



# Assessment of microbial contamination risks factors and safety of out of home food in Lomé-Togo



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## ABSTRACT

**In both developed and developing countries, street food has often been at risk of intoxication. Assessment of risk factors in this sector in Lomé could help to take appropriate measures for their control. Structured questionnaires were used to collect data from 988 street vendors while standard methods were used to search for bacteria in 270 ready-to-eat (RTE) foods sampling in Lomé. The results obtained indicate that out-of-home catering sector is mainly driven by women (96.86%). About 63% of vendors have attended primary school and 72.57% are between 25 and 54 years old. Half of the sellers (50.2%) do not have professional health card. Only one bath of soap and one bath of rinsing water are used in 56.98% of cases to wash the plates. There are no Garbage cans in 26.01% of cases. Briefly, 68.89% of the samples of RTE food analyzed were unsafe and unhygienic to good health. Total coliforms (TC), thermotolerant coliforms and *Escherichia coli* induced 47.03, 58.14 and 33.33% non-conformities, respectively. *Staphylococcus aureus* was counted in 52/270 samples but *Salmonella* were not detected. Food contamination level, preparation of food and sale conditions and types of water used in catering, would constitute potential risks of toxi-infection related to the consumption of street food in Lomé. Education and sensitization of the actors of the street food sector and a follow-up by the health authorities is recommended to guarantee food without major risk of poisoning in the streets of Lomé.**

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## INTRODUCTION

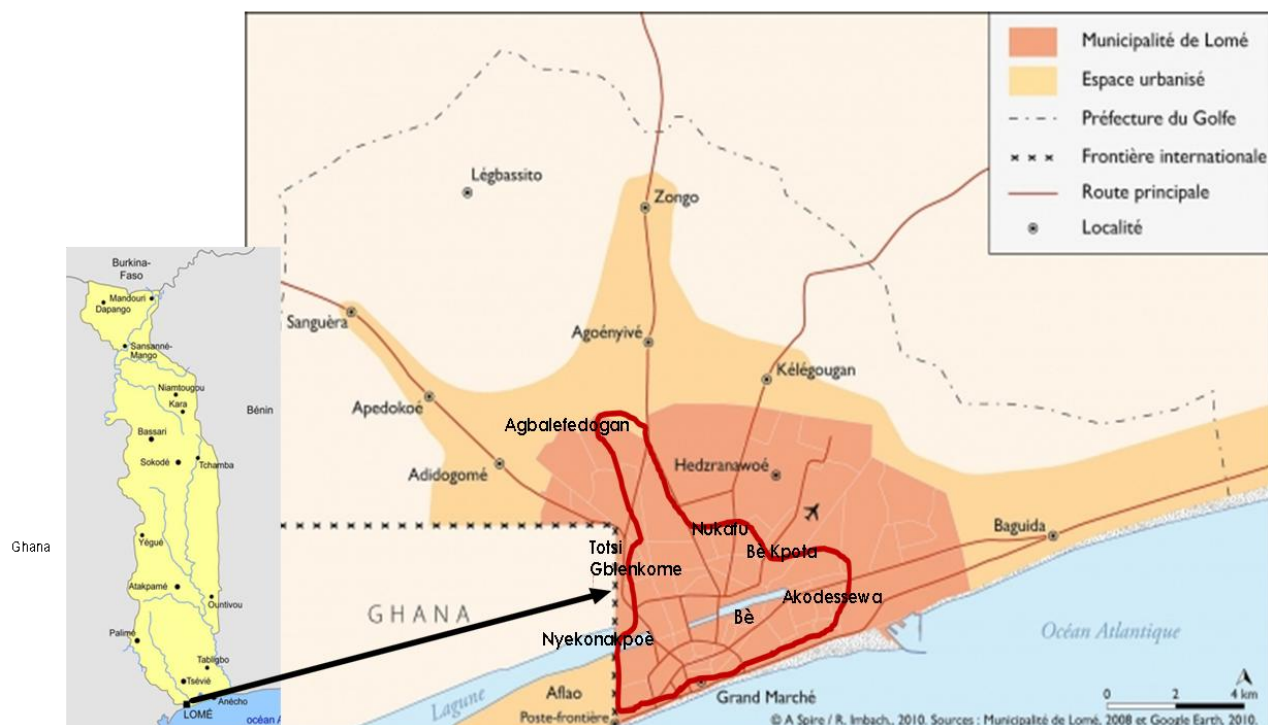
Lomé, capital of Togo, is inhabited by a large part of the population of the country. Socio-economic activities drain daily from their homes nearly 75% of the city's working population. They are essentially all kinds of workers, tradesmen, students and pupils. Like the cities of the West African sub region, Lomé have a rapid urbanization with a rapid increase of its population. The diet of this active population is often out of home in canteens, bars and street vendors.

The ready-to-eat (RTE) food products provide a source of readily available and nutritious meals for the

consumer. However, questions have been raised about the safety and microbiological quality of these food products. The incidence of foodborne illness is increasing worldwide (Mead et al., 2009; Nguz, 2007). OMS (2015) estimated that foodborne diseases in Europe amounted to 23 million with 500 deaths; in Africa the number of cases was estimated at more than 91 million with 137000 deaths. As in many African countries, Togo has no mechanism to collect these cases.

According to the data of the Health Office of Togo, diseases due to the consumption of contaminated food in 2014 were estimated at 44 123 cases of gastroenteritis with 1.5% of deaths. In a school of Lomé (in April 2016), six students were hospitalized for stomachaches and vomiting after eating confined rice in their canteen. Analysis of the rice sample allowed to isolate

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**Figure 1.** Food sampling area bounded in red in the city of Lomé.

**Source:** National Institute of Statistics and Economic and Demographic Studies.

*Staphylococcus aureus* bacteria. High counts of *Escherichia coli* and total coliform (TC) in foods usually indicates lack of hygiene in handling and production operations, inadequate storage and post-process contamination (De Sousa et al., 2002). Adjrah et al. (2013) found that 25% of salads samples analyzed in Lomé 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.

Street foods in Lomé can be potentially dangerous for many peoples who daily eat one or two meal out of home. This study attempts to evaluate the health risks to which street consumers are exposed in Lomé.

## MATERIALS AND METHODS

### Study area

Study was done in Lomé, capital of Togo. According to the 2010 Togo population census, the Lomé city counts 837.437 inhabitants. The active part of Lomé habitants represents nearly 80% of this population (Lambony and Nyassogbo, 2008).

Lomé was stratified into five health districts. Sampling activities took place in all of the districts, mainly in the red bounded zone on the map of Lomé (Figure 1). It was the area where socio-economic activities were daily more important.

### Administration of survey instruments

The survey was conducted under the authorization of the Minister of Health from 988 stationary street food vendors in Lomé. The study consisted of in-depth interviews, administration of questionnaires and observational checklists. A team of one interviewer and an assistant in each location administered a structured questionnaire to each street food vendor to elicit basic socio-demographic details, food handling practices, personal hygiene practices, types of vending sites, storage of food before selling and serving of food, handling and storage of leftovers, water supply and sanitary practices.

### Samples collection

Two hundred seventy samples of ten street foods that are commonly sold in the Lomé area were selected for the microbiological analysis. The nature and the composition

**Table 1.** Nature and composition of cooked foods analyzed.

Food names	Quantity (n=270)	Composition / ingredient
Unfermented corn-based dough	n = 19	Unfermented corn-based dough, tomato sauce of fish, chicken, beef and mutton Sauce of Corrette, okra, spinach Peanuts or palm nut sauce.
Foufou	n = 13	Cassava (or yam), tomato sauce of fish, chicken, beef and mutton.
White rice	n = 36	White rice, sauce or frying, fish, chicken or meat
Fat rice	n = 41	Fat rice, fried fish or chicken
Rice-bean (Ayi-Molu)	n = 78	Rice with beans cooked with potash, sauce and / or frying, fish, chicken or meat
KOD fermented dough of steamed corn	n = 31	Packaged fermented dough, tomato sauce, fried fish, green pepper and Chili pepper
Veyi (cooked beans)	n = 17	Cowpea (bean), oil frying, red oil, gari (cassava semolina)
Pasta	n = 13	Spaghetti, tomato sauce, fish, chicken, meat
Wheat couscous	n = 9	Wheat couscous, tomato sauce, fish, chicken, meat
Akpan (Akassa ball)	n = 13	AKPAN, sauce or frying, fish chicken or meat

of cooked foods sampled are represented in the Table 1.

Cooked samples were collected in sterile jars. Their weight was between 400 and 750 g. Samples were sent to the laboratory in cool equipment within one hour from sampling. Analysis started on the same day.

### Microbiological analyzes

From each cooked food sample, 25 g was aseptically weighed in 225 ml of buffered peptone water (BPW) and blended vigorously for 2 min at normal speed in a kitchen blender (Moulinex, France) to prepare the initial suspensions. Serial dilutions ( $10^{-1}$  to  $10^{-6}$ ) were carried out using sterile Tryptone salt (TS) as diluents.

The microorganisms carried by the dust of the air, were collected on plate count agar (PCA) and Sabouraud + chloramphenicol agar plates previously poured in Petri dish's and exposed during 10 mn. After 72 h and 5 days of incubation, the colonies were counted. The results are expressed in cfu/m<sup>2</sup>/min (Chasseur et al., 2000).

The following microorganisms: total aerobic flora, total coliforms, thermo-tolerant coliforms, anaerobic sulfite-reducing bacteria, *S. aureus* and *Salmonella* spp. were searched for in the food samples using respectively the following methods were: NF V08-051, NF V08-050, NF V08-016, XP V08-06, NF V08-057-1 and NF V08-052. All media used were purchased from Bio Rad (France). Microbial enumeration was performed as follows: 1 ml from initial suspensions or serial decimal dilutions was used to inoculate Petri dishes incubated in appropriate conditions. Only Petri dishes containing between 30 and 300 colonies were selected for enumeration. Total viable bacteria were determined with plate count agar (PCA) after 72 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. Anaerobic sulfite-reducing (ASR) bacteria were assessed with Tryptone-Sulfite Neomycin (TSN) agar after 48 h incubation at 44°C. For *S. aureus* counts, 0.1 ml of appropriate dilutions were spread on Baird-Parker agar plates supplemented with egg yolk-tellurite emulsion (Bio-Rad). The plates were then incubated at 37°C for 24 to 48 h. Each typical colony of *S. aureus* (black smooth colonies showed convex to uniform outline with one clear halo) was sub cultured in nutrient agar (37°C, 24 h). Colonies obtained on the last agar were examined microscopically, tested for gram and catalase reactions, and confirmed by coagulase activity (rabbit plasma, Bio-Rad). Buffered peptone water (BPW) 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) *Salmonella* spp. Characteristics colonies were identified by API 20E test system (Bio Merieux, France). Results were expressed as colony forming units (cfu/g).

The conformity of the analyzed products about legal provision was done using "Association Française de Normalisation (AFNOR) criteria (Arrêté du 21/12/79) for cooked foods": Total aerobic bacteria (30 °C), 3x10<sup>5</sup> cfu/g; Total coliforms (30°C), 1000 cfu/g; Thermotolerant coliforms (44°C), 10 cfu/g; Anaerobic sulfite-reducing bacteria, 30 cfu/g; *S. aureus* (37°C), 100 cfu/g; *Salmonella* absent/25 g.

### Statistical analysis

The experimental data were analyzed using analysis of

**Table 2.** Health profile of vendors and contamination risks at cooked food sales sites.

Parameters		Frequency (n=988)	Percent (%)
Sex	Male	31	3,14
	Female	957	96,86
Level of Education	uneducated	394	39,88
	Primary	230	23,28
	Secondary	341	34,51
	Tertiary	23	2,33
Age (years)	10 – 24	168	17,00
	25 – 54	717	72,57
	≥55	68	6,88
	Non information	35	3,54
Serving of food	Food served with fork/spoon	790	79,96
	Food served with bare hands	443	44,84
	Food served with bare hands and fork/spoon	250	25,30
Cleaning of crockery	No soap used	39	3,93
	Water with soap and a Rinsing Water	563	56,98
	Water with soap and more than a Rinsing Water	343	34,72
	Vendors cross-manipulated money and food	298	30,16
Type of vending site	Outdoors	69	6,98
	In the shade of a tree	144	14,57
	Apatam/Hangar	730	73,89
	Other	45	4,56
Nature of the floor on the vending sites	Bare floor	674	68,25
	Cemented or tiled floor	314	31,75
Heated foods in the course of sale	Yes	472	47,87
	No	516	52,23
Management of waste water	Reject on the selling places	708	71,66
	Reject into gutters on the vending sites	257	26,01
Garbage management	Waterproof trash can	111	11,24
	Improvised trash can	618	62,55
	No trash can	257	26,01
Toilet availability at food handling sites	No	966	97,77
	Yes	22	2,23

Variance (ANOVA) to determine significant difference between the data of the samples analyzed. t-test was used to see whether compared to the results. The level of significance was set at  $p \leq 0.05$ . The data were analyzed using SYSTAT 11.

## RESULTS AND DISCUSSION

### Vendor's socio-demographic and sanitary profile

Demographic characteristics of street food vendors in Lomé are presented in Table 2. The results showed that majority 957 (96.86%) of the street food vendors were women. Only 31 men (3.14%) were engaged in the street

food vending. In the city of Lucknow in Uttar Pradesh, about 75.8% of street vendors are men (Baliyan and Srivastava, 2016). In West Africa, women have a virtual monopoly over street food trade. The important role of women in trade is rooted in a cultural construction of gender where economic functions of men and women are separated but complementary (Marras et al., 2016). In Benin and Ghana, females account respectively 81 and 89 percent of street vendors (ManojPanwar and Garg, 2015; Marras et al., 2016). In many countries, the street food sector occupies the active fringe of the often untrained population of cities. In Lomé, 72.57% of the street vendors are comprised 25 and 54 years old. 168 of them (17.0%) were less than 25 years and 68 (6.88%) of the vendors were above 54 years. According to

education level, 63.28% of the street food vendors in Lomé had either primary level or are not educated; 364 vendors (36.84%) have secondary school level. The educational level among street vendors is usually very low in Lucknow. Around 45 per cent of vendors are primary to only 8<sup>th</sup> class education; approximately 45 per cent street vendors are illiterate and can sign only their names (Baliyan and Srivastava, 2016). In Allahabad City (India), 42.8% of the street vendors were of primary school level and 52.3% of them was ranged in the age group 25 – 35 years old (Gawande et al., 2013). According to Barro et al. (2002), in Ouagadougou women represent 71.22% of vendors. The level of education of these actors (90.40%) did not exceed that of primary education. Bereda et al. (2016) estimated that 90.9% of streets vendors in Jigjiga, East of Ethiopia are female. But, 42.85% of them are between 23 – 49 years old. In Ghana, women are estimated at 76.6% of street food vendors, the majority (39.1%) are in the 41 – 50 age group (Akabanda et al., 2017).

### **Contamination risks factors on the cooked food selling places**

During survey, it was observed that 298 (30.16%) of vendors cross-manipulated money and food without washing their hands. Seventy-nine point nine-six percent (79.96%) of vendors used fork or spoon to serve food; 25.30% of them used hand and fork or spoon. In Abidjan, "attiéké" and fish are served with bare hands; these hands are used to receive money too. By the way, Soungari et al. (2017) think that there is no link between the level of education of vendors and the hand washing recommended in food hygiene practices. Choudhury et al. (2011) also reported that, education has no significant impact on knowledge and attitude of vendors to food safety practices.

Some of street vendors in Lomé ( $n = 443$ ; 44.84%) use only hand to serve food. Cleaning of crockery is done with only one soapy water and one rinsing water by 56.98% ( $n = 563$ ) of food vendors.

The food selling activity often takes place in open market, on the shade of a tree or shed (6.98%, 14.57% or 73.89%). In 4.56% ( $n = 45$ ) of situation, food selling takes place in converted dining areas. The floor of vending site was bare (68.25%) and cemented or tiled floor was observed in 31.75% of situation. Trash cans without lids were observed in many food selling places (62.55%); 26.01% have not trash cans. So, garbage are throw no far from vending sites. Several studies reported that overflowing of garbage bins was a common site in most vending points while the final garbage disposals are usually far away from vending sites. Heaps of garbage around the vending sites could serve as breeding points for rodents, insects and flies which promote proliferation

of microorganisms and increase the risk of contamination of foods and transmission of diseases (Umoh and Odoaba, 1999; Mensah et al., 2002).

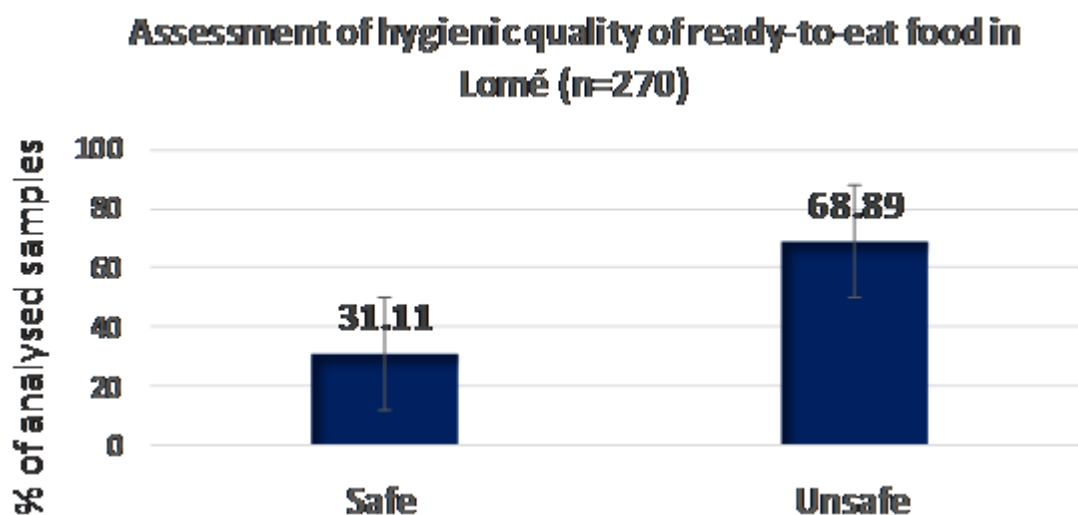
Toilet was lacked (97.77%) at the vending sites. Alimi (2016) considers that, absence of toilet and lavatory facilities at the vending sites forced most street food hawkers to seek secluded areas within the vicinity like bushes and uncompleted buildings for excretion. In the Federal Capital Territory (Nigeria), 89.3% of vendors wash their hands after using the toilet (Ifeadike et al, 2019), surely because of the existence of these facilities in food outlets.

Stray animals (poultry, dog and cat) were observed on the sales sites (23.38%). In Lomé, foods are often sold without being reheated (52.23%), exposed to room temperature and sometimes from morning until four o'clock in the afternoon. The situation was noted by Gbetanou (2000), who found that depending on the type of food sold, 54% of food vendors surveyed can spend more than ten hours (7 am to 6 pm) on the sidewalks and that about 35% would occupy these places of sale for seventeen hours (6 am to 11 pm). The risks of contamination and multiplication of bacteria within the handled foods in these conditions becomes very high.

On the street in Lomé, ready-to-eat food selling activities were done mostly open air. Ninety point twenty-eight percent of vendors exposed food on tables and in the open air; 9.72% of the sales outlets had wire cage or glass cabinet. According to Bonhôte (2011), this is a direct contamination risk factor of food by consumers. There are no significantly difference ( $p > 0.076$ ) between contamination of food vended in open market or in door. So, many ready-to-eat foods are exposed to airborne contamination. Direct contamination of food from the air may or may not be significant, depending upon the type of product and process. For example, it is improbable that an airborne contamination should be detected when exposed product has low *aw* (Water activity), actives preservatives or is conserved to refrigeration in some instances. However, should these bio aerosols contaminate a product conducive to microbial growth, measurable contamination will occur given enough time at an appropriate temperature (Kornacki, 2014).

### **Assessment of the hygienic quality of meal by kind of food**

The results showed that these goods served daily to an important part of the population of Lomé are generally of poor quality. Only 31.11% of food samples had safe quality (Figure 2). Total aerobic flora (50.37%), total coliforms (47.03%), thermotolerant coliforms (58.14%) and *E. coli* (33.33%) were the groups of contaminants that induced more nonconformity in these food samples (Table 3). These are indicators of lower hygienic



**Figure 2.** Assessment of hygienic quality of ready-to-eat food in Lomé (n=270).

**Table 3.** Bacteria contamination level of cooked food in Lomé.

Bacteria sought	Concentration (x log.cfu/g)		Percentage (%) of induced nonconformity
	Minimum	Maximum	
Total viable count	2,7	12,02	50,37
Total coliform count	1,9	5,36	47,03
Thermo-tolerant coliforms	1,3	3,95	58,14
<i>E. coli</i>	0	4,01	33,33
Sulfite-reduction clostridium	0	3,9	5,18
<i>S. aureus</i>	0	3,62	0,3
<i>Salmonella</i> sp.	0	0	0

practices and fecal contamination from street food handlers.

This justifies that, absence of *Salmonella* spp. and low contamination of the foods by *S. aureus* (0.3%) is just a camouflage. Some infected individuals become carriers and persistently shed bacteria belonging to genus *Salmonella* in their feces for long time, so they can be a reservoir for the pathogen (Woolhouse et al., 1997; Stein, 2011). Healthy *Salmonella* carriers can contaminate food and make it dangerous for consumers. Who et al. (2017) found 2.8% asymptomatic *Salmonella* carriers among food handlers migrant population in Malaysia. In Bahir Dar Town (Northwest Ethiopia), 1.6% of food handlers were positive for *S. typhi* and 41% had intestinal parasites (Abera et al., 2010). In Namakkal (Tamilnadu, India), 20% of nail samples shows positive results of the presence of typhoid bacilli indicating that the individual (four women and one male) can harbor the typhoid bacilli without showing any symptoms of typhoid fever (Valli et al., 2010). *S. aureus* was present on 22.72% hands of

Lomé food handlers. In 2004 in Lebanon, 39% of workers in a pastry factory had nasal carriage of *S. aureus* (Hamzé et al., 2008). They remain potential sources of contamination of the food they handle. *S. aureus* is one of the most common causes of zoonotic agent in the world, which are attributable to the contamination of food with enterotoxins. The enterotoxins A (56.29%), B (37.77%), D (13.33%), the leucotoxin LukE/LukD (69.25%), and the Exfoliatin A (14.07%) were identified in street foods in Cotonou (Benin). These toxins of *S. aureus* food contamination were often mediated by various disease (Sina et al., 2011). According to a dispatch from the Agence France Presse (AFP) of 11<sup>th</sup> October 2013, a *S. aureus* present in the dinner of the guests was at the origin of the collective food poisoning which touched 42 people during a sports demonstration in Ornans (Doubs, France). The laboratory analyzes carried out on the dishes consumed during the meal at the origin of the collective poisoning revealed "a strong presence of *S. aureus*."

**Table 4.** Assessment of the hygienic quality of meal by kind of food.

Kind of food and number of sample analyzed	Number of unsatisfactory samples					Unsatisfactory samples rate per product (%)
	Total viable count	Total coliform count	Thermo-tolerant coliforms	<i>E. coli</i>	<i>S. aureus</i>	
Rice-bean (n=79)	51	46	55	23	2	82,05
White rice (n=36)	21	16	22	17	3	61,11
Fattish rice (n=41)	12	9	16	8	1	51,22
Kon (n=31)	8	3	7	9	0	51,61
Corn dough (n=19)	1	3	3	3	0	15,79
Akpan Akassa ball (n=13)	7	8	11	6	1	84,61
Couscous (n=9)	4	7	5	3	0	88,88
Pasta (n=13)	6	10	11	8	2	92,30
Bean (n=13)	13	12	12	6	4	100
Foufou (n=17)	13	13	15	7	1	94,11

**Note:** No salmonella in all types of food analyzed. Only one sample of rice/beans was non-compliant compared to Sulfito-reduction Clostridium criteria.

Mesophilic bacteria (69.7%), *Bacillus cereus* (5.5%), Enterobacteriaceae (33.7%) and *S. aureus* (31.9%) were detected in some food samples analyzed in Accra (Mensah et al., 2002). According to these authors, the microbial quality of most of the foods was within the acceptable limits but samples of salads, macaroni, fufu, omo tuo and red pepper, which are cold foods, had unacceptable levels of contamination. The risk of Staphylococcal food poisoning factor related to consumption of ready-to-eat chickensales in the informal markets of Tshwane municipality are weak. It was estimated at 1.3% (Oguttu et al, 2014); probably because, chickens grilled have often been served hot.

In Lomé, unacceptable levels of contamination of nine of the ten types of RTE food analyzed ranged from 51.22 to 100% (Table 4). The highest levels were detected with bean (100%), foufou (94.11%), pasta (92.30%), couscous (88.88%), akassa (84.61%) and rice-bean (82.05%) foods. Most of these foods are served wholly or partly cold; it would explain this high level of unacceptable quality. Mensah et al. (2002) believe that the lack of training of food hygiene vendors is at the root of these high levels of non-conformity found. Food handlers with poor personal hygiene working in food-serving establishments could be potential sources of infections of many intestinal helminths, protozoa, and enteropathogenic bacteria (WHO, 1989). Knowledge and practice of food hygiene and safety was poor. Almost have very vague notions about food-related diseases (86.57%) and especially good hygiene practices (96.44%) in the field. Choudhury et al. (2011) noted that 30 – 37% of vendors in Guwahati City, India, were familiar with good food handling hygiene practices and only 8 – 11% of these vendors knew of their sources of biological contamination of food.

## Conclusion

Food poisoning risks from microbial contamination of street foods in Lomé are real. Environmental factors, food mishandling by vendors, presence of fecal contaminants and *S. aureus* are elements to be mastered to ensure a lower risk diet for street consumers in Lomé. Improved safety of street foods can be achieved through awareness program involving several partners such as local authorities, food vendors, government agencies, consumer organization, standard setting bodies and non-governmental organizations.

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