the intestinal wall, and may give rise to amebic dysentery. Most amoebiasis is acquired through fecal contamination of food and water, and prevention of infection involved measures designed to break the chain of transmission, like bioling of the water before drinking and avoid eating the food sold by street vendors (Markell *et al.*, 1999).

1.6.2 *Giardia lamblia*

It is a single cell animal, that moves with the aid of five flagella. In Europe, it is sometimes referred to as *Lamblia intestinalis*. It is the most frequent cause of non-bacterial diarrhoea in North America. Human *Giardia* may involve diarrhoea within one week of ingestion of the cyst, which is the environmental survival form and infective stage of the organism. Normally illness last for 1 to 2 weeks, but there are cases of chronic infections lasting months to year.

The disease mechanism is unknown, with some investigators reporting that the organism produce a toxin while others are unable to confirm its existence.

The organism has been demonstrated inside host cell in the duodenum, but most investigators think this is such an infrequent occurrence that is not responsible for disease symptoms.
Giardia can be excysted, cultured and encysted in vitro; new isolates have bacterial, fungal, and viral symbiots. Classically the disease was diagnosed by demonstration of the organism in stained fecal smear. Ingestion of one or more cysts may cause disease. Giardia is most frequently associated with the consumption of contaminated water. Giardia is more prevalent in children than in adults, possibly because many individuals seem to have a lasting immunity after infection. This organism is implicated in 25% of the cases of gastrointestinal disease and may be present asymptomatically (F.D.A, 2006).

1.7 Viruses

1.7.1 Hepatitis A Viruses

Hepatitis A viruses (HAV) is classified with Enterovirus group of the Picornaviridae family, HAV has a single molecule of RNA surrounded by a small protein capsid and a buoyant density in CsCl of 1.33 g/ml. Many other Picornavirus cause human diseases, including Polioviruses, Coxsackieviruses, Echoviruses and Rhinoviruses.

Hepatitis A is usually a mild illness characterized by sudden onset of fever, malaise, nausea, anorexia and abdominal discomfort, followed in several days by jaundice.

HAV is excreted in feces of infected people and can produce clinical disease when susceptible individuals consume contaminated water or food.

Cold cuts and sandwiches, fruits and fruit juices, milk and milk products, vegetables, shellfish and iced drink are commonly implicated in outbreaks. Water, shellfish, and salad are the most frequent sources. Contamination of food by infected workers in food processing plants and restaurants is common (F.D.A, 2006).
1.7.2 Rotavirus

Rotaviruses are classified with the Reoviruses family. They have a genome consisting of 11 double-stranded RNA segments surrounded by a distinctive two-layered protein capsid.

Rotaviruses cause acute gastroenteritis, infantile diarrhoea, winter diarrhoea, acute nonbacterial infectious gastroenteritis, and acute viral gastroenteritis are names applied to the infection caused by the most common and widespread group of a Rotavirus.

Rotavirus gastroenteritis is a self-limiting, mild to severe disease characterized by vomiting, watery diarrhoea, and low grade fever. Because a person with Rotavirus diarrhoea often excretes large numbers of virus, infection can be readily acquired through contaminated hands, objects, or utensils.

Rotaviruses are transmitted by the fecal-oral route. Person-to-person spread through contaminated hands is probably the most important means by which Rotaviruses are transmitted. In close communities, infected food handlers may contaminate foods that require handling and no further cooking (F.D.A., 2006).

1.8 Food Hygiene

1.8.1 Sanitation

Protection of the public from food borne hazards involves maintenance of sanitary control over harvesting or slaughter processing, preserving, distribution, storage and preparation of food for institutional or home consumption.

Sanitary control of the food processing and food service industry would be impossible without laws that authorize sanitary regulations and standard.
Objective of food sanitation are not only to protect the public health but also to reduce economic and nutritional losses from microbial and chemical degradation (John Last, and Robert Wallace, 1992).

The supply of wash–basins and clean towel must be adequate. Cooked and perishable food must not be allowed to stand about in the warm, it must either be very hot so that the organisms are killed or very cold so that they are unable to multiply. The kitchen as whole should be clean regularly (Thomas, 1974).

The building should have a hard surface, dust free and drained. Unused ground should not be a wider ness and not used as a waste ground. The floor must be resistant to the materials used in the department and also temperature changes, the floor must be smooth but not slippery and have adequate drainage. The walls, like floor may be covered by epoxide or polyurthane resigns to give a smooth easily clean surface. Cieling is required to be clean at intervals. Lightining has a very important part to play in hygiene, the florcent lamps are probably the most popular. Ventilation will be required to maintain a comfortable working environment in all departments (Barry and Raymond, 1973).

1.8.2 Food handling and processing

In any particular processing plant or establishment the hazards will depend upon: the source of ingredient, the formulation, the processing equipments, the duration of the process and storage and the experience and attitudes of the personel (Frank, 1992).

1.8.3 Food hygiene polices

1.8.3.1 Examination of food stuff

Examination of food stuff can be divided into three stages.
First, physical examination, by using of the five senses.

In this stage we can detect the change in color, smells, taste, and the shape of the food, like meat which smells sour and later develops an obnoxious putrid smell, cooked vegetable can become slimy, the cheese also can be covered by furry green layer due to moulds growth.

Canned food can be examined by realizing that if there was any swelling because some bacteria form gases and this lead to swelling of the can, also the label on the can must contain the expiry date and manufacturing date of the product and the ingredients (Barry and Raymond, 1973).

Second, biological examination as John, (1980) reported that the microbial analysis of food products may differs according to the types of microorganisms. However we are concerned with the predominant types and those which may cause hazards.

Hallet (1979) analyzed various food for coliform and E.coli. E.coli was found in cheese and products (75% of the samples) fish and seafood (30%) raw and frozen vegetables (15.8%) prepared and convenience food (50%), raw meats (76%) and sandwiches (16.3%) (George, 1979).

Third, chemical examination for both vegetable and animal foods which contain many traces of different metals, many of these are nutritionally necessary as for example iron in blood haemoglobin.

Arsenic and lead both occur naturally in marine crustaceans and shellfish. Statutory regulations have laid down the limits of such metals as arsenic permitted to occur in certain foods. Accidental introduction into the food may occur when a poisonous substance is added to the food in
mistake for a food ingredient.

Cases have been reported of sodium floride, which has been used as insecticide being mistaken for baking powder and for milk powder with fatal results.

Cadmium poisoning has occurred from the use of utensils plated with this metal. In 1968 ten peoples became ill when a cadmium- plated steel clamp fell into the stainless steel container of dispenser unit. The acid beverage dissolved the cadmium and analysis showed it to contain 110 p.p.m. cadmium.

The chemical examination for the food is very important to detect any poisonous substance and to adjust the food additives (Barry and Raymond, 1973).

1.8.3.2 Food preservation

The great industries are concerned with storing fresh food under suitable situation, and it converting them into such a form that they may be transported for a long distance and distributed to the consumer without falling a prey to putrefactive and other organisms. Food can be preserved in large variety of ways according to its nature. Some foods are preserved by physical methods such as heating, cooling, and drying. Some are preserved by chemical methods such as salting, smoking, sugaring, soaring, alcohol addition and other chemical substance. Preserved food generally need a vigilant control from the public health stand point, because any carelessness may become source of infection, it may be free from saprophytes and yet contaminated by other dangerous organism. It may contain poisonous amount of chemical preservatives or chemical substances derived from the container (Burnet and Aykroyd, 1970).
1.8.3.3 Examination for personnel

The prospective employee should be required to produce a certificate of fitness from his doctor giving details of his present condition of health, and previous medical history. The prospective employees should be required to sign a simple declaration like: whether he has been abroad, if so, where and how long, any previous enteric history and that he accept an obligation to report to the hospital medical officer any evidence of intestinal diseases, skin diseases or superficial sepsis during the course of his employment.

Widal, faeces and urine culture should be done. The employee should be required to have chest x-ray and the haemoglobin estimation. A tuberculin test followed by B.C.G vaccination, poliomyelitis immunization, tetanus immunization and diphtheria immunization should be done.

The employees should be required to report to the hospital medical officer on his return from sick leave for enquiry regarding intestinal infection if his illness has lasted longer than three days or has involved vomiting or diarrhoea (Gibson, 1974).

1.9 Personal hygiene

Infection arising from within man's own body is termed endogenous, infection derived from out with an individual's own environment are termed exogenous (Melvyn and John, 1980).

Some germs can stay alive on our hands for up to three hours and in that time they can be spread to all the things we touch including food, so washing hands regularly throughout the day and especially at these times is very essential:
before preparing food, before starting work, between handling raw food, after going to the toilete and after coughing or sneezing (Food link, 2006).

1.9.1 The international food standards

The international food standards which formed by W H O have set many objectives about food handlers which aimed to protect the consumers. These are:

To ensure that those who come directly or indirectly in contact with food are not contaminate food by: maintaining appropriate degree of personal cleanliness and behaving and operating in appropriate manner because people who don't maintain appropriate degree of personal cleanliness can contaminate the food and transmit diseases. People known or suspected to suffer from a disease or illness likely to be transmitted through food, should not be allowed to enter any food handling area. Medical examination of the food handlers should be carried if clinically indicated condition which should be reported to the manager, so that any need for medical examination and possible exclusion from food handling can be considered include: jaundice, diarrhea, vomiting, fever, sore throat with fever, visibly infected skin lesion and discharge from ear, eye, and nose (FAO, 2001).

Food handlers should maintain high degree of personal cleanliness, and suitable protective clothing, head cover and foot wear should be available, cuts and wounds where personel are permitted to continue working should be covered by suitable water proof dressing. People engaged in food handling activities should refrain from behaviours which could result in contamination of food for example smoking, spitting, chewing, eating, sneezing and coughing over unprotected food.
Jewellery, watches or pins should not be worn or brought in to food handling area. (FAO, 2001).
Chapter 2

Materials and Methods
2. Materials and methods

2.1 Collection of samples

2.1.1 Data collection

Data have been collected by filling of 100 questionnaire for 100 food handlers the questionnaire has been design to include some informations about the handlers like their knowledgement about food safety, and their behaviours during working. The questionnaire also include some observations about the personal hygiene of the food handlers.

2.1.2 Swab samples

Twenty five swab samples were collected from the hands of the food handlers from different places of the study area which was Khartoum state, during October 2005 to January 2006. And also there were 10 swab samples have been taken from the noses of some of the food handlers.

The samples were taken by sterile swab, then the swab returned to its sterile tube and the tube was labeled then transported on Ice in thermos flask for immediate culturing.

2.2 Sterilization

2.3.1 Sterilization of equipments

Petri dishes, test tubes, forceps, flasks, Pasteur pipettes and graduated pipettes were sterilized in a hot air oven at 180°C for one hour.

Bottles and plastic containers were sterilized by autoclaving at 121°C (151b/sq.inch) for 15 minutes.
2.3.2 sterilization of culture media and solutions

Media and solutions were sterilized by autoclaving at 121 °C (151b/sq.inch) for 15 minutes, but carbohydrates media were sterilized by autoclaving at 115 °C (101b/sq.inch) for 10 minutes.

2.4 Reagents and indicators

2.4.1 Reagents

2.4.1.1 Tetramethyl- p-phenylene diamine- dihydrochloride.

This reagent was obtained from British Drug house, London (BHD), ltd.

It was prepared as 3% aqueous solution. It was used for oxidase test.

2.4.1.2 Hydrogen peroxide

This reagent was attained from Agropharm limited, Buckingham. It was prepared as 3% aqueous solution and it was used for catalase test.

2.4.1.3 Nitrate reagent

Nitrate test reagent was consisting of two solutions and they were prepared according to Borrow and feltham (1993).

Solution A was composed of 0.33% sulphanilic acid dissolved by gentle heating in 5N.

Acetic acid. Solution B was composed of 0.6% dimethyleamine - alphnephthylamine dissolved by gentle heating in 5N – Acetic acid.

2.4.2 Indicators

2.4.2.1 Andrade's indicator

This indicator composed of acid fuchsin 59, distilled water II, and N. NaoH 150ml.
The acid fuchsin was added, mixed and was allowed to stand at room temperature for 24 hours with frequent shaking until the color change for red to brown.

2.4.2.2 Bromothymol blue

Bromothymol blue indicator was obtained from British Drug House, London (BDH), Ltd. The solution was prepared by dissolving 0.2g of the bromothymol blue powder in 100ml distilled water.

2.5 Collection of blood for enriched media

Defibrinated sheep blood was used in preparing blood agar medium. The blood was collected from the jugular vein in sterile flask containing glass beads and mixed gently during collection. The blood was distributed in 10ml amount in sterile screw capped bottles and stored in refrigerator to be used for blood agar medium.

2.6 Preparation of media

2.6.1 Nutrient agar:

To prepare one liter of nutrient broth (oxoid) 159 of agar were added, dissolved by boiling sterilized by autoclaving at 121 OC for 15 minutes then cooled to about 50 OC and distributed in 15 ml amount per plate. The poured plates were left to solidify at room temperature on leveled surface.

2.6.2 Blood agar

Forty grams of blood agar base No.2(oxoid) were suspended in one liter of distilled water, dissolved by boiling, mixed and, sterilized by autoclaving at 121 OC for 15 minutes.
Then cooled to about 50 OC and defibrinated sheep blood was added aseptically to give final concentration 10:1% mixed gently and 15 ml of complete medium was poured in to each sterile petri dish. The poured plates were allowed to solidify at room temperature on flat surface.

2.6.3 McConkey agar

Fifty two grams of MacConkey agar (oxoid) were suspended in one liter of distilled water, brought to boil to dissolve the ingredients completely, then sterilized by autoclaving at 121 OC for 15 minutes and poured in to sterile Petri dishes in 15 ml amount. The poured plates were left to solidify at room temperature on flat surface.

2.6.4 Motility medium

Thirteen grams of dehydrated nutrient broth (oxoid) were added to 5 grams of oxoid agar No.1 and dissolved in one liter of distilled water. The PH was adjusted to 7.4 this medium was dispended in volumes of 5ml in to 20 ml test tubes containing gragie tubes, and then sterilized by autoclaving at 121 OC for 15 minutes.

2.6.5 Hugh and Leif sons (O/ F) medium

This medium was prepared as described by Barrow and Feltham (1993).

Two grams of peptone powder, five grams of sodium chloride,0.39g of potassium hypophosphate and three grams of agar were added to one liter of distilled water. Then heated in water bath at 55 OC to dissolve the solids, The PH was adjusted to 7.1 and filtered .

Then the indicator bromothymol blue (0.2% Aqueous solution )was
added and the mixture was sterilized by autoclaving at 115 °C for 10 minutes.

Then filtered sterile glucose solution was added aseptically to give final concentration of 1%. Then the medium was mixed and distributed, aseptically in 10 ml amount into sterile test tubes of not more than 16mm diameter.

2.6.6 Manitol sugar

15 grams of peptone water and 10 grams of sugar manitol dissolved in one liter of distilled water, then 10 ml of Andrade's indicator were added, mixed well and distributed in clean test tubes and sterilized by autoclaving at 115 °C for 15 minutes and then preserved in a refrigerator.

2.6.7 lactose sugar

15 grams of peptone water and 10 grams of lactose sugar dissolved in one liter of distilled water, then 10 ml of Andrade's indicator were added, mixed well and distributed in clean test tubes and sterilized by autoclaving at 115 °C for 15 minutes and then preserved in a refrigerator.

2.6.8 Xylose sugar

15 grams of peptone water and 10 grams of xylose sugar dissolved in one liter of distilled water, and 10 ml of Andrade's indicator were added, mixed well and distributed in clean test tubes and sterilized by autoclaving at 115 °C for 15 minutes and then preserved in a refrigerator.
2.6.9 **Maltose sugar**

15 grams of peptone water and 10 grams of maltose sugar dissolved in one liter of distilled water, and 10ml of andrad's indicator were added, mixed well and distributed in clean test tubes and then sterilized by autoclaving at 115 °C for 15 minutes and then preserved in a refrigerator.

2.6.10 **Fractese sugar**

15 grams of peptone water and 10 grams of fractose sugar dissolved in one liter of distilled water, and 10 ml of Andrade's indicator were added, mixed well and distributed in clean test tubes and then sterilized by autoclaving at 115 °C for 15 minutes.

2.6.11 **Glucose phosphate medium**

This medium was prepared according to barrow and Feltham (1993). Peptone powder 59 and 59 phosphate buffer (K2HPO4) were added to one liter of distilled water, dissolved by steaming then PH was adjusted to 7.5 then 5 grams of glucose were added, mixed well, distributed in to clean test tubes and sterilized by autoclaving at 115 °C for 15 minutes.

2.7 **Culture of specimens**

The collected swabs were inoculated on to blood agar and macConkey agar. The inoculated plates were then incubated for 24 hours at 37 °C.

2.8 **Purification of culture**

All Isolates were purified several subculturing from single well-Separated colony of each type on primary culture. The purification was carried out on nutrient agar or blood agar.
The purity was checked by examining gram stained smear. The pure culture was then used for studying cultural and biochemical characteristics and sensitivity test.

2.9 Microscopic Examination

Smears were made from each type of colonies on primary culture and from each type of colonies on primary culture and from purified colonies, fixed by heating and stained by gram method, (Barrow and Feltham, 1993). Then examined microscopically under high power. The smear was examined for cell morphology, arrangement and staining reaction.

2.10 Identification of Bacteria

The purified Isolates were Identified according to criteria described by Barrow and Feltham (1993) this included staining reaction, organism morphology, growth condition, the colonies characteristics in different media, haemolysis on blood agar, motility and biochemical characteristics.

2.11 Biochemical methods

2.11.1 Oxidase test

The method of Barrow and Feltham (1993) was used strip of filter paper was soak in 1% solution of tetraethyl.

P. Phenylonediamine dihydrochloride and dried in hot air oven and then placed on clean glass slide by sterile forcep a fresh young tested culture on nutrient agar was picked of with sterile glass rod and rubbed on the filtered paper strip. If a purple color developed within 5-10 seconds the reaction was considered positive.
2.11.2 Catalase test

The test was carried out as described by Barrow and Feltham (1993). A drop of 3% H$_2$O$_2$ was placed on a clean slide and then a colony of tested culture on nutrient agar was picked by a glass rod added to the drop of 3% H$_2$O$_2$. A positive reaction was indicated by production of air bubbles.

2.11.3 Oxidation- Fermentation (O/F) test

The test was carried out as described by Barrow and Feltham (1993). The tested organism was inoculated with straight wire into duplication of test tubes of Hugh and Leifson's medium. To one of the test tubes a layer of melted soft paraffin oil was added to the medium to seal it from air. The inoculated tubes were incubated at 37°C and examined daily for fourteen days.

Yellow color in open tube only indicated oxidation of glucose, yellow color in both tubes showed fermentation reaction and blue or green color in open tube and yellow color in the sealed tube indicated production of alkali.

2.11.4 Sugar fermentation test

This test was carried out as described by Barrow and Feltham (1993). The peptone water sugar was inoculated with organism under the test, incubated at 37°C and then examined for several days. Acid production was indicated by appearance of reddish color, while gas production was indicated by appearance of empty space in the inverted Durham's tubes.

2.11.5 Nitrate reduction

The nitrate test was carried out as described by Barrow and Feltham (1993).
The test culture was lightly inoculated in to nitrate broth and incubated at 37 °C for two days. Then 1ml of solution (A) followed by 1ml of solution (B) of nitrate test reagent were added. Red color indicated positive reaction that showed nitrate had been reduced. If red color did not develop, powdered zinc was added to see whether there was residual nitrate or not. Red color development indicated that nitrate in medium had been reduced by zinc but not by organism, whereas unchanged color indicated nitrate in original medium had been reduced completely and nitrate was further broken down by the organism.

2.11.6 Coagulase test

The test was done as described by Barrow and Felthem (1993). To 0.5 ml of 1:10 dilution of human plasma in saline, 0.1ml of 18-24 hours old culture of tested organism was added, then incubated at 37 °C and examined after 6-24 h for coagulation. Definite clot formation indicated positive result.

The test was also performed on slide. Two colonies of tested culture were placed on a clean slide, emulsified in drop of normal saline and then a loop full of human plasma was added to the drop of bacterial suspension. Appearance of coarse visible clump was recorded as positive result.

2.11.7 Urease test

A slope of urea agar medium was inoculated with the tested organism and incubated at 37 °C change in color to red indicated positive reaction.
2.11.8 Manitol test

One colony of the tested organism has been taken by the loop under flame and inoculated with the manitol sugar and incubated in 37 °C for 24/hours if the color changed to red color the test was considered as manitol positive.

2.11.9 Xylose test

Tested organism was inoculated with the loop under flame in to test tubes of xylose sugar and then incubated in 37 °C for 24 hours the positive test was indicated by the appearance of red color .

2.11.10 Maltose test

A colony of the tested organism has been taken by the loop under flame and inoculated with the maltose sugar and incubated in 37 °C for 24 hours the maltose positive results were indicated by appearance of red color.

2.11.11 Fractose test

A loop of the tested organism has been taken and inoculated with the fractose sugar under flame and then incubated in 37 °C for 24 hours the red color results were considered as fractose positive.

2.11.12 Lactose test

The tested organism was inoculated with the loop in to test tubes of lactose sugar under flame and then incubated in 37 °C for 24 hours the positive test was indicated by the appearance of red color.

2.12. Motility test

The Gragi tube in semi.solid nutrient agar prepared as described by Cruck shank et al , (1975) was inoculated by straight wire.
A small piece of colony of the bacterium under test was picked by the end of the straight wire and stabbed in the center of semi–solid agar in the Gragi tube and then incubated at $37^\circ$C overnight. The organism was considered motile if it produced turbidity in the medium in the outside the Gragi tube.
Chapter 3

Results
3.1 Survey

3.1.1 Collected Information

Structured form (Appendix) was used to collect informations on investigated food handlers in police establishments.

3.1.1.2 Interview Findings

The recorded data showed that the majority (49%) of the food handlers were in basic education level (Fig. 1). The food handlers who attended health lecture were 63% (Fig. 2).

The number of smokers among food handlers were 13% while snuffers were 5%. In hands washing the survey showed that there were 98% wash their hands before and after work, 44% of the surveyed food handlers use nothing while sweating (Fig. 5 and 6).

Eighty five percent of surveyed food handlers went to the doctor in case of injury.

The questionnaire revealed that 97% of the food handlers used the normal air to dry utensils (Fig. 8), 42% of them kept their home clothes inside work place (Fig. 9). There were 91% of the food handlers did not visit the doctor when they contracted infectious disease as shown in Figure 10. Half (52%) of the surveyed food handlers had no medical certificates and 16% of the certificates were invalid.
Figures (1): Education level of food handlers in surveyed food establishments.

Figures (2): Health education of food handlers in surveyed food establishments.
Figure (3): prevalence of Smoking habits among surveyed food handlers.

Figure (4): prevalence of snuffing habits among surveyed food handlers.
Figure (5): Hands washing practiced by food handlers before and after work.

Figure (6): Behaviour of food handlers to dry themselves while sweating.
Figure (7): The response of the food handlers when they injured during work.

Figure (8): The methods used for drying of utensils in surveyed food places.
Figure (9): The places where the food handlers kept their home clothes during work.

Figure (10): Doctor visits when food handlers contract infectious disease.
Figure (11): Medical certificate issued to food handlers when they are medically examined.

Figure (12): Validity of food handler's medical certificate.
3.1.2 Observations findings

During the survey, it was observed that: 11% of the clothes of food handlers were dirty (Table, 1). All 100% of their hair were short (Table, 2), also it was observed that 81% were not used head covers, and 73% of them were not used the protective clothes (Table, 3 and 4). There were 99% of the food handlers have short finger nails, and 22% of them used the finger rings (Table, 5 and 6). Also it was observed that the majority of the surveyed food handlers were under 45 years (94) as it shown in Table 7.
Table (1)  Appearance of food handler's clothes in surveyed food establishments.

<table>
<thead>
<tr>
<th>Clean</th>
<th>Dirty</th>
</tr>
</thead>
<tbody>
<tr>
<td>89%</td>
<td>11%</td>
</tr>
</tbody>
</table>

Table (2)  Appearance of hair of food handlers in surveyed food establishments.

<table>
<thead>
<tr>
<th>Short</th>
<th>Long</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table (3)  Head cover used by food handlers in surveyed food establishments.

<table>
<thead>
<tr>
<th>Used</th>
<th>Unused</th>
</tr>
</thead>
<tbody>
<tr>
<td>19%</td>
<td>81%</td>
</tr>
</tbody>
</table>
Table (4) Protective coat used by food handlers in surveyed food establishments.

<table>
<thead>
<tr>
<th>Used</th>
<th>Unused</th>
</tr>
</thead>
<tbody>
<tr>
<td>27%</td>
<td>73%</td>
</tr>
</tbody>
</table>

Table (5) Appearance of finger nails of food handlers in surveyed food establishments.

<table>
<thead>
<tr>
<th>Short</th>
<th>Long</th>
</tr>
</thead>
<tbody>
<tr>
<td>99%</td>
<td>1%</td>
</tr>
</tbody>
</table>

Table (6) Use of finger rings by food handlers surveyed.

<table>
<thead>
<tr>
<th>Used</th>
<th>Unused</th>
</tr>
</thead>
<tbody>
<tr>
<td>22%</td>
<td>78%</td>
</tr>
</tbody>
</table>
Table (7) Ages groups of the food handlers surveyed.

<table>
<thead>
<tr>
<th></th>
<th>Under 45 years</th>
<th>Over 45 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>94%</td>
<td>6%</td>
</tr>
</tbody>
</table>
3.2 Bacteriological findings.

3.2.1 Isolation of aerobic bacteria.

Thirty five samples were collected from hands and noses of the food handlers working in police establishments. All the samples showed bacterial growth. The bacteria isolated in this study were identified according to their cultural characteristics, cell morphology, Gram-stain reaction and biochemical properties, as described by Barrow and Feltham (1993).

3.2.1.1 Isolation of bacteria from hands of the food handlers.

A total of (31) aerobic bacteria were isolated from twenty five samples from hands of the food handlers, 20 (65%) of these were Gram-positive, and 11 (35%) were Gram-negative. The isolated bacteria were *Staphylococcus species* (48%) , followed by *Streptococcus species* (13%) and *Enterococcus species* (10%) . Other isolated bacteria included *Pseudomonas spp*, *Nieseria mucosa*, *Bacillus spp*, *Stomatococcus spp*, *Morganella morganii* and *Acentobacter spp*, as shown in table A.

3.2.1.1 Isolation of bacteria from noses of the food handlers.

All the ten swab samples collected from the noses of the food handlers showed the presence of Gram-possitive bacteria (100%) . *Staphylococcus species* (60%) and *Streptococcus species* (40%) were isolated from noses of the food handlers.
**Table (8)** Aerobic bacteria isolated from hands swab samples collected from the food handlers in police establishments.

<table>
<thead>
<tr>
<th>bacteria species</th>
<th>Number of samples</th>
<th>Number isolated</th>
<th>Isolation percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staphylococcus scuiri</em></td>
<td>25</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td><em>Staphylococcus xylosis</em></td>
<td>25</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td><em>Staphylococcus caseolyticus</em></td>
<td>25</td>
<td>4</td>
<td>16%</td>
</tr>
<tr>
<td><em>Staphylococcus schleiferi</em></td>
<td>25</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td><em>Staphylococcus lentus</em></td>
<td>25</td>
<td>4</td>
<td>16%</td>
</tr>
<tr>
<td><em>Staphylococcus capitis</em></td>
<td>25</td>
<td>3</td>
<td>12%</td>
</tr>
<tr>
<td><em>Staphylococcus cohnii</em></td>
<td>25</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td><em>Streptococcus equinus</em></td>
<td>25</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td><em>Streptococcus equisimilis</em></td>
<td>25</td>
<td>3</td>
<td>12%</td>
</tr>
<tr>
<td><em>Pseudomonas spp</em></td>
<td>25</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td><em>Neiseria mucosa</em></td>
<td>25</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td><em>Bacillus mycoides</em></td>
<td>25</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td><em>Stomatococcus mucilaginosus</em></td>
<td>25</td>
<td>3</td>
<td>12%</td>
</tr>
<tr>
<td><em>Morganella moganii</em></td>
<td>25</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td><em>Enterococcus galinarum</em></td>
<td>25</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td><em>Enterococcus casseliflavus</em></td>
<td>25</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td><em>Acentobacter spp</em></td>
<td>25</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td><em>Lactobacillus salivarius</em></td>
<td>25</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td><strong>total</strong></td>
<td><strong>25</strong></td>
<td><strong>31</strong></td>
<td><strong>124%</strong></td>
</tr>
</tbody>
</table>
### Table (9) Aerobic bacteria isolated from noses swabs samples collected from the food handlers in police establishments

<table>
<thead>
<tr>
<th>Bacteria species</th>
<th>Number of samples examined</th>
<th>Number isolated</th>
<th>Isolation percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>10</td>
<td>3</td>
<td>30%</td>
</tr>
<tr>
<td><em>Staphylococcus hominis</em></td>
<td>10</td>
<td>1</td>
<td>10%</td>
</tr>
<tr>
<td><em>Staphylococcus lentus</em></td>
<td>10</td>
<td>2</td>
<td>20%</td>
</tr>
<tr>
<td><em>Streptococcus pyogenes</em></td>
<td>10</td>
<td>2</td>
<td>20%</td>
</tr>
<tr>
<td><em>Streptococcus salivarius</em></td>
<td>10</td>
<td>1</td>
<td>10%</td>
</tr>
<tr>
<td><em>Streptococcus equinus</em></td>
<td>10</td>
<td>1</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>10</td>
<td>10</td>
<td>100%</td>
</tr>
</tbody>
</table>
Table (10) Gram-stain reaction and biochemical properties of Streptococci isolated from hands and noses of food handlers.

<table>
<thead>
<tr>
<th>Character</th>
<th>Streptococcus equinus</th>
<th>Streptococcus equisimilis</th>
<th>Streptococcus pyogenes</th>
<th>Streptococcus salivarius</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gram-reaction</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>oxidase</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>catalase</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Oxidation/fermentation</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>glucose</td>
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<td>+</td>
<td>+</td>
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<tr>
<td>lactose</td>
<td>-</td>
<td>-</td>
<td>+</td>
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<tr>
<td>mannitol</td>
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<td>sucrose</td>
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<td>+</td>
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<tr>
<td>fructose</td>
<td>+</td>
<td>+</td>
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</tbody>
</table>

Table (11) Gram-stain reaction and biochemical properties of staphylococci isolated from hands and noses of food handlers.

<table>
<thead>
<tr>
<th>Character</th>
<th>Staph. aureus</th>
<th>Staph. scuiri</th>
<th>Staph. cohnii</th>
<th>Staph. xylosis</th>
<th>Staph. caseolyticus</th>
<th>Staph. lentus</th>
<th>Staph. schleiferi</th>
<th>Staph. capitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gram-reaction</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>oxidase</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>catalase</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Oxidation/fermentation</td>
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<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>coagulase</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>glucose</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>lactose</td>
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<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>sucrose</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>fructose</td>
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<td>+</td>
</tr>
<tr>
<td>nitrate</td>
<td>+</td>
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<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>
Chapter 4

Discussion
4. Discussion

This study revealed that most of the food handlers (49%) were basic school graduate and (10%) of the handlers were illiterate. This indicates poor education level so it seems difficult to train them on general sanitary measures and food hygiene and safety.

About two third (63%) of the food handlers had not attended any lecture or training on general sanitation or food safety and hygiene. This means they have no idea about food hygiene and safety which may result in bad behavior during food preparation. Bamford (1991) recommended that, the food handlers should be healthily educated and should be trained on general sanitary measures and food hygiene safety. The present investigation revealed high number (87%) of non smokers among the food handlers but there were 13% smokers. Also it revealed the majority (95%) were nonsnuffers while 5% used snuff. Smoking and snuffing are unhygienic practices as stated by FAO/ WHO (1995) rules of personal hygiene during working hours and food handlers should neither smoke, drink nor eat in the working area. In addition, smoking in limited area of restaurants may expose the restaurant's workers to smoking predisposing diseases such as respiratory tract infections and cancers, and then the handlers may transmit the infection to the customers through the contaminated food. It was reported that Klebsiella pneumonia which is causative agent of chest infection was isolated from hand wound and from acute gastroenteritis due to contamination of raw food (Baily, 2002).

This study showed, 98% of the food handlers washed their hands before and after work. This means, the food handlers in police
establishments have some knowledge on food hygiene. Marin (1978) reported that contamination of hands by intestinal organisms after use of water cycle can be a mean of contaminating food.

Thus the washing of hands before work is an important measure in food safety. However, there was less knowledge about the behavior in case of sweating as 44% of the food handlers used nothing when they were sweating. The sweat droppings may contaminate the food by skin microorganisms and skin wounds pathogens.

When the food handlers were injured, the majority of them visited the doctor (85%), some did nothing (10%) while the rest tied the cut with piece of cloth. This indicates the awareness of the most food handlers was good and they knew the risks of food wound infection. The wounds or burns may be infected during work. Thus, the infected wounds and burns might be a source of food contamination.

The practice of washing and drying utensils in surveyed establishments was poor as 97% of the food handlers said that they dry utensils by let them to dry in air. The normal air is full of microorganisms so the utensils while drying are exposed to contamination by air microorganisms, flies and other insects. The contamination of utensils may result in contamination of food. Drying of the utensils must be performed by hot air and then kept in a closed cupboard (FAO.2001).

In 42% of surveyed food handlers put their home clothes inside work place while the other put their home clothes outside work place. So the contamination of food may take place through this clothes. The investigation showed 9% of the handlers visited the doctor when they
were ill, and none of them was given a medical rest, even if he contracted respiratory or alimentary tract infection. This indicates high risk because the infected food handler may contaminate food by respiratory or digestive tract pathogens.

This study also revealed that 52% of the handlers had no medical certificates and 63% of those having medical certificates, their certificates were invalid. This means there were no regular examination for food handlers and more than half of the food handlers had no known medical history, some of them may be carrier of infectious diseases and may constitute a dangerous source of infection. Medical examination of the food handlers before and while they are working is very essential (Frazier and Westhoff, 1992).

It was also observed all (100%) of the food handlers had short hair. The contamination of food by microorganism on hair is possible (Anon, 2001). In this investigation it was observed that 89% of the food handlers wear clean clothes, but 81% of the handlers had no head covers, also 73% did not use protective coats. WHO (1977) advised the food handlers should wear protective clothes.

During this study it was observed that 99% of food handlers had short finger nails and 22% wear finger rings while they were working. The finger ring and dirty uncut nails may be a source of infection that could contaminate food during preparation and handling. The international food standards forbid using finger rings during working in food preparation (FAO, 2002). WHO (1991) reported that the food handlers should refrain from unhygienic practices such as discharges from nose, avoid contamination of food with physical hazards by food
handling practices, protecting food from environment, removing jewels prior to handling of food.

The observations and questionnaire findings in this study showed almost the great majority (94%) of the food handlers were under 45 years of age while, this group may have more resistant to disease and can secure serving of safe food when compared with the other group (6%) of this study.

The observation and questionnaire findings of this study indicated poor personal hygiene, unhygienic behaviors and practices. Health education is lacking because food handlers were not trained in general sanitation and food hygiene. Therefore, it can be concluded, the food handlers in surveyed establishments did not observed strictly the regulations which control food safety nor they practiced hygienically. Thus, it was decided to carryout bacteriological study to examine the food handlers working in police establishments.

Hands and noses of food handlers were chosen to be examined as these are most potential source of food contamination.

In this study, swab samples were collected from handler's hands and noses. The collected samples were examined for bacterial contaminants. The swab collected were cultured onto blood agar and MacConky agar and incubated aerobically at 37°C.

All the 35 samples collected revealed bacterial growth. Both Gram-positive and Gram-negative aerobic bacteria were isolated.

Thirty five swabs samples were collected from the hands and noses of the handlers showed many types of bacteria were isolated. Eight different species of Staphylococci were isolated from hands of the food handlers, this agree with findings of Ibrahim A H (2006) who isolated
handlers, this agree with findings of Ibrahim A H (2006) who isolated six different species of Staphylococci from hands of the food handlers.

The Staphylococci species isolated from hands and noses of food handlers include: S. scuri, S. xylosis, S. caseolyticus, S. schleiferi, S. lentus, S. capitis, S. cohnii, S. hominis and S. aureus. The isolation of Staphylococci from hands of food handlers in this study agree with findings of Hanadi (2006) who isolated six different species from hands of the food handlers.

*Staphylococcus* species is one of the most bacteria that caused food intoxication (Jay, 2000). Staphylococcal food poisoning has been demonstrated to be intoxication caused by the consumption of food containing enterotoxins produced by the Staphylococci primarily *S. aureus* (Khambaty et al., 1994).

The natural habitat of *S. aureus* is warm-blooded animals including human, most apparently healthy people were found to be carrier of *S. aureus* on the skin, arms and hands (Bamwart, 1981), and on mucus membrane of the nose (Adams and Moss, 2000). In this study, *S. aureus* was isolated from the noses of the food handlers. Hence contamination of food with *S. aureus* is possible by food handlers, therefore avoiding sneezing and coughing during work is very important in food hygiene (FAO, 2002).

In this study, four species of Streptococci, *Streptococcus equines*, *Streptococcus equisimilis*, *Streptococcus pyogenes* and *Streptococcus salivarius*, were isolated from hands of food handlers. *Streptococcus* species were reported to be causative agent of sore throat, upper respiratory tract infection, wounds and burns infection in man (Satish, 1993) and also causative agent of mastitis in cattles (Gracey, 1986).
Some Streptococcus species are present as normal inhabitant of mouth, upper respiratory tract and genital tract of man. Therefore, saliva spill, aerosol and urinary tract of the food handlers in this study may contaminate food during preparation and serving.

The bacillus species isolated in this investigation was *Bacillus mycoides* which was isolated from hands of food handlers. This agree with Jah Elnabi (2006) who isolated this bacteria from hands of food handlers and also from dishes. Raw uncooked and cooked meat products might be contaminated by food handler's hands. However, water and soil may also be possible source of contamination (Jay, 2000).

*Enterococcus gallinarum* and *Enterococcus casseliflavus* were isolated from hands of food handlers in this study. Enterococci were found as commensal in alimentary tract of man and animals and were also found in faeces (Satish, 1993). Although Enterococcus are not pathogenic, they may invade tissue and cause urinary tract infection (Gracey, 1986).

*Pseudomonas species* are associated with spoilage of eggs, meat, fishes and milk (Chessburgh, 200). It was reported that *P. aeruginosa* caused food poisoning (Rieman, 1969). Pseudomonas was isolated from hands of food handlers in this study, this agrees Larson et al. (1986) who isolated Pseudomonas from hands, while Sheema and Stiles (1983) isolated Pseudomonas from hands as transient bacteria. *Acentobacter species* are widely distributed in soil and water and may be found in food especially refrigerated fresh products (Jay, 2000). *Acentobacter species* was isolated from hands of food handlers in this study, this agrees Jah Elnabi (2006) who isolated this species from hands of food handlers.

In this investigation, *Lactobacillus species* was isolated from
hands of food handlers. Lactobacilli are normal inhabitants of mouth, nasopharynx and large intestine (Satish, 1993).

* Morganella morganii * is one of enteric bacteria (Glacey, 1986), was isolated from hands of food handlers in this study.

The detection of Lactobacilli and Morganella on hands of food handlers in this study indicates the food could be contaminated by these bacteria.

The isolation of aerobic bacteria in this study from hands and noses of food handlers work in police food establishments, indicates high level of contamination and also indicates the food handlers could be a serious source of food contamination in the police food establishments in Khartoum state.
Conclusion and Recommendations

Conclusion:

From the observations and findings of this investigation, it can be concluded that:

1- The food handlers in police establishments did not observe the regulations of food hygiene and safety.

2- The food handlers in police establishments were not educated on sanitation and food hygiene.

3- Most of the food handlers had no valid health certificates and regular medical examination.

4- Food handlers' poor sanitation was noticed in police establishments.

5- Pathogenic aerobic bacteria causing digestive tract infection, such as *S. aureus*, streptococci and enterococci were isolated from hands and noses of food handlers. These bacteria may contaminate food in these establishments and cause food-borne disease.
**Recommendations:**

To improve sanitation and food hygiene in police establishments, it is recommended that:

1. Establishment of a powerful food hygiene department in the police forces, with wide authorities. The department must have the ability to investigate and inspect samples and training of the public health personnel in food examination.

2. Regular medical examination for the food handlers.

3. Organization of regular health lectures in police establishments for the food handlers.

4. Regular inspection visits to the food preparation places.

5. Setting of legislations that govern the food preparation and handling inside police establishments.
References

Schools in Khartoum North Province.
Cruickshank; Duguid, J.P.; Marino, B.P. and Swain, R.H (1975). Medical Microbiology: The Practice of Medical Microbiology, 12th ed, Vol.2.


WWW. food link .com (2006).


Appendix:

Faculty of Public and Environmental Health

The hygienic status of the food handlers

Questionnaire

Age: ........................

Education:

a. university  b. higher secondary school  c. basic  d. khalwa  e. illiterate

Have you attended any health lecture?

a. yes  b. No

Do you smoke?

a. yes  b. No

Do you snuff?

a. yes  b. No

When do you wash your hands?

a. after work  b. before work  c. both of them

What do you use when you are sweating?

a. use my clothes  b. use my tissue paper  c. wash my face  d. I use nothing.

What do you do when you are injured?

a. tie it with clothes  b. go to the doctor  c. I do nothing

How do you dry utensils?

a. by hot air  b. by towel  c. by normal air

Where do you keep your home clothes?

a. inside work place  b. outside work place
Have you visited the doctor for any illness reason?
   a. yes                     b. No

in case of yes
What type of the disease?

Have you given a medical rest?
   a. yes                b. No

Have you medical certificate?
   a. yes                b. No

validity of medical certificate.
   a. valid             b. invalid

**Observations:**

Clothes:
   a. clean         b. Dirty

Hair:
   a. long           b. short

Head cover:
   a. used           b. unused

Protective clothes:
   a. used           b. unused

Finger nails:
   a. long           b. short

Finger ring:
   a. used           b. unused
Table (D) Gram-stain reaction and biochemical properties of Streptococci isolated from hands and noses of food handlers.

<table>
<thead>
<tr>
<th>Character</th>
<th>Streptococcus equinus</th>
<th>Streptococcus equisimilis</th>
<th>Streptococcus pyogenes</th>
<th>Streptococcus salivarius</th>
</tr>
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<tbody>
<tr>
<td>Gram-reaction</td>
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<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Oxidase</td>
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<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Catalase</td>
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<td>Fructose</td>
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</tbody>
</table>

Table (c) Gram-stain reaction and biochemical properties of staphylococci isolated from hands and noses of food handlers.

<table>
<thead>
<tr>
<th>Character</th>
<th>Staph. aureus</th>
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<th>Staph. lentus</th>
<th>Staph. schleiferi</th>
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<td>+</td>
<td>+</td>
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<td>-</td>
<td>-</td>
<td>-</td>
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