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Socio-economic profile of street food vendors and microbiological quality of ready-to-eat salads in Lomé

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Abstract

Rapid urbanization leads many inhabitants of our young cities to adopt collective food for their daily nutritional needs. This situation may be a risk for consumers due to microbial contamination from street environment and bad practices related to hygiene. The present study aimed to correlate socioeconomic profile of street food vendors and the microbiological quality of ready-to-eat (RTE) vegetable salads served by food shops in Lomé. The data were gathered from 45 food shops owners using semi structured questionnaires. The microbiological quality of 69 RTE vegetable salads purchased from food shops was also assessed using the standardized routine methods adopted in the West African Economic and Monetary Union countries. The results showed that the street food sector is dominated by females, and 71.11% of them attended school. They lacked training on food hygienic and sanitary practice, and personal hygiene was not observed. *Salmonella* spp. was not detected in any of the samples evaluated, but almost 25% of the samples were contaminated by *S. aureus*. The percentage of samples positive for indicator of food safety lack germs like Total aerobic bacteria, Total coliforms, Thermotolerant coliforms were 100, 100 and 37.68 respectively; corresponding to conformity rates of 14.49, 11.59 and 81.16 respectively. As for Aerobic sulfite reducing bacteria, Yeast and Mould, the percentages were respectively 11.59, 78.26 and 72.46 with conformity: 92.75, 68.11 and 94.20. The level of the microbial contamination of the RTE salads collected from collective eating places in Lomé may present a potential health hazard to consumer. In this regards, regular inspections of food premises and education of food vendors has been recognised as one of the measures to ensure improvement of the quality of street foods.

Introduction

In many cities and towns of developing countries, street food vending is a large source of employment (Choudhury *et al*., 2011), and contributes significantly to households incomes (Lucca and Torres, 2006; Biswas *et al*., 2010; Oladipo, 2010; Feglo and Sakyi, 2012). Street foods are defined by the FAO as ready-to-eat (RTE) food and beverages prepared and or sold by vendors and handlers especially in streets and other similar places for immediate consumption or consumption at a later stage without further processing or preparation (Food and Nutrition, 1989). It is well established that urbanization is taking place quickly in Sub-Saharan Africa, and it is one of the greatest challenges of the 21st century (Amponsah-Doku, 2010). The demographic expansion, coupled with the urbanization requirements, has given new dimensions to this activity. Many urban dwellers obtain a significant portion of their diet from street foods-prepared, increasing considerably the street food demand in major cities (Pikuda and Ilelaboye, 2009; Suneetha *et al*., 2011). Ready-to-eat salads constitute an expanding food commodity nowadays served to these consumers (Carrasco *et al*., 2010; Arvanitoyannis *et al*., 2011). Salad can be defined as a food made primarily of a mixture of raw vegetables and/or fruits (Uzeh *et al*., 2009; Rajvanshi, 2010). It is clearly evident that a large number of vegetables are a good source of antioxidants and phytonutrients, and have health protecting properties (Meng *et al*., 2002; Heo and Lee, 2006; Vrchovska *et al*., 2006), to improve human well being. In contrast with these advantages, the salads containing raw vegetables may be unsafe, mainly because of the environment under which they are prepared and consumed (Taban

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et al., 2011) and also of the lake of personal hygiene (Martinez-Tomé *et al*., 2000; Cuprasitrut *et al*., 2011). These foods have been identified as vehicles of bacterial agents and generate food safety problems, especially gastroenteritis (Beuchat and Larry, 1996; Mosupye and Holy, 2000; Kubheka *et al*., 2001; Meng *et al*., 2002; Adu-Gyamfi and Nketsia-Tabiri, 2007). The incriminated microorganisms included *Pseudomonas* spp., *Xanthomonas* spp., *Enterobacter* spp., *Chromobacterium* spp., lactic acid bacteria, yeasts, less frequently *Aeromonas hydrophila*, and occasionally *Listeria monocytogenes* (Lavelli *et al*., 2006).

In a previous study, we reported frequent cases of poisoning following the consumption of vegetables in Lomé (Adjrah *et al*., 2011). There are an increasing number of street food vendors in this city, particularly those who are serving the salads of vegetables. The main contamination stage in these foods process is the transformation and vending. This investigation presents the socioeconomic profile of street food vendors and the microbiological assessment of ready-to-eat (RTE) vegetable salads served by food shops in Lomé.

Materials and Methods

Study area and typology of street food vended

Eight popular districts namely Adawlato, Gblékomé, Nukafu, Nyékonakpoè, Adidogomé, Agoè, Bè and Hanokopé in the city of Lomé (capital of Togo) were concerned by the survey, carried out between April and June 2011. The socioeconomic conditions and hygiene practices were determined using a semi-structured questionnaire and an observation checklist. The questionnaire was addressed to 45 randomly selected owners of food shops vending salads. The following data were gathered: (i) gender, age, education level, experience in food job, income; (ii) sanitary behavior including vestment and health certificate; (iii) preference of disinfecting; (iv) sources of water used; (v) knowledge of food born diseases; (vi) perspective to receive hygiene training.

Food sampling

A total of 69 samples of salads weighting 530 to 640 g were collected from food shops located along the paved streets in districts above mentioned. A total of seven samples were bought every five days at midday or afternoon for analysis. All the samples did not have the same composition, but there were mainly constituted from lettuce mixed with others vegetables (cabbage, cucumber, beet, onion, carrots, and tomatoes), eggs, condiments (mayonnaise, vinegar, oil and salt). In all instances, each sample was placed in labeled sterile polyethylene sachets, kept in icebox and immediately transported to the laboratory.

Microbiological analysis

The microbiological procedures used to analyze vegetable were those recommended in the standardized routine methods adopted in the West African Economic and Monetary Union countries. These analyses related the following germs enumeration: total aerobic flora, total coliforms, thermotolerants coliforms, anaerobic sulfite-reducing bacteria, *Staphylococcus aureus*, fungi and *Salmonella* spp. For microbiological purposes, all media were purchased from Biomerieux (France). Microbial enumeration was performed as follows: 10 grams of each sample were crushed in 90 ml tryptone salt in aseptic conditions. Serial decimal dilutions (10^{-1} to 10^{-5}) were prepared from these suspensions, and 1 ml of each dilution was used to inoculate Petri dishes for cell enumeration. Total aerobic bacteria were determined with Plate Count Agar (PCA) after 24 h incubation at 30°C. Total coliforms and thermotolerant coliforms were enumerated on Violet Red Bile Lactose (VRBL) agar after 24 h incubation at 30 and 44°C, respectively. For *S. aureus* enumeration, 0.1 ml of the suspension was spread on Baird-Paker. After 48 h incubation at 37°C, black smooth colonies showed convex to uniform outline with one or two halos were streaked on Chapman agar. After 24 h incubation at 37°C, morphological characteristics were confirmed by Gram staining, catalase activity, and coagulation of citrated rabbit plasma. The amount of sulphite reducing bacteria was assessed by Most Probably Number with tryptone-sulfite neomycin (TSN) agar after 20 h incubation at 44°C. Sabouraud-Chloramphenicol agar was used for the isolation and identification of Yeast and moulds, and plates were incubated for 3 to 5 days at 30°C. Pure isolates of mould were identified by using macroscopic complete with microscopic characteristics of the colonies. For *Salmonella* spp., Buffered Peptone Water was used for pre-enrichment at 37°C for 24 h; followed by enrichment at 37°C for 24 h with Rappaport vassiliadis soya broth prior to isolation and counting on Hektoen and SS agar at 37°C (24 h).

"Association Française de Normalisation (AFNOR)" limits for frozen vegetables were used to appreciate the conformity of the analyzed samples: Total aerobic bacteria (30°C), $5x10^5$ cfu/g; Total coliforms (30°C), 3x1000 cfu/g; Coliform Themo-tolerants (44ºC), 15 cfu/g; Anaerobic sulfite-reducing bacteria, 10 cfu/g; *S. aureus* (37°), 10 cfu/g; Moulds (30ºC), 1000 cfu/g; Yeasts (30ºC), 500 cfu/g; The

Salmonella 0 cfu/25g.

Statistical analysis

Statistical analysis were performed using Sphinx Plus[2] (ERGOLE INFORMATIQUE version 4.0) program. Descriptive statistics such as means and frequencies were used to express the results.

Results

Socioeconomic characteristics of vendors and hygiene practices

The present study included 45 participants, 15 men and 30 women. Table 1 displays the characteristics of the participants. Over 44% of the persons interviewed were ranged in the age group 25 – 39 years old. With regards to the educational level, 37.78% were of primary school level, while 22.22% attended the secondary school. Few of the respondents (15.56%) indicated that they have received food hygiene training. Street food vending is main occupation of more than two-thirds (68.89%) of participants, and 46.67% of respondents had 5 to 9 years experience in this job. Only 5 persons (11.11%) belonged to cooperatives, 53.33% of the shops used 1 to 3 employees. The average monthly income earning this activity was ranged from 10 000 – 30 000 CFA for over 62.22% owners. Only 4.44% of the respondents declared gain above 50 000 CFA. The percentage of food shop owners who had no health certificate was 55.56, and among those who presented one, 82.22% were not updated. About protective clothing, 53.33% of workers were in their own clothes, and 42.22% did not protect their hair with caps. More of half of participants (51.10%) used tap water to prepare, well (26.70%) and drilling (22.20%) were others sources of water. The majority of the interviewed persons (84.44%) knew that vegetables are possible sources of microbial contamination, and Potassium permanganate (40%), saline water (28.89%) were commonly used for disinfecting vegetables. Sodium hypochlorite, vinegar, lemon and soap were others products used to wash vegetables. More of two thirds (68.89%) were laid out to receive the hygiene training.

Table 1. Characteristics of vendors and hygiene practices

Characteristics	Frequency (%)	Characteristics	Frequency (%)
Gender		Health certificate possessing	
Male	15 (33.30%)	Yes	20 (44.44%)
Female	30 (66.70%)	No	25 (55.56%)
Age groups		Health certificate update	
< 25	16 (35.6%)	Yes	8 (17.78%)
25 – 39	20 (44.4%)	No	37 (82.22%)
40 – 49	9 (20%)	Aprons cover own workers clothes	
50 et plus	0 (0%)	Yes	21 (46.67%)
Education level (years)		No	24 (53.33%)
Illiterate	13 (28.89%)	Use of caps to protect hair	
1 – 6	17 (37.78%)	Yes	26 (57.78%)
7 – 10	10 (22.22%)	No	19 (42.22%)
> 10	5 (11.11%)	Source of water used	
Food hygiene/safety training		Well	12 (26.70%)
Yes	7 (15.56%)	Taps	23 (51.10%)
No	38 (84.44%)	Drilling	10 (22.20%)
Major activity for the vendor		Vegetables are sources of microbial contamination?	
Yes	31 (68.89%)	Yes	38 (84.44%)
No	14 (31.11%)	No	7 (15.56%)
Experience in this occupation		Preference for disinfecting agent	
< 5 years	13 (28.89%)	Only water	2 (4.44%)
5 – 9 years	21 (46.67%)	Sodium hypochlorite	4 (8.89%)
10 – 19 years	10 (22.22%)	Potassium permanganate	18 (40.00%)
20 and over	1 (2.22%)	Saline water	13 (28.89%)
Member of cooperative		Lemon	3 (6.67%)
Yes	5 (11.11%)	Vinegar	3 (6.67%)
No	40 (88.89%)	Soap	2 (4.44%)
Employees engaged in the unit		Willing to receive the hygiene training	
None	12 (26.67%)	Yes	31 (68.89%)
1 – 3	24 (53.33%)	No	14 (31.11%)
4 and over	9 (20%)		
Average monthly income (CFA)			
< 10 000	10 (22.22%)		
10 000 – 20 000	19 (42.22%)		
20 001 – 30 000	9 (20.00%)		
30 001 – 40 000	2 (4.44%)		
40 001 – 50 000	3 (6.67%)		
> 50 000	2 (4.44%)		

Table 2. Prevalence of microbial load on salads sampled in street food shop

	Microorganisms						
	Total aerobic bacteria	Total coliforms	Thermo-tolerant coliforms	Aerobic sulfite reducing bacteria	*S. aureus*	Yeast	Mould
Samples tested							
positive (%)	100	100	37.68	11.59	23.18	78.26	72.46
Minimum (ufc/g)	$0,1x10^5$	10	10	15	10	20	0
Maximum (ufc/g)	$2\,600x10^5$	$3\,000x10^3$	$92x10^3$	300	200	11 800	4 800
Mediane (ufc/g)	$32x10^5$	$19x10^3$	0	0	0	110	20
AFNOR criteria	$5x10^5$	1 000	15	10	10	500	1 000
Conformity (%)	14.49	11.59	81.16	92.75	81.16	68.11	94.20

Microbial assessment

As shown in Table 2, all the 69 samples of street sold salads did not contain Salmonella (conformity, 100%). However all these samples contained total aerobic bacteria (TAB), with a median count of 32.10^5 TAB colony forming units (cfu) per gram of salads (range, $0,1x10^5$ to $2600x10^5$ cfu/g). Concerning these germs, in accordance with the AFNOR limits, only 14.49% of samples were conforms. All the samples were contaminated with total coliforms (TC), with a median count of $19x10^3$ cfu/g (range, 10 to $3000x10^3$ cfu/g), and the conformity rate was 11.59%. Thermotolerant coliforms (ThC) were found in 37.68% of samples, and the median amount was 0 colony with a range of 0 to $92x10^3$. Aerobic sulfite reducing bacteria (ASRB) contaminated 8 samples (11.59%) and the count ranged between 15 and 300 ufc/g. Sixteen samples (23.19%) were tested positive to S. aureus with amount range from 10 to 200 cfu/g (median, 0 cfu/g). Yeast and moulds count respectively ranged between 15 - 11800 cfu/g (median, 110 CFU/g) and 10 - 4800 cfu/g (median,

20). Referring to Thermotolerant coliforms, ASRB, *S. aureus*, Yeast and moulds, the conformity rates of the analyzed salads ranged from 68% to 94%. The isolated moulds included *Aspergillus flavus*, *Aspergillus nidulens*, *Aspergillus niger*, *Aspergillus fumigatus*, *Mucor* sp, *Fusarium* sp and *Rhizopus* sp.

Discussion

This study focused on the socioeconomic profile of the street vegetable salads vendors in Lomé. Their hygiene practices and the microbiological quality of salads sold were assessed in order to draw up strategies to improve the safety of these foods. The street food enterprises in Lomé like São Paulo city in Brazil, Gauteng in South Africa and Bangkok in Thailand is dominated by females (Hanashiro *et al*., 2005; Martin, 2006; Cuprasitrut *et al*., 2011). This is in contrast with the situation in Guwahati city (India), where Choudhury *et al*. (2011) recorded 88% males in this activity. Most of the vendors had not received training on hygiene practices, but the proportion of them who attended secondary school level constitute a major asset to conduct training programs on various aspects of personal, environmental and food safety and hygiene for them. Before thinking about training, there is a need to organize them because the majority of participants were not in cooperative.

Concerning hygiene practices, many of them did not get health certificate to testify that they were medically examined. This is one of the main challenges for the foods control officers, because in many countries, particularly in Togo, local health codes prohibit employees having contagious diseases or those who are carriers of such diseases from preparing and handling foods or participating in activities that may result in contamination of food or food contact surfaces. In addition, the majority of vendors had inappropriate clothing, few of them had protective clothing like aprons and head covers. These findings are in agreement with the study of Hanashiro *et al*. (2005) in Brazil, who pointed out that only 5.5% and 8% of street food vendors respectively wore caps and aprons. The results showed that the participants were aware that several food-born illnesses may have a microbiological origin. This can explain their choice to disinfect vegetables before their preparation. We obtained a similar result as Behrens *et al*. (2010), who reported that in Brazil, various disinfecting agents were used by street food vendors in order to eliminate contaminants. They noted that washing under running tap water and soaking in solutions of vinegar or lemon juice appeared to be commonsense ways to sanitize fruits, green leaves and vegetables. Previous investigation carried about the use of disinfectants in households of Lomé confirms the significant use of saline water in order to remove microorganisms from vegetable (Adjrah *et al*., 2011). The erroneous perception of the populations to use inappropriate products such as salt shows their ignorance.

Numeration of the total aerobic bacteria and the total coliforms on salads samples examined in the present investigation showed the high microbial contamination. Cenci-Goga *et al*. (2005) pointed out that the total aerobic bacteria count was a good indicator of food safety. A similar study was carried out in Lagos (Uzeh *et al*., 2009) and the total aerobic bacteria count ranged from $3.3x10^3$ to $5.9x10^6$ cfu/g. The same findings were reported Hanashiro *et al.* (2005) in São Paulo for Thermotholerant coliforms load. The percentage of salads vended on Jaipur City Street in India (Rajvanshi, 2010) which were colonized by *S. aureus* is below (10.9%). In contrast, Feglo and Sakyi (2012) did not isolate *S. aureus* in any sample of salads collected in Kumasi (Ghana). Vegetable salads do not need to be heated before consumption, whereas, vegetables may act as a reservoir for many microorganisms (Beuchat, 2002). Therefore, RTE salads carry the potential risk of microbiological contamination due to the usage of untreated irrigation water or sewage, inappropriate organic fertilizers or inadequately composted manure, the harvesting, the handling, processing and distributing during the restaurant services (Taban and Halkman, 2011). Previous research pointed out that vegetables produced in Lomé represent a microbiological risk for consumers (Adjrah *et al*., 2011). In this investigation, the high number of TAB in the samples suggest lack of hygienic practices, and the presence of coliforms may indicate fecal contamination which might be due to the use of raw vegetables and inappropriate processing, probably at one or other stage of preparation or from the materials used. Coliforms might appear every phase of preparation; a case was reported (Seo *et al*. 2010). Concerning *S. aureus*, its presence suggests poor hygiene practices of operators. Bezirtzoglou *et al*. (2000) reported that the contamination by food handlers is the most common mode of transmission of this germ. Burt *et al*. (2003) established that its contamination might have resulted from man's respiratory passages, skin and superficial wounds which are his common sources. In this study, poor hygiene practices, particularly deficient of aprons and caps wearing could be the causative factor of contamination of the analyzed samples. HACCP application, including appropriate clothes wearing

contribute to improved food safety in the restaurant (Cenci-Goga *et al*., 2005).

Conclusion

The large number of the total aerobic bacteria, hygiene lack indicator organisms as coliforms and pathogens (*S. aureus*) detected in the RTE salads collected from collective eating places in Lomé revealed that the contamination of these foods may present a potential health hazard to consumer. In this regards, regular inspections of food premises and education of food vendors has been recognised as one of the measures to ensure improvement of the quality of street foods.

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