Microbiological Quality of Um-Jinger (Traditional Sudanese Food), Marketed in Khartoum State

By

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To my family with love, ...
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Abstract
This research has studied the microbiological quality (microbial contamination) of Um-jinger food. The study has been carried out via a selection of random samples exploiting the simple random sample method applied on (60) samples of vendors around Khartoum state markets, within the period from the (21\textsuperscript{th} of May up to the 5\textsuperscript{th} of September 2007). The study includes the procedures that carried out and bacteriological experiments as well as pH measurement.

During the microbiological – bacteriological analysis and observations, the study come up with the following results:

- The study field areas suffer decline of sanitary levels.
- The personal hygiene of vendors was bad.
- Aerobic plate count is estimated $3 \times 10^4$ to $3.5 \times 10^7$ cfu per ml and the MacConkey's agar count ranged form $2 \times 10^2$ to $2.7 \times 10^3$ cfu per ml.
- The total coliform count estimated to be around 3 to 1400 MPN per ml, and Mannitol salt agar count was $2 \times 10^2$ to $1.6 \times 10^4$ cfu per ml.
- The degree of coliform bacteria contamination percentage raised to 6.6\%, whereas \textit{Salmonella spp} was 5\%.
- The highest rate of contamination was due to the \textit{Bacillus spp} raised to 70\%, followed by the \textit{Staphylococcus aureus} 63.3\%.
- The study has figured the occurrence of different kinds and types of the \textit{Enterobacteriace species} represented by \textit{Salmonella spp.}, \textit{Escherichia spp.}, \textit{Proteus spp.}, \textit{Pseudomonas spp.}, \textit{Klebsiella spp.} and \textit{Hafnia spp.}.
- Result have shown and come up with contrast in pH degree (rate) relevant to samples chosen ranged between 6.7 – 3.4.
- Research find out that the consumption of contaminated Um-jinger food could cause and influence dangerous affects upon public health.
• The study recommended the necessity to carry out medical inspection for the vendors and issue medical fitness cards as well as the importance of cleanliness, awareness and, selling and circulation improvements, because the dealing has the greatest impact upon the minimizing of danger assumed.
في هذا البحث تم تسجيل دراسة الجودة الميكروبية – التلوث الميكروبي – لطعام أم جنقر من خلال أخذ عينات عشوائية
تستخدم الطريقة العشوائية السبيكة (60عينة) من البائعات بسواق ولاية الخرطوم المختلفة في الفترة (من 21
مايو حتى 5 سبتمبر 2007م) أشتملت الدراسة على إجراء اختبارات البكتريولوجية (IMVIC) وقياس الرقم
الهيدروجيني.

من خلال الملاحظة والتحليل البكتريولوجي (الميكروبيولوجي): أظهرت النتائج أن مناطق التداول يقل بعشرة الإصاح البيئي.

- أوضحت النتائج أن المياه المستخدمة للغسيل لا تتم تغييرها ويعاد استعمالها بالرغم من تلوثها.

- أظهرت الدراسة مستوى الصحة الشخصية بالنسبة للنساء البائعات.

- بينت النتائج أن التعداد الحيوي للمستعمرات تراوح ما بين 3×10⁴ إلى 3.5 × 10⁷، وأن العائلة المعوية

- تراوحت ما بين 2×10³ إلى 2.7 × 10⁶. MPN/ ml، وأن العد

- أظهرت النتائج أن العد الكلي لبكتريا الفولون تراوح ما بين 3 إلى 1400 للعناقيدات كان 2×10³ إلى 10³.

- أظهرت النتائج أن درجة التلوث ببكتريا الفولون بلغت نسبتها 6.6% بينما أجنس السالمونيلا 5%.

- أظهرت النتائج أن أعلى درجة تلوث كانت بواسطة العائلة الباسيلية حيث بلغت نسبتها 70% تلتها العنقودية

- الذهبية بنسبة 63.3%.


- أظهرت النتائج بيناء في درجة الأس الهيدروجيني بالنسبة للعينات المأخوذة حيث تمايزت ما بين 6.7 – 3.4.

- خلصت النتائج إلى أن استهلاك طعام أم جنقر الملوث من شأنه أن يؤدي إلى تأثيرات ومخاطر على

الصحة العامة.

- أوصت الدراسة بضرورة إجراء الكشف الطبي للبائعات واستخراج كروت اللياقة الطبية، كما أن الاهتمام

بالنظافة والتوعية والتحسين من طرق البيع وال التداول له الأثر الأكبر في تقليل المخاطر الناجمة.
Chapter one
**Introduction**

Food hygiene may be defined as the sanitary science, which aims to produce food, which is safe for the consumer and of good food keeping quality (Jay, 2000).

Although food is essential to maintain life, it can also be responsible for ill health; foods are complex mixture of chemicals and often contain compounds that are potentially harmful as well as those that are beneficial. In addition to the hazards posed by natural toxins that are an intrinsic feature of their composition, foods may also act as the vehicle by which an exogenous harmful agent may be ingested (Jay, 2000).

Food borne disease has been defined by the WHO as “Any disease of an infection or toxin nature caused by, or through to be caused by, the consumption of food or water”. Studies conducted in the USA found that the risk of becoming ill as a result of microbiological contamination of food is 100,000 times greater than risk from pesticides contamination (WHO, 2002).

Researchers who investigated the microbiological quality of street-vended foods have reported high bacterial counts and a high incidence of food borne pathogens in such foods in different countries (Bryan et al, 1992).

A wide range of ready-to-eat foods have been reported as a source of food borne diseases in different countries, in Canada 38% of food poisoning outbreaks occurred resulted from ready-to-eat meals consumption (Todd, 1989)
In the Sudan there are more than 80 different fermented foods. The diversity of these foods originates from the diversity of raw starting materials from which they are made (Dirar, 1993).

Um-Jinger is a fermented food product virtually restricted to the region of Darfur and Kordofan and to date seems to be made from pearl millet only (Dirar, 1993).

Um-Jinger belongs to the category of ready-to-eat food; it is mainly prepared from grinded millet, sugar, yogurt, lemon, little salt, and sometime tahnia sweet is added. Millet is cooked in hot pot, after that, other constituents are added.

There has been increase in the consumption of Um-Jinger out of its traditional places as it’s a readily available, inexpensive and nutritious meal.

Food can become microbiologically hazardous to the consumer when the principals of hygiene and sanitation are not met or when it becomes contaminated by pathogens from human or from the environment during production, processing or preparation.
**Rationales**

- The microbiological quality of street-vended food has reported high bacterial counts and a high incidence of food borne pathogens in such food.
- Untreated foods may be expected to contain varying numbers of bacteria.
- Utensils used may contain a wide range of airborne bacteria.
- There are several genera of bacteria that are specifically associated with the hands, mouth and of food handlers, they reflect the environmental and habits of the individuals.

Thus assessment of microbiological safety from food borne pathogen and detection of wide spread groups or species which are easily enumerated and whose presence in foods indicates exposure to conditions that might introduce hazardous organisms and / or allow their growth are use is vital. These groups are referred to as indicator organisms eg *E.coli*, *Salmonella*.
**Objectives**

**General Objective:**

To determine the microbiological quality of a traditional Sudanese Food (Um-Jinger) in Khartoum state 2007.

**Specific objectives:**

- To detect the viable count of microorganisms in Um-Jinger
- To determine types of organisms in Um-Jinger.
- To assess the personal hygiene of vending women (target group).
- To evaluate the food safety aspects associated with Um-Jinger vending.
Chapter Two
Chapter Two

Literature Review

Food transmission diseases:

The contamination of raw ingredients from infected food-producing animals and cross-contamination during processing is more prevalent causes of food borne disease than is contamination of foods by persons with infectious or contagious diseases. However, some pathogens are frequently transmitted by food contaminated by infected persons. The presence of symptoms like diarrhoea, vomiting, open skin sores, boils, fever, dark urine, or jaundice in persons who handle food may indicate infection by a pathogen that could be transmitted to others through handling of food. The failure of food-handlers to wash hands (in situations such as after using the toilet, handling raw meat, cleaning spills, or carrying garbage, for example), wear clean gloves, or use clean utensils is responsible for the food borne transmission of these pathogens. Pathogens that can cause diseases after an infected person handles food may include: Noroviruses, Hepatitis A virus, *Salmonella Typhi*, *Shigella species*, *Staphylococcus aureus*, *Streptococcus pyogenes*. Other pathogens are occasionally transmitted by infected persons who handle food, but usually cause disease when food is intrinsically contaminated or cross-contaminated during processing or preparation. Bacterial pathogens in this category often require a period of temperature abuse to permit their multiplication to an infectious dose before they will cause disease in consumers (Dobson, 1996).

More than 200 known diseases are transmitted through food. The causes of food borne illness include viruses, bacteria, parasites, toxins, metals, and the symptoms of food borne illness range from mild gastroenteritis to life-threatening neurologic, hepatic, and renal syndromes. In the United States, food borne diseases have been estimated to cause 6 million to 81 million illnesses and up to 9,000 deaths each year (Norman et. al., 1995).
Surveillance of food borne illness is complicated by several factors. The first is underreporting, although food borne illnesses can be severe or even fatal, milder cases are often not detected through routine surveillance. Second, many pathogens transmitted through food are also spread through water or from person to person, thus obscuring the role of food borne transmission. Finally, some proportion of food borne illness is caused by pathogens or agents that have not yet been identified and thus cannot be diagnosed. The importance of this final factor cannot be overstated. Many of the pathogens which are of greatest concern today (e.g., *Campylobacter jejuni*, *Escherichia coli* O157:H7, *Listeria monocytogenes*, *Cyclospora cayetanensis*) were not recognized as causes of food borne illness just 20 years ago (Ray, 2004).

**Reasons of increase in food borne illness cases:**

The number of people suffering from food borne illness has increased dramatically over the last decade. There are many reasons proposed for the increase of food borne illness including:

1. More people eating out and takeaway foods.
2. A greater number of meals served at certain time as wedding and parties.
3. Misuse of equipments such as refrigerators or ovens.
4. Seasonal variation.

(Hafiz, 2005).

**Food poisoning:**

"Food poisoning" is a general name given to illnesses contracted by consuming contaminated food or water.

The micro-organisms responsible for illness are bacteria, viruses and fungi but illness can also be caused by chemical contaminants (such as heavy metals), toxins produced by the growth of some micro-organisms and by a variety of organic substances that may be
present naturally in foods (such as certain mushrooms and some seafood). Food poisoning outbreaks are often recognised by the sudden onset of illness within a short period among many individuals who have eaten or drunk one or more foods in common. Single cases are difficult to identify unless, as in Botulism for example, there are distinct symptoms (Hobbs and Richard, 1979).

The Ten main reasons for food poisoning

1. Inadequate cooling/refrigeration, food left at room temperature.
2. Too long between preparation and consumption.
3. Inadequate reheating.
4. Inadequate cooking.
5. Cross-contamination from raw to high risk/ready to eat foods.
6. Infected food handlers.
7. Inadequate hot holding temperatures.
8. Inadequate hand washing.
10. Improper cleaning of equipment and utensils.
(Hobbs, 1993).

Prevention of food borne illness:

- Washing hands thoroughly after going to the bathroom or changing diapers.
- Eating only thoroughly cooked ground beef.
- Cooking products to an internal temperature of 71.1 °C degrees Celsius.
- Avoiding unpasteurized milk and juices.
- Washing fresh fruits and vegetables thoroughly before eating raw or cooked.
- Keep raw food separate from ready-to-eat foods.
Encourage basic research and helping scientists to better understanding of how pathogens contaminated food or water cause disease in humans (Hafiz, 2005).

There are three main ways of breaking the food poisoning chain:

- Protecting food from contamination.
- Preventing any bacteria present in the food from multiplying.
- Destroying those bacteria that are present in the food.

(Hobbs, 1993)

High Risk Foods:

High risk foods are those perishable foods which can support the growth of harmful bacteria and are intended to be eaten without further treatment such as cooking, which would destroy such organisms. They include -

- All cooked meat and poultry.
- Cooked meat products including gravy, stock, and roll/sandwich fillings.
- Milk, cream, artificial cream, custards and dairy products.
- Cooked eggs and products made with eggs, eg. mayonnaise.
- Shellfish and other seafood.
- Cooked rice (Larkin, 2008).

Source of food contamination

Clean food can be contaminated by bacteria from four main sources-

1. The people present in the workplace and their clothing.
2. Other food that is already contaminated.
3. Dirty kitchen or work premises and equipments.
4. Insects and vermin’s.
Sometimes, harmful bacteria pass directly from the source to high risk food, but usually they rely on other things to transfer them to foods. These things are called Vehicles. Indirect contamination using an intermediate vehicle is the most common, e.g.- the movement of bacteria from the intestine of a food handler to food via their hands, after using the toilet.

Where contamination is passed from raw food to high risk food via for example, a cutting board, this is known as Cross Contamination. The path that bacteria use to move from the source to the food, is known as the Route (Hobbs, 1993).

**Characteristics of some Bacteria that cause food contamination:**

**Enterobacteriaceae:**

Some members of the family Enterobacteriaceae are found frequently on the external and internal surfaces of man and in his environment. These species may act as opportunistic pathogens to cause a wide variety of infections in parts of the human body where there is some abnormality or impairment of host defences.

Members of the Enterobacteriaceae are gram negative, non spore-forming bacilli that grow both aerobically and anaerobically on ordinary media, including MacConkey's lactose bile salt agar. They are oxidase negative, catalase positive; they ferment glucose and other carbohydrates in peptone water with the production of gas and acid; reduce nitrates to nitrites; and are motile or non motile (Reid et al., 2001).

**Escherichia coli:**

*Escherichia coli* is a widespread organism that is normally found in the guts of animals and humans. There are many different types, some of which are capable of causing illness. One uncommon type that can cause serious illness is Verocytotoxin producing
Escherichia coli O157 has been found in raw and undercooked meats, unpasteurised milk and dairy products, and raw vegetables (Reid et al., 2001).

Coliform bacteria:

Coliform bacteria are commonly-used bacterial indicator of sanitary quality of foods and water. They are defined as rod-shaped Gram-negative organisms which ferment lactose with the production of acid and gas when incubated at 35 °C. Coliforms are abundant in the faeces of warm-blooded animals, but can also be found in the aquatic environment, in soil and on vegetation. In most instances, coliforms themselves are not the cause of sickness, but they are easy to culture and their presence is used to indicate that other pathogenic organisms of fecal origin may be present. They are tested using the MPN (most probable number) method, which is a probabilistic test that assumes bacteria meeting certain growth and biochemical criteria. Fecal pathogens include bacteria, viruses, protozoa or parasites (WHO, 2002).

Faecal coliforms:

Faecal coliforms are facultatively-anaerobic, rod-shaped, gram-negative, non-sporulating bacteria. They are capable of growth in the presence of bile salts or similar surface agents, oxidase negative, and produce acid and gas from lactose within 48 hours at 44 ± 0.5°C. The faecal coliform assay should only be used to assess the presence of faecal matter in situations where faecal coliforms of non-faecal origin are not commonly encountered.

Faecal coliforms include the genera that originate in faeces; like Escherichia as well as genera that are not of faecal origin; Enterobacter, Klebsiella, and Citrobacter. The assay is intended to be an indicator of faecal contamination, or more specifically, which is an indicator microorganism or other pathogens, which may be present in faeces (Doyle and Erickson, 2006).
**Staphylococcus aureus:**

*Staphylococcus aureus* may be found on the skin, in infected cuts and boils and in the nose. It may also be found in unpasteurised milk. It can be transferred to food from the hands or from droplets from the nose or mouth. Food poisoning from *Staphylococcus aureus* follows the consumption of heavily contaminated food, where bacteria have multiplied and produced toxins, which causes illness when the food is consumed. *Staphylococcus aureus* survives when refrigerated although it does not multiply. The bacteria are destroyed by pasteurisation of milk and cooking of food, but the toxin may survive these processes. The main foods associated with illness are cooked meats, poultry and foods, which are handled during preparation without subsequent cooking. The presence of this bacterium or its enterotoxins in processed foods or on food processing equipment is generally an indication of poor sanitation. *Staphylococcus aureus* can cause severe food poisoning. Foods are examined for the presence of *Staphylococcus aureus* and/or its enterotoxins to confirm that *Staphylococcus aureus* is the causative agent of foodborne illness, to determine whether a food is a potential source of Staphylococci food poisoning. Also to demonstrate post-processing contamination, which is generally due to human contact or contaminated food-contact surfaces. The presence of a large number of *Staphylococcus aureus* organisms in a food may indicate poor handling or sanitation; however, it is not sufficient evidence to incriminate a food as the cause of food poisoning (Bennett *et al.*, 1986).

**Personal hygiene:**

Some microorganisms 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 and other people. Washing hands regularly throughout the day and especially before preparing food, eating, caring for the sick, changing dressings, giving medicines, looking after babies or the elderly, starting work by food handler or health professional and putting in contact lenses is
essential. Washing hands also should be carried between handling raw foods (meat, fish, poultry and eggs) and touching any other food or kitchen utensils to avoid cross contamination of ready foods and also after handling raw foods, particularly meat, fish and poultry, going to the toilet, touching rubbish/waste bins, changing nappies, caring for the sick, especially those with gastro-intestinal disorders, coughing or sneezing, handling and stroking pets or farm animals and gardening (Strachan, 2000).

**Habits:**

There are certain bad habits that should be avoided by the food handler, the unguarded cough or sneeze can disperse from the nose, mouth or throat, numbers of bacteria suspended in droplets of moisture. These droplets serve to pass infection directly from one person to another; they may also contaminate foodstuffs. The habit of licking the fingers to pick up paper or sack is bad one at any time but particularly, so when the paper contaminated with saliva, is used for wrapping food. Nose picking or fingering the nose may leave staphylococci on the fingers – clean handkerchiefs are almost free of bacteria, but dirty ones may harbour millions. Education on good standards of health and hygiene for all those working with food should be provided and regular talks should be encouraged (Hobbs, 1993).

**Food quality:**

Food quality is the quality characteristics of food that is acceptable to consumers. This includes external factors as appearance (size, shape, colour, gloss, and consistency), texture, and flavour; factors such as federal grade standards (eggs) and internal (chemical, physical, microbial).

Food quality is an important food manufacturing requirement, because food consumers are susceptible to any form of contamination that may occur during the manufacturing process. Many consumers also rely on manufacturing and processing
standards, particularly to know what ingredients are present, due to dietary, nutritional requirements, or medical conditions. Besides ingredient quality, there are also sanitation requirements. This is important to ensure the food processing environment is as clean as possible in order to produce the safest possible food for the consumer. Food quality also deals with product traceability, in terms of ingredient and packaging suppliers in the need for a recall of the product. It also deals with labelling issues to ensure there are correct ingredient and nutritional information as well (Potter et al, 1995).

Food safety:

Food safety is a major focus of food microbiology, pathogenic bacteria, viruses and toxins produced by microorganisms are all possible contaminants of food. However, microorganisms and their products can also be used to combat these pathogenic microbes. Probiotic bacteria, including those which produce bacteriocins can kill and inhibit pathogens. Alternatively, purified bacteriocins such as nisin can be added directly to food products. Finally, bacteriophage, viruses which only infect bacteria, can be used to kill bacterial pathogens. Thorough preparation of food, including proper cooking will kill most bacteria and viruses. However, toxins produced by contaminants may not be heat-labile, and some will not be eliminated by cooking (Shiklomanov, 2000)

Control of Microorganisms:

Control of microorganisms is needed to prevent the spread of diseases and infections, spoilage of foodstuffs and contamination of foods. The most common ways of killing microorganisms are by heat and by chemicals. Other less common means include, irradiation, ultrasonic sound and very high pressure. Some bacteria, and almost all virus, yeast and mould cells are killed by a temperature of 60 °C for 10 to 20 minutes. Yeast and mould spores, and most other bacteria are destroyed at temperatures between 70-
100°C for 5 to 10 minutes exposure. Bacterial spores however, are very difficult to destroy. Some for example, need at least 10 minutes at 100 to 120°C (Andrews, 1992).

**Food Quality control:**

The general purpose of quality control is to ensure that a maximum amount of the product being processed reaches the desired level of quality with minimum variation and that is, achieved as economically as possible. The products of natural raw materials are never exactly the same, so control is necessary to keep product quality within the standards set. Raw materials should be purchased from reliable suppliers who hold a current food manufacturer's registration (Andrews, 1992).

**Quality control generally involves inspections of three kinds:**

- Raw materials.
- Materials in process.
- Finished product.

If effective raw material and process controls are not put in place and only examination of the finished product is done, then quality control stops being a control and becomes merely an inspection. A good control system rejects substandard ingredients before the process begins and once it has begun, prevents wastage of good raw material (Andrews, 1992).

Food can be protected from causing diseases by the following preservation methods and handling practices:

- Canning
- Proper preparation
- Good marketing
- Good storage
- Prevent contamination
- Stop the growth of food poisoning causing organisms.
Fermented food:-

Fermentation typically refers to the conversion of sugar to alcohol using yeast under anaerobic conditions. A more general definition of fermentation is the chemical conversion of carbohydrates into alcohols or acids. When fermentation stops prior to complete conversion of sugar to alcohol, a stuck fermentation is said to have occurred. The science of fermentation is known as zymology.

Fermentation usually implies that the action of the microorganisms is desirable, and the process is used to produce wine, beer, hard cider, and vinegar. Fermentation is also employed in preservation to create lactic acid in sour foods such as pickled cucumbers, kimchi and yogurt.

The primary benefit of fermentation is the conversion of sugars and other carbohydrates, e.g., converting carbohydrates into carbon dioxide to leaven bread, and sugars in vegetables into preservative organic acids (Steinkraus, 1995).

Food fermentation main purposes:

1. Enrichment of the diet through development of a diversity of flavours, aromas, and textures in food substrates.
2. Preservation of substantial amounts of food through lactic acid, alcohol, acetic acid and alkaline fermentations.
3. Biological enrichment of food substrates with protein, essential amino acids, essential fatty acids, and vitamins.
4. Detoxification during food-fermentation processing.
5. A decrease in cooking times and fuel requirements.
6. Fermentation has some uses exclusive to foods, and can produce important nutrients or eliminate antinutrients. Food can be preserved by fermentation, since fermentation uses up food energy and can make conditions unsuitable for
undesirable microorganisms. For example, in pickling the acid produced by the dominant bacteria inhibit the growth of all other microorganisms. Depending on the type of fermentation, some products (e.g., fusel alcohol) can be harmful to people's health (Steinkraus, 1995).

**Classification of fermented food:-**

Fermented food can be classified in a number of ways:

1. Alcoholic beverages fermented by yeast,
2. Vinegars fermented with Acetobacter,
3. Milks fermented with Lactobacilli,
4. Pickles fermented with Lactobacilli,
5. Fish or meat fermented with Lactobacilli, and
6. Plant proteins fermented with moulds with or without Lactobacilli and yeasts (Dirar, 1993).
7. Grains dough fermented by Lactic acid bacteria and yeasts.

**Nutritional value of fermented foods**

Significant increase in the soluble fraction of a food is observed during fermentation. The quantity as well as quality of the food proteins as expressed by biological value, and often the content of water soluble vitamins is generally increased, while the antinutritional factors show a decline during fermentation (Paredes-López & Harry, 1988). Fermentation results in a lower proportion of dry matter in the food and the concentrations of vitamins, minerals and protein appear to increase when measured on a dry weight basis (Adams, 1990). Single as well as mixed culture fermentation of pearl millet flour with yeast and lactobacilli significantly increased the total amount of soluble sugars, reducing and non-reducing sugar content, with a simultaneous decrease in its starch content (Khetarpaul & Chauhan, 1990).
**Food safety aspects of fermented foods**

Foods prepared under unhygienic conditions and frequently heavily contaminated with pathogenic organisms play a major role in child mortality through a combination of diarrhoea diseases, nutrient malabsorption, and malnutrition. All food items contain microorganisms of different types and in different amounts. Which microorganisms that will dominate depends on several factors, and sometimes microorganisms initially present in very low numbers in the food, for example lactic acid bacteria (LAB), will outnumber the other organisms inhibiting their growth. In contrast to fermented meat, fish, dairy and cereal products, fermented vegetables have not been recorded as a significant source of microbial food poisoning (Fleming & McFeeters, 1981).

**Um-Jinger:**

Um-Jinger is a food product virtually confined to the region of Darfur and Kordofan and to date seems to be made from pearl millet only. There appears to be not technical reason why it cannot be made from sorghum; it is possible that the technology has not been transferred to sorghum – producing areas of the country. The usefulness and attractiveness of this food should have been enough incentive to justify it is wide spread production in the country. The starting material is whole millet grain, half of which is malted, sun chide and reduced to fine flour, and the other half is turned in to flour using a modern mill and fermented, or sour Ajin (thin dough) is produced in the standard way using the Murhaka (stone mill) (Dirar, 1993).
Chapter Three
Chapter Three

Materials and Methods

Samples collection:

Sixty samples of Um-Jinger were randomly collected from women vendors with diverse sanitation levels in Khartoum markets. Sampling was performed weekly over a period of three months from 21 May to 5 September 2007. The samples were collected in sterile icebox and transported to the laboratory within two hours, where they were analyzed.

Methods used:

1. Observations.
2. Microbiological Analysis.

Observations:

These include

- Observing the personal hygiene of women vendors.
- Observing sanitary and cleanliness condition of the materials & utensils used for Um-Jinger storage, handling and serving.

Equipments & Materials used in Microbiological Analysis of samples:

1. Autoclave. YXQ. SG41. 280
2. Colony counter. STUART SCIENTIFIC. CO.Ltd UK
3. Drying oven. Memmerl 854 Schwabach – W GERMANY
5. Incubator, 37º C. J.E GERBER & CO.ZURICH (Suisse).
6. Loops, racks, markers, filter papers, cotton and soap.
7. pH meter. ORION Research Incorporated
8. Sensitive balance. *GERMANY–NO 3303079*

9. volumetric flasks, test tubes, Petri dishes (glass and plastic), slices, Durham’s tubes, Sterile pipettes (10ml, 1ml, 0.1ml), sterile bottles for samples handling.

10. Water bath *FUNkE–DR-N--GERBER–GMBH*

**Culture Media and Reagents:**

1. Glucose phosphate peptone water
2. Kliger iron agar. (*S.d. fine-chemistry Ltd Mumbai*)
3. MacConkey's agar. (*Biomark laboratories, Pune, India*)
4. MacConkey's Broth media (*S.d. fine-chemistry Ltd Mumbai*)
5. Mannitol salt agar (*S.d. fine-chemistry Ltd Mumbai*)
7. Nutrient agar media (*Lab M Ltd Topley house, UK*)
10. Peptone water. *Biomark laboratories, Pune, India*
11. Plate count agar (APC). (*Biomark laboratories, Pune, India*)
12. Simons citrate agar. (*Micro Master Laboratories PUT Ltd*)

**Reagents**

1. Bromothymol blue indicator,
2. Catalase test reagent,
3. Coagulase plasma,
4. Gram stain reagents,
5. Kovac’s reagent,
6. Lactose broth, xylose, glucose, maltose, mannitol sugars.
7. Methyl red indicator,
8. Sterile distilled water.

Cleaning and sterilization of glassware, lab ware and Culture Media

Washing and cleaning of glassware was an important step during the practical work, which was done for glass Petri dishes, test tubes, and media bottles (flasks) pipettes and samples bottles. This was done by tap water and soup solution followed by sterilization of test tubes, Petri dishes, flasks and graduated pipettes by hot air oven at 160°C for one hour. On the other hand Culture media and solutions were sterilized in an autoclave at 15 pounds per inch pressure for 15 minutes at 121°C. Finely, other equipments such as loops, slices were sterilized by direct flame (benzene flame). Disinfection of laboratory benches and surfaces and certain equipments was performed by 70% ethyl alcohol solution. Hands were washed regularly with soap and disinfected during work.

Culture media:

Glucose phosphate peptone water:

This was a fluid medium used for the methyl red test. Prepared according to Cheesbrough (1999), contained peptone 0.5g, glucose 0.5g, di-potassium hydrogen phosphate 0.5g, dissolved in 100 ml distilled water and sterilized by steaming, the pH adjusted to 7.5 and sterilized by autoclaving to 15Ibs for 15 minutes at 121°C.

Kliger’s iron agar.

This medium was prepared according to instructed by the manufacturer(S .d . fine-chemistry L td-Mumbai )contained Lab-lemco powder 3.0 mg, yeast extract 3.0g, peptone 20.0 mg, sodium chloride 5.0 mg, lactose 10.0g, glucose 1.0 mg, ferric citrate 0.3 mg, sodium thiosulphate 0.3 mg, phenol red 0.05, agar 12.0 mg. The medium was used at a concentration of 5.5g in every 100ml distilled water, dispensed in 6ml
amounts in large size tubes, sterilized by autoclaving for 15 minutes at 121°C, then solidified in a sloped position.

**MacConkey's agar.**

The dehydrated form (*Biomark laboratories, Pune, India*) consisted of peptic digest of animal tissue 20.0, lactose 10.0, bile salts 5.0, sodium chloride 5.0, neutral red 0.075; agar. The medium was prepared according to the manufacture's instruction by dissolving 51.55 gms of powder in one litre of distilled water, boiled to dissolve the medium completely, and then sterilized by autoclaving for 15 minutes at 121°C.

**MacConkey's Broth media (MPN):**

To dehydrated form (*S.d. fine-chemistry Ltd-Mumbai*) consisted of peptone 20.0, lactose 10.0, bile salts 5.0, sodium chloride 5.0, neutral red 0.075. The medium was prepared according to the manufacture's instruction by dissolving 37.0g of powder in one litre of distilled water, boiled to dissolve the medium completely and the pH adjusted to 7.3-0.2, then sterilized by autoclaving for 15 minutes at 121°C and stored in a refrigerator.

**Mannitol salt agar:**

This medium was prepared from peptone water 3.7g, sodium chloride 17.5g, phenol red 0.006g, agar agar 3.7g, D-mannitol 2.5g. The ingredients dissolved in 250 ml distilled water, heating to homogenous the medium completely, then sterilized by autoclaving for 15 minutes at 121°C (Cheesbrough, 1999).

**MR – medium:**

The medium was prepared according to Cheesbrough (1999) containing buffered peptone 0.5 g, di-potassium di-hydrogen phosphate 0.5g and bacto-dextrose, dissolving in one litre of distilled water and sterilized by autoclaving 15 minutes at 121°C.

**Nutrient agar medium.**
This medium was obtained in dehydrated form Lab M Ltd Topley house, U K, (which contained heart infusion tryptose, sodium chloride and agar. It was prepared according to manufacture's instructions by dissolving 40gm at the medium into one litre of distilled water. It was dispensed into 250 ml amounts in bottle and sterilized by autoclaving for 15 minutes at 121°C. It was used for slants preparation and subculture of isolates.

**Oxidation – Fermentation media (O-F media):**

This medium was used to differentiate organisms that attack carbohydrates oxidatively, and those utilize carbohydrates fermentatively using paraffin oil as oxygen barrier. The medium was prepared according to Cheesbrough (1999), containing peptone water 1gm, sodium chloride 2.5gm, agar powder 1.2gm, bromothemol blue 1.5gm, di-potassium hydrogen phosphate 0.15gm, dissolving in 500 ml of distilled water, pH was adjusted to 7.1. Sterilized by autoclaving for 15 minutes at 121°C.

**Sugars preparation :-**

This medium was prepared according to Cheesbrough (1999), contained 0.62g from each sugar (Lactose broth, xylose, glucose, maltose, mannitol sugars), dissolving in 6.25ml distilled water in screw cap bottle, sterilized by steaming for 10 minutes.

**Peptone water .**

This medium was prepared according to Cheesbrough (1999) by dissolving 10gm peptone (Biomark laboratories, Pune, India) and 5gm sodium chloride in one litre of distilled water. The pH of medium was adjusted to 7.2-7.3, The medium sterilized by autoclaving for 15 minutes at 121°C.

**Simmons citrate agar :**

This medium was prepared according to instructed by the manufacturer (Micro Master Laboratories PUT Ltd) it contained magnesium sulphate 0.2g, ammonium di-hydrogen phosphate 1.0g, di-potassium hydrogen phosphate 1.0g, sodium citrate 2.0g, sodium chloride 5.0g, bromothymol blue 0.08g, agar 15.0g, dissolved 21.3g of media in one
liter distilled water, heated to boiling to dissolve completely and distributed into tubes
3ml, sterilized by autoclaving to 15lbs for 15 minutes at 121°C, then, solidified in a
sloped position.

**Plate count agar (APC):**

This dehydrated medium (*Biomark laboratories, Pune, India*), contains mainly
enzymic digested casein. 23.5gms of powder were suspended in one litre of distilled
water, boiled to dissolve the powder completely, and then sterilized by autoclaving for
15 minutes at 121°C.

**Motility medium:**

(0.4%) agar was dissolved in nutrient broth and distributed in sterile test tubes and
slipping the media, then the media autoclaved at 121°C for 15 minutes.

**Reagents**

1. **Bromothymol blue:**

   It was used as a liquid form at 0.04% concentration and pH of 6.0 to 7.6

2. **Catalase test reagent (H₂O₂)**

   H₂O₂ (B.D.H) used as 3% aqueous solution for the test.

3. **Kovac’s reagent:**

   The reagent contained 2 gms di-methylaminobenzaldehyde, 30 mls Isoamylalcohol
   and 10 mls concentrated HCl. It was prepared according to Cheesbrough (1999), by
dissolving the aldehyde in the alcohol by heating in the water bath about 50-55°C. It was
then cooled and HCL was added. The reagent was protected from light and stored at 4°C
till used.
4. **Methyl red indicator**:  

Methyl red indicator was prepared according to Cheesbrough (1999), 0.05gms of methyl red were weighted and dissolved in 28 mls absolute ethanol and 22 mls distilled water then transferred to a clean brown bottle and stored in a dark place.

**Microbiological Analysis of samples:**  

All samples (n=60) were prepared and microbiologically analyzed according to the standard techniques recommended, the collected samples were analyzed for viable count (APC), coliform count, MacConkey’s agar count, Mannitol Salt Agar count (coagulase positive). Biochemical tests to differentiate between isolates were performed.

**Aerobic Plate Count (APC):**  

APCs were determined using plate count agar. Plates were incubated at 37 °C for 24-48 hr. 1 ml from each sample homogenate was added to 9 ml peptone water tube and the process was repeated to make serial dilutions (from $10^{-1}$ to $10^{-6}$). Then 0.1 ml was taken from each of $10^{-4}$ and $10^{-6}$ dilution and plated on the surfaces of media in duplicate. The APCs reflects the aerobic content of samples.

**Coliform count:**  

10 ml, 1 ml, 0.1 ml, of different dilution of each sample were inoculated in nine tubes (three tubes for each). Each tube contained 9 ml of MacConkey's Broth with inverted Durham’s tubes. Those tubes to which were added 9 ml portions of samples contained double strength medium., the tubes were incubated at 37°C for 24-48 hr. Then the tubes were observed for acid and gas production, and coliform counts were calculated from MPN tables (Cochran, 1950).
MacConkey’s agar Count:
From each samples of previously prepared serial dilution (10^-2 and 10^-3) 0.1 ml was transferred into sterile Petri dishes contained 15 ml of MacConkey’s agar medium (using surface plate count) and incubated at 37ºC for 24hr. Then, purple colonies were observed and counted with colony counter.

Mannitol Salt Agar Count:
Mannitol salt agar medium was used, 0.1 ml of the previously prepared serial dilution (10^-2 and 10^-3) was taken from each sample and transferred to the sterile medium (using surface plate count), incubated at 37ºC for 24 hr, yellow and orange colonies were enumerated and further tested by coagulase test.

pH Measurement:
pH of all samples were measured by pH meter.

Examination of morphological features of isolates:
After they were cultured, all colonies grown in above media were examined with naked eye for; growth, colonial morphology and any changes in medium (Elseddek, 2002).

Microscopic Investigation (Gram’s stain):
Staining was used for observing the structural details and to differentiate between bacteria genera (Gram positive or negative).
- smear was made on the sterile slide, dried and fixed by heat;
- reagents used; Crystal violet was applied for one minute, washed;
- flooded with iodine for one minute then washed;
- decolorized by alcohol for few seconds and rinsed with water;
- Flooded with safranine for one minute, washed and air dried, then examined under the microscope oil immersed lens (Cheesbrough 1999).

**Biochemical methods used for identification of isolated bacteria:**

All biochemical tests were performed according to Cheesbrough (1999), they included:

**Indole test:**

Testing for indole production is important in the identification of enterobacteria, most strain such as *Escherichia coli* break down the amino acid triptophan with the release of indole.

**Requirements:**

1- Peptone water medium 5g, sodium chloride 1.25g, distilled water
2- Kovac's reagent.

**Method:**

1- Four ml of sterile peptone water were transferred into test tube;
2- The organism was removed by using a sterile loop and inoculated in the test tube;
3- Incubated at 37ºC for 24 hr (overnight).
4- Examined for indole production by adding 1 ml of Kovac's reagent to the culture.
5- A positive reaction was indicated by the red colour in the reagent layer (red circle).

**Methyl red test (MR):**

This test was used to assist in the differentiation of enterobacteria.

**Requirements:**

- (Glucose 0.5, peptone 0.5, distilled water 100ml, di-potassium hydrogen phosphate 0.5 (glucose phosphate peptone water).
- Methyl red solution.

**Method:**
- Two ml of sterile glucose phosphate peptone water were transferred into test tube and inoculated with the test organism using a sterile loop; incubated at 37°C for 24 hr.
- After overnight incubation, a drop of methyl red was added, the tube was shaken;
- A red colour indicated positive reaction, orange colour indicated a positive or negative reaction, yellow colour indicated a negative reaction.

**Citrate utilization:**

This test was used to differentiate between Enterobacteriace that utilize citrate as a sole source of Carbon.

**Requirements:**
- Simmon's citrate media (slant position) 2g.
- Distilled water 100 ml.

**Method:**
- Transferred 3 ml of sterile Simmon's medium into test tube and with a sterile straight wire inoculated the test organism;
- Incubated at 37°C for up to 4 days (the growth had been checked daily).
- Blue colour indicated positive reaction, while negative reaction was green.

**Catalase test:**

This test was used to differentiate those bacteria that produce the enzyme catalase such as staphylococci – from non – catalase producing bacteria.

- **Requirements:** Hydrogen peroxide (H₂O₂) reagent 3%.
- **Method:**
- 2 ml of H₂O₂ solution was taken in a test tube.
- The test organism was removed using a sterile wooden stick and immersed into the hydrogen peroxide solution.
- Positive result production of gas bubbles, negative no gas bubbles.

**Oxidase test:**

This test was used to assist in the indication of Pseudomonas and all organisms produce oxidase enzymes.

- **Requirements:**
  - Kovac's reagent.
  - Filter paper; Petri dish.
  - A piece of filter paper was placed on a clean Petri dish and 2 drops of Kovac's reagent were added.
  - A colony of the test organism was removed with a stick and smeared on the filter paper.
  - A positive reaction was indicated by formation of dark purple color within 10 seconds.

**Coagulase test:**

This test was used to identify *Staphylococcus aureus*, and differentiate between it and other staphylococci, which doesn't produce coagulase.

**Requirements:**

- Undiluted plasma.
- Slide, distilled water, sterile applicator stick.

**Method:**
A drop of distilled water was placed on a slide.
- A colony was emulsified in the drop to make a thick suspension.
- A drop of plasma was added to the suspension and gently mixed.
- A positive reaction was indicated by coagulant plasma.

**Oxidation – Fermentation Test:**

Test to differentiate between aerobic and anaerobic breakdown carbohydrate.

**Requirements:**

- O-F media, bromothymol blue solution, paraffin oil.
- Glucose 10g, distilled water, tubes.
- Weighted ingredients of the medium was dissolved with 500ml of distilled water then the pH was measured (7.1) before adding the indicator (bromothymol blue).
- The medium was sterilized by autoclaving for 15 minutes at 121°C.
- 10 gms of glucose was dissolved in 100ml distilled water and sterilized by steaming in an autoclave for 10 minutes.
- The carbohydrate added to the sterile medium, then transferred into sterile test tubes about 5ml (2 tubes were used for each test).
- Duplicate tubes of medium were inoculated by test organism (used sterile straight wire).
- One tube was covered with a layer of sterile paraffin oil to a depth of 10mm and both incubated at 37°C for 14 days.
- Fermenting organisms produced acid reaction throughout the medium in both covered and opened tube, while the oxidizing organisms produced acid reaction only in the opened tube.
- On the other hand, organisms that can not breakdown the carbohydrate show no changes in the medium.

**Fermentation of sugars:**
Requirements:
- Peptone water media 3.75gms , distilled water 500 mls
- Carbohydrate media ( lactose broth , xylose , glucose , maltose , mannitol ).
- Bromothymol blue solution . (adjust the pH 7.2-7.3 )
- Durham’s tubes .
- Test tubes .

Method:
- 3.75g m of peptone were dissolved in 250 ml of distilled water , then 3.12ml of bromothymol blue solution (adjust the pH 7.2-7.3 ) were , added
- Then transferred into test tubes contained Durham’s tubes (inverted) , and sterilized by autoclaving for 15 minuets at 121°C .
- Sugars were prepared by dissolved 0.62gms from each sugar into 6.25 ml of distilled water ( in screw cap bottle ) sterilized by autoclaving (steaming) for 10 minutes ;
- Each sugar were added to each sterilized medium , All tubes were inoculated with cultures from surface of the culture media and incubated at 37°C for 24 – 48 hours.
- Positive reaction indicated by changing color to yellow and gas production ( showed in Durham’s tube )

Motility test:

Requirements:
- Semi solid media .( 0.4% of agar mixed with 3.25g nutrient broth powder )
- Tubes
- 250 mls distilled water.

Method:
- An isolate was inoculated it by stabbing tube containing semi solid media (about half the depth) using straight wire , then incubated at 37°C for 24 hours.
- A motile bacterium showed diffuse and hazy growth spread throughout the medium.
Chapter Four
Chapter Four

Results

Um-Jinger sales zones are located between markets, residential areas and industrial areas and near bus stations; these places are crowded and unclean. The Sanitary level in the sale places were not good; they were dirty places in which food remains, waste water, solid wastes and flies are recognized (figure 1).

Observation of women vendors revealed that they use plastic buckets and utensils for carrying and distribution of Um-Jinger. Aluminum bowls were used for serving Um-Jinger meals; vendors used no cooling facilities (figure 2).

Each vendor uses single bucket contains unchanged water to wash serving bowls and spoons. The bucket water became contaminated after the first wash turn, but vendors continue using it for washing bowls and spoons during serving meals. The personal hygiene of women vendors was poor and no cleaning facilities were present (figure 3).

The results of bacteriological analysis of Um-Jinger samples demonstrate population of aerobic plate count ranging from $3 \times 10^4$ to $3.5 \times 10^7$ cfu per ml of sample. Whereas the total coliform count are ranging from 3 to 1400 MPN per ml. The MacConkey's agar count ranged form $2 \times 10^2$ to $2.7 \times 10^3$ and Mannitol salt agar count ranged from $2 \times 10^2$ to $1.6 \times 10^4$ (tables 1 and 2).

Samples of Um-Jinger show high incidence of Staphylococcus aureus, Bacillus spp. in addition, to Enterobacteriace. The percentage of Staphylococcus aureus was 68.3% whereas, the Bacillus spp. form 70% and Enterobacteriace form 43% (figure 4).
The minimum pH of Um-Jinger samples is 3.4 where the highest pH is 6.7 (table 3).

Presumptive identification of *Enterobacteriaceae species* showed the presence of *Salmonella spp.*, *Escherichia spp.*, *Proteus spp.*, *Pseudomonas spp.*, *Klebsiella spp.* and *Hafnia spp.* ranging from 3.3 to 8.3 percent (table 4).
Figure (1) Um-Jinger sale place
Figure (2) women vendors serving Um-Jinger
Figure (3) single bucket used for bowls and spoons wash.
<table>
<thead>
<tr>
<th>Samples</th>
<th>Aerobic plate count {APC}</th>
<th>Coliform count</th>
<th>MacConkey’s agar count</th>
<th>Mannitol saltagar count</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8×10⁴ to 6×10⁶</td>
<td>4</td>
<td>1.7×10³ to 9×10³</td>
<td>6×10² to 3×10³</td>
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</tr>
<tr>
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<td>1.5×1⁰⁴ to 4×1⁰³</td>
<td>2.5×1⁰³ to 1.2×1⁰⁴</td>
</tr>
<tr>
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<td>1.7×1⁰⁴ to 5×1⁰³</td>
<td>8×1⁰³ to 6×1⁰³</td>
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Figure (4) Predominant isolates from Um-Jinger samples:
Table (2)

Bacterial loads of Um-Jinger samples shown by aerobic plate count (APC), Total coliform, MacConkey's agar count and Mannitol salt agar count:

<table>
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<tr>
<th>Microorganisms</th>
<th>Minimum</th>
<th>Maximum</th>
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<tr>
<td>APCs</td>
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<td>Coliform count</td>
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<tr>
<td>MacConkey's agar count</td>
<td>$2 \times 10^2$</td>
<td>$2.7 \times 10^4$</td>
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<td>Mannitol salt agar count</td>
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Table (3) pH of Um-Jinger samples

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<td>3.4</td>
<td>1</td>
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<tr>
<td>Total</td>
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Table (4)

Incidence of Enterobacteriaceae organisms recovered from analyzed samples of Um-Jinger as presumptively identified:

<table>
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<tr>
<th>Organism</th>
<th>Number(samples)</th>
<th>Percentage</th>
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<tr>
<td><em>Proteus spp.</em></td>
<td>5</td>
<td>8.3</td>
</tr>
<tr>
<td><em>Klebseilla spp.</em></td>
<td>5</td>
<td>8.3</td>
</tr>
<tr>
<td><em>Hafnia spp.</em></td>
<td>5</td>
<td>8.3</td>
</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>4</td>
<td>6.6</td>
</tr>
<tr>
<td><em>Salmonella spp.</em></td>
<td>3</td>
<td>4.9</td>
</tr>
<tr>
<td><em>Escherichia spp.</em></td>
<td>2</td>
<td>3.3</td>
</tr>
<tr>
<td><em>Pseudomonas spp.</em></td>
<td>2</td>
<td>3.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>26</strong></td>
<td><strong>43%</strong></td>
</tr>
</tbody>
</table>
Figure (5) Incidence of Enterobacteriaceae organisms recovered from analyzed samples of Um-Jinger:
Chapter Five
Chapter Five

Discussion

This study was carried in Khartoum markets to focus on hygiene and microbiological quality of the fermented nutritious food Um-Jinger served at industrial area.

Many workers in industrial area workshops depend on this high carbohydrate enriched food to provide energy for their long working hours in a price they can afford.

Um-Jinger is mainly prepared from millet (after grind), sugar, yogurt, lemon, little salt, and sometime tahnia sweet are added. Millet is cooked in hot pot, after that, other constituents are added uncooked. It was recognized from this study that some vendors change the formula by omitting yogurt from the ingredients and replace it with citric acid to add the bitter taste. Potter et al (1995) confirmed the good quality characteristics of food that is acceptable to consumers. Um-Jinger is prepared according to consumers acceptability.

Um-Jinger prepared and served in poor hygiene conditions; The study confirmed that the sanitary level in the sale places are deteriorated, leading to the occurrence of severe public health hazards (Hobbs et al, 1979). As clarified in the study; women vendors lack good personal hygiene which is vital in reducing the chance of contamination of foods. This is in agreement with the findings of Strachan (2000). Personal hygiene reduces risks of health hazards. The study indicated that the sale zones are centred in crowded areas of markets and near hotels, residential premises, industrial zones and crowded traffic stations.

The utensils used for preparation and serving are made of reusable low quality plastic and aluminum that are difficult to be clean, washing of these utensils are not carried properly because they are washed in a single bucket with unchanged water. This
method of washing utensils act as a source of contamination by pathogenic bacteria and viruses from person to person as the water became contaminated from the first wash turn and the water is getting dirtier after each washing turn. Therefore, proper cleanliness has significant role in minimizing health hazards associated with this type of food. This fact agreed with that stated by Jay (2000) ‘the Cleanliness has play basic role in the application of hygienic practices. Also Hobbs 1993 declared that cross contamination causes health hazards.

It is not surprising in such poor hygiene and handling situation to isolate \textit{Staphylococcus spp} from the majority of samples. The soil bacteria \textit{Bacillus spp} indicate clearly the effect of crowding and forming dust as these organisms are widely distributed in nature (human, animals, soil, water and food) (Omer, 1990).

Enterobacteria isolated and high MPN prove clearly that such poor hygiene meals can be sources of typhoid, dysentery or cholera for example.
Chapter Six
Chapter Six

Conclusion

In spite of the high nutritional value of Um-Jinger and increasing of it’s consumption, the microbiological examination of samples collected from women vendors, confirm that Um-Jinger contains both indicator and pathogenic bacteria, the presence of this bacteria makes it a potential health threat to consumers. Therefore, the educational programs and personal hygiene to women vendors may reduce the risks associated with poor preparation or storage procedures.

It’s also important to remember that the hygiene of the premises is regarded as extremely important and this is probably one of the important factors in insuring a safe product at the end of the day.
Recommendations

1. More work should be carried on the traditional food Um-jinger.
2. Inspection and control on the preparation of Um-jinger ingredients and avoiding the use of chemicals like citric acid as substitute for yogurt.
3. Formulation and establishing standards to this type of food.
4. Organizing um-jinger vendors in stable stalls supplied with tap water, cooling facilities and sanitation improving tools is vital.
5. Hygiene training of vendors is very important.
6. Licensing of women vendors after Medical examination is important.
7. Encouraging consumption of hygienically prepared foods among consumers can be of great benefits to public health.
Chapter Seven

References:


## Appendix

**Biochemical tests for different isolates:**

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<th>Biochemical tests</th>
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* Rod single
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Biochemical tests results for gram positive rod : *Bacillus*

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<th><em>B mycoides</em></th>
<th><em>B firmus</em></th>
<th><em>B badius</em></th>
<th><em>B polymyxa</em></th>
<th><em>B alvei</em></th>
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## Biochemical tests results for gram negative Rod: *Enterobacteriac*

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<th><em>Proteus morganii</em></th>
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