The Microbiological Assessment of Ready-To-Eat-Food (Shawarma) In Port Harcourt City, Nigeria

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ABSTRACT: The study was carried out to analyze the microbial quality of shawarma purchased in Port Harcourt city. Twelve (12) Shawarma samples were randomly sampled from (3) local eateries and four (4) home prepared samples were analyzed for the presence of microorganism using appropriate selective media. Inoculations were done using the spread plate technique. The total viable count (TVC) of bacterial population in all shawarma samples were in the range of $2.0x10^3$ to $1.8x10^6$cfu/g. Generally, the vegetables recorded the highest ($1.8x10^6$) number of bacterial growth especially in Elelenwo. Also, when all elements where combined, Elelenwo still had the highest total viable bacterial count ($1.1x10^6$). The total coliform count ranged from $1.9x10^3$ to $9.4x10^5$, with Elelenwo having the highest count. The range for staphylococci count was $1.9x10^3$ to $5.3x10^3$, with Choba recording the highest. The home made sample which was used as a control had significantly smaller total viable count of aerobic bacteria. Some fungal species was isolated from the dough and vegetables and this includes; *Rhizopus stolonifer* and *Aspergillus niger* and the total fungal count ranged from $2.0x10^4$ to $8.1x10^4$, with Government Residential Area (GRA) having the highest count. The TVC for aerobic mesophillic bacteria for all 3 locations and the home made samples were $1.1x10^6$cfu/g, $8.0x10^5$cfu/g, $9.0x10^5$cfu/g and $4.2x10^3$cfu/g respectively, with Elelenwo and GRA having the highest TVC, while the total viable bacterial count for both Choba and home-made samples were the lowest ($8.0x10^5$ and $4.2x10^3$). It showed that bacterial isolates were most predominant (84.6%) compared to the fungi isolates (15.4%). The frequency of occurrences of the eight genera of pathogenic bacteria isolated from all shawarma samples showed that *Proteus* spp. (22.7%) was the most predominant. This was followed by *Escherichia coli* (13.6%), *Bacillus* spp. (13.6%) and *Staphylococcus aureus* (13.6%). *Enterobacter aerogens* (9.1%), *Klebsiella* spp. (9.1%), *Serratia marcescens* (9.1%), and *Micrococcus* spp. (9.1%) were least predominant. The study showed that the home made samples, which were prepared in the right sanitary condition, showed that contamination may be as a result of poor manufacturing practices employed by the food vendors. This is of public health concern as these organisms are known causes of food-borne diseases and food intoxications.
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1. INTRODUCTION

Different terms can be used to describe ready- to- eat foods. These include convenient, ready, instant and fast foods. An example of such ready to eat food includes; pastries, meat pie, sausage rolls, burger, doughnut, shawarma, salads or coleslaw, milk and milk products. Ready to eat food can be described as the status of food being ready for immediate consumption at the point of scale, it could be raw or cooked, and can be consumed without further treatment (Tsang, 2002). Street vended food can contribute to food security of those involved in its production, particularly, suppliers of raw produce, food processors, vendors and consumers (Opeolu et al., 2010). There is an increase in the consumption of ready-to-eat fast food because of a change in social patterns characterized by increased mobility, large numbers of itinerary workers and less family centered activities. Thus, good manufacturing practices of foods taken outside the home such as good sanitation or sanitary measure and proper food handling have been transferred from individuals/families to the food vendor who rarely enforces such practice (Musa and Akande, 2002).

Shawarma (pronounced SHWAR-muh) or also spelled schawarma, shwarma, shuarma, shawema, siaorma is a Middle Eastern Arabic style sandwich usually composed of shaved lamb, goat, chicken, turkey, beef or a mixture of meats (Wikipedia, 2010). Shawarma is a fast food staple across the Middle East, Europe, Caucasus and North-Africa, but it is fast gaining recognition in West-Africa especially in Nigeria and Ghana where it is sold in popular fast food centers. Pita is high in protein and carbohydrate, its low water activity is such that it resists the growth of all microorganisms if stored properly (Hasseltine et al., 1969). The microbial flora of flour is low since some of the bleaching agent reduces the load. Possible spoilage organisms include: *Bacillus sp* and molds of several genera like *Rhizopus stolonifer* often referred to as "bread mold" and *Neurospora sitophilie,* these growth are seen as typical mycelium growth and spore formation. The spoilage of fresh refrigerated

dough products including sweet rolls and pita dough is caused mainly by lactic acid bacteria. In a study conducted by Hasseltine (1969), 92% of isolated microorganisms were *Lactobacillaceae* with more than half belonging to the genus *Lactobacillus,* 36% to the genus *Leuconostoc* and 30% to *Streptococcus.* The ropiness may be seen as stringiness by carefully breaking a batch of dough into two parts (Jay, 2005).

In most countries, the most common food borne illness is *Staphylococcus* spp. food intoxication (Talaro and Talaro, 1996). Enterotoxigenic *Staphylococcus* spp. and *E. coli* strains have been isolated from foods implicated in illnesses (Adesiyun, 1995). In Nigeria, a number of foods have been reported to have high incidence of bacteria (Adesiyun, 1995; Okonko et al., 2008). But there is a high prevalence of food borne diseases caused by Escherichia coli 0157: H7, *Listeria monocytogens*, *Campylobacter jejuni*, *Clostridium perfringes*, *Salmonella* spp. and *Staphylococcus aureus* which accounts for approximately 3.3 – 12.3 million cases of food borne illnesses and a record of 3, 900 deaths each year (Talaro and Talaro, 1996; Buzby et al., 1997) in the United States.

S. aureus is a Gram positive cocci resistant to heat, drying and radiation. Its strains can be pathogenic and relatively non-pathogenic. They produce disease when the bacteria contaminate food, they produce some enzymes which are implicated with *Staphylococcus* invasiveness and many extracellular substances some of which are heat stable enterotoxins that renders the food dangerous even though it appears normal (Prescott et al., 2005). Though the bacteria can be killed during extensive cooking but the toxin may not be destroyed because most of the toxins are gene based i.e. they can be carried on the plasmid (Talaro and Talaro, 1996). The intensity of the signs and symptoms may vary with the amount of contaminated food ingested and susceptibility of the individual to the toxins. Some signs and symptoms of *Staphylococcal* poisoning includes: nausea, vomiting, abdominal cramp, prostration and diarrhea.

E. coli is a member of the genus *Escherichia* with the family Enterobacteriaceae; it is a facultative anaerobe non-sporing. Members are widely distributed in the environment and contaminated food and water are the major sources on which the bacteria are spread, selected strains can cause a wide variety of infections in hospitals and community settings (Donnenberg et al., 2005). These infections include diarrhea illnesses, urinary tract infections, meningitis, sepsis etc and it's commonly used as surrogate indicator, it's presence in food generally indicates direct and indirect feacal contamination. Food borne illness is a major international problem with consequent economic reduction (Duff et al., 2003).

Microbiological quality problems of ready-to-eat food (shawarma) depends greatly on the following factors: low initial quality of raw meat and other ingredients, inefficient cooking process, improper sanitary practices for personnel, and for cooking/processing utensils (Kayaardi et al., 2006). One or several of these factors may lead to potential health hazard for humans (Evans et al., 1999; Harakeh et al., 2005). According to WHO (1989), food handling personnel play important role in ensuring food safety throughout the chain of food production and storage. Mishandling and disregard of hygienic measures on the part of the food vendors may enable pathogenic bacteria to come into contact with and in some cases multiply in sufficient numbers to cause illness in the consumer. Trivader (2003) highlighted the increasing prevalence of eating away from home and the use of partly or fully cooked food items were not regulated; they operated haphazardly without any monitoring of what they prepared and how they prepared it (Ekanem, 1998; Abdalla et al,. 2008a,b, 2009). Studies by FAO (1995) recorded poor knowledge practiced in food handling in the assessment of microbial contamination.

The aims of this study are to assess the microbial quality of shawarma in Port Harcourt city and to highlight the public health implication of consuming heavily contaminated shawarma.

2. MATERIALS AND METHODS

2.1 Sample collections

The major materials used for the analysis were 12 samples of instant prepared ready to eat shawarma samples which were purchased at 3 different locations around Port Harcourt metropolis and 4 samples that was home made or prepared in adequate condition.

2.2. Sample Preparation (Home Made)

The preparation of shawarma is divided into three parts: preparation of pita, preparation of chicken and vegetables and preparation of the sauce. The pita was bought, not home made. The boneless chicken was washed, put in a pot, seasoned with salt, curry, thyme, black pepper, nutmeg and garlic sodium glutamate and garlic. Water was added to facilitate cooking; the pot was covered and content was allowed to cook until soft and tender. Cooking time was 30 mins. Vegetable oil was added to the grill and the chicken was gently fried until the surface turned golden brown. This was left to stand until vegetables were ready. Vegetables were washed, dried, sliced and cut into tiny pieces. Vegetable oil was then added into the grill and allowed to get hot. Afterwards,

vegetables were added. This was allowed to cook for 8minutes at 60^0F. Pita bread was placed on a clean foil, the vegetables and grilled chicken were added inside the pocket, to the content was added the mayochilli sauce, allowed to cool before re-separating the mixtures for homogenizing. Sauce was prepared in a food processor, 5 table spoonful of mayonnaise was scooped into the food processor. This was allowed to mix until fluffy. Afterwards, tomato paste, vinegar, ground black pepper, gingers and garlic and added. This was mixed together and a pitch of salt was added to taste.

2.3. Enumeration, Isolation and Identification of Bacterial and Fungi Isolates

Pour plate method was employed for the determination of microbial load of samples using different solid media. Multiple tube fermentation procedure (also known as the Most probable number procedure); a quantitative analysis of food and water samples was employed to give a statistical estimate of the number of bacteria that would give the observed result. It was used in the enumeration of coliforms especially feacal coliforms. Ten fold serial dilutions of the samples was made and 10^{-5} dilution of the samples from different location were plated out on Nutrient agar, MacConkey, Salmonella-Shigella agar, Sabouraud 4% Dextrose Agar (SDA), Mannitol Salt Agar, Buffered Peptone water, Triple Sugar Iron (TSI) Agar and Kovac's Indole reagent using the spread plate technique. These plates were incubated for 24 hours at 37^0c in the incubator. Sabourand dextrose agar and potato dextrose agar (PDA, Difco) were used for the total fungal counts and incubated at 28 ± 1oC for 5 days under 12 h photoperiod. After incubation, observed colonies were counted and then isolated. The bacterial isolates were further examined for their ability to ferment sugar, carbohydrate production of indole from tryptophan, citrate utilization, catalase production and oxidase test. The bacterial isolates were also identified by comparing their characteristics with those of known taxa, as described by Jolt et al. (1994) and Oyeleke and Manga (2008). The pure isolated fungi were identified using cultural and morphological features according to the most documented keys in fungal identification (Samson and Varga, 2007).

3. RESULTS

The shawarma samples used in this study was 12 samples purchased from three different location and four samples which was home-made this served as the control. All component or major components of shawarma samples were studied extensively by plating on different agar medium to enumerate types and levels of contamination. Also the multiple tube fermentation technique was also done to determine the presence of feacal and total coliforms. Locations were Elelenwo, Choba, and Government Residential Area (GRA). The total viable count of bacterial population in all shawarma samples were in the range of $2.0x10^3$ to $1.8x10^6$cfu/g. Generally, the vegetables recorded the highest ($1.8x10^6$) number of bacterial growth especially in Elelenwo as shown in Table 1. Also, when all elements where combined Elelenwo still had the highest total viable bacterial count ($1.1x10^6$) as shown in Table 1. The total coliform count ranged from $1.9x10^3$ to $9.4x10^5$, with Elelenwo having the highest count (Table 1). The range of staphylococci count was $1.9x10^3$ to $5.3x10^3$ with Choba recording the highest (Table 1). The home made sample which was used as a control had significantly smaller total viable count of aerobic bacteria as shown in Table 1. Some fungal species was isolated from the dough and vegetables this includes; *Rhizopus stolonifer* and *Aspergillus niger* and the total fungal count ranged from $2.0x10^4$ to $8.1x10^4$, with Government Residential Area (GRA) having the highest count, this is shown in Table 1.

Table 1: Total bacterial and fungi Counts in Shawarma samples obtained from different locations and home made

Samples	Location	Total viable counts (CFU/g)	Total Coliform Counts (CFU/g)	Total Staphylococci Counts (CFU/g)	Total Fungal Counts (CFU/g)
Vegetables	Elelenwo	1.8×10^6	9.5×10^4	$3.8x10^5$	$3.0x10^4$
	Choba	6.9×10^5	$5.8x10^3$	$1.7x10^5$	$0.0x10^4$
	GRA	5.7×10^4	$3.6x10^5$	$0.0x10^4$	$2.0x10^4$
	Home made	2.0×10^3	$1.35x10^3$	$0.0x10^4$	$0.0x10^4$
Dough	Elelenwo	7.0×10^4	5.1×10^4	$5.5x10^4$	$6.0x10^4$
	Choba	6.2×10^5	$8.3x10^4$	$1.1x10^3$	$5.2x10^4$
	GRA	6.7×10^5	$4.5x10^4$	$7.1x10^4$	$8.1x10^4$
	Home made	4.8×10^4	$3.9x10^3$	$3.5x10^4$	$5.1x10^4$
Meat	Elelenwo	5.5×10^5	1.4×10^4	$6.0x10^4$	$0.0x10^4$
	Choba	6.2×10^4	$6.0x10^3$	$0.0x10^4$	$0.0x10^4$
	GRA	7.9×10^5	$3.5x10^4$	$1.2x10^4$	$0.0x10^4$
	Home made	3.0×10^3	$1.9x10^3$	$0.0x10^4$	$0.0x10^4$
Combined	Elelenwo	1.0×10^6	9.4×10^4	$1.2x10^5$	$0.0x10^4$
	Choba	8.0×10^5	$5.3x10^5$	$2.0x10^4$	$0.0x10^4$
	GRA	9.0×10^5	$5.2x10^5$	$1.4x10^4$	$0.0x10^4$
	Home made	4.2×10^3	$1.95x10^3$	$1.1x10^3$	$0.0x10^4$

Table 2 shows the most probable number of fecal coliform present in Shawarma samples using the five tubes method. Positive tubes from presumptive test plated on Eosin Methylene blue agar grew *Serratia* and *Proteus* spp., there was growth of *Escherichia coli* but growth was too minute (<30) for any statistical significance. The number of positive tubes and their statistical value is shown in Table 2.

Table 2: Most Probable Number of fecal coliform present in Shawarma samples using the five tubes method

Samples	Location	Fecal coliform count (MPN/100ml)
Vegetables	Elelenwo	4
	Choba	9.2
	GRA	3.6
	Home made	<1.8
Dough	Elelenwo	8.2
	Choba	6.1
	GRA	6.1
	Home made	8.2
Meat	Elelenwo	1.8
	Choba	<1.8
	GRA	12
	Home made	<1.8
Combined	Elelenwo	1.8
	Choba	8.2
	GRA	9.2
	Home made	6.1

Table 3 shows the frequency of occurrences of microorganisms isolated from Shawarma samples. It showed that bacterial isolates were most predominant (84.6%) compared to the fungi isolates (15.4%) as shown in Table 3.

Table 3: Frequency of occurrences of Microorganisms isolated from Shawarma samples.

Isolates	No. (%)
Bacteria	22(84.6)
Fungi	4(15.4)
Total	**26(100.0)**

Table 4 shows the frequency of occurrences of bacteria isolated shawarma samples. A total of twenty-two (22) bacteria isolates belonging to eight genera were obtained from shawarma samples and identified as *Staphylococcus* spp., *Escherichia coli, Proteus* spp., *Bacillus* spp., *Klebsiella* spp., *Serratia marcescens, Micrococcus* spp. and *Enterobacter aerogens* based on their biochemical reaction. Their frequency of occurrences is shown in Table 4. It showed that *Proteus* spp. (22.7%) were most predominant bacterial isolates associated with shawarma. This was followed by *Escherichia coli* (13.6%), *Bacillus* spp. (13.6%) and *Staphylococcus aureus* (13.6%). *Enterobacter aerogens* (9.1%), *Klebsiella* spp. (9.1%), *Serratia marcescens* (9.1%), and *Micrococcus* spp. (9.1%) were least predominant (Table 4).

Table 4: Frequency of occurrences of Bacteria isolated from Shawarma samples

Bacteria	No. (%)
Bacillus spp.	3(13.6)
Escherichia coli	3(13.6)
Klebsiella spp.	2(9.1)
Micrococcus spp	2(9.1)
Proteus spp.	5(22.7)
Staphylococcus aureus	3(13.6)
Enterobacter aerogens	2(9.1)
Serratia marcescens	2(9.1)
Total	**22(100.0)**

Table 5 shows the colony, morphology, and microscopic characteristics of the fungi isolates. Only two fungi species was identified as *Rhizopus stolonifer* and *Aspergillus niger* (Table 5).

Table 5: Morphological Characteristics of Fungal Isolated from Shawarma Samples (Vegetables and Dough) on Sabouraud Dextrose Agar (SDA).

Samples	Colonial Morphology	Microscopic	Fungi identified
Vegetables	Gray white with matter with dark spot	Presence of hyphae, straight unbranched and bore opposite rhizoids	*Rhizopus stolonifer*
Dough	Effuse black colonies	Simple septate and conidia	*Aspergillus niger*

Table 6 shows the frequency of occurrences of fungi associated with vegetables spoilage in Uyo metropolis. It showed that of the three fungi species isolated from vegetables, *Rhizopus stolonifer* (75.0%) were most predominant while *Aspergillus niger* (25.0%) was the least predominant (Table 6).

Table 6: Frequency of occurrence of Fungi Isolated from Shawarma Samples

Fungi	No. (%)
A. niger	1(25.0)
Rhizopus stolonifer	3(75.0)
Total	**4(100.0)**

4. DISCUSSION

The food we eat carries some form of microbial association (Adams, 2000). Microorganisms affecting food comes from natural micro flora or are introduced by manufacturing steps ranging from harvesting, processing storage and distribution. In some cases these micro flora have no effect on the food and can be consumed without

consequence, but those that are introduced during course of processing depending on type and level of contamination can spoil the food and cause food borne illnesses.

This study revealed that shawarma samples gotten from three locations in Port Harcourt city had significant growth of microorganisms, but the microbial load of shawarma sample gotten from some locations where higher than others to the extent that it may pose a threat to the health of regular consumers. There were a total of eight genera of microorganisms isolated from these samples these include: *Proteus* spp. (22.7%), *Escherichia coli* (13.6%), *Bacillus* spp. (13.6%) and *Staphylococcus aureus* (13.6%), *Enterobacter aerogens* (9.1%), *Klebsiella* spp. (9.1%), *Serratia marcescens* (9.1%), and *Micrococcus* spp. (9.1%), this agrees to reports of (Oluwafemi and Semisaye, 2005; Okonko et al., 2009) as they isolated most similar organisms from sausages, hamburgers and sea foods. The organisms isolated were mostly coliforms such as *Klebsiella spp, Serratia spp. Proteus spp, Enterobacter spp* and *Escherichia coli*. Coliforms are mainly found in water, soil and feacal matter as they are widely distributed in water, soil and vegetation (Rompre et al; 2002). They belong to the family Enterobacteriaceae; they are short gram negative rods. That do not form spores, they also ferment lactose to produce acid and gas (Jawetz et al; 2008). They are among the most common bacteria that cause disease. The presence of these organisms in ready-to-eat food (shawarma) depicts a deplorable state of poor hygience and sanitary practices employed in the processing and packaging of this food product (Jay, 2005). Similar organisms were isolated by Abdalla et al. (2009), Okonko et al. (2009) and Adebayo-Tayo et al. (2012). The most prevalent isolated bacteria from cooked meals, bottled drink and fresh juice in a study by Abdalla et al. (2009) were; *Escherichia coli, Staphylococcus auerus* and *Bacillus* sp. Adebayo-Tayo et al. (2012) also reported *E. coli* to be the most predominant bacteria isolated in their study.

Some of these pathogens cause gastroenteritis and diarrhea especially *Escherichia coli* which is a major cause of travelers and childhood diarrhea. *Klebsiella spp* and *Serratia spp* are considered opportunistic pathogens but produce significant endotoxin that can mediate fatal infection. *Proteus spp* can cause serious disease condition on the immunocompromised causing infections of the respiratory tract (Jawetz et al., 2008). Samples from location 1 had the highest total bacterial count in the vegetables ($1.8x10^6$) while the home-made sample had the least ($2.0x10^3$) and biochemical analysis of the isolate showed that they were contaminated with mostly coagulase positive *Staphylococcus spp. Staphylococcus* is a Gram positive bacterium; they are facultative anaerobe growing better in the presence of air (Prescott et al., 2005). Their presence in food indicates human contact such as poor personal hygiene and poor manufacturing practices of the food vendor (Musa and Akande, 2002). They produce enterotoxins that can withstand high temperature which on ingestion can cause vomiting and diarrhea (Cowan and Steel, 1974). They also can withstand high sodium chloride concentration (Jawetz et al., 2008).

Although death from *Staphylococci* food poisoning is rare (Ibe, 2008) it can cause death in small children and the immunocompromised. The presence of *Staphylococcus auerus*, a pathogenic organism of public health concern and significance in these vegetables might have contaminated the stored vegetables from source as a result of handling by farmers or retailers. Improper handling and improper hygiene might lead to the contamination of food and this might eventually affects the health of the consumers (Dunn *et al*., 1995; Omemu and Bankole, 2005; Okonko *et al*., 2008, 2009; Mgbakor et al., 2011).

Government Residential Area (GRA) had the highest growth in the dough and meat samples ($6.7x10^5$ and $7.9x10^5$) respectively. And the organisms isolated were mainly *Proteus spp* in the dough and Bacillus spp and in the meat samples. *Bacillus cereus* is a Gram negative spore forming bacteria, it's a well known food borne pathogen causing two types of illness: the emetic and the diarrheal syndrome this is due to the production of enterotoxins that can withstand harsh conditions (Valero et al., 2002). There were considerable growths of *Bacillus spp* in vegetable sample obtained from GRA (5.7×10^4) this agrees with the result obtained by Valero and co-workers as they isolated *Bacillus cereus* from vegetables in ready-to-eat sandwiches (Valero et al., 2002).

The home made sample yielded little or no growth of bacteria but there was growth of a *Proteus spp* in the dough when isolated alone. This contamination may be as a result of improper storage temperature as pita bread is bought in large amount and stored in the refrigerator. There was the presence of fungi *Rhizopus stolonifer* and *Aspergillus niger* in vegetable and dough samples. These are simply opportunistic molds which may be as a result of improper storage causing this foods stuff especially the pita bread to become humid therefore supporting the growth of these fungi. The vegetables have high water content or water activity this may encourage spoilage if not well preserved. These fungi produce important metabolite called aflatoxin which has been shown to be highly toxic to man and all domestic and

laboratory animals (Aletor, 1990). Moreover, the presence of *Rhizopus spp.* has been reported to cause an elevation of pH beyond safety value of 4.6 which makes the environment very conducive for pathogenic bacteria (Efiuvwevwere, 1990).

The fungi reported in this study are similar to what has been reportedly isolated in other studies in Nigeria (Baiyewu et al., 2007; Chukwuka et al., 2010; Akintobi et al., 2011; Al-Hindi et al., 2011; Adebayo-Tayo et al., 2012). Baiyewu et al. (2007) had also isolated *Rhizopus nigricans* and *Aspergillus niger* among others, in their study on post harvest losses in Pawpaw in South Western Nigeria. Chukwuka et al. (2010) also isolated *R. nigricans* and *A. niger* from Pawpaw fruits in Oyo State, South Western Nigeria. The isolation of *Rhizopus stolonifer* and *A. niger* from vegetables further confirmed the studies of Efiuvwerwere (2000), Chuku *et al*. (2008), Akinmusire (2011), Akintobi et al. (2011) and Adebayo-Tayo et al. (2012). In the same vein, Onyia *et al.* (2005) also isolated *Aspergillus niger* and *Rhizopus stolonifer* from rotten tomato fruits.

Using the guidelines for the microbiological quality for ready to eat food by Advisory committee for food and diary product (ACFD), the microbiological quality of ready to eat foods has been placed into category two. The mean total plate count for the three locations gotten from the enumeration of shawarma samples with all combined element produced to aerobic colony of $1.1x10^6$ cfu/g, $9.0x10^5$ cfu/g, $8.0x10^5$ cfu/g and $4.2x10^3$ cfu/g in all locations and home made respectively. This study has shown that samples from Elelenwo have the highest aerobic colony count. According to the microbiological standards of the public health laboratories (PHLS, 1992, 1993, 1996) of the Advisory committee for food and diary products, the total aerobic count/g for ready-to-eat foods placed into category two where the aerobic colony count at $<10^3$ is rated as satisfactory, 10^3 to $<10^4$ as acceptable, $>10^4$ as unsatisfactory. By this standard, shawarma gotten from all three locations can be rated as unsatisfactory, while the home-made sample can be rated as satisfactory. The established food safety knowhow among ready-to-eat food and thier vendors regarding food contamination, types and symptoms of food diseases was significant since several pathogenic microorganisms had also been isolated from many street vended foods (Omemu et al., 2005). Adequate temperature in cooking and storage of foods is important to minimize the growth of bacteria and the food that cannot maintain within the safety temperature zone may act as incubator for pathogenic bacteria whether the food is raw, partially cooked or fully done (Roller, 1999; Abdalla et al., 2008b).

5. CONCLUSION

This study shows that despite the preparation of shawarma by heating, there were still some pathogenic microorganisms observed on the samples enumerated. This is as a result of the fact that some of the observed microorganism can survive high temperatures. Also, handling, storage and processing steps are major avenue for the cross contamination of the major materials used for the preparation of shawarma. Personal hygiene and processing practice of the food vendors are major factors that determine the safety in the consumption of ready-to-eat- food (shawarma). For further studies, it is recommended to screen shawarma for parasites such as Ascaris and Planaria. The hands of food vendor should also be screened or analyzed for pathogenic microorganisms. There should be an establishment of sub-units of committees like National Association of Food and Drugs Administration (NAFDAC) that would be involved in the regular check up of sanitary conditions of fast food centers just like the Food Safety and Inspection Service (FSIS) UK. Lastly, there should be awareness on the health implication of pathogens introduced during cross contamination.

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