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Full Length Research Paper

Hygienic status assessment of dish washing waters, utensils, hands and pieces of money from street food processing sites in Ouagadougou (Burkina Faso)

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During investigations on street food vendors' materials, seventy samples of three types of dish washing water (E_1, E_2, E_3), eighty-five pieces of money, eighty utensils were collected for microbiological assessment. Hands microbiological status of one hundred twenty-five consumers and seventy sellers were also assessed. The analysis revealed that 100% of E_1 washing waters were very impure, while, 44.5% of second washing water (E_2) were impure, 44.5% very impure and 11% acceptable. 45.45% of E_3 washing water were acceptable, 27.27% impure and 27.27% very impure. The spoons and the dinner plates were sometimes contaminated with unacceptable levels (above 10^2) of different bacteria such as, coliforms and *Staphylococcus aureus* ($P \leq 0.05$). Knives microbiological examination revealed presence of numerous bacteria (8.6×10^5 cfu/knife) such as coliforms, *S. Aureus, Salmonella* and *Shigella*. Pieces of money analysis revealed presence of coliforms and *S. aureus*. These data showing pathogen bacteria in food vending sites indicates hygiene monitoring failure.

Key words: Street foods, hands, pieces of money, utensils, dish washing waters, bacteria, hygiene.

INTRODUCTION

In developing countries, drinks, meals and snacks sold by street food vendors are widely consumed by millions of people (FAO, 1988). These street foods provide an affordable source of nutrients to many sectors of population (Ohiokpehai, 2003). Urban street foods vending provides employment and incomes for many people (Barro et al., 2002a; Canet and N'Diaye, 1996). Street foods are well appreciated by consumers, because of their taste, low price and availability at right time (Barro et al., 2002b; Canet and N'Diaye, 1996). However, street foods are frequently associated with diarrhoeal diseases due to their handlings (Akinyele, 1998; Barro et al., 2002a; 2002b; Bryan et al., 1988; King et al., 2000; Mosupye and Van Holy, 1999; Tjoa et al., 1977; Umoh and Odoba, 1999; WHO, 2002).

Street food trade is popular in Burkina Faso but only few information are available on their related diseases. About 75% of vendors are women and 56% of them are illiterates (Barro et al., 2002a). They are mostly uninformed of good hygiene practices (GHP) and causes of diarrhoeal diseases (Barro et al., 2002a; Mensah et al., 2002), which can increase the risk of street food contamination (Bhaskar et al., 2004; Bryan et al., 1988; Barro et al., 2002b).

Therefore, the conditions of street food preparation and

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vending raise many concerns for consumers health (Bryan et al., 1988; Mosupye and van Holy, 1999). In most cases, running water is not available at vending sites, hands and dish washing are usually done in one or more buckets, and sometimes without soap. Waste waters and garbages are discarded nearby, providing nutrients for insects and rodents. Some of the foods are not efficiently protected against flies which may carry foodborne pathogens. Safe food storage temperatures are rarely applied to street foods (Bryan et al., 1988). In addition, there are potential health risk associated with initial contamination of foods by pathogenic bacteria as well as subsequent contamination by vendors during preparation and through post-cooking handing and cross-contamination (Bryan et al., 1988). The present study aims to establish the hygienic status of vendor hands, dish washing waters, utensils and pieces of money and their impact in street foods contamination.

MATERIALS AND METHODS

Study site and samples collection

Investigations were done during the year 2003. The study was conducted in the major streets, markets and schools in three districts of Ouagadougou: Wemtinga, Zone 1 and Zogona. There were aproximatively seventy vending sites. Samples were collected during visits to the sites with a Food Hygiene Office. Vending sites hygiene and salubrious status were determined by use of structured interview and through observations.

Investigations on dish waters

Three types of dish washing waters used for utensils washing were collected from seventy street food vending sites. The first dish washing water (E_1) is soapy and used for washing. The second (E_2) and the third dish washing waters (E_3) are used for utensils' rinsing according to the vendors. Volumes of 100 ml of dish washing water were taken in sterile jar for bacteriological analysis within two hours of collection.

Practices such as methods of washing, place of preparation, enviromental conditions were studied. Location of street food vendors, utensils used and environmental surrounding were observed and recorded on a checklist. At the same time, face to face interviews with street food vendors were conducted by trained interviewers using questionnaire. Respondents were asked questions about their "activities", "type of trade" and "the number of dish washing water buckets used".

Pieces of money collection

Eighty-five pieces of money made of metal and copper of 25.62 mm diameter and 1.4 mm thickness were collected from thirty vendors during food vending operations and placed in separate sterile containers for laboratory analysis.

Utensils surface sampling procedure

Utensils comprised of twenty-five spoons, thirty dinner plates of 25 cm diameter made of aluminum or plastic and twenty-five knives. After their washing by vendor , utensils were taken for surface sampling procedure. Surface was rinsed with 100 ml of sterile buffered peptone water. The rinsing water of each utensil was collected in a sterile jar. Samples were kept at 4°C on ice and tranported to laboratory for microbiological analysis the same day.

Consumers and vendors hands status assessment

One hundred twenty-five consumers and seventy vendors were selected during differents street foods eating and vending, respectively. Their finger tips were analysed according to the standard fingersprint method on the different specific bacteria growth media. After microbiological analysis procedure and incubation at appropriate temperature for24 to 48 h, bacteria were counted based on the fingers tips impact on different growth media used.

Bacteria identification and counting

All samples collected were processed in laboratory for microbiological analysis. Ten (10) ml of each dish washing water and utensil surface rinsing water were diluted 1:10 with 90 ml of sterile buffered peptone water. Pieces of money were placed in 100 ml of sterile peptone water and shaken vigorously to remove bacteria which might have adhered.

Further tenfold serial dilutions were made with in sterile buffered peptone water. A volume of 0.1 ml of each dilution was spread over the specific growth media in petri dishes. Bacteria isolation and counts were done according to microbiological analysis standard methods (Speck, 1976). Mesophilic aerobic bacteria (MAB) were isolated on plate count agar (Fluka BioChemica 70152). The specific bacteria examined were coliforms indicative of hygiene and recent faecal contamination. For the detection of faecal coliforms, the production of acid and gas taken as positive indication. The *Enterobacteriaceae* were isolated on the violet red bile lactose agar medium (Fluka BioChemica 70189) incubated aerobically for 24 h at 44°C. Staphylococci were counted on Chapman mannited medium (Difco) and incubated aerobically for 24 h at 37°C. The detection of bacteria belonging to *Salmonella* and *Shigella* genera were done on the SS medium (Fluka BioChemica 85640). Inoculated media were incubated aerobically at appropriate conditions according to Mensah et al. (2003) method.
After these appropriate incubations, suspected colonies were identified based on their morphological, physiological and biochemical features using microscope and standard biochemical methods.

Data handling and analysis

The number of colony forming unit per fingers (cfu/f), per milliliter (cfu/ml), per utensil (cfu/ut) or per piece money (cfu/mo) was calculated by standard methods. The significance of any observed differences was determined using χ^2 test. Statistical significance was set at $P \leq 0.05$. The data were also analysed using Statistical Package for Social Sciences (SPSS) and Microsoft Excel 2000.

RESULTS AND DISCUSSION

Early studies have shown that street foods contamination sources were endogenous and exogenous (Barro et al., 2002b; Bryan et al., 1988; Dawson and Canet, 1991). As expected, bacterial counts on hands, dish washing waters, utensils and pieces of money showed presence

Table 1. Hygiene failure indicator and enterotoxigenic bacteria count in dishwaters (cfu/ml).

Types of sellers	dishwaters	MAB	Coliforms	*S. aureus*	*Salmonella Shigella*
Small restaurants	E_1	1.7×10^7	4.4×10^5	2.2×10^4	< 10
N=30 ; n =15 (50%)	E_2	7.1×10^6	2.1×10^4	1.4×10^3	0
m = 15 (50%)	E_3	8.2×10^5	4.1×10^3	5.0×10^1	0
Kiosks	E_1	9×10^7	6.8×10^4	1.2×10^4	< 10
N = 21 ; n =10 (47.61%)	E_2	4.3×10^7	2.3×10^4	0.6×10^3	0
m = 11 (52.39%)	E_3	2.7×10^6	1.3×10^3	0.4×10^2	0
butcher	E_1	1.3×10^8	7.8×10^4	3.0×10^5	1.2×10^1
N=19 ; m=17 (89.48%)	E_2	4.2×10^6	8.5×10^3	2.4×10^3	0
n = 2 (10.52%)					
Average	E_1	7.9×10^7	1.9×10^5	2.1×10^2	< 10
N_T=70 ; n_T = 27 (38.57%)	E_2	18.1×10^6	1.7×10^4	1.4×10^2	0
m_T = 43 (61.43%)	E_3	17.6×10^5	2.7×10^3	4.5×10^1	0

MAB = mesophilic aerobic bacteria, cfu = colony-forming unit, N = number of sellers, n = number of sellers using three dishwaters, E_1, E_2 and E_3 = 1st, 2nd and 3rd dishwaters, m = number of sellers using two dishwaters, E_1 and E_2 , in parentheses = percentage of sellers using 2 or 3 dishwaters, N_T; n_T; m_T .= totals.

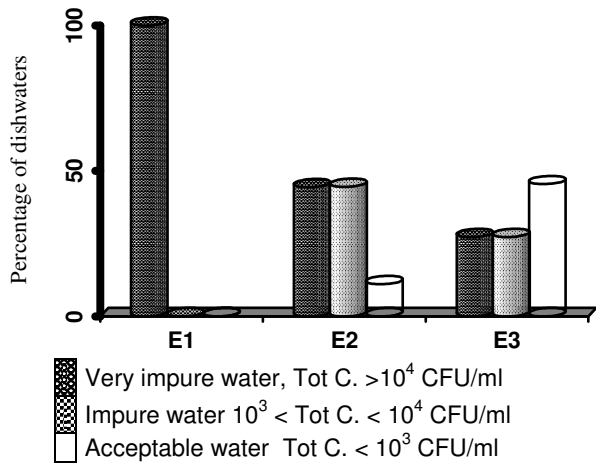

Figure 1. Percentage of dishwaters according their total coliforms 'Tot C' load. E_1, E_2 and E_3 = 1st, 2nd and 3rd dishwaters.

of large number of foodborne pathogens such as *Salmonella*, *Shigella*, coliforms and *Staphylococcus aureus*.

Microbiological quality of dish washing waters

Table 1 summarizes determination of the number of dish washing waters used by vendors and their microbiological quality assessment. It appears that in accordance with the recommendations of the Food Hygiene Office only, 38.57% of vendors used the three types of dish washing water (E_1, E_2 and E_3). The others (61.43%) used two types of dish washing water (E_1 and E_2). Amongst the street-restaurants and kiosks vendors, about 50% used the three types of dish washing water, while, 89.48% of roasted or fried meat/poultry/pork vendors used two types of dish washing water (E_1 and E_2).

The mesophilic aerobic bacteria count average in first dish washing waters (E_1) was 7.9 x 10^7 cfu/ml and total coliforms count average was 1.9 x 10^5 cfu/ml. Few bacteria belonging to *Salmonella* and *Shigella* genera has been identified in E_1. In rinsing waters E_2 and E_3, coliforms counts were 1.7 x 10^4 and 2.7 x 10^3 cfu/ml, respectively. Figure 1 shows how dish washing waters were classified according to their total coliforms load. Samples of the first dish washing water (E_1) had unacceptable levels of contamination and were classified very impure quality. For second dish washing waters (E_2), impure and very impure qualities were equal percentages (44.5%) and only 11% were of acceptable quality. Lastly, among third dish washing waters (E_3), 45.45% were acceptable quality, with impure and very impure waters of 27.27% each.

Most of vendors used dish washing waters in buckets placed on the floor. The waters for washing and rinsing the utensils were rarely renewed and generaly was observed to be dirty ($P \leq 0.05$). In some others, the dishes washing places were characterized by the presence of small puddles, insects and animals (Barro et al., 2002b). Unrenewal of dish washing waters explains their poor bacterial quality (Mensah et al., 2002; Mosupye and Van Holy, 1999; Muinde and Kuria, 2005).

Utensils microbiological quality

Table 2 shows microbiological analysis of utensils surface. Coliforms and *S. aureus* were identified on 100% of knives. In general *Salmonella* and *Shigella* counts were high in butcher knives. Utensils used in street food

Table 2. Hygiene failure indicator and enterotoxigenic bacteria (cfu/ut) at the surface of common utensils after washing.

Utensils	MAB	Tot C.	Th C.	*S. aureus*	*Salmonella Shigella*
Spoons (n = 25)	2.8×10^4	2.8×10^2 (68)	1.2×10^1 (28)	2.5×10^2 (60)	0
Dinner plates (n = 30)	4.1×10^4	3.2×10^2 (36.6)	1.3×10^1 (40)	2.3×10^2 (33.3)	0
Knives (n = 25)	8.6×10^5	5.1×10^4 (100)	1.4×10^2 (100)	3.4×10^3 (100)	1.7×10^2 (85)

ut = Utensils, Th C. = Thermotolerant coliforms, Tot C. = Total coliforms ; MAB = mesophilic aerobic bacteria ; cfu/ut = colony-forming unit per utensil, n= number of sample; in parentheses are percentage of contaminated utensils.

Table 3. Money bacterial carriage (cfu/mo).

Orgine of money*	MAF	Tot C	Th C.	*S. aureus*	*Salmonella shigella*
Dèguè (n=15)	1.9×10^4	1.3×10^3	2.3×10^2	2.5×10^2	0
Skewers of meat (n = 15)	7.0×10^2	1.0×10^2	0	3.1×10^2	0
Fish fries (n=15)	2.8×10^3	1.4×10^2	0	1.7×10^2	0
Benga and rice (n = 25)	4.9×10^3	2.7×10^2	0	0.7×10^2	0
Zom koom (n = 15)	5.4×10^3	9.0×10^2	0	1.2×10^2	0
Means (n = 85)	6.6×10^3	5.4×10^2	4.6×10^1	1.8×10^2	0

Th C. = thermotolerant coliforms ; Tot C = Total coliforms ; MAB = mesophilic aerobic bacteria ; n = number of samples; cfu/mo = colony-forming unit per money, * from sellers of differents street foods listed.

vending areas generaly pathogen bacteria ($P \leq 0.05$). Several authors have observed that bacteria from dirty dish washing waters and others sources can adher to utensil surfaces and constitute a risk for contamination during food vending (Bhaskar et al., 2004; Hood and Zottola, 1997; Miettinen et al., 2001; Mosupye and Van Holy, 1999; Mosupye et al., 2000). In some cases, during meat preparation and vending, raw meat/poultry as well as gravy and salad raw materials were cut and chopped using the same knife without in-between cleaning. The knives were not at all washed and often were invaded by flies (Bryan, 1988; Mensah et al., 2002). These findings confirm previous observations that contamination from utensils was possible during serving but not from storage containers, since leftovers were generally stored in the original cooking pots (Mensah et al., 2002; Bryan, 1988; Bhaskar et al., 2004; Mosupye et al., 2000).

Money bacterial carriage

The Table 3 shows that pieces of money carry various bacteria. There was a dominant presence of coliforms and *S. aureus*. Total coliforms and thermotolerant coliforms numbers were 5.4×10^2 and 4.6×10^1 cfu/mo, respectively. 1.8×10^2 cfu/mo *S. aureus* was also counted. No *Salmonella* or *Shigella* was identified. Pieces of money were found to be always associated with microorganisms ($p \leq 0.05$). Severals authors have reported similar results of money microbiological status under temperate climate conditions (Abrams and Waterman, 1972; Barry, 2002; Brady and Kelly, 2002; Wendy and Bonifazi, 2002). Coliforms and *S. aureus* can be re-introduced in food by many ways. It was observed that, during vending operations, the same hand alternatively served and held food and money (Barro et al., 2002a; 2002b). Pieces of money are in permanent movement, passing in all environments that constitute a reservoir and source of various bacteria as pathogenic *Escherichia coli*, which can survive 11 days on the inert surfaces (Pomperayer and Gaylarde, 2000). Money handling constitutes another risk factor of street foods contamination.

Consumers and vendors hands hygienic status

Consumers and sellers fingerprints bacteriological analysis gave the results in Figures 2 and 3. Two groups of hands were distinguished: those in which the number of bacteria was countable called 'C' and second group called 'U', on which bacteria number was not countable. Here, 37% and 60% of consumers and vendors hands respectively were classified 'C'. In this group, 75% of consumers and 68% vendors' hands were *S. aureus* carriers. 37% of consumers and 19% of vendors were thermotolerant coliforms carriers. Vendors' hands were carriers of a variety of bacteria including *Salmonella* and *Shigella.*

Defective personal hygiene can facilate the transmission of these pathogens bacteria found in environment and on peoples's hands via food to humans (Bhaskar et al., 2004; Mensah et al., 2002). Burt et al. (2003) and Black et al. (1989) showed that hands are important in the contamination and the dissemination of fecal-oral

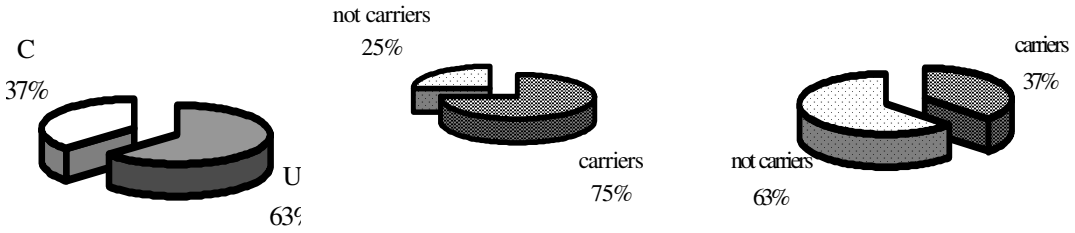

Figure 2. Consummers hands bacterial carriage assessment, (a) ratio of hands classified: C = on which bacteria number can be counted, U = bacteria number cannot be counted, (b) *Staphylococcus aureus* carriers with average of 52 CFU per finger, (c) coliforms carriers with average of 29 CFU per finger.

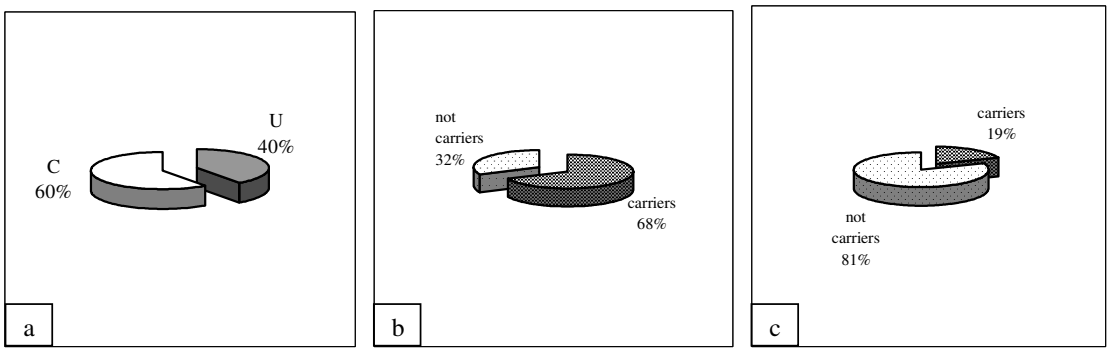

Figure 3 : Vendor hands bacerial carriage assessment, (a) ratio of hands classified: C = on which bacteria number can be counted, U = bacteria number cannot be counted, (b) *Staphylococcus aureus* carriers with average of 12 CFU per finger, (c) coliforms carriers with average of 8 CFU per finger.

transmitted bacteria. The risk increases when vendors during vending use bare hands to serve. In genaral, spoons and bare hands were used to serve rice, pork, salads, *Benga* and other foods. Several authors have shown that serving stage is a critical point in the street food industries (Barro et al., 2002a; Bryan et al., 1988; Bryan, 1988; El-Sherbeeny et al., 1985). Enteropathogens can survive on the hands for three hours or longer. Bacteria in food can survive and multiply if held for prolonged periods at ambient temperature.

Our findings show the need for more respect of Good Manufacturing practices (GMP) and Good Hygiene Practices (GHP) to reduce street foods contamination. Consumers' organisations could play key roles in food control system by calling attention to deficiencies. Special attention should be given to the following: transmission of fecal germs; handling of food after cooking and equipments used for serving; and hand washing and environmental hygiene. Action along these lines can be expected to improve the safety of street foods and protect consumers.

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