

Comparative study of bacteriological qualities of meat pies sold in some standard eateries and local kiosks in Ogun State, Nigeria

Bello Olorunjuwon Omolaja^{1*}, Osho Adeleke²

1. Department of Microbiology, Olabisi Onabanjo University, Ago-Iwoye, Ogun State, Nigeria

2. Department of Biological Sciences, Redeemer's University, Mowe, Ogun State, Nigeria

*Corresponding Author email: olorunjuwon.bello@oouagoiwoye.edu.ng

Key words

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Pastry

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bacteria

health

risk

Contamination

ABSTRACT

Comparative investigation was carried out on bacteriological qualities of meat pies sold in some standard eateries and local kiosks in Ogun State, Nigeria. MacConkey agar was used for coliform enumeration; mannitol salt agar was used for the isolation of *S. aureus* while total viable aerobic bacteria count was performed on Mueller Hinton agar. Isolates were characterized according to standard methods. Bacteria isolated were *S. aureus*, *E. coli*, *Klebsiella* spp, *Pseudomonas* spp, *Bacillus* spp and *Enterococcus* spp. In standard eateries, mean total bacteria counts of fresh meat pies, 2-day refrigerated meat pies and 2-day room air preserved meat pies ranged from 2.1×10^2 to 5.0×10^2 cfu/g, 6.5×10^2 to 4.5×10^3 cfu/g and 1.5×10^4 to 5.0×10^4 cfu/g, respectively. From local kiosks, the mean total bacteria counts in fresh meat pies, 2-day refrigerated meat pies and 2-day room-air preserved meat pies ranged from 2.0×10^3 to 4.5×10^3 cfu/g, 2.0×10^4 to 4.0×10^4 cfu/g and 3.0×10^4 cfu/g to counts too numerous, respectively. There was a significant difference between the microbial loads obtained from meat pies from standard eateries and those from local kiosks. The difference among the bacterial loads obtained from fresh meat pies, 2-day refrigerated meat pies and 2-day room air preserved meat pies also tested significant. It was concluded in this study that meat pies other than fresh from standard eateries are not fit for consumption, while all categories of meat pies from local kiosks pose high health risk to consumers.

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Introduction

Food contamination is the introduction or occurrence of a contaminant (any biological or chemical agent, foreign matter or other substance not intentionally added to food which may compromise food safety or suitability) in food or a food environment. Food is prone to contamination at every stage in the food chain, i.e. the various stages from primary production of food to when it is ready for consumption (often described as 'farm-to-fork'). The consumption of food contaminated by micro-organisms will result in food-borne illnesses. These are usually either infectious or toxic in nature, caused by agents that enter the body through ingestion of food (WHO, 2007). Ready to eat foods can be described as the status of foods being ready for immediate consumption at the point of sale. Ready to eat foods could be raw or cooked, hot or chilled and can be consumed without further heat treatment (Tsang, 2002). Different terms have been used to describe such ready to eat foods. These include convenient, ready, instant and fast foods. Examples of such ready to eat foods include pastries, meat pie, sausage, rolls, burger, moin-moin, salad or coleslaw, fried meat, fried chicken, milk and milk products. Outbreaks of food borne diseases are caused by foods that are contaminated intrinsically or that become contaminated during harvesting, processing or preparation (Torok et al., 1997). Enterotoxigenic *Staphylococcus* strains and *E. coli* strains have been isolated from foods implicated in illnesses (Firstenberg and Sullivan, 1997; Cencil et al., 2003; Bello et al., 2013). Food borne illnesses have continued to form a significant part of the morbidity and mortality of Nigerians, and have been on the increase in recent times. In Nigeria and many other developing countries, there are inadequate diagnostic facilities, leading to inadequate investigation of outbreaks and the

subsequent gross under-reporting of food-borne illnesses Bacteria are the causative agents of food borne illness in 60% of cases requiring hospitalization (Mead et al., 1999). The international impact of food borne illness is difficult to estimate. However, about 2.1 million children in developing countries die due to diarrheal-related illnesses annually. It is suspected that food or water is the vehicle for many of these illnesses (WHO, 2002). Because food is biological in nature and is capable of supplying consumers with nutrients, it is equally capable of supporting the growth of contaminating microorganisms. Water supplies may contain pathogens when contaminated with fecal matter. In Nigeria, a number of foods have been reported to have high incidence of bacteria (Adesiyun, 1995; Okonko et al., 2009; Bello et al., 2013; Adesetan et al., 2013). However, there is limited information on the bacteriological risks associated with meat pies retailed in local kiosks and standard eateries in Ogun State, Nigeria.

Materials And Methods

Sample collection

Twenty-seven fresh meat pie samples were purchased from different standard eateries and local kiosks at different locations in Ijebu-Ode, Ogun State, Nigeria. The samples were aseptically collected in a clean polyethylene bag and transferred immediately to the laboratory for bacteriological analysis. Samples were collected between the months of August and October, 2012. Three samples each from standard eateries and local kiosks were preserved by refrigeration and by room-air for two days.

Sample analysis

Bacteriological analyses of the meat pies were carried out in 2 parts: a) pastry and b) minced meat. This is because of the difference in mode of preparation of the pastry and minced meat making up the final meat pie product. 10 g of each food sample was weighed out and homogenized into 90 ml of sterile distilled deionized water using a sterile warring blender. Ten fold dilutions of the homogenates were prepared and up to 10^{-7} dilution factors of the homogenate were plated in triplicates on MacConkey agar, Eosin Methylene blue agar, Mueller Hinton Agar, Mannitol salt agar using the spread plate technique. The plates were then incubated at 37°C for 24 - 48 h. MacConkey agar was used for coliform enumeration while Mannitol salt agar was used for the isolation of *S. aureus*. Total viable aerobic bacteria count was performed on Mueller Hinton agar. At end of the incubation periods, colonies were counted using the illuminated colony counter (Gallenkamp, England). The count for each plate were expressed as colony forming unit per gram of the sample (cfu/g).

Identification of isolates

Colonies identifiable as discrete on the Mueller Hinton Agar were carefully examined macroscopically for cultural characteristics such as the shape, color, size and consistency. Gram staining as well as appropriate biochemical tests according to Cowan and Steel (1985) and Olutiola et al. (1991) were carried out. For morphological characteristics, a small portion of the discrete colonies on each plate was smeared on a microscope slide with a drop of distilled water added. The smear was gently fixed by heat and immersion oil was dropped on the surfaces, and then viewed under the $\times 10$ and $\times 40$ objective lens of the microscope.

Statistical analysis

Using IBM SPSS statistics (version 22.0) package and at 95% level of confidence, one-way analysis of variance (ANOVA) was employed to establish if there was a significant difference between the microbial loads obtained from meat pies from standard eateries and those from local kiosks. The difference among the bacterial loads obtained from fresh meat pies, the 2-day refrigerated meat pies and 2-day room air preserved meat pies was also tested for using ANOVA.

Results

Six genera of bacteria were isolated from the meat pies purchased from standard eateries and local kiosks in Ijebu-Ode, Ogun State. The isolates were identified as *S. aureus*, *E. coli*, *Klebsiella* spp, *Pseudomonas* spp, *Bacillus* spp and *Enterococcus* spp as revealed by their morphological and biochemical characteristics (Table 1).

Table 1. Biochemical characteristics of bacterial isolates from meat pies purchased from some standard eateries and local kiosks in Ogun State, Nigeria

Parameters	Most probable isolates					
	Staphylococcus aureus	Escherichia coli	Klebsiella sp	Pseudomonas aeruginosa	Bacillus sp	Enterococcus sp
Gram's reaction	+	-	+	-	+	+
Catalase test	+	+	+	+	+	-
Coagulase test	+	-	-	-	N/A	+
Citrate utilization test	-	+	+	+	N/A	+
Oxidase test	-	-	+	+	N/A	-
Urease test	+	-	+	N/A	N/A	N/A
Indole test	-	+	-	-	-	-
Glucose	+	+	+	N/A	N/A	+
Lactose	+	+	N/A	N/A	N/A	+
Sucrose	+	+	+	N/A	N/A	+
Mannitol	+	+	-	N/A	N/A	+
Maltose	+	+	-	N/A	N/A	+
Cellular morphology	Cocci	straight rods	Rods	Rods	rods	Cocci
Growth in Mannitol salt agar	bright yellow	N/A	N/A	N/A	N/A	N/A
Growth in MacConkey agar	N/A	red/ pink	Mucoid	Pale	pink	Pink
Growth in blood agar (colony)	creamy white	Circular	large white	Greenish	N/A	Creamy

Table 2 represents the mean total bacteria count in colony forming unit per gram of meat pie sample from standard eateries. Mean total bacteria count of fresh meat pie ranged from 2.1×10^2 to 5.0×10^2 cfu/g; that of 2-day refrigerated meat pie ranged from 6.5×10^2 to 4.5×10^3 cfu/g and the mean total bacteria count of the 2-day room air preserved meat pie samples ranged between 1.5×10^4 to 5.0×10^4 cfu/g. Total bacteria count was highest in the minced meat C of 2-day air preserved meat pies.

Table 2. Mean total bacteria count in meat pies from some standard eateries in Ogun State, Nigeria

Control	Samples	Mean total bacteria count cfu/g
Fresh meat pie samples	Pastry A	2.1×10^2
	Minced meat A	5.0×10^2
	Pastry B	3.0×10^2
	Minced meat B	4.5×10^2
	Pastry C	2.5×10^2
	Minced meat C	4.5×10^2
2-day refrigerated meat pie samples	Pastry A	7.5×10^2
	Minced meat A	3.0×10^3
	Pastry B	8.0×10^2
	Minced meat B	3.5×10^3
	Pastry C	6.5×10^2
	Minced meat C	4.5×10^3
2-day room air preserved meat pie samples	Pastry A	1.5×10^4
	Minced meat A	3.0×10^4
	Pastry B	2.2×10^4
	Minced meat B	4.5×10^4
	Pastry C	4.0×10^4
	Minced meat C	5.0×10^4

Both the pastries and minced meats of fresh meat pie samples were devoid of *E. coli*; while the occurrence of *E. coli* ranged from nil to 2.0×10^2 cfu/g, and nil to 3.5×10^3 cfu/g in the 2-day refrigerated meat pie samples and 2-day room air preserved meat pie samples, respectively. Similarly, samples of fresh meat pies and 2-day refrigerated meat pies were found to be devoid of *Bacillus sp*, while count of 1.4×10^2 cfu/g was obtained from a minced meat sample of 2-day room air preserved meat pie. Occurrence of *S. aureus* ranged from nil to 4.5×10^4 cfu/g, *Klebsiella sp* ranged from nil to 4.5×10^3 cfu/g; *Pseudomonas aeruginosa* ranged from nil to 4.0×10^3 cfu/g while the occurrence of *Enterococcus sp* ranged from nil to 3.5×10^3 cfu/g (Table 3).

Table 3. Diversity of bacteria in meat pies from standard eateries in Ogun State, Nigeria

Control	Samples	E. coli count (cfu/ml)	S. aureus count (cfu/ml)	Klebsiella sp (cfu/ml)	Pseudomonas aeruginosa (cfu/ml)	Bacillus sp (cfu/ml)	Enterococcus sp (cfu/ml)
Fresh meat pie samples	Pastry A	-	-	-	-	-	-
	Minced meat A	-	2.0×10^2	1.5×10^3	-	-	-
	Pastry B	-	-	-	-	-	-
	Minced meat B	-	-	-	-	-	-
	Pastry C	-	1.5×10^3	-	1.0×10^2	-	1.5×10^2
	Minced meat C	-	2.2×10^3	-	2.0×10^2	-	2.2×10^2
2-day refrigerated meat pie samples	Pastry A	-	-	2.0×10^2	-	-	-
	Minced meat A	2.0×10^2	3.0×10^3	3.5×10^2	1.5×10^2	-	1.0×10^2
	Pastry B	-	-	2.0×10^2	2.0×10^2	-	-
	Minced meat B	-	2.0×10^2	1.2×10^3	3.5×10^2	-	1.5×10^2
	Pastry C	-	1.5×10^3	4.0×10^2	2.0×10^2	-	3.0×10^2
	Minced meat C	1.0×10^2	3.5×10^3	3.2×10^3	1.2×10^3	-	5.0×10^2
2-day room air preserved meat pie samples	Pastry A	-	2.0×10^4	4.5×10^3	4.0×10^3	-	3.5×10^3
	Minced meat A	3.0×10^3	4.0×10^4	3.0×10^3	2.0×10^3	-	2.0×10^3
	Pastry B	-	3.0×10^4	2.5×10^3	3.5×10^3	-	-
	Minced meat B	1.5×10^3	4.0×10^4	2.7×10^3	3.2×10^3	1.4×10^2	2.5×10^2
	Pastry C	5.0×10^2	3.5×10^4	2.0×10^3	4.2×10^3	-	3.5×10^2
	Minced meat C	3.5×10^3	4.5×10^4	3.2×10^3	4.0×10^3	-	2.5×10^3

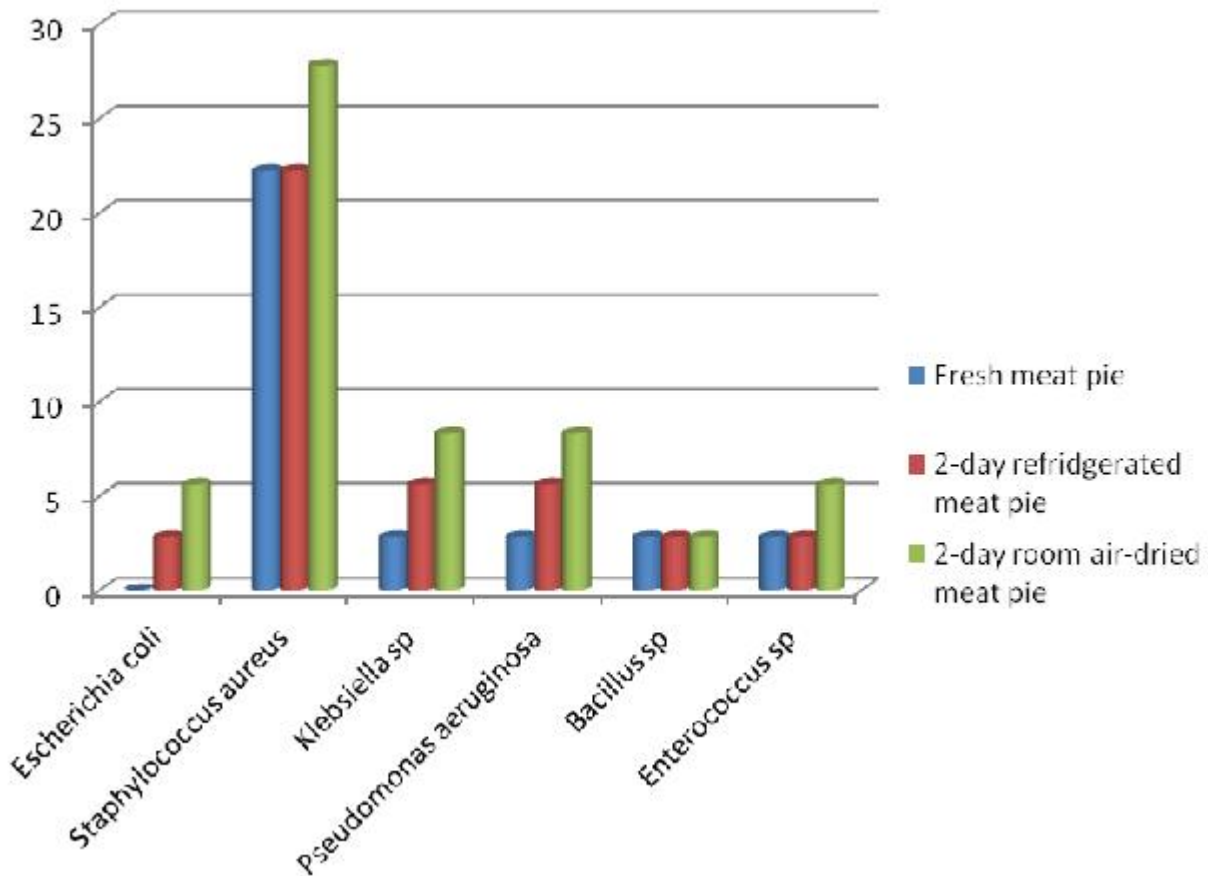


Figure 1. Percentage occurrence of bacterial isolares from meat pies purchased from some standard eateries in Ogun State, Nigeria

The mean total bacteria counts in fresh meat pie samples from local kiosks ranged from 2.0×10^3 to 4.5×10^3 cfu/g; the mean total bacterial count recorded in 2-day refrigerated meat pie samples ranged from 2.0×10^4 to 4.0×10^4 cfu/g, while in 2-day room-air preserved meat pie samples, a range of 3.0×10^4 cfu/g to counts too numerous ($> \times 10^7$) was recorded (Table 4). This is indicative of the fact that meat pies purchased from local kiosks constitute a great health risk to consumers especially if not freshly prepared.

S. aureus was the most prevalent bacteria isolated from meat pies from standard eateries with highest percentage occurrence of 27.8% obtained from the 2-day room air-dried meat pies, while fresh meat pies and the 2-day refrigerated meat pies had same percentage occurrence of 22.2% in this study. There was no occurrence of *E. coli* in the fresh meat pies from standard eateries while percentage frequencies of 2.8% and 5.6% were obtained from 2-day refrigerated meat pies and 2-day room air-dried meat pies, respectively. The 2-day room air-dried meat pies showed the highest percentage occurrences of *Klebsiella* sp (8.3%), *Pseudomonas aeruginosa* (8.3%) and *Enterococcus* sp (5.6%). However, *Bacillus* sp had a percentage of 2.8% in each of fresh, 2-day refrigerated and 2-day room air-dried meat pies (Figure 1)

Table 4. Mean total bacteria count in meat pies from some local kiosks in Ogun State, Nigeria

Control	Samples	Mean total bacteria count cfu/ml
Fresh meat pie samples	Pastry A	4.0×10^3
	Minced meat A	4.5×10^3
	Pastry B	3.0×10^3
	Minced meat B	4.0×10^3
	Pastry C	2.0×10^3
	Minced meat C	3.5×10^3
2-day refrigerated meat pie samples	Pastry A	2.0×10^4
	Minced meat A	4.0×10^4
	Pastry B	3.0×10^4
	Minced meat B	3.3×10^4
	Pastry C	2.7×10^4
	Minced meat C	3.0×10^4
2-day room air preserved meat pie samples	Pastry A	3.0 10^4
	Minced meat A	$> \times 10^7$
	Pastry B	3.5×10^5
	Minced meat B	$> \times 10^7$
	Pastry C	3.3×10^5
	Minced meat C	$> \times 10^7$

Table 5 showed the bacteria counts in samples of meat pies from local kiosks. Occurrence of *E. coli* in all categories of samples investigated ranged from nil to 2.7×10^2 cfu/g. However, *S. aureus*, *Klebsiella* sp and *Pseudomonas aeruginosa* were found to be present in all categories of samples assayed with ranges 2.1×10^2 to 4.5×10^4 cfu/g, 1.2×10^2 to 2.5×10^7 cfu/g and 2.0×10^2 to 4.5×10^7 cfu/g, respectively. Occurrence of *Bacillus* sp and *Enterococcus* sp in the samples ranged from nil to 3.7×10^3 cfu/g, and nil to 3.0×10^5 cfu/g, respectively.

Table 5. Diversity of bacteria in meat pies from some local kiosks in Ogun State, Nigeria

Control	Samples	<i>E. coli</i> count (cfu/ml)	<i>S. aureus</i> count (cfu/ml)	<i>Klebsiella</i> sp (cfu/ml)	<i>Pseudomonas aeruginosa</i> (cfu/ml)	<i>Bacillus</i> sp (cfu/ml)	<i>Enterococcus</i> sp (cfu/ml)
Fresh meat pie samples	Pastry A	-	2.1×10^2	1.2×10^2	2.3×10^2	-	-
	Minced meat A	-	3.0×10^3	2.5×10^2	3.0×10^2	-	-
	Pastry B	-	1.5×10^3	1.3×10^2	2.2×10^2	-	2.5×10^2
	Minced meat B	1.0×10^2	4.5×10^3	2.0×10^2	3.1×10^2	-	3.1×10^2
	Pastry C	-	2.1×10^2	2.2×10^2	2.0×10^2	3.5×10^2	-
	Minced meat C	-	2.5×10^3	2.7×10^2	2.3×10^2	4.2×10^2	-
2-day refrigerated meat pie samples	Pastry A	1.5×10^2	1.7×10^3	3.5×10^2	3.2×10^2	2.2×10^3	-
	Minced meat A	2.2×10^2	4.0×10^3	4.0×10^2	4.5×10^2	3.2×10^3	1.0×10^3
	Pastry B	-	8.0×10^2	2.5×10^2	2.7×10^2	-	3.0×10^3
	Minced meat B	2.7×10^2	3.5×10^3	3.3×10^3	4.0×10^2	-	3.5×10^3
	Pastry C	-	3.0×10^3	7.0×10^2	2.5×10^3	-	-
	Minced meat C	1.4×10^2	3.6×10^3	4.3×10^3	3.1×10^3	-	-
2-day room air preserved meat pie samples	Pastry A	-	4.5×10^4	2.7×10^4	2.0×10^4	4.0×10^2	-
	Minced meat A	1.0×10^2	4.0×10^4	1.0×10^7	2.0×10^7	3.0×10^2	2.3×10^4
	Pastry B	-	2.2×10^4	3.5×10^4	1.5×10^5	-	3.0×10^3
	Minced meat B	1.5×10^2	4.5×10^4	2.5×10^7	3.2×10^7	-	2.0×10^4
	Pastry C	-	2.5×10^4	4.5×10^4	3.7×10^5	2.5×10^3	4.0×10^3
	Minced meat C	-	2.0×10^4	2.0×10^7	4.5×10^7	3.7×10^3	3.0×10^5

Figure 2 showed percentage occurrence of bacterial isolates from meat pies from some local kiosks. *S. aureus* had the highest percentage occurrences as shown in fresh meat pie (44.4%), 2-day refrigerated meat pie (50%) and 2-day room air-

dried meat pie (55.6%). The 2-day room air-dried meat pies showed percentage occurrences of 8.3%, 22.2%, 22.2%, 8.3% and 5.6% in *E. coli*, *Klebsiella* sp, *P. aeruginosa*, *Bacillus* sp and *Enterococcus* sp, respectively.

Discussion And Conclusion

The result of this finding is in accordance with the reports of Oluwafemi and Simisaye (2005) and Okonko et al. (2009), where they isolated similar organisms from sausages and seafood processors, respectively. The presence of these organisms in meat pies depicts a deplorable state of poor hygienic and sanitary practices employed in the processing and packaging of these food products. From the results obtained, meat pie samples (pastry and minced meat) were contaminated with high level of *S. aureus* and *E. coli*. This result agrees with previous reports by El-Gohany (1994) that foods of animal origin (minced meat) either cooked or uncooked were predominantly contaminated with *E. coli* and *S. aureus*. Waites and Arbuthnott (1999) reported *S. aureus* and *E. coli* contamination in minced meat, sausage rolls and pies. They reported 60.9% prevalence of *S. aureus*, 50% *E. coli*, 40% *Shigella*, 38% *Morganella morganii* in the ready-to-eat food product. From recent findings, food mixtures such as pastries, salads, sauces, soups have been frequently incriminated in food poison outbreaks (FSRI, 2003; FDA, 2007 a, b, c, d). *Bacillus* spp were incriminated to contribute towards life threatening food-borne illnesses. On comparing the bacterial contamination between the eating outlets (standard eateries and local kiosks), the result obtained from the local kiosks samples was found to be on the higher side than that of standard eateries. This is an indication of recontamination in food handling hygiene techniques starting from the processing raw material to the finished product (Ikeme, 1990; Ojeibun, 1994). According to Edema et al. (2001) and Okonko et al. (2008 a, b), the presence of *E. coli* is an indication of fecal contamination of the water sources that were utilized during the processing of these food products. The refrigerated samples tend to show reduced growth when compared with the normal room air preserved samples. This could be attributed to the change in temperature which leads to having the normal metabolic activities of these organisms coming to near halt. From the results, it is clear that minced meat sample had more bacterial contamination than the pastry. This is because meat offers a rich nutrient medium for microbial growth (Phillips, 2003). It was, however, established statistically that there was a significant difference between the microbial loads obtained from meat pies from standard eateries and those from local kiosks ($p > 0.05$). The difference among the bacterial loads obtained from fresh meat pies, the 2-day refrigerated meat pies and 2-day room air preserved meat pies also tested significant ($p > 0.05$). It was concluded in this study that meat pies other than fresh from standard eateries are not fit for consumption, while all categories of meat pies from local kiosks pose high health risk to consumers.

Recommendation

Food poisonings/illnesses are entirely preventable by practicing good sanitation and food handling techniques. There is need to educate and advocate for good manufacturing practices among food processors and food vendors. Also relevant agencies in Nigeria such as Consumer Protection Rights, NAFDAC and SON need to ensure and enforce strict compliance to Hazard Analysis Critical Control Points (HACCP) in all food production sectors in Nigeria. Food safety concerns in this Country typically include inappropriate use of agricultural chemicals; the use of untreated or partially treated wastewater; the use of sewage or animal manure on crops; the absence of food inspection, including meat inspection; a lack of infrastructure, such as adequate refrigeration; poor hygiene, including a lack of clean water supplies. Proper handling, cooking, and storage practices in food service operations and in the home can prevent the majority of food-borne illnesses as well. Additionally, extensive quality control procedures should be maintained to ensure that these processes are effective.

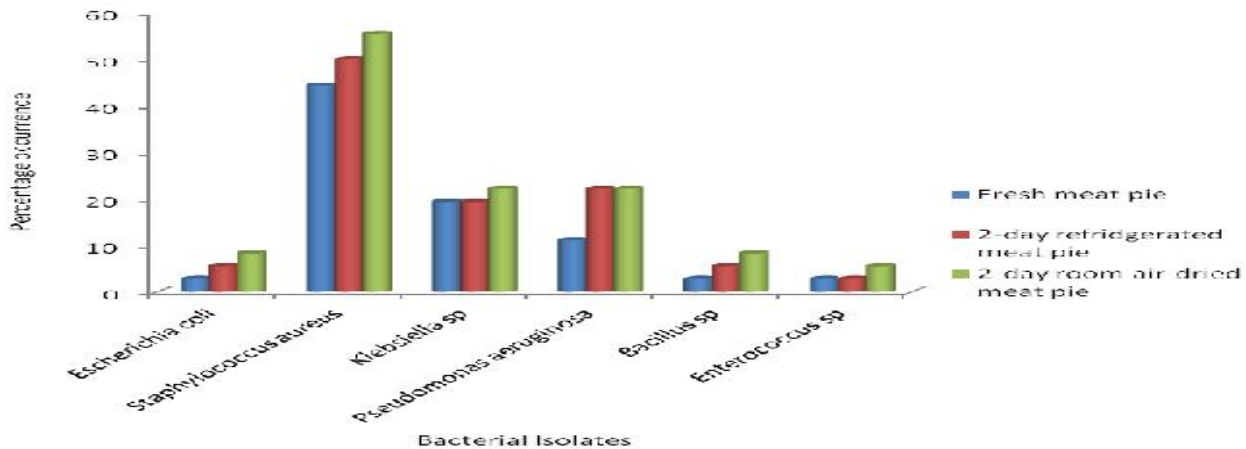


Figure 1. Percentage occurrence of bacterial isolares from meat pies purchased from some local kiosks in Ogun State, Nigeria

References

- Adesetan TO, Egberongbe HO, Ilusanya OAF, Bello OO. 2013. Antimicrobial sensitivity of bacterial isolates from street vended fruits in Ijebu area of Ogun state, Nigeria. *International Research Journal of Microbiology*, 4(9): 220-225.
- Adesiyun AA. 1995. Bacteriologic quality of some Trinidadian ready to consume foods and drinks and possible health risks to consumers. *Journal of Food Protection* . 58(3): 651-655.
- Bello OO, Bello TK, Bankole SA. 2013. Occurrence of antibiotic-resistant *Staphylococcus aureus* in some street-vended foods in Ogun State, Nigeria. *Journal of Advances in Biology*, 1(1): 21-28.
- Cambridge University Press, Verlage, New York, p. 502.
- Cencil GBT, Karma M, Rositto PV, Morgante RA, Cullor JS. 2003. Enterotoxin production by *Staphylococcus aureus* isolated from mastitic cows. *Journal of Food Protection*. 66 (9): 1693-1696.
- Cowan ST, Steel KJ. 1985. Manual for the identification of bacteria.
- Edema MO, Atayese AO, Idowu AO. 2005. Microbiological Quality of microwave processed Foods. In: the Book of Abstract of the 29th Annual Conference & General Meeting on Microbes As Agents of Sustainable Development, organized by Nigerian Society for Microbiology (NSM), UNAAB, Abeokuta from 6-10th Nov. p. 17
- El Gohany AH. 1994. Sausage and minced meat as a source of food poisoning microorganisms to man. *Assint-vet-med. J.* 30: 146-215.
- Firstenberg ER, Sullivan NM. 1997. E. coli rapid detection System a rapid method for the detection of *Escherichia Coli* 0157 in milk and other food. *Journal of Food Protection* 60(3): 219-225.
- Food and Drug Administration (FDA Draft) 2007b. "Guide to minimize microbial food safety hazards of fresh-cut fruits and vegetables". Retrieved on 14 October.
- Food and Drug Administration (FDA) 2007a. "Fish and fisheries products hazards and controls guidance, third edition". Retrieved on 14 October.
- Food and Drug Administration (FDA) 2007d. "Managing Food Safety: A HACCP Principles Guide for Operators of Food Establishments at the Retail Level (Draft)". Retrieved on 14 October.
- Food and Drug Administration 2007c. "Guidance for Industry: Juice HACCP Hazards and Controls Guidance, First Edition". Retrieved on 14 October.
- Food Safety Research Information Office (FSRI) 2003. "A Focus on Hazard Analysis and Critical Control Points". Created June 2003, Updated March 2008.
- Ikeme AL. 1990. Fermented sausage –dry and semi-dry. In meat science and Technology 1st edition .The African fep publishers limited Nigeria p. 210.
- Mead PS, Slutsker L, Dietz V, McCaig LF, Bresee JS, Shapiro C, Griffin PM, Tauxe RV. 1999. Food-related illness and death in the United States. *Emerg. Infect. Dis.* 5: 607-625.
- Ojeibun FI. 1994. Isolation of *Staphylococcus aureus* and other bacteria from some ready to eat foods sold in Benin city. B.sc Hon Thesis University of Benin, Benin city p. 100.
- Okonko IO, Adejoye OD, Ogunnusi TA, Fajobi EA, Shittu OB. 2008a. Microbiological and physicochemical analysis of different water samples used for domestic purposes in Abeokuta and Ojota, Lagos State, Nigeria. *African Journal of Biotechnology*. 7(3): 617-621.
- Okonko IO, Donbraye E, Babatunde SOI. 2009. Microbiological Quality of Seafood processors and water used in two different sea processing plants in Nigeria *EJEAFche* 8(8): 621-629.
- Okonko IO, Ogunjobi AA, Adejoye OD, Ogunnusi TA, Olasogba MC. 2008b. Comparative studies and Microbial risk assessment of different water samples used for processing frozen sea-foods in Ijoraolopa, Lagos State, Nigeria. *African Journal of Biotechnology*. 7(16): 2902-2907
- Olutiola PO, Famurela O, Sontag HE.1991. An introduction to General Microbiology, a practical Approach. Heideberger Verlagsanstalt and Druckerei GmbH Germany, p. 24-39.
- Oluwafemi F, Simisaye MT. 2005. Extent of microbial contamination of sausages sold in two Nigerian cities. In: the Book of Abstract of the 29th Annual Conference & General Meeting (Abeokuta 2005) on Microbes As Agents of Sustainable Development, organized by Nigerian Society for Microbiology (NSM), University of Agriculture, Abeokuta, from 6-10th Nov. p. 28.
- Phillips M. 2003. Analysis of Microbial Hazards related to time/temperature control of foods for safety. *Comprehensive Review in Food Science and Food Safety* 2 : 33-35.
- Torok TJ, Tauxe RV, Wise RP, Livengood JR, Sokolow R, Manvans S. 1997. A large community outbreak of Salmonellosis caused by International contamination of a restaurant salads /bars. *J. Am. Med. Assoc.* 278(8): 389-395.
- Tsang D. 2002. Microbiological guidelines for ready to eat food Road and Environmental Hygiene department Hong Kong pp.115-116.
- Waites NM, Arbutnott JP. 1999. A lancet reviews on food borne illness. *Food contamination residues and Toxicology* 3: 146.
- World Health Organization (WHO).2002. Fact Sheet 237: Food Safety and Food borne Illness. World Health Organization, Geneva, Switzerland. www.who.int/mediacentre/factsheets/fs237/en/, accessed 5/5/04.
- World Health Organization (WHO).2007. Food safety and food borne illness. Fact sheet No. 237. Geneva: pp. 1-2.