

Original Research Article

Microbiological quality of street vended fruit juices in Hyderabad, India and their association between food safety knowledge and practices of fruit juice vendors

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ABSTRACT

Keywords

Microbiological quality,
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Food safety practices

Street vended fruit juices are on high demand because of their nutritive value and mineral and vitamin content but the concern on food safety is very high. This study is aimed to detect foodborne pathogens along with Knowledge and Practices (KP) of fruit juice vendors on food safety. A total of 150 samples of fruit juices like grapes, pineapple, sapota and sweet lime were collected for microbiological analysis and simultaneously a pretested questionnaire on KP was administered to the respective vendors. About 96.6% of fruit juices were contaminated with fecal coliforms (77.3%) *S. aureus* (73.3%), *Shigella* spp. (48.6%) and *E. coli* (42.6%). Contamination was found high in sapota juice followed by pineapple, sweet lime and grapes. Respondents had a good knowledge on food safety aspects like hand washing (92%), utensil washing (86%) and storage of cut fruits (64%). However, 52% of vendors have translated above food safety aspects into practice. Some specific hygiene practices have shown significant associations ($p < 0.05$) with the presence of foodborne pathogens and also with their food safety knowledge. There exists a gap between their knowledge and practices. Therefore, targeted food safety training of vendors is essential to avoid contamination with foodborne pathogens.

Introduction

Microbial contamination of ready-to-eat foods and beverages sold by street vendors make them unacceptable for human consumption and has become a global health problem (Lewis *et al.*, 2006). In many tropical countries fresh fruit juices are common man's beverages and are sold at all public places and roadside shops. However, in view of their availability for ready

consumption, quick methods of extraction they could often prove to be a public health threat (Health Canada, 2000). Different types of street foods are sold in different seasons in the twin cities of Hyderabad. Most common among them are fruit juices like sweet lime, pine apple and grape (Waghray and Bhat RV, 1995). Fresh fruit juices are well recognized for their nutritive

value, mineral and vitamin content (Deanna and Jeffrey, 2007) but there are reports of foodborne illness associated with the consumption of fruit juices at several places in India and elsewhere (Parish, 1997; Sandeep *et al.*, 2001).

A number of studies on knowledge and practices of street food vendors regarding food safety conducted in different countries have shown a gap between knowledge on food hygiene and handling practices (Muyanja *et al.*, 2011; Chukuezi *et al.*, 2010; Omemu *et al.*, 2008; Bas M. *et al.*, 2006; Elizabeth Walker *et al.*, 2003). All these findings indicate that studies to assess Knowledge and Practices (KP) are necessary to assess street food vendors and provide education to them.

In Hyderabad (Telangana, India) there is a great demand for fresh fruit juices. Being tropical in location, hot weather continues for a greater part of the year (February-August) increasing the need for these commodities. No KP study was conducted in Hyderabad on street vendors selling fruit juices. The purpose of this study was to identify the microbiological quality of street vended fruit juices during summer season and also to assess knowledge, attitude and practices of these vendors on food safety to find out the associations between foodborne pathogens and vendors' practices. This study was approved by Institutional Ethical Committee, National Institute of Nutrition, Hyderabad (NIN Protocol Number: 14/2013/I).

Materials and methods

Research design

A cross-sectional study was conducted to evaluate the microbiological quality of locally prepared fresh fruit juices in Hyderabad city.

Sample collection and processing

Using a stratified random sampling method a total of one hundred and fifty (150) fruit juice samples of four types (Grape, Pine apple, Sapota and Sweet lime) from five zones of Hyderabad viz north, east, central, south and west were collected. From each zone, thirty (30) freshly extracted fruit juices (150 ml each) were collected in sterile containers and transported to the laboratory through ice box by maintaining 4 ° C temperatures and processed within an hour after collection. In this process, pH of all undiluted samples were measured immediately (ORION 2 STAR pH Benchtop) after getting the samples to the laboratory. For isolation of fecal coliforms, *E. coli*, *S. aureus*, *Shigella* spp., 25 ml of each sample was diluted in 225 ml of buffered peptone water. And for isolation of *Salmonella* spp. and *Listeria* spp. enrichment broths like selenite F broth and listeria enrichment broth were used respectively. From these diluents 100 µl of filtrate was used for inoculation.

Identification and Enumeration

Identification and enumeration of foodborne pathogens have done as per USFDA – BAM (United States Food and Drug Administration – Bacteriological Analytical Manual). In this process, selective media were obtained from Himedia Laboratories Ltd., Mumbai, India. They included MacConkey agar for *E. coli*, M-fecal coliform agar (MFC) for fecal coliforms, Baird parker agar base (BPA) for *S. aureus*, Salmonella Shigella agar (SS) for *Shigella* spp., Thiosulfate citrate bile sucrose agar (TCBS) for *Vibrio cholera*, Xylose lysine deoxycholate agar (XLD) for *Salmonella* spp. and Listeria identification agar base (PALCAM) for *Listeria* spp. All inoculated plates were incubated under aerobic

conditions at 37°C for 24 hours. The mean number of colonies counted was expressed as log colony forming units (CFU)/ml. For confirmation of the foodborne pathogens, typical colonies were checked using appropriate biochemical tests.

Data collection

A pretested questionnaire was administered on vendors to obtain data on general profile, knowledge, and practices by interview method, behavior and personal hygiene were observed in connection to the food safety.

The proforma contains four sections with 52 questions in which first and second sections have open and closed ended questions regarding general information about vendor and his/ her business and knowledge of street vendor on food safety respectively. Third section dealt with comparisons between knowledge and practices of street vendors by open ended questions and observations. The last section dealt with personal hygiene and behavior of vendors by observation method. It was administered on participants during the time of fruit juice samples collection.

Statistical analysis

Data was analyzed by SPSS version 16.0 Software. P-value less than 0.01 and 0.05 was considered statistically significant.

Result and Discussion

General Profile of street food vendors

All the respondents of this study (n = 50) were male subjects which is quite different than the other studies conducted in Nigeria, Ghana, Uganda, Kenya, Malaysia and Botswana (Idowu & Rowland, 2006; Mensah *et al.*, 2002; Mutalib *et al.*, 2012;

Umoh & Odoa, 1999). The present study was similar to the studies conducted in Nairobi and Guwahati, India (Muinde *et al.*, 2005; Choudhury M. *et al.*, 2011). The age group of most of the subjects was in the range of 25 – 50 years which is similar to studies conducted in Guwahati, Nigeria and West Indies (Omemu & Aderoju, 2008; Choudhury M. *et al.*, 2011; Badrie *et al.*, 2006).

About 30% & 46% of vendors have completed their secondary education and primary education respectively; these results are comparable with the studies conducted in Bahirdar and Malaysia (Mulugeta *et al.*, 2012; Mutalib *et al.*, 2012). Majority of the vendors had been in this trade for less than 10 years which is comparable with the studies conducted in Guwahati, Nigeria and Turkey (Choudhury M. *et al.*, 2011; Omemu & Aderoju, 2008; Tokuc *et al.*, 2009). About 72% of them were not having any helpers and most of the vending units were unhygienic with scattered combustibles and houseflies or fruit flies around, which is similar to the study conducted in Amaravathi city, India (Tambekar *et al.*, 2009).

Microbiological contamination of street vended fruit juices

The results demonstrate 96.6% (145/150) of samples were contaminated with one or the other foodborne pathogen (Figure 1). Contamination of sapota juice was found high with *E. coli*, *S. aureus* and *Shigella* spp. which may be attributed to its pH (4.73 – 6.53) (Table 1). Sweet lime and pine apple juices were also contaminated which was in accordance with studies conducted in Amaravathi, Tirumala, Vishakhapatnam, Vidarbha of India and Nigeria (Tambekar *et al.*, 2009; Suneetha *et al.*, 2011; Lewis *et al.*, 2006; Sharma, 2013; Ukwo *et al.*, 2011).

Table.1 pH range and Mean values (log₁₀ CFU/ml) of foodborne pathogens in street vended fruit juices

Fruit juice	pH (Min – Max)	<i>E. coli</i>	fecal coliforms	<i>S. aureus</i>	<i>Shigella</i> spp.
Grape	3.02 – 4.01	1.1	2.6	1.4	1.4
Pine apple	4.00 – 4.04	1.4	2.9	2.1	1.6
Sapota	4.73 – 6.53	2.0	2.5	3.0	2.6
Sweet lime	3.68 – 4.01	1.4	2.7	2.3	1.6

Table.2 Knowledge and practices of fruit juice vendors on food safety (n = 50)

Parameter	Knowledge Frequency (%)	Practices Frequency (%)
Hand Washing:		
- Before preparing fruit juice	46 (92%)	5 (10%)
- With water only	25 (50%)	39 (78%)
- With water & soap	25 (50%)	2 (4%)
Washing of utensils:		
- With water only	7 (14%)	43 (86%)
- With water & soap	43 (86%)	2 (4%)
Type of glasses used for serving fruit juices:		
- Disposable	-	32 (64%)
- Non disposable	-	18 (36%)
Wiping utensils after washing:		
- Yes	11 (22%)	5 (10%)
Wiping to be done with-		
- Cotton cloth	9 (18%)	5 (10%) - Unclean cloth
Which fruits need to wash before preparation:		
- Grapes	41 (82%)	47 (94%)
- Sapota	9 (18%)	-
Washing of fruits-		
-Dipping in water container	48 (96%)	47 (94%)
Storage of cut fruits:		
- Closed container	32 (64%)	18 (36%)
Kind of water to be used for dilution:		
- Municipal water		
- Packaged drinking water	39 (78%)	39 (78%)
	7 (14%)	7 (14%)
Vessels to be closed with lids:		
- Yes	39 (78%)	27 (54%)
Frequent mopping of preparation area:		
- Necessary	34 (68%)	25 (50%)
Covered waste bin at vending unit is necessary:		
- Yes	17 (34%)	8 (16%)

Table.3 Association between specific knowledge and practices related to street vended fruit juice preparation (n = 50)

Knowledge parameter	Frequency (%)	Practice parameter	Frequency (%)	P Value
Do you think washing of juicer is necessary after preparation of every juice?		Washing of juicer after preparation of every juice:		
- Yes	19 (38%)	- Done	13 (68.4%)	0.000*
- No	31 (62%)	- Done	0 (0%)	
Do you think wiping of utensils with clean cloth is important after cleaning?		Wiping of utensils after cleaning:		
- Yes	11 (22%)	- Done	4 (36.4%)	0.001*
- No	39 (78%)	- Done	1 (2.6%)	
How to store cut fruits in the unit?		Storage of cut fruits:		
- Closed container	32 (64%)	- Closed container	15 (46.9%)	0.033*
- Kept open	18 (36%)	- Closed container	3 (16.7%)	
Do you think vessels in the unit should be closed with lids?		Status of vessels in the unit:		
- Yes	39 (78%)	- Closed	25 (64.1%)	0.007*
- No	11 (22%)	- Closed	2 (18.2%)	
Do you think frequent mopping of preparation area is necessary?		Frequent mopping of area:		
- Yes	34 (68%)	- Done	23 (67.6%)	0.000*
- No	16 (32%)	- Done	2 (12.5%)	
Do you maintain waste disposal in the unit properly?		Status of dust bin at vending unit:		
- Yes	17 (34%)	- Covered	5 (29.4%)	0.063 ^t
- No	33 (66%)	- Covered	3 (9.1%)	

* p < 0.05 ^t Trend

Table.4 Personal hygiene and behavior of fruit juice vendors

Parameter	Frequency (Percentage) n = 50
Vendor's cloths:	
Neat	20 (40%)
Untidy	30 (60%)
Long finger nails:	
Yes	30 (60%)
No	20 (40%)
Handles juice with bare hands:	
Yes	50 (100%)
Handles money while serving:	
Yes	47 (94%)
No	3 (6%)
Wear hand jewelries while preparing juice:	
Yes	32 (64%)
No	18 (36%)
Smoking:	
Yes	1 (2%)
No	49 (98%)
Pan chewing:	
Yes	1 (2%)
No	49 (98%)
Scalp scratching:	
Yes	14 (28%)
No	36 (72%)
Wiping hands with his dress frequently:	
Yes	18 (36%)
Vendor response:	
Good	26 (52%)
Moderate	17 (34%)
Poor	7 (14%)

Table.5 Association between hygiene practices and microbial contamination

Parameter	Foodborne pathogen	Mean (log ₁₀ CFU/ml) ± SD	P value
Pine apple: - Kept in uncovered container after cutting	<i>S. aureus</i>	2.6 ± 1.4	0.085 (trend)
Sapota: - Kept in uncovered container after peeling	<i>E. coli</i>	2.9 ± 1.6	0.037*
Disposable glasses used for serving	<i>S.aureus</i>	2.2 ± 1.4	0.08 (trend)
Mopping of preparation area with unclean cloth	<i>Shigella</i> spp.	1.7 ± 1.6	0.05*
Bore water used for washing utensils	fecal coliforms	2.7 ± 1.6	0.06 (trend)
Vessels not closed with lids	<i>E. coli</i>	1.5 ± 1.4	0.001**

* P < 0.05, ** P < 0.01

Fig.1 Microbial contamination of street vended fruit juices

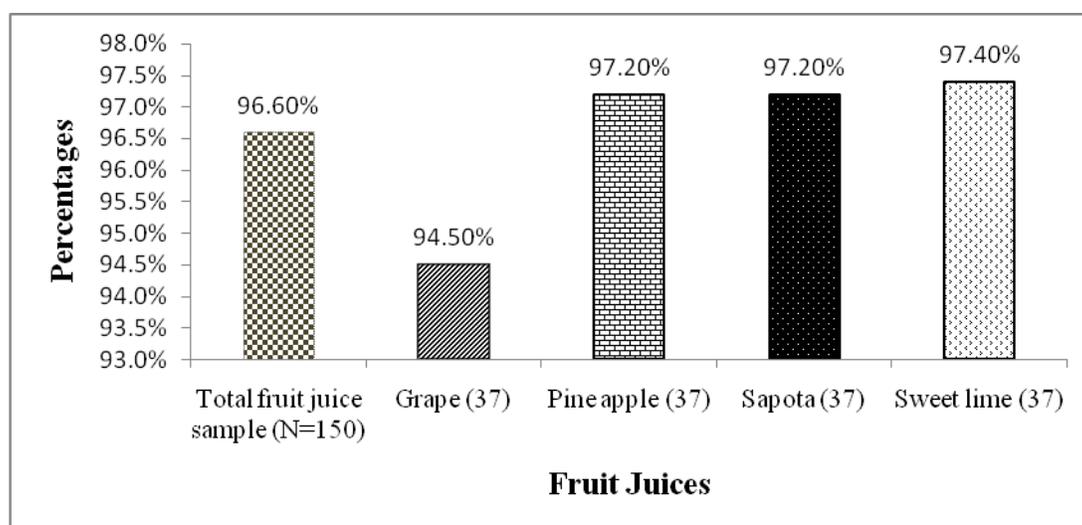


Fig.2 Percentage of isolated foodborne pathogens in street vended fruit juices (N= 150)

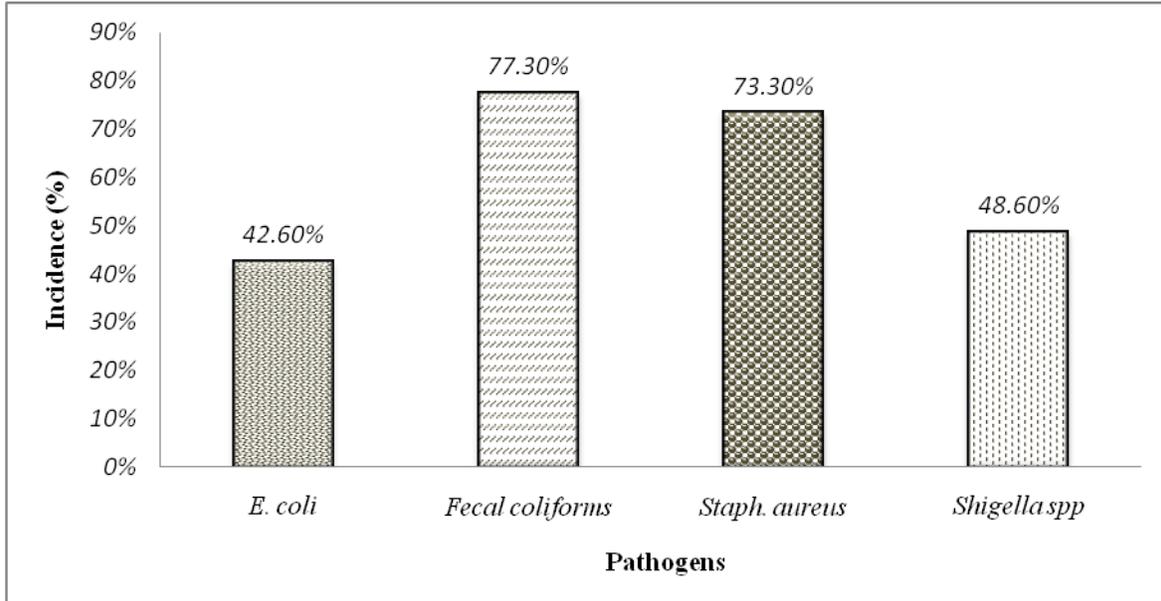
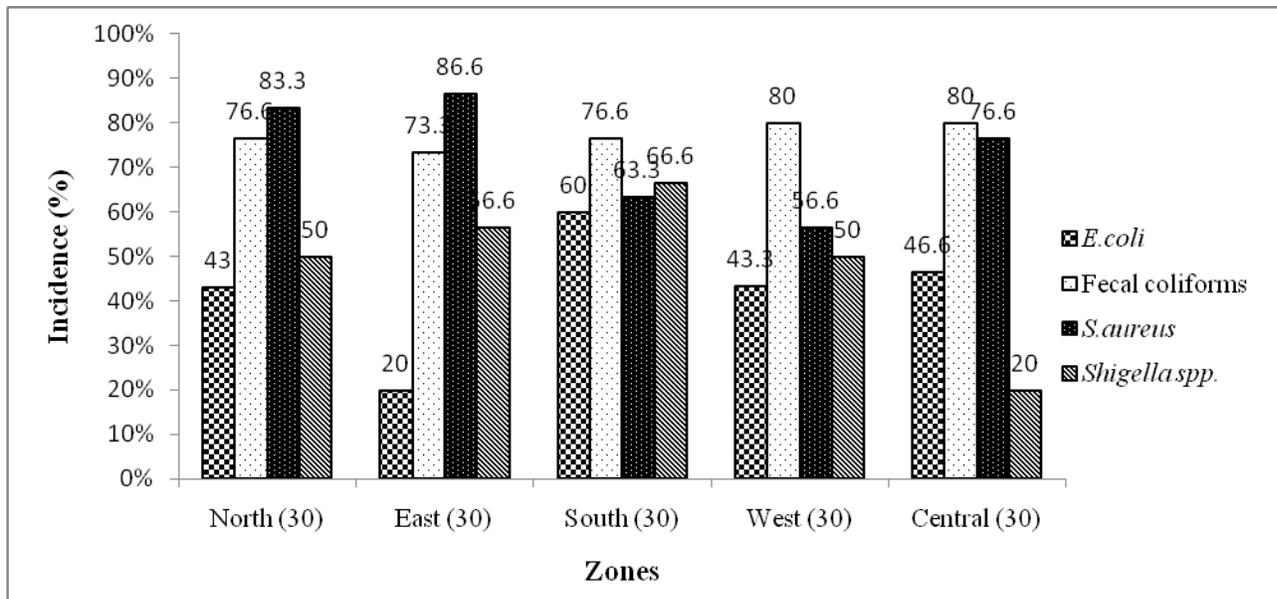


Fig.3 Distribution of foodborne pathogens in street vended fruit juices in five zones of Hyderabad



These fruit juices which are on high demand, vendors tend to peel and keep them in an uncovered container much before time of consumption. Fruit juices generally attract house flies because of their sweet odour. So, these swarming house flies can act as

sources of contamination. This may be the reason for high contamination though they are in acidic pH (Sandeep *et al.*, 2001; Sheri *et al.*, 2007). Our study demonstrated that grape juice was less contaminated. This may be due to its acidic pH than other fruit

juices. These findings are similar to the study conducted at Vishakhapatnam (Lewis *et al.*, 2006).

Incidence of foodborne pathogens in street vended fruit juices

In the present study, fruit juices were found to be contaminated with fecal coliforms (77.3%), *S. aureus* (73.3%), *Shigella* spp. (48.6 %) and *E. coli* (42.6%) (Figure 2). This higher incidence of fecal coliforms in fruit juices shows that water and ice used for juice preparation and water used for washing of utensils may be of poor quality (Lewis *et al.*, 2006; Tambekar *et al.*, 2009; Titarmare *et al.*, 2009; Lateef *et al.*, 2006; Vieira *et al.*, 1997; Nichols *et al.*, 2000).

The presence of *S. aureus* (73.3%) in fruit juices may be due to contamination with normal microflora present on or in several parts of the human body (Shakir *et al.*, 2009; Sharma, 2013; Mesfinworku, 2011; Mahale *et al.*, 2008; Rashed *et al.*, 2013; Ukwo *et al.*, 2011; Neha *et al.*, 2011). In this study, contamination of fruit juices with *Shigella* spp. (48.6%) was high when compared with other studies conducted in Vishakhapatnam (16.6%) and Vidarbha (17.14%) (Lewis *et al.*, 2006; Sharma, 2013). It may be due to lack of sanitary conditions and swarming house flies in street vending units (Sandeep *et al.*, 2001; Barro *et al.*, 2006).

Distribution of foodborne pathogens in different zones of Hyderabad

In Hyderabad city, fruit juices from all five zones have shown contamination with either one or the other foodborne pathogens (Figure 3). These five zones are generally overcrowded and polluted due to heavy traffic. This was supported by another study conducted in Vishakhapatnam, India where over crowded areas along with heavy vehicular traffic have shown high fecal

contamination (Lewis *et al.*, 2006). In our study south zone was highly contaminated with foodborne pathogens which was similar to the study conducted on poultry based street foods of Hyderabad. Demographically this zone belongs to the old city wherein the density of the population is high and most of the population was inhabited by lower income group (Sudershan *et al.*, 2012).

Knowledge and Practices of fruit juice vendors on food safety

The KP results of respondents were shown in table 2. About 60% of vendors had knowledge on contamination of food, of which 44% of them were able to recognize contaminated food by various senses like smell (16%), appearance (14%), and taste (8%). Around 36% of the vendors thought that the consumption of spoiled fruits can cause diarrhea or vomiting, but none of them knew the reason for contamination.

About 92% of vendors thought that hand washing is necessary before preparation of fruit juice, but our observational studies indicated that only 10% of the vendors were followed it to practice. About 86% of vendors were aware about the necessity of washing utensils with soap and water but only 4% of them translated it into practice. About 64% of vendors used disposable glasses for serving fruit juices. Regarding waste disposal, about 34% of the vendors were aware of its importance but most of them (84%) have left waste bins uncovered, which was similar to a study conducted in Uganda where street food vendors did not cover trash receptacles thus attracting flies and other insects creating the possibility of contamination of foods (Muyanja *et al.*, 2011).

In the present study, poor personal hygiene and some of the key risk behaviors of vendors which are major contributors for the

contamination of fruit juices were observed (Table 4). About 60% of vendors wore untidy clothes and had long finger nails. All the vendors were handling the fruit juices with bare hands and 64% of the vendors wore jewelry. Our study, findings showed that 94% of vendors were handling money while serving fruit juice, which is similar to the study conducted at Nigeria (Chukuezi, 2010). About 28% of vendors were scratching their scalp while preparing fruit juices and 36% of them were frequently wiping hands to their clothes. Although majority of the street vendors have good knowledge and attitude about food safety in most of the aspects but in reality they did not practice them. This attitude of vendors was also observed in other studies where food handlers did not translate their knowledge on food safety into practice (Omemu & Aderoju, 2008; Muinde *et al.*, 2005; Van-kampen *et al.*, 1998; Muyanja *et al.*, 2011; Mutalib *et al.*, 2012).

The results of the study also demonstrated that 52% (average of all translated practices from knowledge) of vendors have translated specific knowledge of some food safety aspects into practice. These findings have shown significant associations (Table 3) between some of the specific food safety knowledge and practices which includes washing of juicer after preparation of juice (P = 0.000), Wiping of utensils with clean cloth after cleaning utensils (P = 0.001), storage of cut fruits in covered container (P = 0.033), vessels in the unit covered with lids (P = 0.007), frequent mopping of preparation area (P = 0.000) and maintenance of waste disposal in the unit (P = 0.063).

Associations between foodborne pathogens and practices of fruit juice vendors on food safety

A significant association (Table 5) was

found between *E. coli* and some of the practices like vessels uncovered in vending units (P = 0.001) and peeled sapota fruits which were kept in uncovered container (P = 0.037). *E. coli* is widely disseminated in the environment through the feces of humans and other animals. This, coupled with the ability of the bacterium to survive for months external to the colon makes its presence ubiquitous. Fruit juices generally attract houseflies because of their sweet odour which act as vectors of bacterial pathogens like *Campylobacter* spp. and *E. coli* (Sheri *et al.*, 2007). There was also an association (trend) found between use of bore well (ground) water for washing of utensils and presence of fecal coliforms in fruit juices (p = 0.06). This finding was supported by a study conducted in Uyo Metropolis where, ice samples were contaminated by *E. coli*, coliforms and other pathogenic microorganisms in which the major source of water was bore wells and deep wells (NAFDAC, 2004), and similarly in Uli, Nigeria high fecal coliform counts detected in borehole water where boreholes are proximal to pit latrine (Ibe *et al.*, 2005). There was also another significant (trend) association where disposable glasses used for serving (P = 0.08) and pine apple fruits which were peeled and kept uncovered (P = 0.085) with *S. aureus*. Among all isolated foodborne pathogens in this study *Shigella* spp. was considered as high risk pathogen because of its low infective dose (10 - 200 organisms) (Public health agency of Canada, 2010) which has shown significant association with frequent use of same mopping cloth to clean preparation area (P = 0.05) which was similar to a study conducted in Vadodara on table mop cloths from food handlers (Mini Sheth *et al.*, 2011).

The present study revealed that street vended fruit juices are contaminated with foodborne pathogens like *S. aureus* and

Shigella spp. The indicator organisms such as fecal coliforms and *E. coli* had a high prevalence which indicates that these fruit juices are hygienically of low standards. This study results showed that even though there was a good knowledge in vendors regarding food safety translation into practice was not expectable so, this gap exists between their knowledge and practices is enormous. Also some of the key risk behaviors which are major contributors for contamination of fruit juices were observed. Specific food safety practices regarding preparation of street vended fruit juices such as washing of juicer after preparation of juice, storage of cut fruits in a covered container and frequent mopping of preparation area have shown significant associations with foodborne pathogens and vendors' knowledge. These findings indicated that targeted food safety education and training to vendors is essential by using behavior change communication theories to create awareness among vendors and translate into practice to avoid possible sources of microbial hazards.

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References

- Badrie, N., Gobin, A., Dookeran, S., & Duccan, R. 2006. Consumer awareness and perception to food safety hazards in Trinidad, West Indies. *Food Control*. 17: 370 – 377.
- Barro, N., Bello A.R., S. Aly, Ouattara C. A. T., Ilboudo A. Jules and Traoré A. S. 2006. Hygienic status an assessment of dishwashing waters, utensils, hands and pieces of money from street food processing sites in Ouagadougou (Burkina Faso). *African Journal of Biotechnology*. 5 (11), 1107-1112.
- Bas, M., Ersun, A.S. & Kivanc, G. 2006. The Evaluation of Food Hygiene Knowledge, Attitudes and Practices of Food Handlers' in Food Businesses in Turkey. *Food Control*. 17:317-322.
- Choudhury, M., Mahanta, L., Goswami, J., Mazumder, M. & Pegoo, B. 2010. Socio-economic Profile and Food Safety Knowledge and Practice of Street Food Vendors in the City of Guwahati, Assam, India. *Food Control*. 22 (2):196-203.
- Chukuezi CO. 2010. Food Safety and Hygienic Practices of Street Food Vendors in Owerri, Nigeria. *Studies in Sociology of Science*. 1: 50-57.
- Deanna M. M. and S. B. Jeffrey. 2007. Acid-alkaline Balance: Role in Chronic Disease and Detoxification. *Alternative therapy*. 13(4):62-65.
- Elizabeth Walker, Catherine Pritchard, Stephen Forsythe. 2003. Food handlers_ hygiene knowledge in small food businesses. *Food Control*. 14: 339–343.
- Health Canada. 2006. It is your health. Unpasteurized fruit juices/cidar. Retrieve from <http://www.hc-sc.gc.ca/www/ha-vs/iyh-vsv/food-aliment/juice-jus-eng.php>. (accessed January 28, 2013).
- Ibe S. N., J.I. Okpleny. 2005. Bacteriological analysis of borehole water in Uli, Nigeria. *African Journal of Applied Zoology & Environmental Biology*. 7: 116 – 119.
- Idowu, O. A., & Rowland, S. A. 2006. Oral fecal parasites and personal hygiene of food handlers in Abeokuta, Nigeria. *African Health Science*. 6(3): 160–164.
- Lateef A, Oloke JK, Kana EB and Pacheco E. 2006. The Microbiological Quality of Ice Used to Cool Drinks and Foods in Ogbomoso Metropolis, Southwest, Nigeria. *Internet Journal of Food Safety*.

- 8:39-43.
- Lewis JE, Thompson P, Rao BVVBN, Kalavati C and Rajanna B. 2006. Human bacteria in street vended fruit juices: A case study of Visakhapatnam City, India. *Internet Journal of Food Safety*. 8:35-38.
- Mahale D P, Khade RG, Vaidya VK. 2008. Microbiological Analysis of Street Vended Fruit Juices from Mumbai City, India. *Internet Journal of Food Safety*, 10:31-34.
- Mensah P. Yeboah-Manu D. Owusu-Darkok, A. Ablordey. 2002. Street Foods in Accra, Ghana: How Safe are they? *Bull WHO*. 80:546-554.
- Mesfin worku. 2011. Bacteriological profile of locally prepared fresh fruit juices in hawassa town, Southern Ethiopia. Master of Science Thesis, Department of Microbiology, Immunology and Parasitology, Addis Ababa University. <http://etd.aau.edu.et/dspace/bitstream/123456789/2873/1/93291944738682206834589649388074650188> (accessed January 8, 2013).
- Mini Sheth, Ashima Gupta, Tejpal Ambegaonkar. 2011. Handlers' hygiene practices in small restaurants of Vadodara. *Nutrition & Food Science*. Vol. 41 Iss: 6, pp.386 – 392.
- Muinde OK, Kuria E. 2005. Hygienic and sanitary practices of vendors of street foods in Nairobi, Kenya. *AJFAND online* www.ajfand.net. 5 (1): 1-13.
- Mulugeta Kibret, Bayeh Abera. 2012. The sanitary conditions of food service establishments and food safety knowledge and practices of food handlers in Bahir Dar town. *Ethiop J. Health. Sci*. 22(1), No.1, 27 – 35.
- Mutalib Noor-Azira Abdul, Mohammad-Faid Abdul-Rashid, Shuhaimi Mustafa, Syafinaz Amin-Nordin, Rukman Awang Hamat, Malina Osman. 2012. Knowledge, attitude and practices regarding food hygiene and sanitation of food handlers in Kuala Pilah, Malaysia. *Food Control*. 27: 289 – 293.
- Muyanja Charles, Leontina Nayiga, Namugumya Brenda, George Nasinyama. 2011. Practices, knowledge and risk factors of street food vendors in Uganda. *Food Control*. 22: 1551 – 1558.
- NAFDAC. 2004, Guidelines for Production and Registration of Package Water. New Guidelines and Regulations p.1-10. NAFDAC, Abuja Nigeria.
- Neha I. Bagde and P.M. Tumane. 2011. Studies on microbial flora of fruit juices and cold drinks. *Asiatic Journal of Biotechnology Resources*. 2(04): 454-460.
- Nichols G, Gillespie I, and deLouvois J. 2000. The Microbiological Quality of Ice Used to Cool Drinks and Ready-to-Eat from Retail and Catering Premises in the United Kingdom. *Journal of Food Protection*. 63: 78-82.
- Omemu, A. M. & Aderoju, S. T. 2008. Food Safety Knowledge and Practices of Street Food Vendors in the City of Abeokuta, Nigeria. *Food Control*. 19(4): 396- 402.
- Parish M. E. 1997. Public health and non pasteurized fruitjuices. *Crit. Rev. Microbiol*. 23:109-119.
- Public health agency of Canada. 2010. Pathogen regulation directorate, Canada. <http://www.msdsonline.com/resources/msds-resources/free-safety-data-sheet-index/shigella-spp.aspx> (accessed January 28, 2013)
- Rashed, N., Md. Aftab, U., Md. Azizul, H., Saurab, K. M., Mrityunjy, A. and M. Majibur, R. 2013. Microbiological study of vendor and packed fruit juices locally available in Dhaka city, Bangladesh. *International Food Research Journal*. 20(2): 1011-1015.
- Sandeep M. D., Waker A. and Abhijit G. 2001. Microbiological Analysis of street vended fresh squeezed carrot and kinnow-mandarin juices in Patiala city, India. *Internet Journal of Food Safety*. 3: 1-3.
- Shakir M. Uddin Ahmed, Tania Nasreen,

- Badrunnessa Feroza and Sahana Parveen. 2009. Microbiological quality of local market vended freshly squeezed fruit juices in dhaka city, Bangladesh. *Bangladesh J. Sci. Ind. Res.* 44(4), 421-424.
- Sharma U. Poonam. 2013. Bacteriological analysis of street vended fruit juices available in Vidarbha. *Int.J.Curr.Microbiol.App.Sci.*2(5): 178-183.
- Sheri M. Brazil, C. Dayton Steelman & Allen L. Szalanski. 2007. Detection of pathogen DNA from filth flies (Diptera: Muscidae) using filter paper spot cards. *Journal of Agricultural and Urban Entomology.* 24 (1): 13–18. doi:10.3954/1523-5475-24.1.13
- Sudershan Rao V., R. Naveen Kumar, L. Kashinath and K. Polasa. 2012. Microbial hazard identification and exposure assessment of poultry products sold in various localities of Hyderabad, India. *ScientificWorldJournal.* 2012: 736040.
- Suneetha C., K. Manjula and Baby Depur. 2011. Quality assessment of street foods in Tirumala. *Asian Journal Exp. Biol. Sci.* 2 (2): 207-211.
- Tambekar D. H., V. J. Jaiswal, D. V. Dhanorkor, P. B. Gulhane and M. N. Dudhare. 2009. Microbial Quality and safety of street vended fruit juices: A case study of Amravati city. *Internet Journal of Food Safety.* (10): 72:76.
- Titarmare Ankur, Pranoti Dabholkar and Suchitra Godbole. 2009. Bacteriological Analysis of Street Vended Fresh Fruit and Vegetable Juices in Nagpur City, India. *Internet Journal of Food Safety.* 11: 1-3.
- Tokuç, B., Ekuklu, G., Berberog̃lu, U., Bilge, E., & Dedeler, H. 2009. Knowledge, attitudes and self-reported practices of food service staff regarding food hygiene in Edirne, Turkey. *Food Control.* 20(6), 565–568.
- Ukwo P. Sunday, Nyaudoh U. Ndaeyo, Etido J. Udoh. 2011. Microbiological Quality and Safety Evaluation of Fresh Juices and Edible Ice Sold in Uyo Metropolis, South-South, Nigeria. *Internet Journal of Food Safety.* 13: 374-378.
- Umoh, V. J., & Odoba, M. B. 1999. Safety and quality evaluation of street foods sold in Zaria, Nigeria. *Food Control.* 10: 9–14.
- Van kampen, J., Gross, R., Schultinik, W. and USFAR.A. 1998. The microbiological quality of street foods in Jakarta as compared to home prepared foods and foods from tourist hotels. *Int. J. Food Sci. Nutr.* 49: 17 – 26.
- Vieira RHSF, de Souza OV and Patel TR. 1997. Bacteriological Quality of Ice used in Mucuripe Market, Fortaleza, Brazil. *Food Control.* 8: 83-85.
- Vojdani, J.D, L.P. Beuchat, and R.V. Tauxe. 2008. Juice associated outbreaks of human illness in the United States, 1995 through 2005. *J. Food Prot.* 71: 356 – 364.
- Waghray K, Bhat RA. 1995. Street foods of Hyderabad: A profile. *Nutrition.* 29: 11-23.