Original Research Article

Qualitative Risk Assessment of Campylobacter jejuni in Street Vended Poultry in Informal Settlements of Nairobi County

ABSTRACT

Aim: To determine the food safety risks of consumption of street-vended poultry products, to evaluate the determinants of microbial safety and the risk rank of these products.
Study design: A cross-sectional survey was done in the Korogocho and Kariobangi North slums among the consumers and vendors to assess their food safety knowledge and practices. Swab samples of the cooking equipment, utensils, and personnel, raw and cooked portions of poultry were collected for microbial quality evaluation. The most prevalent microorganism was assessed for its qualitative risk rank using the Risk Ranger software.
Place and duration of study: The study was carried out in the capital city of Kenya, Nairobi, from June 2018 to July 2018.
Methodology: A total of 15 vendors were exhaustively sampled and included in the study with the food safety and hygiene practices evaluated using a food safety checklist. The snowballing sampling technique was used to locate all the vendors. Samples of raw and cooked street vended poultry products were subjected to microbial analysis. All samples were collected in sterile polythene bags followed by transportation to the laboratory of the Department of Food Science and Technology of the University of Nairobi and microbial analysis.

Results: Campylobacter jejuni contamination, in both raw and cooked poultry products, was 8.95±0.94 log_{10} CFU g-1 and 4.66±2.67 log_{10} CFU g-1 respectively; the probability of contamination of raw street-vended poultry was found to be 48.96 %. The mean weekly intake of the poultry was reported 140.0 g per person. The probability of campylobacter infection in an individual consumer was found as 7.12 x 10-3 with the predicted illnesses among the population found as 1.11 x 106 cases. The qualitative risk estimate from the study was reported as 67, above the limit of 48 for medium risk.
Conclusion: The study concluded that *Campylobacter jejuni* posed high food safety risks as a resultant from consumption of street-vended poultry.

Keywords: Campylobacter jejuni; Qualitative; Risk assessment; Street-vended; Poultry; Informal settlements

1. INTRODUCTION

Informal food vending either along the streets or market places contributes to the daily food intake of the urban and peri-urban poor [1]. The utilization of street foods is so high in developing countries, especially in informal settlements [2]. The increasing popularity of street vended poultry is coupled with the increasing intake of ready to eat poultry, especially in urban areas [3]. This is because street-vended poultry are known to be affordable, accessible and ready-to-eat, thereby the high utilization in the urban households. Street-vending in sub-Saharan African countries and other developing countries is informal with less regulation of the sector [4], thus the value and quality of food in this sector are usually not easily documented.

Despite the ever increasing utilization of street-vended poultry products, safety concerns still linger over these foods. These foods are often sold in compromised hygienic conditions and are usually left open for display [5]. Microbial pathogens including but not limited to *Salmonella, Escherichia coli, Listeria monocytogenes, Staphylococcus aureus and Campylobacter jejuni* are prevalent in these products [6–9]. A study done on street-vended chicken in Taiwan and Philippines reported a salmonella contamination level of 7% and 8%, respectively [6]. Considering that poultry is a vehicle for various microorganisms, it's contamination with disease causing microorganisms such as *Salmonella* and *Campylobacter* becomes a public health concern [8]. Factors that predispose these foods to contamination include personal and equipment hygiene, working environment and time and temperature abuse for the cooked food [10].

Campylobacter species including *C. jejuni* and *C. coli* are potent food pathogens found in poultry products and indeed several risk assessment reports have attributed chicken consumption to several campylobacter incidents [3, 11]. The two microorganisms are part of a group of *Campylobacter species* that causes campylobacteriosis, a major food borne infection from poultry products [12]. Campylobacteriosis is highly infectious and a leading cause of bacterial gastroenteritis [13]. The EU notification rate for campylobacteriosis in 2012 was found to be 55.49 per 100,000 populations [14]. *C. jejuni* and *C. coli* account for almost 95% of the global incidence of campylobacteriosis [15]. Additionally, *C. jejuni* infection can also lead to auto-immune conditions of Guillain-Barré syndrome (GBS) and Miller Fisher syndrome [12].

The risk posed by the contamination of *C. jejuni* in street vended poultry needs to be managed through guided policy action with a scientific justification of its course. However, quantitative risk assessment of C. jejuni in street-vended chicken in Nairobi County was difficult due to limited specific data on the food-borne illnesses associated with this microorganism in the country [16]. In as much as the qualitative risk assessment obtains a categorical or descriptive risk estimate rather than a numerical value as in the case of quantitative, the outcome is still valid for guided action [17]. In Europe, risk assessment has become a norm due to availability of tools, reliable data, and experts; however, the converse is true in Kenya; making the present study to be of such a priority. This study used the qualitative risk assessment technique to rank the risk resulting from the contamination of the street vended poultry with *C. jejuni* in the informal settlements of Nairobi County; an area of study that poses serious public health concerns.

2. MATERIALS AND METHODS

2.1 Study Area

A cross sectional study was conducted in the informal settlements; Korogocho (1.2504° S, 36.8909° E GPS coordinates) and Kariobangi North (1.2534° S, 36.88815° E GPS coordinates), Nairobi County (1.2921° S and 36.8219° E GPS coordinates), of Kenya. The 2009 national population census estimated the population of Nairobi County to be over three million, with over half of the population living in slums (Kenya National Bureau of Statistics, 2015). Street vended foods were collected in the following regions within Korogocho; Gitathuru, Nyayo, Kisumu Ndogo, Paradise and Kariobangi North.

2.2 Sampling and sample collection

Nairobi County was purposively selected for the study because of its populous nature. Korogocho and Kariobangi North areas were also purposively selected for the study as they are largely informal settlements with the population being those of low-income. A total of fifteen vendors were exhaustively sampled and included in the study with the food safety and hygiene practices evaluated using a food safety checklist. The snowballing sampling technique was used to locate all the vendors. Samples of raw and cooked street vended poultry products were subjected to microbial analysis. The respondents were purposely selected from the villages to include all the vendors selling the ready-to-eat (RTE) chicken products. All samples were collected in sterile polythene bags followed by transportation to the laboratory of the Department of Food Science and Technology of the University of Nairobi and microbial analysis done for *Escherichia coli, Salmonella, Staphylococcus aureus* and *Campylobacter jejuni.* The samples were stored at a temperature of 4 ◦C and analyzed within 24 hours of collection.

2.3 Microbial analysis

2.3.1 Determination of *Escherichia coli*

Based on ISO method 9308-1:2000 [18], the E. coli was accordingly enumerated. About 10g of sample was homogenized in 90ml peptone water. Decimal serial dilutions of the homogenized solution in sterile peptone water were prepared and plated in duplicate on the selective agar media. Blue green colonies for E. coli were counted after 48 hours of incubation at 44◦C. The number of colony forming units (CFU) of presumptive E.coli per gram of sample was calculated.

2.3.2 Determination of *Salmonella spp.*

The ISO method ISO 6579 [19], was used to enumerate the salmonella species. A sample of 10 g was weighed, homogenized in buffered peptone water and incubated at 37±1oC for 18±2 hours. From pre-enrichment broth, the inoculums were transferred to Rappaport-

Vassiliadis broth and selenite cysteine broth and then incubated at 41.5±1oC and 37±1oC for 24 hours for selective enrichment. A loopful of the selective enrichment was streaked onto solid selective media: xylose lysine desoxycholate agar (XLD). XLD agar was incubated at 37±1oC and observed after 24±3 hours for typical salmonella transparent red halo and a black center.

2.3.3 Determination of *Staphylococcus aureus*

EN ISO method ISO 6888-1:1998 [20], was used for the detection and enumeration of Staphylococcus aureus. In a sterile pipette, 0.1ml of the appropriate sample test dilutions were transferred in duplicate onto the Baird Parker agar (BPA). The plates were then incubated at 35-37oC for 24±2 hours, then re-incubated for further 24±2 hours. Observation ensued for typical colonies appearing black or grey, shining and convex, 1-1.5mm in diameter after 24hours and 1.5-2.5mm after 48 hours of incubation, surrounded by a clear zone but partially opaque zone. Coagulase positive staphylococci were then expressed as cfu/g of sample.

2.3.4 Determination of *Campylobacter jejuni*

Analysis was conducted according to ISO 10272-1:2017 [21] procedures which specify a horizontal method for the detection and enumeration of Campylobacter spp.

2.4 Risk assessment tools

Data generated from secondary sources from published articles in renowned databases including Science Direct, Elsevier, Springer, Hindawi and reports by global bodies like FAO and WHO were used. The data was used to respond to a set of eleven questions posed by the risk ranger and risk rank obtained [22]. The risk estimate was generated in a risk ranger which represented the relative risk of campylobacteriosis due to consumption of street-vended poultry. The spreadsheet uses its in-built functions to convert qualitative responses into numerical values that it uses to generate a risk rank [23]. The risk estimate generated by the Risk Ranger is usually on a scale of 0-100.

2.5 Data analysis

Genstat version 15 was used to analyse the microbial data. ANOVA was used to establish significant differences in the log counts of microbial pathogens. The LSD was used to separate means that were significantly different. Descriptive statistics including mean and SD of the mean microbial contamination levels were also generated. The risk estimate was generated from the risk ranger [23]. The risk estimate generated was on a scale of 0-100.

3. RESULTS AND DISCUSSION

3.1 Hazard Identification

Campylobacter jejuni which was the most prevalent microorganism in both raw and cooked poultry products at 8.95±0.94 and 4.66±2.67 log CFU g-1 respectively; as compared to Salmonella, E. coli and Staphylococcus which had contamination levels of 6.42±1.64, 6.60±1.25 and 6.92±1.32 log CFU g-1 in raw poultry respectively and 2.22±1.88, 2.67±1.98 and 2.86±1.61 in cooked poultry respectively $p<0.05$. These findings are different from those established in another study done on street-vended poultry in Egypt where *Staphylococcus aureus* was found to be the most prevalent food pathogen [3]. Cardinale et al. (2015) in his study on street vended poultry in Madagascar established that there was no contamination of the products with C. jejuni as proper heat treatment of the products addressed the problem.

Campylobacter jejuni is a gram-negative, non-spore forming and motile microorganism [12]. The microorganism also has flagella which are serves a role in its invasion [25]. The microorganisms accounts for about 90% of all human infections by Campylobacter sp. in human beings [26]. In recent times, the microorganism has been associated with enteritis and gastroenteritis in both the adult and pediatric patients [27]. About 30% of the cases of campylobacteriosis have been attributed to the consumption of poultry [28].

The microorganism induces food poisoning through intake of contaminated water or food [25]. Campylobacter isolation in patients suffering from diarrhea in Kenya was reported as 12%, higher than for both *Salmonella* and *Shigella* [29]. Additionally, the prevalence of Campylobacter spp. in chicken in the informal settlements of Kenya was reported as 60-64% in the retail market. Mageto et al. (2018) reported that 32.5-76.5% of the *campylobacter* isolates from chicken in Nairobi County were *C. jejuni*. Another study by Nguyen et al. (2016) reported that 61.3% of the C. jejuni isolates from chicken in Kenya showed multi-drug resistance.

3.2 Hazard Characterization

The clinical manifestations of the infection are gastroenteritis, meningitis and acute cholecystitis [12[. The severity of the illness due to the infection by the microorganism was established as low as it was reported by Smith (1985) that the overall fatalities were 0.059 per 100,000 population. [33] reported that the illnesses would at times result into death thus rarely medical attention due to diarrheal episodes. Other diseases that are resultant from campylobacter infection include Guillain-Barré syndrome (GBS) and Miller Fisher syndrome.

Gastroenteritis due to campylobacter infection is usually occasioned by diarrhea, malaise, fever and abdominal pain and sometimes vomiting, inflammation of the intestinal mucosa, presence of blood in faeces and disruption of the epithelial cells [25]. The incidence of food borne illnesses with diarrheal symptoms, in the study area, was found to be 52.9%. A study done in the informal settlements of Yaoundé, Cameroon, found that 59.5% of the diarrheal cases there were attributed to infectious microorganisms like *C. jejuni*. Deogratias et al. (2014) also reported a prevalence of 9.7% of campylobacter infection among under-five year old children in Tanzania with diarrheal infection. The global burden of campylobacteriosis in 2013 was reported as 7.5 million DALY [35].

The global data on GBS and Miller Fisher syndrome are so limited [35]. The GBS is characterized with sensory symptoms including sensation in the legs, rapidly progressive distal weakness, loss of vibration and proprioception and respiratory symptoms. WHO (2014) reported the disability weight of GBS at 0.445, lower than the one for gastroenteritis and enteritis. The illness, however, has life-long disability.

3.3 Exposure Assessment

Contamination of the poultry occurs at any given stage of the process of preparation of the poultry. The process of preparation of the street vended poultry in the informal settlements follows the schematic illustration shown in Figure 1. More than eight in every ten (87.5%) of the households in the informal settlements had the whole family as consumers of the street vended. Similar findings were reported in the informal settlements in India where both the adults and children were found to be consumers of street-vended [37]. The consumption of the street-vended chicken is either with or without further processing. Eight in every ten (82.8%) of these consumers had an intake of at least once a week. Namugumya and Muyanja (2011) also reported that poultry and meat products were one of the most frequent dishes of urban communities in Uganda. All the raw and cooked samples which were sampled were contaminated with C. jejuni. The microbial load of *C. jejuni* on raw and cooked portion of chicken was reported as 8.95±0.94 and 4.66±2.67 log_{10} CFU g-1 in this study. Another study that evaluated the raw portions of chicken in Burma and Ngara that were reported by the vendors as the sources of the chicken found that they had a microbial load of >4 log CFU g^{-1} [39]. The high level of contamination in raw poultry was attributed to handling whereas undercooking was found to be responsible for the contamination in the cooked portions.

The informal settlements of Nairobi County host majorly the low economic class. The informal settlements in Nairobi that would be of greatest interest including Kibera, Mukuru Kwa Njenga, Mathare and Korogocho slums have an estimated population of 1.7 million people [40]. The low income status of this area occasions the largest proportion of the residents to opt for compromised quality of products. The study established that street food consumption in the area stood at 86%, which involved intake by the general household including children under the age of five years.

Through derivation from studies by Carron et al. (2018) and Mageto et al. (2018), the occurrence of C. jejuni in street vended raw poultry in the informal settlements was established as 48.96%. The high level of contamination in theses raw portions are due to poor food handling practices [41]. The raw portions of poultry are usually roasted or deep-fried before sale. Proper heat treatment has been proven as an effective strategy in eliminating the microbial counts of *C. jejuni* to undetectable levels [42, 43]. However, roasting as one of the fastest heat techniques has been indicated as one of the improperly practiced food preparation techniques that enhance the food safety risks and heat resistance in microbes [44]. Karoki et al. (2018) in his study showed that roasting would not reliably reduce the microbial counts in meat. Heating temperatures of ≥70oC for about two minutes would reliably eliminate *C. jejuni*, though the cooking at the informal settlements is highly questionable.

The cooked samples of poultry had an average *C. jejuni* count of 4.66±2.67 log_{10} CFU g-1 which was above the infective dose for *C. jejuni*; the infective dose of *C. jejuni* has been indicated to be low, 2.7-2.9 log_{10} CFU g-1 [45]. The average weekly consumption sizes of poultry were found to be 140g per person. The intake levels found in this study were lower than those reported for both the children and adults who were reported to have consumption levels of 300g and 450 g respectively [37]. Further contamination of the cooked poultry products has been attributed to the poor post processing handling that included contamination from the display surfaces and hands. This study established that all the display surfaces of the vendors were contaminated with C. jejuni averaging at 6.84±0.71 log_{10} CFU g-1. Three quarters of the vendors (76.9%) did not cover their food on display. There were no systems for control against post process contamination. In as much as 72.1% of the vendors had been oriented on food safety issues, none of them (0%) had any formal training or expertise in food handling. Food safety training improves the food safety of processed food [46].

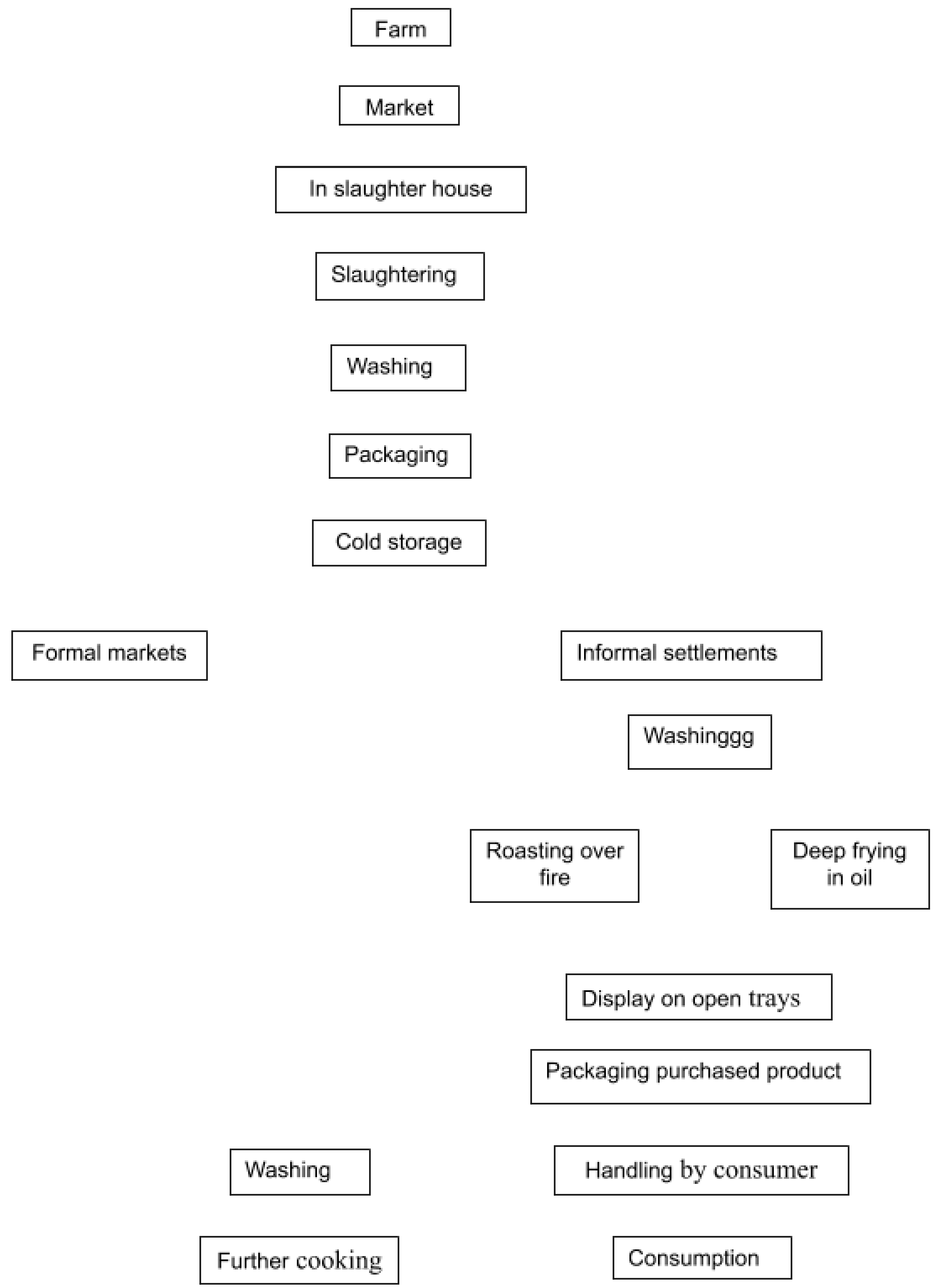

Fig. 1. : Process of preparing street vended poultry in informal settlements. Sources [47, 48].

3.4 Risk Characterization

No study has established the quantitative estimate of the risk posed by consumption of street vended poultry in the informal settlements. There is also no documented information on the process controls of the preparation of street foods. The information from the three previous steps of qualitative risk assessment was combined in the Risk Ranger software for the generation of a risk estimate. The probability of illness per day in a considered consumer was found as 7.12E-03. Another study that evaluated the risk of Campylobacter infection due to consumption of ham reported that the probability of illness in an individual was 2.20E12 [49]. Predicted illnesses in the population were found to be 1.11E06.

The risk estimate generated for consumption of found to be 67. The level of risk posed is interpreted as to be a high risk, >48 [22]. The risk estimate is also higher than that posed by chicken consumed either in rural or urban china which were 52 and 49 respectively [50]. Another study in South Korea agreed that the outdoor, eating, of chicken and other poultry feeds poses additional risks than the indoor [51]. This calls for better controls to be put in place to manage the current risk. Proper cooking of the food and that which will reliably eliminate all hazards will reduce the risk posed in the consumption of street-vended poultry.

Table 1: Summary of Risk Ranger input data

Risk criteria	General population
Dose and severity	
Hazard severity	Mild hazard
Susceptibility	General, all members of the population
Probability of exposure	
Frequency of consumption	Weekly
Proportion consuming	Most (75%)
Size of population	1.7 million
Probability of consumption	
Probability of raw product contamination	48.96%
Effect of processing	The process usually (99% of cases) eliminates hazards
Possibility of recontamination	Yes- Major (50% frequency)
Post-process control	Not controlled-no systems, untrained staff (10-fold increase)
Increase to infective dose	Slight (10 fold increase)

Further cooking before eating	Meal preparation usually eliminates (99%) hazards
Probability of illness per day in the considered consumer	7.12×10^{-3}
Predicted cases of illnesses in the population	1.11×10^{6}
Risk ranking (0-100)	67

4. CONCLUSION

In as much as the street vended poultry have a greater preference and affordability, the food safety risks of consuming the products are very high. The risk of campylobacteriosis due to intake of street vended poultry is very high among the dwellers of the informal settlements. Less surveillance and disregard of important food hygiene and preparation practices creates this gap that endangers the lives of the consumers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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