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Food contamination with salmonella and human health in Kinshasa city, Democratic Republic of Congo (DRC)

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ABSTRACT

Objectives: The objective of this study was to assess the level of salmonella contamination of fish and meat from public markets, meat from butcheries and beef carcasses offered for retail sale in Kinshasa, the capital city of the Democratic Republic of Congo

Methodology and results: *Salmonella spp.* in fish and meat was isolated using the classical technique with a pre-enrichment, enrichment, isolation and identification. The mean number of colonies counted was expressed as log_{10} colony forming units per gram (log10 cfu/g). The prevalence of *Salmonella* contamination was 11.1% for fish, 18.3 % for meat from public markets, 14.4 % for meat from the butcheries and 27.5 % for beef carcasses at the public abattoir. The positive rate in the evening was higher than in the morning ($p<0.05$). The bacterial loads ranged from 2.48 - 9.84 log_{10} cfu/g.

Conclusions and applications: This study revealed salmonella contamination of fishes and meats offered for retail sale in Kinshasa city. The contamination was higher in the evening than in the morning. Salmonella are pathogenic microorganisms significant in food infection and intoxications. Results from this study indicate that the food hygiene is poor demonstrating the importance of controlling this pathogen in food processes

Key words: Salmonella, meat, retail sale, abattoir, Democratic Republic of Congo

INTRODUCTION

Most developing countries are faced with high incidences of food poisoning outbreaks. Food borne diseases remain an important public health problem worldwide and one of the most significant food safety hazards associated with foods from animals (Maripandi and Al-Salamah, 2010). Meat is one of the most consumed foods in the Democratic Republic of Congo in general and the city of Kinshasa in particular. However, meat is the most perishable of all staple foods since it contains sufficient nutrients needed to support the growth of microorganisms (Huda *et al.*, 2010). In the Democratic Republic of Congo, meat is sold at a retail level to the public on open markets (Fig. 1) and kept exposed making it naturally vulnerable to infection with different types of microorganisms such as *Salmonella*. Salmonellosis is an important public health problem causing substantial morbidity, and thus having a significant economic impact. Although most infections cause mild to

moderate self-limited disease, serious infections leading to death do occur (Laconha *et al*., 2000; Birgitta de Jong and Ekdah, 2006).

Fig 1: Meat for sale in open market

In the last years, global surveillance data indicated that the incidences of salmonellosis has increased mainly associated with the consumption of raw or undercooked eggs, poultry, meat or dairy products (Katayama *et al*., 2013; Samiullah, 2013), demonstrating the importance of controlling this pathogen in food processes. In the developed world, salmonellosis due to *S. Enteritidis* is most often associated with consumption of poultry and eggs (Stojanović *et al*., 2010). They are relatively few surveys and lack of information on the bacteriological status of meat sold in Kinshasa and the level of hygiene of the public abattoirs in the Democratic Republic of Congo. Several food borne outbreaks linked to *Salmonella* were attributed to meat and poultry (Thomas *et al*., 2006). Salmonellosis is the disease caused by *Salmonella* serovars. A few serotypes are host-specific like *Salmonella typhi* for typhoid fever in human beings. However, the others are not host-specific and may infect several animal species including human beings. These serotypes are generally responsible for food borne diseases such as nausea, intestinal cramps, diarrhoea, vomiting and possible arthritic symptoms. These diseases are treatable (Coburn *et al*.,2007, Neto *et al*., 2010). The presence of Salmonella infections such as typhoid fever caused by *Salmonella typhi* is a major public health concern in the Democratic Republic of Congo. In December 2004, there was an outbreak of typhoid fever in Kinshasa, the capital city of the Democratic Republic of Congo. A total of 13 400 cases were reported. Between 1 October and 10 December 2004, 615 severe cases with peritonitis, with or without perforation, including 134 deaths have occurred (WHO, 2004). The aim of this study was to assess the level of salmonella contamination of fish and meat from public markets, meat from butcheries and beef carcasses offered for retail sale in Kinshasa, the capital city of the Democratic Republic of Congo.

MATERIALS AND METHODS

Material and sampling: Seventy-two samples of fresh fish, 120 samples of meat (beef, pork, mutton, goat and chicken meat) were randomly selected from public markets in Kinshasa. Eighty-for samples of meat (beef, pork and chicken meat) were also selected from butcheries and 40 samples of beef carcasses from the public abattoir. All samples were collected from 2010-2011. Fishes collected were Tilapia, Mackerel, Catfish, Roach fish, Common carp and Bleak fish. Fish and meat samples from retail markets and butcheries were collected 50 % in the morning (8.00 – 9.00 am) and 50 % in the evening (4.00 -5.00 pm). Samples were kept in separate sterile plastic bags, stored in cool boxes and transported to laboratory on the same day of sample collection.

Microbiological assays: Twenty-five Grams of meat were cut into small pieces before being added to a stomach bag containing 225 mL of buffered peptone water (BPW). The 1 mL of the homogenate was serially diluted in an aseptic condition and used for the enumeration of microorganisms. *Salmonella spp.* were isolated using the classical technique with a pre-

enrichment on buffered peptone water (Oxoid CM 509), enrichment into Rappaport Vassiliadis Broth (Merck 1.07700), isolation on Salmonella-Shigella Agar (Merck 1.07667) and identification with the API 20 E (Biomérieux, France). The mean number of colonies counted was expressed as log_{10} colony forming units per gram (log10 cfu/g).

Statistical analysis: The Chi-square test were used to compare the prevalence of salmonella contamination between samples collected in the morning and those collected in the evening (p=0.05).

RESULTS

Salmonella contamination of fish samples from public markets: A total of 72 fish samples were collected and among which 8 positive. The positive rate was 11.1% (Table 1). All fish species were contaminated except Tilapia and bleak fish. The highest number of *Salmonella* was found in roach fish sold in the evening (6.95 log_{10} cfu/g).There was no significant difference between the prevalence of Salmonella contamination in the morning and the evening (Table 5).

Table 1: Results of *Salmonella* in fishes

Species	Time	n	Positive	Positive rates (%)	Mean counts (log_{10}cfu/g)
Tilapia sp	Morning	6	0	0	0
	Evening	6	0	0	0
Mackerel	Morning	6	1	16.7	2.48
	Evening	6	2	33.3	3.73 ± 2.45
Cat fish	Morning	6	1	16.7	5.48
	Evening	6	1	16.7	4.30
Roach fish	Morning	6	1	16.7	4.48
	Evening	6	1	16.7	6.95
Common carp	Morning	6	1	16.7	5.30
	Evening	6	0	0	0
Bleak fish	Morning	6	0	0	0
	Evening	6	0	0	0
TOTAL		72	8	11.1	

Results of *Salmonella* in meats and beef carcasses: Meats from public markets were contaminated with *Salmonella* and the positive rate was 18.3% (Table 2). Mutton was more contaminated (50%) than all other meats followed by pork (41.7%). Meats sold in the evening were more contaminated than those sold in the morning were ($p<0.05$) (Table 5). The highest number of *Salmonella* was found in pork (8.30 log_{10} cfu/g). From the butcheries, 84 samples of beef, pork and chicken were collected with a positive rate of 14.3% (Table 3).There was no significant difference between the prevalence of *Salmonella* contamination in the morning and the evening (Table 5). The chicken meat was less contaminated than other meats. The prevalence of *Salmonella* contamination for beef carcasses at the public abattoir was 27.5% (Table 4) with a mean value of 5.76 ± 2.71 log_{10} cfu/g.

Table 2: Results of *Salmonella* in meat from public markets

Species	Time	n	Positive	Positive rate (%)	Mean counts (log_{10} cfu/g)
Beef	Morning	12	1	8.3	6.70
	Evening	12	2	16.7	6.85 ± 0.21
Goat meat	Morning	12	0	0	0
	Evening	12	4	33.3	6.25 ± 2.03
Mutton	Morning	12	0	0	0
	Evening	12	6	50	7.66 ± 1.02
Pork	Morning	12	1	8.3	8.30

	Evening	12	5	41.7	6.66 ± 2.04
Chicken meat	Morning Evening	12 12	0 3	0 25	0 6.90 ± 1.42
TOTAL		120	22	18.3	

Table 3: Results of *Salmonella* in meats from the butcheries

Species	**Time**	**n**	**Positive**	**Positive rate (%)**	**Mean counts (log_{10} cfu/g)**
Beef	Morning Evening	14 14	1 4	7.1 28.6	7.70 6.91 ± 0.59
Pork	Morning Evening	14 14	3 3	21.4 21.4	7.93 ± 0.33 8.11 ± 1.22
Chicken meat	Morning Evening	14 14	0 1	0 7.1	0 6.48
TOTAL		84	12	14.3	

Table 4: Positive rate and mean values of *Salmonella in* beef carcasses at the public abattoir

N	40
Positive	11
Positive rate	27.5 %
Mean value (log_{10} cfu/g)	5.76 ± 2.71
Min	2.60
Max	8.60

Table 5: Prevalence of Salmonella contamination for fishes and meats in the morning and the evening

Variable	Time	N	Positive	Positive rate (%)
Fish	Morning Evening	36 36	3 5	8.3^a 13.9^a
Meat from markets	Morning Evening	60 60	2 20	3.3^a 33.3^b
Meat from butcheries	Morning Evening	42 42	4 8	9.5^a 19^a

Prevalence with the same letter in the same category sample is not significantly different at 5%

DISCUSSION

Across the world, food contamination by pathogens is a health concern to consumers as well as for several governments (Birgitta de Jong and Ekdah, 2006). The search of *Salmonella*, microbe responsible for food poisoning and gastroenteritis in humans becomes a priority for many nations (Dobrinas *et al.,* 2014). In this study, 72 samples of six species of fish from public markets in Kinshasa revealed the prevalence as 11.1%. All markets were contaminated. This result for Salmonella contamination in fish samples (11.1%) was in close agreement with that of Qiumey *et al*., (2012) who reported that 10% of fish samples were contaminated with *Salmonella sp*. in Shanghai province. These studies showed also that all types of meat from the markets as well as from the butcheries were contaminated (Table 2 and Table 3) with a positive rate of 18.3 % and 14.3% respectively. These products, according to many reports, are the sources of *Salmonella* contamination (Vindigni *et al*., 2007; Ghimire *et al*., 2013; Dobrinas *et al*., 2014). In the markets, retail mutton and pork were highly contaminated. The prevalence of *Salmonella* contamination in retail mutton, pork, goat, beef and chicken meat from the market were 25% (6/24), 25% (6/24), 16.7% (4/24), 12.5% (3/24) and 12.5 %(3/24) respectively. The prevalence of *Salmonella* in retail pork and chicken meats in this work was less than that reported by Lertworapreecha *et al*. (2013) from retail markets in Phatthalung Province, Thailand. In the public markets, the prevalence of *Salmonella* contamination

was 11.1% (8/72) for fish and 18.3 % (22/120) for meat but there was no significant difference ($p>0.05$) between the prevalence of *Salmonella* contamination for fish and meat. According to Erdogrul and Bulbul (2006), Salmonella microorganism is rarely seen in fish. However, it could reproduce upon the contamination from the environment. Previous studies examining the presence of *Salmonella* reported that different fish species could be contaminated with *Salmonella sp*. (Erdogrul and Bulbul, 2006; Akaki *et al*., 2012). Of 120 meat samples collected from the markets, 60 were collected in the morning with a positive rate of 3.3% (2/60) and 60 in the evening with a positive rate of 33.3% (20/60). The positive rate in the evening was higher than in the morning ($p<0.05$). These results showed increased environmental contamination and reflect poor condition and unhygienic practices (Adetunji and Isola, 2011). At the public abattoir, the prevalence of *Salmonella* in beef carcasses was 27.5% (11/40). The number of *Salmonella* was ranging from 2.60 – 8.60 $\log_{10}$ cfu/g. This result was in agreement with those of Gormley *et al*. (2010); Koffi-Nevry *et al*. (2011) indicating that the contamination with bacterial pathogens occurred earlier in the production chain. In this study, the presence *of Salmonella sp.* was indicative of poor hygiene and a potential danger to consumers. Therefore, *Salmonella sp.* in foods constitutes a significant risk can be used as an indication of cross-contamination as emphasized by other reports (Mattick *et al*., 2002; Maharjan *et al*., 2006). Numerous studies have demonstrated how pathogens can be effectively distributed around the environment and back to food in the absence of strictly observed hygiene guidelines (Onenyeho and Hedberg, 2013 ; Redmond and Griffith, 2003). The high-risk human population, which is infants, elderly, immuno-compromised and malnourished persons are highly susceptible and the presence of *Salmonella* even in low numbers constitutes a major public health concern (Dominguez *et al*., 2002; Molla *et al*., 2003).

CONCLUSION

This study revealed salmonella contamination of fishes and meats from the public markets, butcheries and abattoir. The presence of Salmonella in fishes and meats, which are pathogen microorganisms significant for food infection and intoxications, are highly important for public health. Results from this study indicate that the food hygiene should be improved. In addition, the specific salmonella a species needs to be researched into for better prevention of the disease.

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