BACTERIOLOGICAL QUALITY OF STREET -VENDED *UM-JINGIR*: A TRADITIONAL SUDANESE FOOD

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ABSTRACT

Um-Jingir is a fermented indigenous Sudanese food product made mainly from cooked grinded pearl millet to which sugar, yogurt, lemon and salt will be added upon serving. It is vended by women and widely consumed by workers in industrial areas in Khartoum State, Sudan. Sixty samples of Um-Jingir were randomly collected from vending women near industrial areas in Khartoum State over a period of three months from 21st of May to 5th of September 2007. The study was focused on determining the bacteriological quality and safety of street vended Um-Jingir. Microbial analysis resulted in aerobic plate counts from 3×10^4 to 3.5×10^7 colony forming unit (cfu)/ml, while MacConkey's agar counts ranged from 2×10^2 to 2.7×10^3 cfu/ml and mannitol salt agar growth of about 2×10^2 to 1.6×10^3 cfu/ ml. Total coliforms ranged from 3 to 1400 MPN/100 ml. *Bacillus* spp., *Staphylococcus aureus, Escherichia coli* and *Salmonella* spp. were detected in 70, 68.3, 6.6, and 5% of samples, respectively. *Pseudomonas* spp. and several Enterobacteriaceae species were isolated including *Proteus* spp., *Klebsiella* spp., *Hafnia* spp. and *Escherichia* spp. The minimum pH of Um-Jingir samples was 3.4, whereas the highest pH was 6.7. Alteration of the classic formula by omitting yoghurt and replacing it with citric acid showed that the nutritional value of Um-Jingir could be reduced to meet the low price requirements. Observation of Um-Jingir vending places showed that they were crowded, unclean and the sanitary levels were low. In spite of the high nutritional value of this product and its importance for low income consumers, the established results in addition to close observation of Um-Jingir marketing conditions indicated that consumption of street vended Um-Jingir might have negative effects on public health. Therefore, vending this type of food requires more attention from health authorities, better educational programmes for vendors and improvements of preparation and handling environment.

Key words: Um-Jingir, fermented food, street food

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INTRODUCTION

Um-Jingir is a fermented indigenous Sudanese food product made from pearl millet; it is virtually restricted to the regions of Darfur and Kordofan [1]. A great increase in its consumption by industrial zone workers outside of traditional places is because it is readily available, inexpensive and is a nutritious ready-to-eat meal.

The starting material is whole millet grain, half of which is malted, sun dried and reduced to fine flour while the other half is turned into flour using a modern mill followed by fermented [1]. The ground millet is cooked and then other constituents are added post-cooking. These ingredients include sugar, yogurt, lemon, little salt, and sometimes dry Halawa Tahineya (sweet sesame seed paste) is also added.

Fermented foods contain probiotics which are beneficial microorganisms. Probiotics list of benefits include but not limited to, improving intestinal tract health, enhancing the immune system, synthesizing and enhancing the bioavailability of nutrients, decreasing the prevalence of allergy in susceptible individuals and reducing risk of certain cancers [2]. The mechanisms by which probiotics exert their effects may depend on modifying gut pH, counteracting pathogens through production of antimicrobial compounds and competing for pathogen binding and receptor sites in host cells and available nutrients and growth factors [2].

More than 200 known diseases are transmitted through food [3]. Viruses, bacteria, parasites, toxins and chemicals could cause food borne illness. The symptoms range from mild gastroenteritis to life-threatening neurologic, hepatic and renal symptoms. The number of people suffering from food borne illness has increased dramatically over the last decade [3].

Microbiological quality investigations of street-vended foods have reported high bacterial counts and a high incidence of food borne pathogens in such foods in different countries [4].

Previous studies concerning microbiological safety of street vended foods showed high incidence of bacterial contamination. In a study carried out in Ouagadougou (Burkina Faso) the researchers who investigated hygienic status of dish washing waters, utensils, hands and money from street food processing sites reported isolation and identification of a large number of foodborne pathogens such as *Salmonella*, *Shigella*, coliforms and *Staphylococcus aureus* [5]. In another study concerned with the microbiological quality of informally vended foods in Harare, Zimbabwe, vendors' hands were unacceptably contaminated indicating poor hygienic practices. In that study, 32% of hand swabs were positive for *S. aureus*, and 6.4% positive for *Escherichia coli*. Some swabs from spoons, knives, cutting boards, and plates were also positive for *E. coli* and *S. aureus*, but with lower incidences compared to hand swabs [6]. In a study carried out in New Delhi and Patiala city, India to determine the prevalence of *S. aureus* and *Shigella* serotypes in raw coconut slices, green coriander sauce, and ready-to-eat salads sold by vendors, the enterotoxigenic *S. aureus* count was the most dominant among other pathogens investigated [7].

No information concerning the safety of this type of fermented street food is available. Reported information in this study could be used to improve handling and preparation condition of this nutritious food and protect its consumers. The aim of this study was to determine the microbiological quality and safety of the traditional Sudanese food (Um-Jingir) sold by women vendors in Khartoum State, Sudan.

MATERIALS AND METHODS

Samples collection

Sixty samples of Um-Jingir were randomly collected from women vendors in Khartoum markets. Sampling was performed weekly over a period of three months from 21st May to 5th of September 2007. The samples were collected in sterile glass containers and transported in an icebox to the laboratory of the Department of Food Hygiene and Safety at University of Khartoum within two hours, where they were analyzed.

Prior to sample collection, observation notes regarding ingredients, serving procedures and environmental health conditions of sale surrounding area were taken after permission from local environmental health office and upon the cooperation agreement of vendors.

Aerobic Plate Count (APC)

APCs were determined using plate count agar. One 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} dilutions and plated on the surfaces of agar plates in duplicate. The plates were incubated at 37˚C for 48 hr before colonies were counted.

Coliform count:

From each sample homogenate; 10 ml, 1 ml, and 0.1 ml portions were inoculated in nine tubes (three tubes for each volume), each tube contained 10 ml of MacConkey's Broth with inverted Durham's tubes. The strength of medium was doubled in the tubes that contain ten ml portions of samples. The tubes were incubated at 37ºC for 24- 48hr. Then the tubes were observed for acid and gas production. Coliform counts were calculated from MPN tables according to International Standards Organisation [8, 9].

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 and incubated at 37ºC for 24 hr. Pink colonies were then observed and counted with a colony counter.

Mannitol salt agar count:

Mannitol salt agar medium was used with 0.1 ml of the previously prepared serial dilution (10^{-2} and 10^{-3}) taken from each sample and transferred to the sterile medium,

Scholarly, Peer Reviewed
ISSN 1684 5374

Volume 11 No. 5
September 2011

Published by ASCAT

AJFAND ONLINE
African Journal of Food, Agriculture, Nutrition and Development

and incubated at 37ºC for 24 hr. Yellow and orange colonies surrounded by yellow zones due to mannitol fermentation were enumerated and further tested by coagulase test after overnight sub-culturing in nutrient agar plates.

pH Measurement

pH of all samples were measured by pH meter (Hanna Instruments Ltd, Italy) at 25 ±2 °C.

Examination of morphological features of isolates:

Microscopic investigation of morphological features of isolates using Gram's stain was performed to each colony using standard methods.

Biochemical methods used for identification of isolated bacteria:

All biochemical tests were performed according to Cheesbrough [10]. They included: Indole test, methyl red test (MR), citrate utilization, catalase test, oxidase test, coagulase test, oxidation – fermentation test, fermentation of sugars, and motility test.

RESULTS

Um-Jingir sale zones are located mainly in industrial areas and their nearby bus stations, markets and residential areas. All these places were crowded and unclean. The sanitary levels in the sale places were low; food remains, wastewater, solid wastes and flies were evident (Figure 1).

Observation of women vendors revealed that they used plastic buckets and utensils for carrying and distributing Um-Jingir meals. Aluminium bowls were used for serving Um- Jingir meals.

For washing serving bowls and spoons, each vendor used a single bucket containing water. The bucket water became dirty just after the first wash turn, but vendors continued using it for washing bowls and spoons during serving meals. The personal hygiene of women vendors was poor and no other cleaning facilities were present. In addition to unsafe handling practices no food preservation or cooling facilities were present (figure 2).

The results of bacteriological analysis of Um-Jingir samples demonstrated that population of aerobic plate count ranged from 3×10^4 to 3.5×10^7 cfu per ml of sample. Whereas the total coliform count were ranging from 3 to 1400 MPN per 100 ml. The MacConkey's agar count ranged from 2×10^2 to 2.7×10^4, and mannitol salt agar count ranged from 2×10^2 to 1.6×10^4 per ml (Table 1).

Samples of Um-Jingir showed high incidence of *S. aureus* and *Bacillus* spp., in addition to Enterobacteriaceae. The percentage of samples from which *S. aureus* was isolated was 68.3%, whereas the *Bacillus* spp. was isolated from 70% of samples and *Enterobacteriace* from 43% of samples.

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The minimum pH of Um-Jingir samples was 3.4, and the highest pH was 6.7. Presumptive identification of Enterobacteriace species showed the presence of *Salmonella* spp., *Escherichia* spp., *Proteus* spp., *Klebsiella* spp., and *Hafnia* spp. ranging from 3.3 to 8.3 percent of total samples. *Pseudomonas* spp. was isolated from 3.3% of samples (Table 2).

Figure 1: Um-Jingir sale site

Figure 2: Preparation and serving of Um-Jingir meal by a vendor

DISCUSSION

Street vended foods are important source of nutrients to low income populations group in developing countries. This emphasizes the necessity of organizing this sector to improve its low hygienic and hazardous situations.

Many workers in workshops in Khartoum, Sudan depend on the high carbohydrate enriched Um-Jingir food to provide energy for their long working hours at an affordable price. Um-Jingir is mainly prepared from millet flour, sugar, yogurt, lemon and salt. However, it was recognized from this study that some vendors changed the formula by omitting yogurt from the ingredients and replaced it with citric acid to add the sour taste.

Um-Jingir was prepared and served in poor hygiene conditions and this study confirmed deteriorated sanitary level in the sale environment, which constitutes severe public health hazards as has been reported previously [11]. As observed in this study, women vendors lacked good personal hygiene, which was vital in reducing the chance of contamination of foods. The study indicated that the sale environments were centred in crowded areas of industrial zones and crowded traffic stations. In spite of the economic benefits gained by women vendors in selling their food products, such unhygienic environments significantly increased the chances of contamination and disease transmission. Intense traffic in the sale environment increased dust formation which constitutes a major source of enterotoxigenic *Bacillus*

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cereus. The APCs reflects the microbial content and sanitary conditions during preparation and storage. The soil bacteria *Bacillus* spp. indicated clearly the effect of crowding and environmental dust, as these soil bacteria are widely distributed in nature (human, animals, soil, water and food).

It is not surprising that in such a poor hygiene and handling situation, *Staphylococcus* spp. was isolated from majority of the samples.

The utensils used for preparation and serving were made of low quality plastic and aluminium that were difficult to clean. Washing of these utensils were not carried out properly because they were washed in a single bucket with unchanged water. This method of washing utensils acts as a source of contamination by pathogenic bacteria and viruses from person to person, as the water became dirtier with repeated use. The lack of proper utensils may be because women vendors belonged to the most economically fragile community sector, and could not afford purchase of high quality utensils.

Implementing proper cleanliness procedures through basic training in food hygiene would have significant role in minimizing health hazards associated with this type of food product. However, without an organized street-vended food sector, basic food hygiene training will be difficult to implement.

The isolation of *Enterobacteriaceae* species and the high MPN prove clearly that such poor hygiene meals could be sources of typhoid, dysentery or cholera as previously stated [12, 13].

Low pH can slow or stop multiplication of microorganisms [14]. However, low pH does not reduce the high load of bacterial contaminants to a degree that make it safe. The absence of a stable formula for preparing Um-Jingir could result in unstable pH and nutritional value.

Alteration of the classic formula, for example, by omitting yoghurt and replacing it with citric acid showed that nutritional value of street foods could be reduced in order to meet the low price requirements. This also showed that the chances of food adulteration could increase significantly.

To minimize health risks associated with this type of food, it is important to organize Um-Jingir vendors in officially allocated stalls that are supplied with clean water facilities, cooling and sanitation facilities in addition to providing vendors with basic food hygiene training.

ACKNOWLEDGMENTS

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Table 1: Bacteriological analysis results of Um-Jingir samples

Microorganisms	Minimum (cfu)	Maximum (cfu)
APCs	3×10^4/ml	3.5×10^7/ml
Coliform count	3/100ml	1400/100ml
MacConkey's agar count	2×10^2/ml	2.7×10^4/ml
Mannitol salt agar count	2×10^2/ml	1.6×10^4/ml

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Table 2: Incidence of Enterobacteriaceae and pseudomonad organisms recovered from analyzed samples of Um-Jingir as presumptively identified

Organism	Number of samples	Percentage
Proteus spp.	5	8.3
Klebsiella spp.	5	8.3
Hafnia spp.	5	8.3
Escherichia coli	4	6.7
Salmonella spp.	3	5
Escherichia spp.	2	3.3
Pseudomonas spp.	2	3.3
Total	26	43.3%

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