RESULTS and DISCUSSION

CHAPTER V

RESULTS and DISCUSSION

The broad objective of the present study was to study the effectiveness of imparting food safety education to food service providers of urban Vadodara and to determine ways of reducing microbial load on coriander leaves. This chapter presents the results of the study, under the following heads.

5.1 Phase I –Situational analysis of 153 Food Service Providers (FSPs)

5.2 Phase II – Formation of PIMC and its contribution

5.3 Phase III – Imparting food safety education to street food vendors and along with follow up training

5.4 Phase IV – Imparting food safety education to restaurant owners and handlers

5.5 Phase V – Microbial load of fresh coriander after treatment with different levels of disinfectants namely sodium hypochlorite (NaOCl) and potassium permanganate ($KMnO_4$).

5.1: PHASE I – SURVEY RESULTS OF SITUATIONAL ANALYSIS OF 153 FOOD SERVICE PROVIDERS (FSPs)

In the Phase I of the study, about 90 structured and 63 unstructured units were surveyed for their knowledge and practices on food safety. The structured units comprised of small and medium restaurants (N = 50), Fast food joints (N = 10), Bus stand food outlets (N = 10), Railway food outlets (N = 10) and Dhabas (N = 10). The unstructured units comprised of the street food units (N = 63).

The results of this phase are presented under the following heads:

5.1.1: General information of the respondents belonging to structured and unstructured units

5.1.2: General information about the structured and unstructured units

5.1.3: Raw food procurement and storage practices of the structured and unstructured units.

5.1.4: Knowledge of the respondents on food safety.

5.1.5: Practices of the respondents on food safety

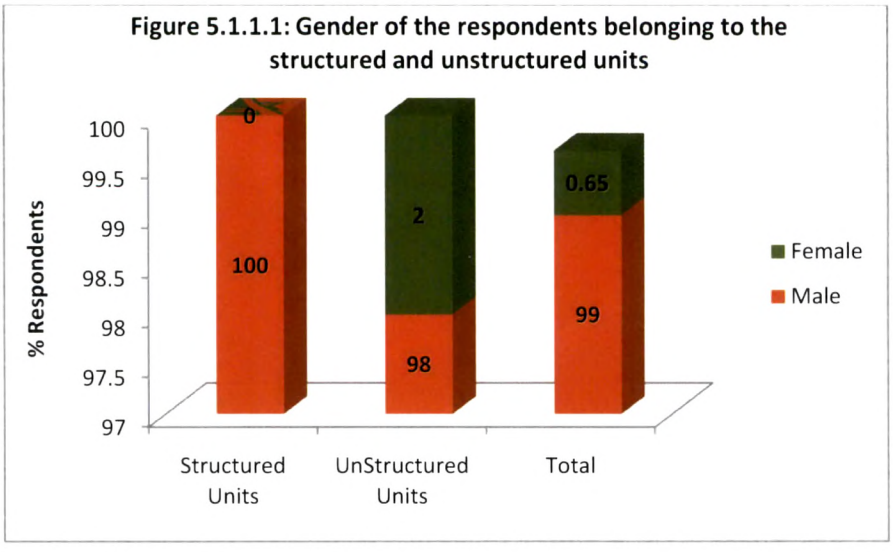
5.1.1: General information of the respondents belonging to structured and unstructured units

Table 5.1.1.1 shows the ownership details and migration status of the respondents of the food service establishments. The results of the survey revealed that majority of the structured units (90%) and unstructured units (82%) owned their units, while few respondents (13% and 18%) of the structured and unstructured units respectively, migrated from other areas for employment purpose. The migration and ownership status did not statistically differ for the types of units.

Table 5.1.1.1: General information of the respondents of the Structured and Unstructured Food service establishments:

Food service establishments	Ownership details		λ^2	Migration status		λ^2
	Owner	Rental		Local	Migrated	
Structured Units (N = 90)	81 (90)	9 (10)	1.82 ^{NS}	78 (87)	12 (13)	0.494 ^{NS}
Unstructured Units - SFVs (N=63)	52 (82)	11 (18)		52 (82)	11 (18)	
Total (N=153)	133 (87)	19 (13)		130 (85)	23 (15)	

Note: Figures in parenthesis indicate percentages
NS – Not significant



Most of the structured and unstructured units had male food handlers, with only one female as street food vendor (Figure 5.1.1.1).

Majority of the respondents (77%) were between the age group of 25 – 50 years, whereas about 24 per cent of street food vendors were young (< 25 years) (Figure 5.1.1.2).

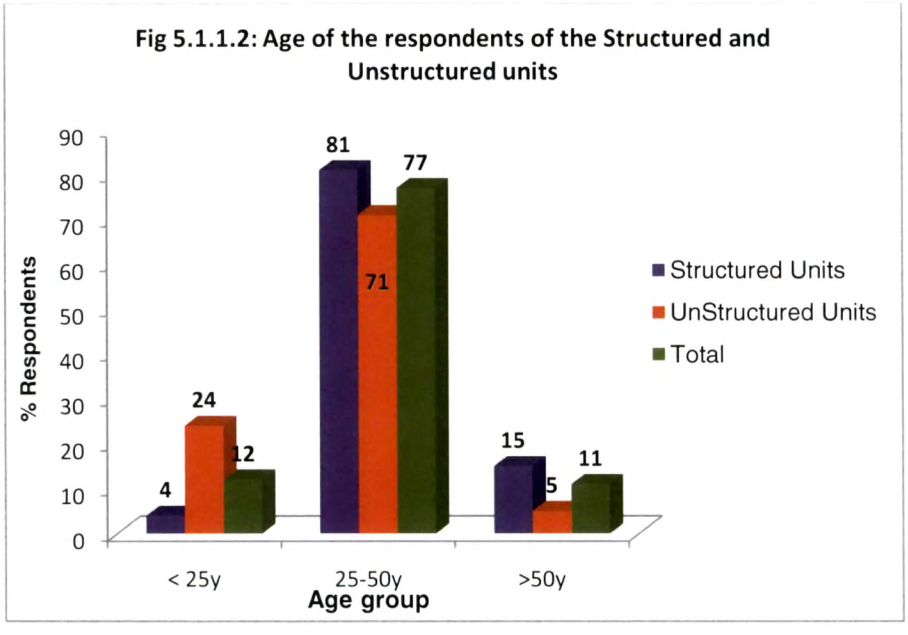


Table 5.1.1.2 shows that 43 per cent of the structured units were found to be more experienced (10-20y) as compared to the unstructured units (62%) who had less than 10 years of experience in food service. This difference in the

years of experience for both the groups was found to be statistically significant. Majority of the respondents (89%) had food service as their main occupation.

More number of the street food vendors had employees below 16 years of age as compared to structured units and this difference was found to be statistically significant (Table 5.1.1.2).

Table 5.1.1.2: Information related to the respondents employed in the Structured and Unstructured Food service establishments:

Food service establishments	No. of yrs in this occupation			λ^2	Main occupation		λ^2	Employees below 16y		λ^2
	< 10y	10-20y	> 20y		Yes	No		Yes	No	
Structured Units (N = 90)	31 (34)	38 (43)	21 (23)	11.53**	81 (90)	9 (10)	0.27^{NS}	1 (1)	89 (99)	6.01*
Unstructured Units - SFVs (N=63)	39 (62)	17 (27)	7 (11)		55 (87)	8 (13)		6 (9.52)	57 (90.47)	
Total (N=153)	70 (46)	55 (36)	28 (18)		136 (89)	17 (11)		7 (4.57)	136 (88.88)	

Note: Figures in parenthesis indicate percentages
* Significant at p<0.5 ** Significant at p<0.01

Table 5.1.1.3 and 5.1.1.4 shows the educational status of the respondents. Results showed that the respondents belonging to the structured units were more educated as compared to the street food vendors. More number of the respondents belonging to the unstructured units (21%) were illiterate as compared to only 5 per cent of the respondents belonging to the structured units and this difference was found to be statistically significant (P<0.01). As high as 47 per cent of the respondents employed in structured units had received education above the higher secondary level as compared to only 3 per cent of the street food vendors. This difference in the educational status of the two groups was found to be statistically significant.

Table 5.1.1.3: Educational level of the respondents of the Food service establishments

Food service establishments	Educational level				
	Illiterate	Up to primary	Up to HS	Above graduate	Up to graduate
Restaurant (small/medium) (N=50)	1 (2)	3 (6)	15 (30)	3 (6)	28 (56)
FFJs (N=10)	-	1 (10)	4 (40)	1 (10)	4 (40)
Dhabas (N=10)	2 (20)	-	5 (50)	-	3 (30)
Railway food outlets (N=10)	-	2 (20)	7 (70)	-	1 (10)
Bus stand food outlets (N=10)	2 (20)	4 (40)	2 (20)	1 (10)	1 (10)
SFVs (N=63)	13 (20.63)	19 (30.15)	29 (46.03)	-	2 (3.17)
Total (N=153)	18 (11.76)	29 (18.95)	62 (40.52)	5 (3.26)	39 (25.49)

Note: Figures in parenthesis indicate percentages

Table 5.1.1.4: Statistical analysis between the type of the unit and educational level of the respondents

Food service establishments	Educational level				λ^2
	Illiterate	Up to primary	Up to HS	>HS	39.43**
Structured Units (N = 90)	5 (5)	10 (11)	33 (38)	42 (47)	
Unstructured Units - SFVs (N=63)	13 (21)	19 (30)	29 (46)	2 (3)	
Total (N=153)	18 (12)	29 (19)	62 (40)	44 (29)	

Note: Figures in parenthesis indicate percentages
** Significant at $p<0.01$

The table 5.1.1.5 shows the nature of jobs done by the family members. Majority (61%) of the structured units and 40 per cent of the street food vendors involved their family members in supervision and cash holding. About 30 per cent of the street food vendors took help of their family members for cooking purpose. Only few of the structured units involved their family members for cooking (9%), serving (4%) and cleaning (4%).

Table 5.1.1.5: Nature of jobs done by the family members of the structured and unstructured units

Food service establishments	Nature of jobs				
	Supervision and cash holding	Purchases	Cooking	Serving	Cleaning
Structured Units (N = 90)	55 (61)	29 (32)	8 (9)	4 (4)	4 (4)
Unstructured Units - SFVs (N=63)	25 (40)	14 (22)	19 (30)	8 (13)	12 (19)
Total (N=153)	80 (52)	43 (28)	27 (18)	12 (8)	16 (10)

Note: Figures in parenthesis indicate percentages

5.1.2: General information about the structured and unstructured units

Table 5.1.2.1 provides information on the number of employees engaged in the structured and unstructured units. Majority of the structured establishments (61%) had more number of employees (>5), as compared to the unstructured units (36%) who were self employed and this difference was found to be statistically significant (P<0.01).

Table 5.1.2.1: Number of employees engaged in the structured and unstructured units

Food service establishments	No. of employees in unit				λ^2
	Self	Up to 3	Up to 5	> 5	
Structured Units (N = 90)	2 (2)	17 (19)	16 (18)	55 (61)	60.04**
Unstructured Units-SFVs (N=63)	23 (36)	23 (36)	13 (21)	4 (7)	
Total (N=153)	25 (16)	40 (26)	29 (19)	59 (39)	

Note: Figures in parenthesis indicate percentages
** Significant at p<0.01

The income levels of the structured and unstructured units (Table 5.1.2.2 and 5.1.2.3) revealed that a majority of the structured units (68%) earned more wages (>₹1000/-) daily as compared to 89 per cent of the street food vendors who earned <₹1000/- per day. Only 11 per cent of the street food vendors had a daily average earning of more than ₹1000/-. This difference in the income levels of the two types of units was statistically significant (P<0.01).

Table 5.1.2.2: Daily average income of the respondents of Food service establishments:

Food service establishments	Income level (₹)			
	< 200	200-600	600-800	>1000
Restaurant (small/medium) (N=50)	-	-	12 (24)	38 (76)
FFJs (N=10)	-	-	-	10 (100)
Dhabas (N=10)	-	-	6 (60)	4 (40)
Railway food outlets (N=10)	-	-	5 (50)	5 (50)
Bus stand food outlets (N=10)	-	1 (10)	5 (50)	4 (40)
SFVs (N=60)	5 (7.93)	31 (49.2)	20 (31.74)	7 (11.11)
Total (N=150)	5 (3.26)	32 (20.91)	48 (31.37)	68 (44.44)

Note: Figures in parenthesis indicate percentages

Table 5.1.2.3: Statistical analysis between the daily average income of the respondents and the type of units:

Food service establishments	Income level (₹)		λ^2
	< 1000	>1000	
Structured Units (N = 90)	29 (32)	61 (68)	48.20**
Unstructured Units - SFVs (N=63)	56 (89)	7 (11)	
Total (N=153)	85 (55)	68 (44)	

Note: Figures in parenthesis indicate percentages
** Significant at p<0.01

Majority (94%) of the structured units were licensed, while 41 per cent of the street vending units were not licensed and this difference was found be statistically significant (Table 5.1.2.4).

Table 5.1.2.4: Possession of license of the structured and unstructured units:

Food service establishments	Unit licensed		λ^2
	Yes	No	
Structured Units (N = 90)	85 (94)	5 (6)	29.26**
Unstructured Units - SFVs (N=63)	37 (59)	26 (41)	
Total (N=153)	122 (80)	31 (20)	

Note: Figures in parenthesis indicate percentages
** Significant at p<0.01

It is clear from the figure 5.1.2.1 that majority (87%) of the street vending units had a sitting capacity for less than 10 persons. However, about 50 per cent of the structured units had provision for seating more than 20 persons at a time.

As high as 97 per cent of the structured units had electricity as the mode of lighting, whereas 65 per cent of the street vending units made use of battery operated lights (Figure 5.1.2.2).

Figure 5.1.2.3 provides information on the source of water supply in the food service establishments. Results showed that majority of the structured units (83%) had facility for running water supply as compared to the unstructured units that had only stored water at site.

A majority (92%) of the structured food service establishments did not have water purifier in working condition. This facility was totally absent in street vending units (Figure 5.1.2.4).

Figure 5.1.2.1: Sitting capacity of the structured and unstructured units

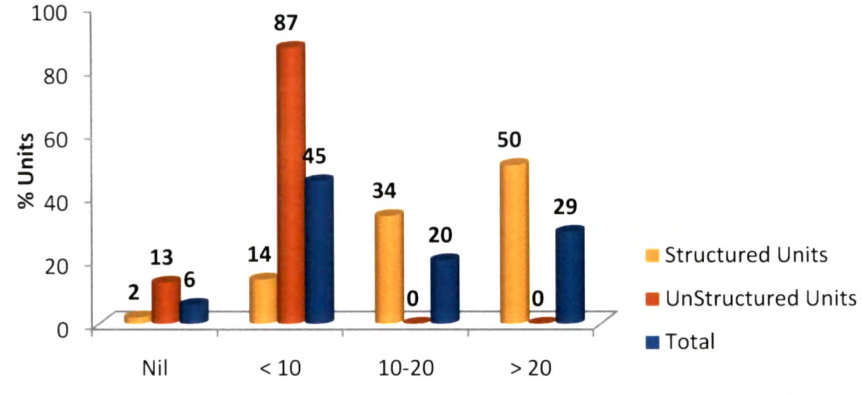


Figure 5.1.2.2: Mode of lighting of the structured and unstructured units

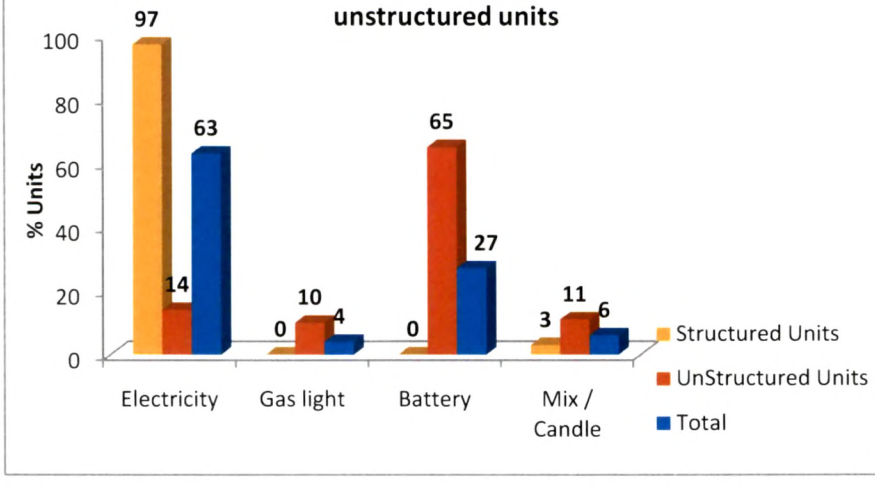


Figure 5.1.2.3: Information on the source of water supply at site of the food service establishments

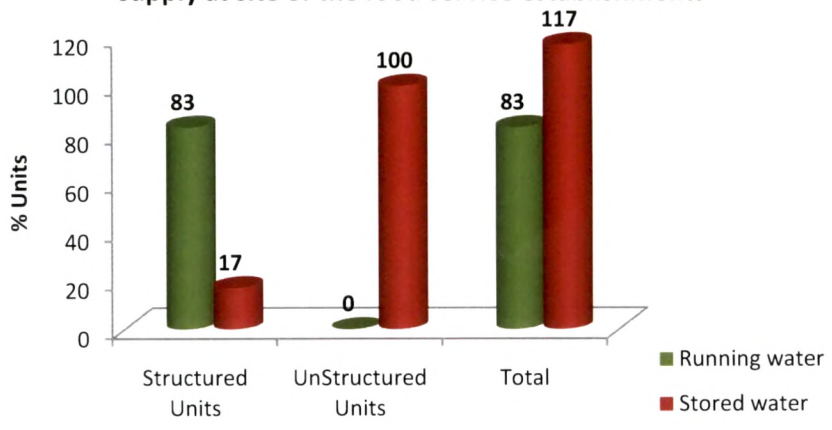
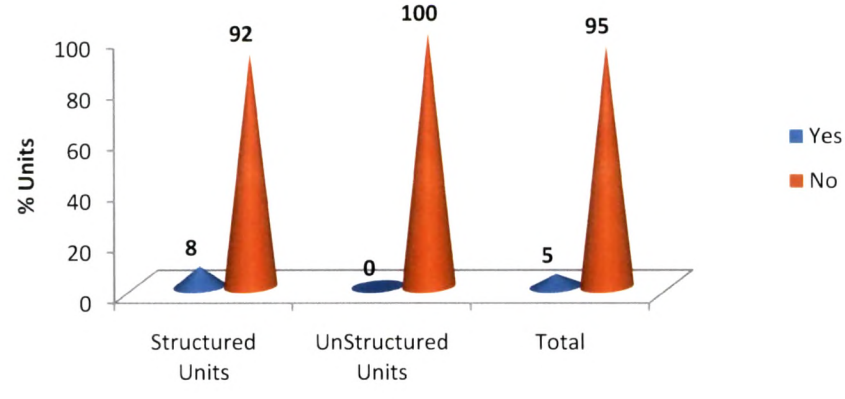


Figure 5.1.2.4: Information on the availability of water purifier in working condition



A statistically significant difference was noticed in the working hours of the structured and unstructured units (Table 5.1.2.5). It is clear from the table, that majority (54%) of the workers of the structured unit worked for longer hours (> 12h) as compared to street food vendors who worked for only 8 hours.

Table 5.1.2.6 reveals that the structured establishments had more number of consumers visiting their establishments per day. About 50 per cent of the structured units received as high as 100 – 150 consumers on daily basis. As angst this, 44 per cent of the street food vendors had about 50 -100 consumers visiting their establishments daily. In addition to this, 25 per cent of the structured units received about more than 150 consumers per day, as

compared to only 3 per cent of the street vendors and this difference was found to be statistically significant (P<0.01).

Table 5.1.2.5: Information on the working hours of the food service units:

Food service establishments	Working hrs.			λ^2
	Up to 8h	8-12 h	> 12h	
Structured Units (N = 90)	3 (3)	39 (44)	48 (53)	39.12**
Unstructured Units - SFVs (N=63)	25 (40)	27 (43)	11 (17)	
Total (N=153)	28 (18)	66 (43)	59 (39)	

Note: Figures in parenthesis indicate percentages
** Significant at p<0.01

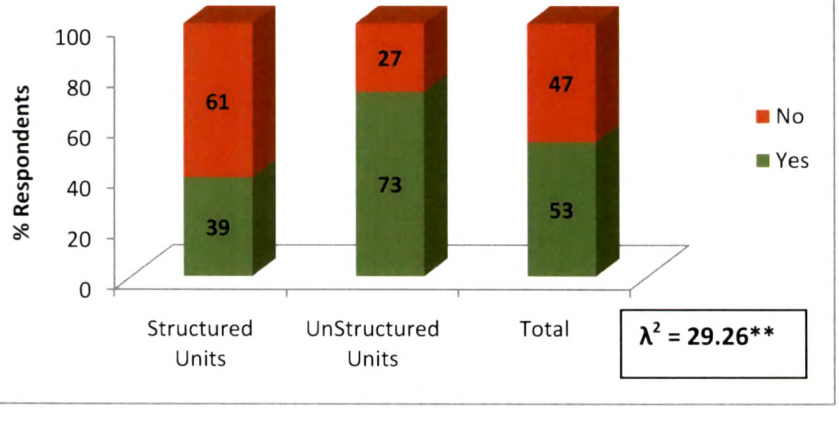
Table 5.1.2.6: Information on the average consumers visiting the food service units:

Food service establishments	Average no. of consumers				λ^2
	< 50	50-100	100-150	>150	
Structured Units (N = 90)	2 (2)	20 (23)	45 (50)	23 (25)	21.37**
Unstructured Units - SFVs (N=63)	6 (9)	28 (44)	27 (43)	2 (3)	
Total (N=153)	8 (5)	48 (31)	72 (47)	25 (16)	

Note: Figures in parenthesis indicate percentages
** Significant at p<0.01

Figure 5.1.2.5 shows that majority (73%) of the street vendors expressed their willingness to undergo food safety training. Whereas only 39 per cent of the respondents of the structured units agreed for attending food safety training and this difference was found to statistically significant (P<0.01).

Figure 5.1.2.5: Responses regarding willingness to undergo training



5.1.3: Raw food procurement and storage practices of the structured and unstructured units

Table 5.1.3.1 shows the procurement practices of raw materials by the Structured and Unstructured Units. It is clear from the above table that none of the structured as well as unstructured units purchased labeled and packed fresh vegetables, fruits and salads, eggs, meat and fish. As high as 89 per cent of the structured units and 51 per cent of the street food vendors made use of packed and labeled spices condiments. Less than half of the structured units (45%) and street food vendors (38%) procured packed and labeled food grains. Majority (95%) of the structured units made use of packed and labeled oil and ghee.

Table 5.1.3.1: Raw food procurement practices of the Structured and Unstructured Units

Type of food materials	Purchase of labeled items by the FSEs (n=153)		Chi square value	Purchase of packed items by the FSEs (n=153)		Chi square value	Not Procured
	Yes	No		Yes	No		
	Food grains and semi processed ingredients						
Structured Units (N = 90)	41 (45)	48 (53)	0.63 NS	41 (45)	48 (53)	0.63 NS	1 (1)
SFVs (N=63)	24 (38)	21 (33)		24 (38)	21 (33)		18 (28.57)
Total (N=153)	65 (42)	69 (45)		65 (42)	69 (45)		19 (12.41)
	Condiments and spices, nuts and dry foods						
Structured Units (N = 90)	80 (89)	10 (11)	18.31**	80 (89)	10 (11)	18.31**	-
SFVs (N=63)	32 (51)	23 (36)		32 (51)	23 (36)		8 (29)
Total (N=153)	112 (73)	33 (22)		112 (73)	33 (22)		8 (5)
	Leafy and fresh vegetables						
Structured Units (N = 90)	-	79 (88)	-	-	79 (88)	-	11 (12)
SFVs (N=63)	-	50 (79)		-	50 (79)		13 (21)
Total (N=153)	-	129(84)		-	129 (84)		23 (15)
	Fruits and salads						
Structured Units (N = 90)	-	22 (24)	-	-	22 (24)	-	68 (75)
SFVs (N=63)	-	10 (16)		-	10 (16)		53 (84)
Total (N=153)	-	32 (21)		-	32 (21)		121 (79)
	Oil, butter and ghee						
Structured Units (N = 90)	85 (95)	4 (4)	2.95 NS	85 (95)	4 (4)	2.95 NS	1 (1)
SFVs (N=63)	42 (67)	6 (9)		42 (67)	6 (9)		15 (24)
Total (N=153)	127 (83)	10 (6)		127 (83)	10 (6)		16 (10)

		Semi processed vegetables					
Structured Units (N = 90)	7 (8)	2 (2)	1.25 NS	7 (8)	2 (2)	1.25 NS	81 (90)
SFVs (N=63)	3 (5)	3 (5)		3 (5)	3 (5)		57 (90)
Total (N=153)	10 (6)	5 (3)		10 (6)	5 (3)		138 (90)
		Eggs, meat and fish					
Structured Units (N = 90)	-	11 (12)	-	-	11 (12)	-	79 (88)
SFVs (N=63)	-	5 (8)		-	5 (8)		58 (92)
Total (N=153)	-	16 (10)		-	16 (10)		137 (89)

Figures in parenthesis indicate percentages
Note: ** Significant at p<0.01 and NS – Not significant

Table 5.1.3.2 gives information about the information on availability of smokeless fire and separate store for raw materials in the unit. Results showed that majority of the structured (80%) as well as unstructured units (90%) used smokeless fire and fuel for cooking. As high as 60 per cent of the structured units had the facility for separate store for raw materials.

Table 5.1.3.2: Information on availability of smokeless fire and separate store for raw materials in the unit:

Food service establishments	Use of smokeless fire and fuel for cooking		Facility of a separate store for raw materials		
	Yes	No	Yes	No	NA
Structured Units (N = 90)	72 (80)	18 (20)	54 (60)	36 (40)	-
SFVs (N=63)	57 (90)	2 (3)*, NA-4	-	-	63 (100)
Total (N=153)	129 (84)	20 (13)	54 (35)	36 (23)	63 (41)

*Smokeless fire and fuel
Note: Figures in parenthesis indicate percentages; * Significant at p<0.05

Figure 5.1.3.1 provides information on the storage practices of semi perishables at room temperature and under chilling. Data revealed that about 11per cent of the structured units and 6 per cent of street food vendors did not make use of semi perishables. As high as 74 per cent of the structured kept semi perishables for less than 2 hours at room temperature whereas majority (92%) of the street food vendors stored the semi perishables for > 2 hours. It was noted that 53 per cent of the structured units stored the semi perishables for less than 3 days under chilling.

It was seen that about 25 per cent of the structured units and 81 per cent of the street food vendors did not use high risk foods. About 58 per cent of the

structured units and 36 per cent of the street vending units had a good practice of storing the high risk foods for less than 2 hours at room temperature (Figure 5.1.3.2). It was also noted that none of the units stored the high risk foods for more than 3 days under chilling. As low as 9 per cent of the street vendors kept the high risk foods for less than 3 days under chilling as against 46 per cent of the structured units (Figure 5.1.3.2).

Figure 5.1.3.1: Information on the storage practices for semi perishables at room temperature and under chilling

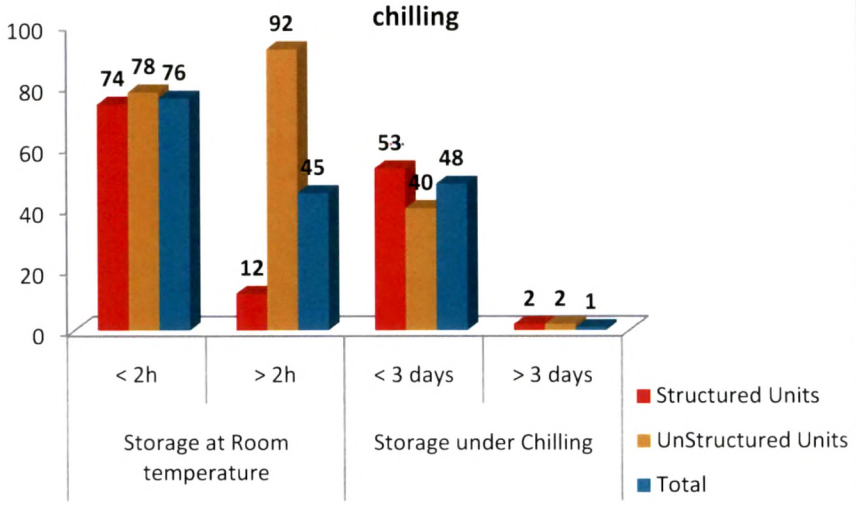
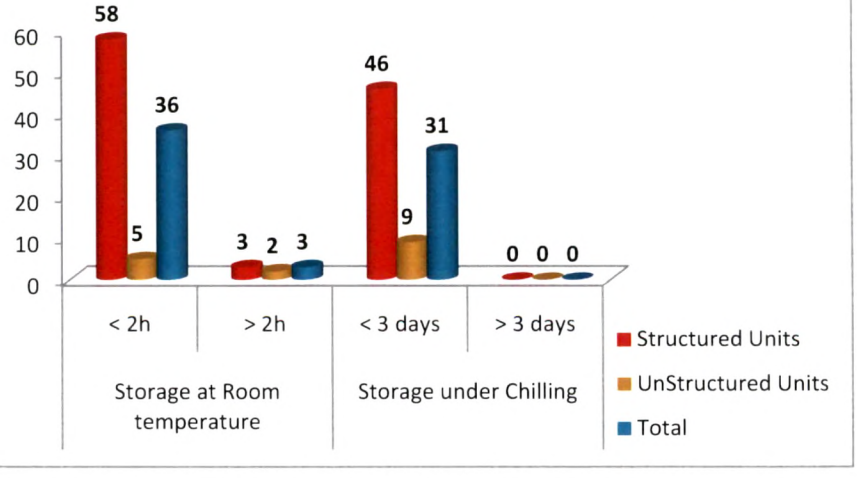


Figure 5.1.3.2: Information on the storage practices for high risk foods at room temperature and under chilling



5.1.4: Knowledge of the respondents on food safety

The respondents (N = 153) were interviewed on a total of 17 questions on the three basic aspects of food safety namely personal hygiene, food hygiene and nutrition and health. The mean knowledge scores of all the six categories of food service establishments viz., restaurants, fast food joints, dhabas, railway food outlets, bus stand food outlets and street food vendors are depicted in Table 5.1.4.1. The respondents were asked to state whether each statement was true or false. Based on this they were given a score of 2 for every right response, score of 1 for wrong response and a score of 0 for no response.

Personal Hygiene: The food handlers were tested for their knowledge on use of towel if dirty and whether or not washing hands is essential for cooks, servers. Results revealed that the mean per cent scores of the respondents ranged from 80 per cent – 100 per cent, with restaurants having the lowest score under the personal hygiene category. A significant difference in the knowledge scores was seen amongst all the categories of food service establishments. It was noticed that the owners of the bus stand food outlets could correctly answer both the questions on personal hygiene.

Food Hygiene: The respondents were interviewed on 8 aspects of food hygiene such as; effect of high and low temperature of food on growth of microorganisms, water as source of food contamination, avoiding consumption of peeled and cut fruits from fruits shops, etc. All the owners of food service establishments gained higher scores for food hygiene, except restaurants and street food vendors that had mean per cent scores of 53 per cent and 39 per cent respectively.

Nutrition and Health: In the area of nutrition and health, the respondents were asked questions on adulteration of foods, nutritional facts, purchase of labeled and packaged foods, etc. The street food vendors and restaurant owners had poor mean per cent scores of 37 per cent and 31 per cent respectively. The owners of the bus stand food outlets had high scores of 70 per cent, followed by dhabas (66%), fast food joints (65%). A significant difference was noticed in the knowledge scores of owners of restaurant and bus stand food outlets, dhabas as well as fast food joints.

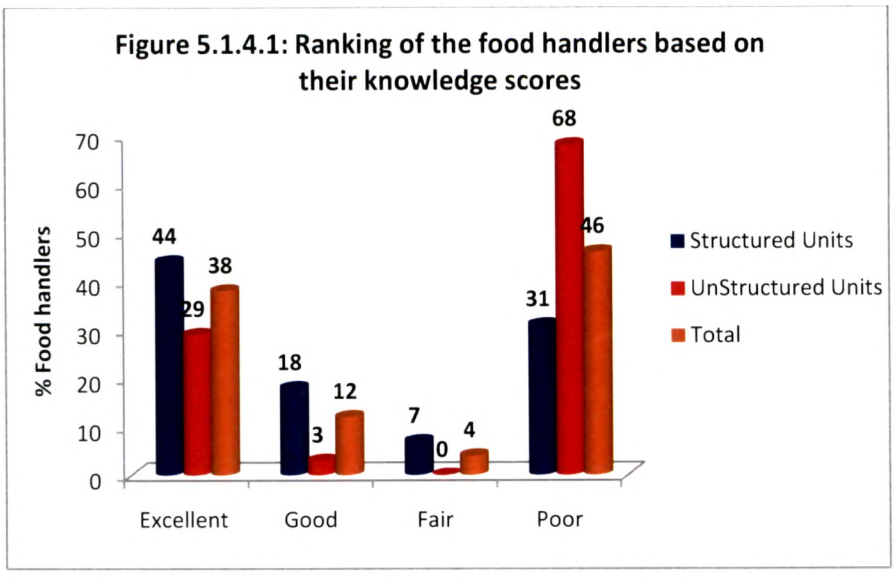
Total Score: It was noticed that the bus stand food outlets scored a total of 83 per cent in the knowledge as compared to the other establishments. The street food vendors (41%) scored least in knowledge followed by the restaurant (50%).

Table 5.1.4.1: Mean Knowledge scores of the food service establishments

Knowledge scores	Restaurants (n = 50)	FFJs (n = 10)	Dhabas (n = 10)	Railway food outlets (n = 10)	Bus stand food outlets (n = 10)	SFVs (n = 63)	F test
Personal Hygiene Max Score = 4	3.26 ± 1.02 (81.5) ^{a}	3.7 ± 0.67 (92.5) ^{abd}	3.7 ± 0.67 (92) ^{abd}	3.6 ± 0.84 (90) ^{cbd}	4 ± 0 (100) ^{bd}	3.73 ± 0.67 (93) ^{d}	2.67*
Food hygiene max score = 16	8.5 ± 5.63 (53) ^{a}	14.3 ± 2.66 (89) ^{eb}	13.1 ± 15.5 (82) ^{db}	12.6 ± 2.95 (79) ^{cb}	14.3 ± 1.82 (89) ^{b}	5.96 ± 5.85 (37) ^{f}	10.85***
Nutrition and Health Max score = 14	5.2 ± 4.43 (37) ^{ae}	9.1 ± 2.55 (65) ^{db}	9.3 ± 2.16 (66) ^{cb}	7.9 ± 3.14 (56) ^{ab}	9.9 ± 1.85 (70.71) ^{b}	4.38 ± 4.81 (31) ^{e}	6.59***
Total Max score = 34	16.96 ± 10.40 (50)	27.1 ± 4.14 (80)	26.1 ± 3.66 (77)	24.1 ± 6.24 (71)	28.2 ± 6.24 (83)	14.07 ± 10.62 (41)	8.84*

Note: * Significant at p<0.5 ** Significant at p<0.01 and *** Significant at p<0.001
The superscripts with similar alphabets in each row indicate no significant difference between the values.
The figures in parenthesis denote the mean percent scores.

Figure 5.1.4.1 shows the ranking of the food handlers based on their knowledge scores. Results revealed that as high as 68 per cent of the street food vendors had poor knowledge on food safety as compared to only 31 per cent of the structured units. Of these 31 per cent, majority comprised of the restaurant owners that had significantly low scores on food safety. About (44%) of the structured units had excellent knowledge on food safety.



The Table 5.1.4.2 shows the relation of the educational level with the knowledge and practice scores for different food service establishments. A strong relation between the education of the respondents and their knowledge on food safety was seen. The table also clearly demonstrates that those respondents having education above the higher secondary level had good knowledge on food safety.

Table 5.1.4.2: Effect of Education level on the Knowledge scores for different FSPs (n=153)

Educational level	Knowledge			Chi square
	Good	Fair	Poor	33.42**
Up to Primary	10 (21.27)	1 (2.12)	36 (76.59)	
Up to HS	35 (55.55)	1 (1.58)	27 (42.85)	
Above HS	31 (72.09)	4 (9.30)	8 (18.60)	

Figures in parenthesis indicate percent values
** Significant at $p<0.01$

5.1.5: Practices of the respondents on food safety:

The respondents (N=153) belonging to the six different categories of food service establishments were observed for a total of 23 practices on four basic aspects of food safety namely personal hygiene, food hygiene, unit hygiene and environmental hygiene. Table 5.1.5.1 shows the mean practice scores of food service establishments. The respondents were given

satisfactory, average, unsatisfactory ratings on the basis for their practices and were given scores of 3, 2 and 1 accordingly. It was noticed that the dhabas scored as less as 42 per cent followed by bus stand food outlets (48%). The railway food outlets and the street food vendors had scored a little above 50 per cent. Restaurants as well as fast food joints had high scores amongst all the other food service establishments. A significant difference in the practice scores was observed amongst all the six categories of food service establishments.

Personal Hygiene: The food handlers were observed for practices such as wearing of protective clothes, their appearance, refraining from habits such as gutkha eating, tobacco chewing, use of clean hand towels and cut and clean nails. It is clear from the table all the food service establishments had more than 45 per cent mean scores for practices related to personal hygiene. It was observed that amongst all the categories, restaurants (60%) and fast food joints (61%) had significantly higher practice scores on personal hygiene.

Food Hygiene: The food hygiene practices included covering of cooked foods, availability of chilling facilities for storage of perishable foods, availability of exhaust fan, ventilators and chimney, use of clean chopping boards, proper washing of fruits and vegetables prior to chopping, etc. Results revealed that the dhabas scored very low (41%) in practice related to food hygiene followed by bus stand food outlets (46%). On the contrary, restaurants and fast food joints had significantly higher scores as compared to other food service establishments.

Unit Hygiene: In the area of unit hygiene, the food service establishments were observed for cleanliness of the unit, washing of the utensils using three tub method, use of commercial detergent for washing utensils, facility for running tap water at wash basin. It was noticed that the restaurants and fast food joints had again higher scores as compared to the dhabas and bus stand food outlets. The dhabas (39%) and bus stand food outlets (47%) had significantly lower scores.

Environmental Hygiene: Environmental hygiene of the unit included, neat and clean surroundings away from water logged drains, animals, regular cleaning of dining tables with disinfectants, disposal of garbage in waste bins having proper lids, etc. it was observed that the restaurant scored the highest (72%) followed by street food vendors (70%) and fast food joints (69%). On the other hand, the bus stand food outlets and railway food outlets had poor scores and this difference in the scores was found to be highly significant.

It can be concluded that, dhabas scored only between 39 per cent – 47 per cent for all the practices. On the contrary, restaurants and fast food joints performed much better as compared to the other food service establishments. The street food vendors scored more than 50 per cent for all the practices except food hygiene.

Table 5.1.5.1: Mean Practice scores of the food service establishments:

Practice scores	Restaurants (n = 50)	FFJs (n = 10)	Dhabas (n = 10)	Railway food outlets (n =10)	Bus stand food outlets (n = 10)	SFVs (n =63)	F test
Personal Hygiene Max Score = 15	9.08 ± 1.88 (60) ^{ae}	9.1 ± 2.80 (61) ^{egi}	7.1 ± 2.18 (47) ^{dg}	7.6 ± 1.57 (51) ^{cgi}	7.7 ± 1.56 (56) ^{bgh}	8.38 ± 1.60 (56) ^{fhij}	3.31*
Food hygiene max score = 30	19.34 ± 4.01 (64) ^{ae}	18.4 ± 5.44 (61) ^{egk}	12.4 ± 2.63 (41) ^{dghl}	16.2 ± 3.96 (54) ^{cgij}	13.9 ± 4.50 (46) ^{bgh}	14.41 ± 3.26 (48) ^{fhj}	12.88***
Unit Hygiene Max score = 12	8.32 ± 1.83 (69) ^{ac}	8 ± 2.62 (67) ^{cg}	4.7 ± 1.33 (39) ^{be}	6.2 ± 1.68 (52) ^{agh}	5.7 ± 2.11 (47) ^{aef}	5.98 ± 1.37 (50) ^{dfh}	15.99***
Environmental Hygiene Max score = 12	8.68 ± 1.97 (72) ^{a}	8.3 ± 2.71 (69) ^{ac}	5 ± 1.41 (42) ^{de}	6.6 ± 2.27 (55) ^{ce}	5.8 ± 2.14 (48) ^{be}	8.39 ± 1.88 (70) ^{a}	9.62***
Total Max score = 69	45.42 ± 8.58 (66)	43.8 ± 11.9 (63)	29.2 ± 6.77 (42)	36.6 ± 8.55 (53)	33. 1 ± 8.58 (48)	37.17 ± 6.93 (54)	11.72*

Note: * Significant at p<0.5 ** Significant at p<0.01 and *** Significant at p<0.001
The superscripts with similar alphabets in each row indicate no significant difference between the values.
The figures in parenthesis denote the mean percent scores.

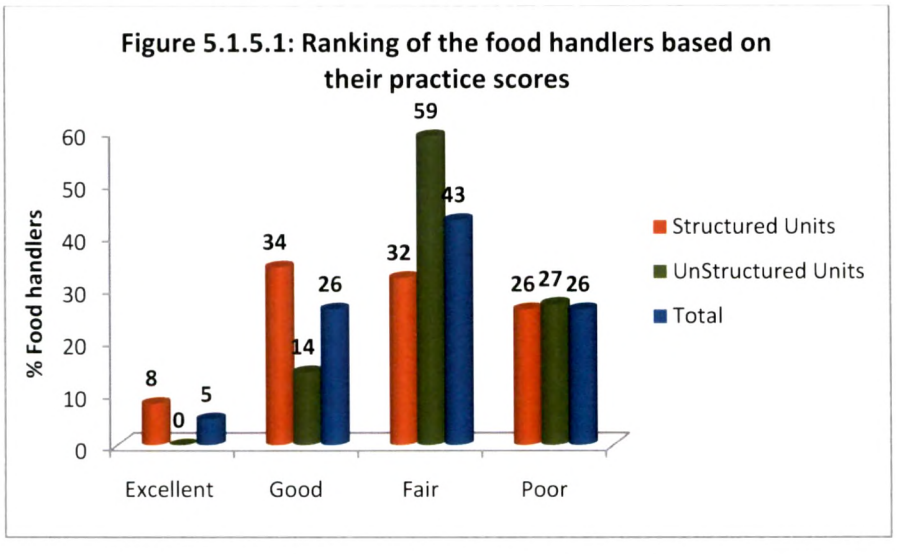
Plate 5.1.5.1, 5.1.5.2 and 5.1.5.3 depicts the poor personal hygiene, food hygiene and unit hygiene of bus stand food outlets, medium restaurant and street food unit respectively.

Plate 5.1.5.1: Typical bus stand unit depicting poor personal hygiene of the staff, poor food hygiene and unit hygiene

Plate 5.1.5.2: Typical kitchen of medium restaurant depicting poor food hygiene and unit hygiene

Plate 5.1.5.3: Typical street food unit depicting poor food hygiene and unit hygiene

Figure 5.1.4.2 shows the ranking of the food handlers based on their practice scores. Results revealed that about 59 per cent of the street food vendors ranked fair in the practice. About 34 per cent of the structured units had good practices as compared to only 14 per cent of the street food units. About 26 per cent of the structured and 27 per cent of the street food vendors scored poor in the practices related to food safety.



A strong relation was also noticed between the education and practice scores of the respondents (Table 5.1.5.2). The respondents having education up to

the higher secondary level had better practices on food safety as compared to those with lower level of education (P<0.05).

Table 5.1.5.2: Effect of Education level on the practice scores for different FSPs (n=153)

Educational level	Practice scores			Chi square
	Good	Fair	Poor	10.11*
Up to Primary	11 (23.4)	27 (57.44)	9 (19.14)	
Up to HS	17 (26.98)	24 (38.09)	22 (34.92)	
Above HS	19 (44.18)	15 (34.88)	9 (20.93)	

Figures in parenthesis indicate percent values
* Significant at p<0.05

Table 5.1.5.3 shows the effect of ownership on the practices scores of the respondents. Results revealed that there was no association between the ownership and the practice scores.

Table 5.1.5.3: Effect of Ownership on Practice scores for different FSPs (n=153)

Ownership	Practice rank			Chi square
	Good	Fair	Poor	1.569 NS
Owner	43 (32.33)	57 (42.85)	33 (24.81)	
Employed	4 (20)	9 (45)	7 (35)	

Note: Figures in parenthesis indicate percentages; NS – Not significant

Availability of exhaust fan, ventilation and chimney had a strong and statistically significant association with the daily wages of the establishment. Whereas the daily income had no association between availability of smokeless fire and storage facilities (Table 5.1.5.4).

Table 5.1.5.4: Daily income for structured units vs availability of various infrastructural facilities (n=90)

Daily wages (in ₹)	Availability of smokeless fire and fuel			Chi square
	Yes	No		0.235 NS
< 1000	22 (75.86)	7 (24.13)		
> 1000	49 (80.32)	12 (19.67)		
Daily wages (in ₹)	**Availability of separate store**			**Chi square**
	Yes	No		0.322 NS
< 1000	18 (62.06)	11 (37.93)		
> 1000	34 (55.73)	27 (44.26)		
Daily wages (in ₹)	**Availability of facility of exhaust fan, ventilation and chimney**			**Chi square**
	Satisfactory	Average	Unsatisfactory	8.013*
< 1000	4 (13.79)	9 (31.03)	16 (55.17)	
> 1000	21(34.42)	24 (39.34)	16 (26.22)	

Note: Figures in parenthesis indicate percentages
NS – Not significant * Significant at p<0.05

It is clear from table 5.1.5.5 that educational status had a strong association with willingness to undergo training. Higher the education, i.e., above the higher secondary level, more (76%) respondents were not willing to undergo the training program.

Also a strong association existed between willingness to undergo training and the age of the respondents. It was seen that the respondents < 25 years of age, showed greater willingness to undergo the training.

Daily wages also strongly associated with willingness for training. The respondents earning <₹600/- per day expressed greater degree of willingness to undergo the training as compared to those earning > ₹1000/-per day.

Results revealed a very strong association between the years of experience on their willingness to undergo the training program. It is clear from the table that less the years of experience (< 10y), more (84%) was the willingness to undergo the training. As the years of experienced increased (> 20y), the willingness to undergo the training program decreased (3%).

Table 5.1.5.5: Willingness for training vs Educational status, Age, Daily wages and Experience in occupation (n=153)

Educational status	Willingness for training		Chi square
	Yes	No	29.985**
Illiterate	15 (83.33)	3 (16.66)	
Up to primary	23 (79.31)	6 (20.68)	
Up to HS	33 (52.38)	30 (47.61)	
Above HS	10 (23.25)	33 (76.74)	
Age (in years)	**Willingness for training**		**Chi square**
	Yes	No	6.0027*
< 25y	15 (78.94)	4 (21.05)	
25-50y	58 (48.73)	61 (51.26)	
> 50y	8 (53.33)	7 (46.66)	
Daily wages (in ₹)	**Willingness for training**		**Chi square**
	Yes	No	42.67**
< 600	36 (97.29)	1 (2.70)	
600-1000	24 (50)	24 (50)	
>1000	21 (30.88)	47 (69.11)	
Experience in occupation (yrs)	**Willingness for training**		**Chi square**
	Yes	No	59.81**
< 10y	59 (84.28)	11 (15.71)	
10-20y	21 (38.18)	34 (61.81)	
>20y	1 (3.57)	27 (96.42)	

Note: Figures in parenthesis indicate percentages
* Significant at p<0.05 and ** Significant at p<0.01

Table 5.1.5.6 shows the results obtained when educational status was correlated with daily income and the years of experience. Educational status was positively correlated with daily income as well as years of experience.

Table 5.1.5.6: Association of educational status with income and years of experience (n=153)

Variables	r value
Education status Vs Daily income	0.66
Education status Vs Years of experience	0.79

Table 5.1.5.7 shows the correlations obtained between knowledge and practices of various food service establishments. There was a positive correlation between the food safety knowledge and practice of all the food service establishments. However, in the case of street food vendors food safety knowledge was negatively correlated with practices.

When the age of the food handlers was associated with their practice ranks, it was observed that the handlers of the younger age group had fair practices as compared to the older ones (Table 5.1.5.8). However, age had no association with the knowledge scores of the food handlers (Table 5.1.5.9).

Table 5.1.5.7: Correlations between knowledge and practices of various food service establishments:

Food service establishments	r value
Restaurants (N = 50)	0.12
Fast food joints (N = 10)	0.07
Dhabas (N = 10)	0.41
Railway food outlets (N = 10)	0.11
Bus stand food outlets (N = 10)	0.27
SFVs (N = 63)	- 0.75

Table 5.1.5.8: Effect of Age on Practice scores for different FSPs (n=153)

Age (in yrs)	Practice rank			Chi square
	Good	Fair	Poor	11.45*
< 25y	5 (26.31)	12 (63.15)	2 (10.52)	
25-50y	32 (27.35)	52 (44.4)	33 (28.20)	
> 50y	9 (52.94)	2 (11.76)	6 (35.29)	

Note: Figures in parenthesis indicate percentages
* Significant at p<0.05

Table 5.1.5.9: Effect of Age on Knowledge scores for different FSPs (n=153)

Age (in yrs)	Knowledge rank			Chi square
	Good	Fair	Poor	8.62 NS
< 25y	5 (26.31)	1 (5.26)	13 (68.42)	
25-50y	64 (54.23)	3 (2.54)	51 (43.23)	
> 50y	7 (43.75)	2 (12.5)	7 (43.75)	

Note: Figures in parenthesis indicate percentages
NS – Not significant

HIGHLIGHTS OF PHASE I

- Majority of the structured units owned their units, were between the age group of 25 – 50 years, were literate, involved their family members in supervision and cash holding and had more of employees.
- More number of the street food vendors had employees below 16 years of age as compared to structured units.
- Majority of the respondents in the structured units were licensed, earned more wages as compared to street food vendors that were not licensed.
- Difference was seen in the mode of lighting, were majority of the structured units had electricity and 65 per cent of the street vending units made use of battery operated lights.
- None of the street food vendors had running water facility or a water purifier and used stored water procured from the Municipal Corporation tanks.
- Majority of the street vendors expressed their willingness to undergo food safety training as compared to only 39 per cent of the respondents of the structured units.
- Almost all the units had smokeless fire and fuel for cooking, made use of packed and labeled spices condiments, oil and ghee.
- With regards to knowledge on food hygiene, the restaurant owners and street food vendors had scores of 53 per cent and 37 per cent respectively. Rest of the establishments had scores ≥ 80 per cent.
- With regards to knowledge on personal hygiene all the food service establishments had mean per cent scores above 80 per cent.
- With regards to practice scores on personal hygiene, all the establishments had scores between 47 – 61 per cent.
- Amongst all the categories, restaurant scored the highest (64%) for practices related to food hygiene, as compared to dhabas that had scores < 45 per cent.

- For practices related to unit hygiene and environmental hygiene, the dhabas scored < 40 per cent as compared to the restaurant that had higher scores (> 70%).
- Education of the respondents was strongly associated with their knowledge and practices on food safety.
- No association existed between the ownership and the practice scores.
- Availability of exhaust fan, ventilation and chimney had an association with the daily wages of the respondents.
- Willingness to undergo training was strongly associated with educational status, age of the respondents, their daily wages and years of experience in food service.
- Educational status was positively correlated with daily income as well as years of experience.
- There was a positive correlation in the knowledge and practice of the all the food service establishments. However, in the case of street food vendors knowledge was negatively correlated with practices.

DISCUSSION

Food borne diseases continue to be a major public health problem in the developed and developing countries. Current statistics for food borne illnesses in various industrialized countries show that up to 60 per cent of cases may be caused by poor food handling and contaminated food served in food service establishments (Mohan et al 2006). Food service establishments (FSE) have come to stay in today's contemporary world, due to increased need for food outside home, be it for people who are migrating for educational purpose or for other purposes. Tivadar (2003) highlighted the increasing prevalence of eating way from home and the use of partly or fully cooked food. The consumers of Vadodara are fond of food and it has been seen that a majority of them prefer to consume food outside home during the weekends. Moreover, Vadodara being a city that offers a wide range of educational opportunities, many students migrate from other cities as well as states for educational purpose and consume food prepared at the hostel mess. In the present study, 153 food handlers from different food service establishments of Vadodara city were surveyed for their knowledge and practices related to food safety.

FSE such as restaurants, hotels, bars and cafeterias are considered an important source of foodborne outbreaks as studied in various European countries (Effler et al 2001; Olsen et al 2000; Hughes et al 2007).

According to WHO, the most important cause of the spread of food borne disease is the poor knowledge on food safety and unhygienic methods adopted by the food handler.

It was noted from our study, that more number of respondents of both the structured as well as the unstructured sector owned their units. This seems to be a very positive finding of our study, as the owners would be in a better position to adopt food safety practices as compared to their counterparts who do not own their units.

It was also noted from the study that majority of males are involved in the food service business; unlike in other cities or countries wherein more number of

women are running the food service business. In a study by Jevsnik et al (2008) reported majority (88.8%) of the food handlers of Slovenia were females. In yet another study by Abdalla et al (2009) reported to have majority of females involved in food service business.

All the raw food materials purchased by the owners of the establishments should be labeled and packed in order to avoid adulteration of food products. However, our study revealed that majority of the owners of the structured units purchased labeled and packed condiments and spices; whereas majority of the street food vendors purchased unlabeled and loose condiments and spices. Such a practice of buying unlabeled food items is a potential hazard and has greater chance of contaminating the cooked product. It was also observed that majority of owners of both the units had the practice of purchasing unpacked and unlabeled food grains. Food grains sold loose at low prices indicate that they might be infested with insects and rodents. Consumption of such products is hazardous to health. However, a good practice that was noticed that, majority of the owners of both the units purchased labeled and packed oil, butter and semi processed ingredients.

Poor food safety knowledge of the food handler can be attributed to the poor educational status of the workers. It has been clearly noted from our study that poorly educated food handlers had insufficient knowledge and practices on food safety. A study carried out by Unusan (2007) showed that food safety attitudes and knowledge of a person differ significantly on the basis of his/her educational background. About 18 per cent of the handlers under study were found to illiterate and 29 per cent had received education up to the primary level. Mohan et al (2001) reported that about 38.31% of the food handlers working in the educational and health institutions of Amritsar were illiterate. Similar finding was reported by Zain and Naing, 2002. Amongst the various food service establishments surveyed, it was observed that the street food vendors were less literate as compared to the rest of the food handlers. Abdalla et al (2009) reported that 42 per cent of the street food vendors of Atbara city were illiterate and 48 per cent had received education only up to the primary level.

In the present study, about 46 per cent of the food handlers had poor knowledge on all the aspects of food safety. Askarin et al (2004) reported that the food service staff in hospitals of Iran had little knowledge regarding the pathogens that cause Food Borne Illnesses and the correct temperature for the storage of hot or cold ready – to – eat foods. Bas et al (2006) demonstrated that the food handlers in Turkish food businesses often have lack of knowledge regarding the basic food hygiene.

About 39.21 per cent of the respondents of our study reported that chilling hinders the growth of microorganisms. Similar results have also been reported by Walker et al (2003) wherein 21 per cent of food handlers thought that freezing killed bacteria and 63 per cent correctly answered that the temperature of food in refrigerator should be at low or below 8^0C. However, Jevsnik et al (2008) reported a higher percentage of food handlers (64%) who believed that microorganisms grow very slowly in cooling units.

In the present study no association existed between the age of the handlers and their knowledge. However, the food handlers having education above the higher secondary level had better knowledge on food safety. This indicated that food safety education can be imparted to all age groups on a similar platform.

Of the various factors responsible for outbreaks of food borne diseases due to consumption of food at food service establishments is the poor personal hygiene of the food handlers. Olsen et al (2000) found that annually from 1993-1997, poor personal hygiene of food workers was a contributing factor in 27 to 38 per cent of food borne illnesses outbreaks. In our study the respondents had excellent knowledge in the area of personal hygiene; however they lacked in the practices related to personal hygiene. Many times it has been observed that the even after having the appropriate knowledge, the employees of food service establishments do not always follow the correct food safety practices (Clayton and Griffith 2002; Clayton et al 2002; Clayton and Griffith 2004; Manning and Snider 1993).

When the age of the handlers was associated with their practices, it was observed that the younger staff had good to fair practices as compared to the

older ones. This association of age with practices may be explained by the fact that younger food service staff was more educated than the older ones. Hence it can be inferred that education has an important role to play in following good practices. Therefore, it is recommended for the policy makers to keep education as an important criterion for issuing license to the food service establishments.

It was observed that the structured food outlets had more number of employees as compared to the street food outlets; they were self employed or had only one employee at site. Thus lack of staff could be one of the major reasons for following poor practices with regards to food hygiene, personal hygiene and unit hygiene. Another reason that could be attributed is that the street food vendors earned much less as compared to the structured units and therefore were not able to afford various facilities such as provision of a wash basin with liquid soap and clean serving utensils. The street food vendors had bare minimum facilities available at their *laari* for just cooking and serving food and in the process ignored the necessities required for serving safe and hygienic food.

Running water at the vending site was not available and therefore, the vendors stored water in big plastic uncovered tanks; unlike the structured units that had running water facility. Due to this, the water available to them had to be used for cooking as well as washing and therefore they made use of minimum water for washing of hands as well as utensils. Availability of less water at site could be potential source of contamination.

In spite of all these constraints, the vendors kept their surroundings neat and clean and therefore had good scores for practices related to environmental hygiene. However, this situation was not seen in dhabas, railways and bus stand food outlets.

Our study also revealed that amongst all the categories of food service establishments, street food vendors and the restaurant food handlers scored pretty less in food safety knowledge. This is in agreement with another study carried out in Nairobi, Kenya, wherein the street food vendors were not aware

of hygiene and sanitary practices and lacked training (Muinde and Kuria, 2005).

This study highlights the association of age with the willingness to undergo the training as well as the practices. People of younger generation are more prone to changes as compared to the older ones. The older people are less flexible and do not easily express their willingness to undergo a training program. Since these people are more experienced in the business of food services feel that they have nothing more to learn from a food safety training program.

Chi square analysis revealed that the respondents earning < Rs. 600/- per day had more willingness to undergo the training program as compared to ones earning > Rs. 1000/- per day. The respondents earning more feel that they need no further training as their business is already well flourishing and consumers are happy the way they are preparing and serving food. On the other hand, the food service providers earning < Rs. 600/- per day feel that they can attract more customers and make business flourish by undergoing the food safety training.

In conclusion, the data gathered from this phase of the study suggests that there is a need for a food safety education to the food service providers especially the street food vendors as well as the restaurant food handlers, in order to improve their food safety knowledge and practices and thereby ensure a safe food supply to the consumers of Vadodara city.

5.2 PHASE II – ESTABLISHMENT OF FOOD COURT

PIMC (Program Implementation Monitoring Committee) was formulated in order to seek help from the government officials as well as other non governing bodies for the successful implementation of the food safety messages. PIMC was formed to ensure complete participation and cooperation from the beneficiaries during the training program.

The results of this phase are presented under the following heads:

5.2.1: Constitution of PIMC

5.2.2: Organization of PIMC meeting and the discussion during the meeting

5.2.3: Results of PIMC meeting

5.2.4: Salient features of the meeting

5.2.1: Constitution of PIMC:

- ✓ Municipal Commissioner, Chairman, PIMC
- ✓ Medical Officer Health, Vice Chairman, PIMC
- ✓ Add. Medical Officer Health
- ✓ Nodal Officer Sanitation
- ✓ Chief Food Inspector
- ✓ Food Inspector
- ✓ Representatives of SFVs
- ✓ Representatives from NGO
- ✓ Bank official
- ✓ HOD, Foods and Nutrition Department and Advisor, SFS project
- ✓ Coordinator, SFS Project
- ✓ Co-coordinator, SFS Project
- ✓ Field Investigator
- ✓ Volunteers

5.2.2: Organization of PIMC meeting:

The first meeting with the members of PIMC was carried on 17th January, 2007. All the members of the PIMC were informed about the date, venue and time for the meeting. The agenda for PIMC meeting was as follows:

I. Introduction of members of PIMC.
II. Presentation of the results of first phase of the study
III. Discussion on the training program of street food vendors
    - ➢ Identification of 50 vendors for training
    - ➢ Planning for orientation program

    a). Number of food vendors to be invited for orientation program

    b). Date, time and venue for orientation program

    c). Dignitaries to be invited for orientation program from University/Municipal Corporation

    d). Program schedule for the orientation

IV. Discussion on feasibility of non-training program

1. To identify the vending zone for the street food vendors with:
    - ◻ Adequate water supply, both drinking and wash water
    - ◻ Drainage facility,
    - ◻ Solid and liquid waste disposal and collection facility,
    - ◻ Proper lighting facility,
    - ◻ Rest room facility
2. To make available well-designed, economically constructed food cart to the street food vendors
3. To make available low cost, food grade disposable serving ware to the vendors
4. To carry out regular inspection for food quality by the food inspectors/ sanitary officers
5. To conduct routine medical check-ups of the vendors
6. To provide provisional license/formal registration to the trained vendors

5.2.3: Results of PIMC meeting

Eighteen members including Chief Medical Officers and food inspectors from VMSS, HOD, Foods and Nutrition department, representatives of vendors,

member from NGO and project staff were present for the PIMC meeting. Following is the list of the members present.

i. Prof. (Dr.) U. V. Mani, Head. Department of Foods and Nutrition, Faculty of Home Science.
ii. Dr. Asari, Medical Officer Health, Vice chairman, PIMC, SFS Project
iii. Dr. Pathak, Additional Medical officer Health, Vice chairman, PIMC
iv. Shri Jeetendra Gohil, Chief Food Inspector
v. Mrs. Rubina Sheikh, Chief Food Inspector
vi. Dr. Sangeeta Patel, member, SOCLEEN (NGO)
vii. Dr. Mini Sheth, Co-ordinator, SFS Project
viii. Dr. Neena Jaju. Co-Coordinator, SFS, Project
ix. Ms. Sujoya Sukul, Field Investigator, SFS, Project
x. Ms. Reshma Thakkar, Volunteer, SFS, Project
xi. Gopi Lal Ahir,and other Street food Vendors - Visnu, Arjun Jaju, Laxman Rajput, Gopul Thapa, Raju Jaat, Milton Parmar, Rajesh

The following 3 members of the PIMC were not present for the meeting.

i. Mr. C.R. Kharsan, (Dy. Municipal Commissioner), Chairperson of PIMC of SFS Project
ii. Bank Official, to give inputs on the micro loans for ideal laari (Bank of Baroda)
iii. Shri. R.M. Patel, Nodal officer sanitation

5.2.4: Salient features of the meeting

1. Presentation of the findings of the first phase of the project and objectives of the second phase.
2. Discussion about the problems of street food vendors by their representatives. Some of the major problems reported by them were:
   a) Space problem
   b) Security problem i.e., even the licensed laari were taken away by the VMC officials and were charged handsome amount for taking back their laaris. This happened almost every 3 months.
   c) The laari timings were fixed by the VMC officials 6pm – 10pm
   d) The vendors had the compulsion to take back their heavy laaris every day.

2. To these problems Dr. Pathak said that all the problems couldn't be solved immediately. He also gave some suggestions to prevent water borne diseases.

   eg. The vendors can boil the water and serve the same to the public, so that the problem arising due to water borne diseases can be solved.
3. Prof. (Dr.) U.V. Mani added that now days all sections of the society go to laari and the VMC has a great responsibility of making changes in the present situation
4. The question of vending zone was raised by the coordinator of this project but there was no competent authority to respond to this problem.
5. When the point on garbage collection was raised by Dr. Mini Sheth, Dr. Sangeeta Patel explained to the vendors the 2 types of garbage and also the mode of disposal. She also briefed them about the process of vermiculture.

   To this Dr. Pathak, told that there is a solid waste department at VMC that regularly collects wastes. He also told that the vendors should first learn to collect waste instead of throwing it here and there.
6. The design of an ideal laari was explained to all members present and a copy of it was handed over to Danielbhai, a vendor representative
7. Shri Jeetendra Gohil, told that regular inspection is carried out every 2 - 3 months and if at all there is any outbreak then inspection is carried out on daily basis. Food sample is not collected for analysis.
8. Dr. Pathak informed that the food samples are not analyzed because the vendors do not give their correct names and addresses also their laari placement is also not on permanent basis and hence it becomes very difficult to trace them down.
9. The point of medical check ups of the vendors was raised during the training program and Dr. Pathak agreed to this, however later no such check – up was carried out.
10. Lastly, Dr. Pathak indicated that a proposal for allotting hawking zone for food vendors may be presented to the competent authority in the VMC.

11. The orientation program for motivating the vendors to undergo the training on food safety was fixed for 1st February, 2007.
12. The discussion on the allotment of the vending zone for the vendors was postponed as per the suggestion of the vice chairpersons to a later date after the completion of the training program.

Plate 5.2.4.1:Food vendors discussing their problems with VMSS officials and the project staff

Plate 5.2.4.2: Members of the PIMC From left food inspector, Additional CMO, CMO from VMSS, HOD, Department of Foods and Nutrition, Project Coordinator in the PIMC meeting

Table 5.2.4.1 shows the extent of support provided by the PIMC. Partial support was obtained from PIMC for identification of vendors and presence of the officials during the training. In rest of the areas no support was provided by the PIMC.

Table 5.2.4.1: Extent of support provided by the PIMC:

Sr. No	Activities	Full Support	Partial	No Support
i.)	Identification of vendors		√	
ii.)	Presence of officials during training programme		√	
iii)	Providing venue for training			√
Iv.)	Follow-up on adoption of food safety practices			√
v.)	Providing space for food street/ street food court.			√
vi.)	Health check-up of vendors			√

HIGHLIGHT OF PHASE II

- Partial support was obtained from PIMC for identification of vendors and presence of the officials during the training. Whereas the efforts failed to convince local government bodies for providing location to place the trained street food vendors.

DISCUSSION

For serving safe street foods to the public it is necessary to develop a street food court that would have all the necessary facilities or preparation and serving of safe food. Such a food court will have street food vendors trained in safe food preparation and serving practices. The first step towards establishment of street food court was the formation of Program Implementation Monitoring Committee (PIMC). Constitution of PIMC includes involvement of various governmental and non-governmental bodies which can put in their expertise to achieve this goal. For this, various officials from VMSS, academicians from educational institutions, bank officials, and heads of street food vendors association were contacted. Government has the primary responsibility for identifying and assessing health risks associated with food supply and developing national strategies to manage the risks (FAO / WHO 2004).

Thereafter several visits were made to the VMSS in order to motivate them for the formation of PIMC. An orientation meeting was arranged for all the stakeholders for formation of PIMC as well as to discuss about the plans for establishment of the food court. Numerous letters from the Government of India were also sent to the VMSS in this regard. However, even after so many trials, the PIMC was formed but it did not help in formation of food court. The committee decided that they would help only for enrolling the vendors for the food safety training and the establishment of food court would be thought upon later.

It is a well established fact that the survival and sustainability of any system depends on the joint efforts of several governing bodies. Formation of the 'Canadian Partnership' for consumer food safety education is a testimony towards such joint efforts (FAO / WHO 2004).

The development of Calcutta Model and its success can be attributed to the fact that there was mutual trust and dependence among all stakeholders (Chakravarty I 2006).

In the present study poor cooperation was received from the government officials that resulted in the failure to establish a street food court. It was also evident from the meetings that there was lack of coordination as well as differences in between members of PIMC. Due to this, it became difficult for

them to work together and this also resulted in poor attendance during the meetings.

However, it is very essential to bring the various governing bodies together and motivate them to form a food court for the consumers of Vadodara city. Several more such efforts should be made from the Central Government for pestering the local governing bodies to take up the project of establishment of food court soon. The governing officials of Vadodara city should take up examples from other cities where such food courts have already been established and running successfully.

5.3 PHASE III – IMPARTING FOOD SAFETY EDUCATION TO STREET FOOD VENDORS ALONG WITH FOLLOW UP TRAINING

Street food vendors (SFVs) as food service providers are the most vulnerable group of our society. Baseline data revealed that SVFs had relatively poor food safety knowledge and practices. Therefore a selected group of 41 street food vendors from 2 locations of Vadodara city were selected and studied in detail for their food safety knowledge and safe food preparation practices. They were then imparted food safety education on the 5 basic aspects of food safety using the methods outlined in the Methods and Materials chapter.

The results of this phase are presented under the following heads.

5.3.1: General information of the Street Food Vendors (SFVs)

5.3.2: Information on the Street Service Units

5.3.3: Impact of Food Safety Education on the knowledge of the Street Food Vendors (SFVs)

5.3.4: Impact of Food Safety Education on the practices of the Street Food Vendors (SFVs)

5.3.5: Results of follow up training to street food vendors on their food safety knowledge and practice

5.3.1: General Information of the Street Food Vendors (SFVs):

The general information of the 41 street food vendors (Table 5.3.1.1) showed that 73 percent of the vendors owned the units, 12 percent were employed at the units and the rest (15%) hired the lorry and paid rent. Forty nine percent of the vendors were between the age group of 25 and 50 y; and 5 percent were above 50 y of age. Majority (98%) of the food vendors were male.

About 58 per cent of the vendors had below 10y of experience in street food service. However 42 percent of the street food vendors had experience above 10 y (Table 5.3.1.1).

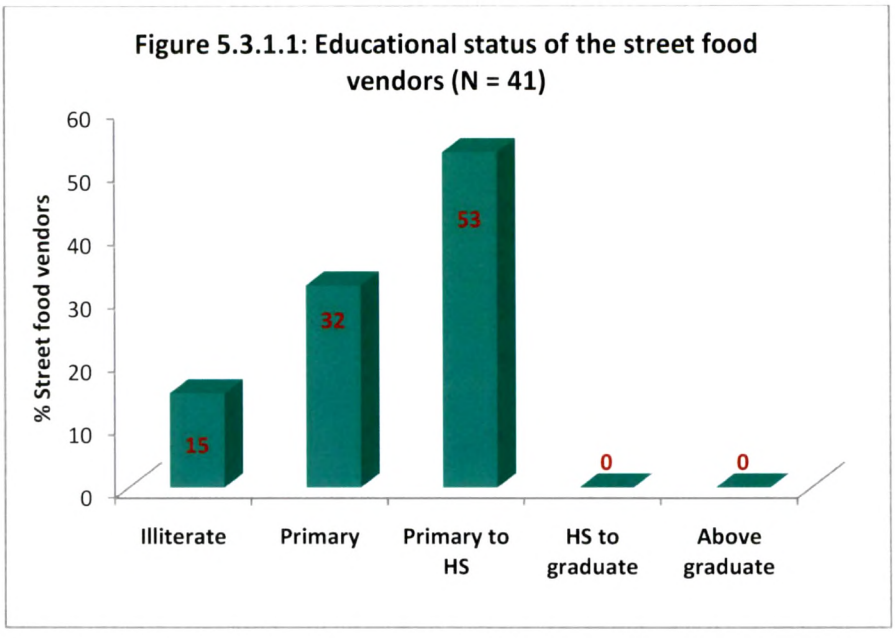
Table 5.3.1.1: General information of the street food vendors (N = 41)

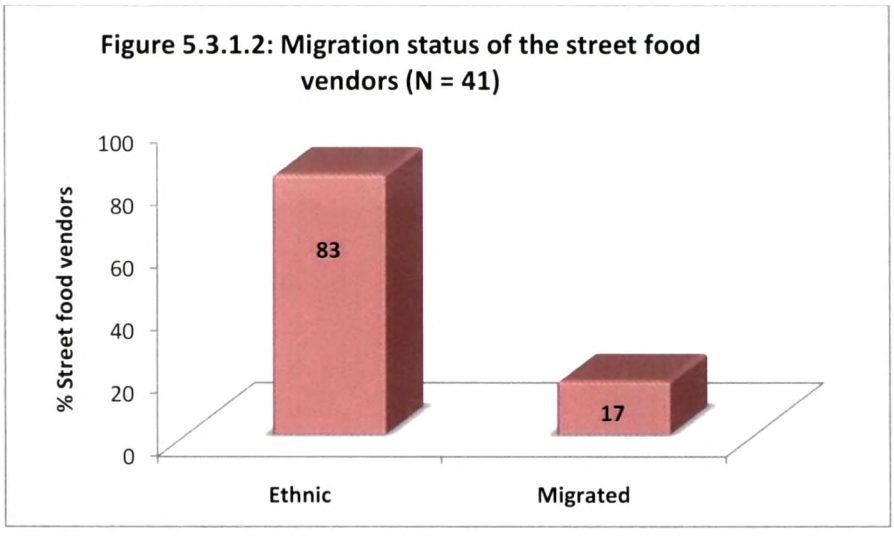
Sr. No.	Variable	Sub category	Total (n = 41)
1	Ownership of the Unit	Owner	30 (73)
		Rental	6 (15)
		Employed	5 (12)
2	Age of the vendor	Below 25y	19 (46)
		Between 25-50y	20 (49)
		Above 50y	2 (5)
3	Gender information	Male	40 (98)
		Female	1 (2)
4	Years of Experience	< 10y	24 (58)
		10-20y	13 (32)
		20-30y	2 (5)
		> 30y	2 (5)
5	Employees engaged in unit	1+0	15 (36)
		1+1	10 (24)
		1+2	1 (2)
		1+3	5 (12)
		1+4	6 (15)
		1+5 & above	4 (10)

*Figures in Parenthesis indicate percentages

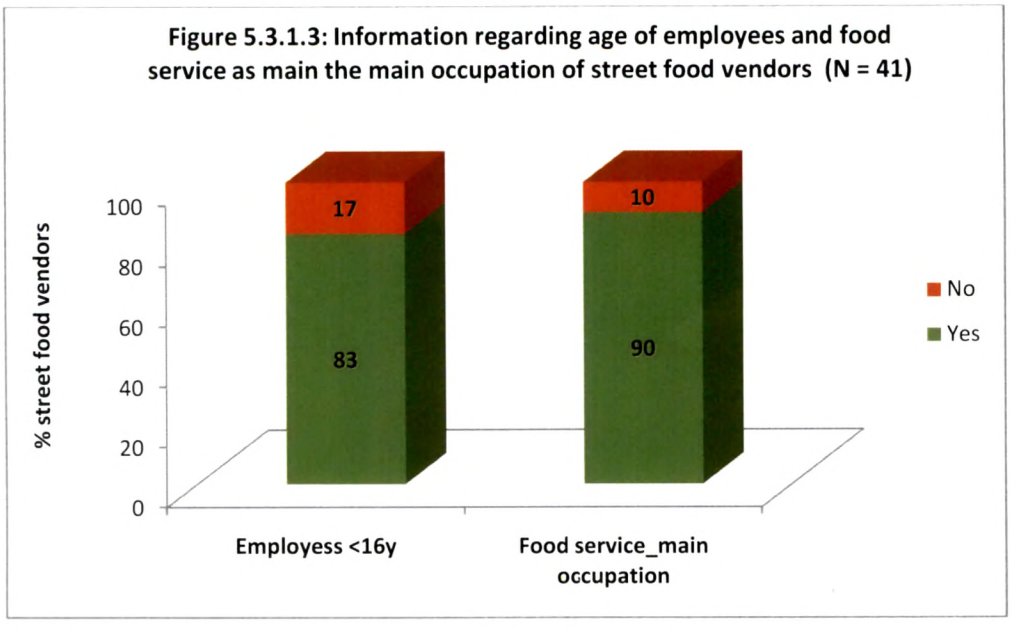
Figure 5.3.1.1, shows the educational status of the street food vendors. About 54 percent of the vendors were educated above the primary level; while 32 percent had education only up to the primary level. About 15 percent of the vendors from both the locations were found to be illiterate.

Only few (17%) of the street food vendors had migrated from other areas for employment purpose (Figure 5.3.1.2).





Street food service was the main occupation for majority (83%) of the vendors. As high as 90 per cent of the units did not have employees below 16 years of age (Figure 5.3.1.3).



5.3.2: Information on the Street Service Units

Not all (35%) of the street food-vending units were licensed. Greater number of street food units (51%) had sitting capacity for more than 7 persons (Table 5.3.2.1).

As shown in Figure 5.3.2.1, majority (95%) of the street food units had electric lamps as the mode of lighting. The survey results also revealed that about 46 percent of the street vending units had permanent cover, while the rest were either left open (30%), or were covered from tent (24%) (Figure 5.3.2.2).

Table 5.3.2.1: Information on the street food unit (n = 41)

Sr. No.	Variable	Sub category	Total (n = 41)
1	Unit licensed	Yes	26 (63)
		No	15 (37)
2	Eating capacity	Nil	6 (15)
		Up to 3	4 (10)
		Up to 5	5 (12)
		Up to 7	5 (12)
		> 7 persons	21 (51)
3	Age of the unit	< 5y	17 (41)
		5-10y	13 (31)
		10-15y	5 (12)
		>.15y	7 (17)

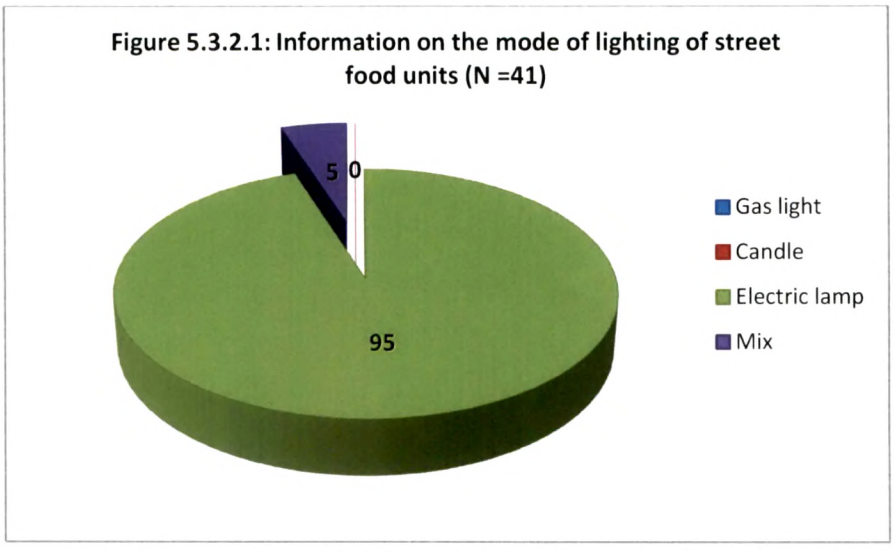


Figure 5.3.2.1: Information on the mode of lighting of street food units (N =41)

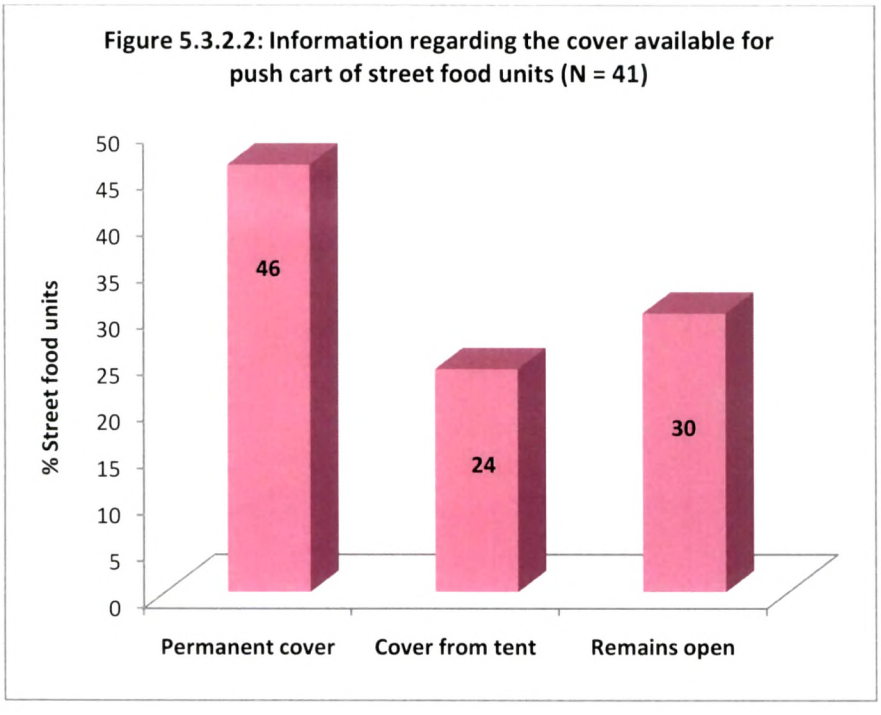


Figure 5.3.2.2: Information regarding the cover available for push cart of street food units (N = 41)

Table 5.3.2.2 provides Information on the working hours, average number of consumers and average income on weekdays and weekends for street food vendors. In most cases, the average number of customers visiting the units during weekdays and weekends ranged from 30 –120. Only 10 percent of the respondents reported that more than 120 customers visited their units. In all cases more number of customers visited the units during weekends.

Results revealed that the vendors earned more during the weekends. About 39 percent of the vendors earned around ₹600-800 during the weekdays. Also 17 percent of the vendors earned more than ₹1000 during weekends.

Table 5.3.2.2: Information on the working hours, average number of consumers and average income on weekdays and weekends

Sr. No.	Variable	Sub category	Total (n = 41)
1.	Working hrs on weekdays	<6h	19 (46)
		6 - 9 h	14 (34)
		9 - 12 h	2 (10)
		>. 12h	6 (15)
2.	Working hrs on weekends	<6h	14 (34)
		6 - 9 h	17 (41)
		9 - 12 h	4 (10)
		>. 12h	6 (15)
3.	Average no. of consumers on weekdays	< 30	7 (17)
		30-60	16 (39)
		60-90	9 (21)
		90-120	3 (7)
		> 120	5 (12)
4.	Average no. of consumers on weekends	< 30	1 (2)
		30-60	9 (22)
		60-90	13 (31)
		90-120	11 (27)
		> 120	7 (17)
5.	Average income on weekdays (₹)	< 200	9 (22)
		200-400	14 (34)
		400-600	6 (39)
		600-800	6 (39)
		800-1000	2 (5)
		> 1000	4 (10)
6.	Average income on weekends (₹)	< 200	5 (12)
		200-400	8 (19)
		400-600	11 (27)
		600-800	7 (17)
		800-1000	2 (5)
		> 1000	7 (17)

Note: Figures in parenthesis indicate percentages

Figure 5.3.2.3 shows that not many of the SFV made use of disposables. As low as 7 percent of SFVs made use of plastic plates and disposed it at the street in open.

Majority (66%), of the SFVs were found using stainless steel as serving utensils (Figure 5.3.2.4). Only few of the vendors made use of glass / ceramic and melmoware utensils for serving food. Majority of the vendors (83%) made use of tools and appliances for mixing of food stuff (Figure 5.3.2.5).

Figure 5.3.2.3: Types of disposables used by the street food vendors (N = 41)

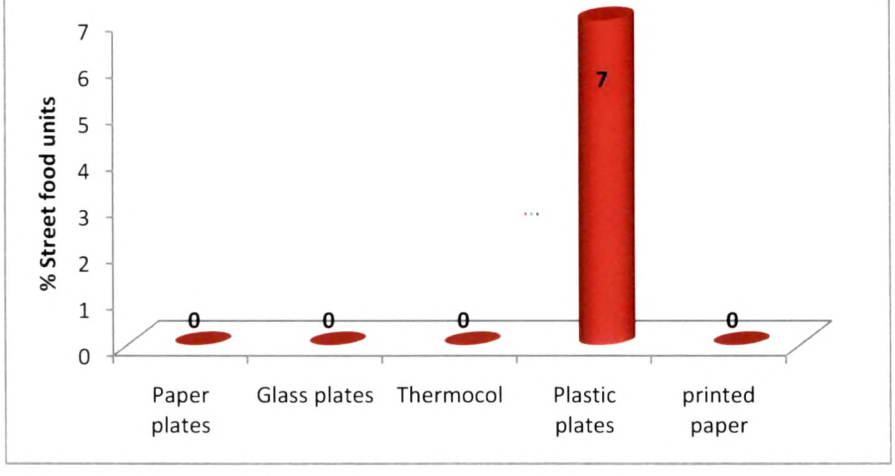
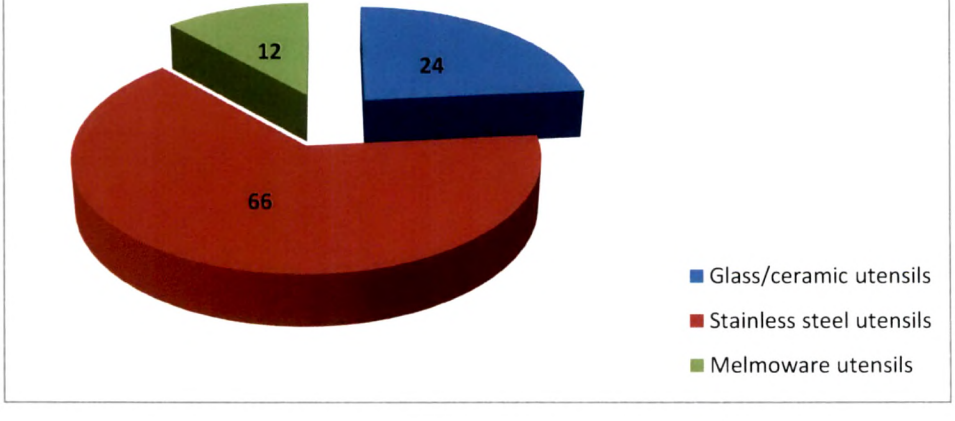


Figure 5.3.2.4: Types of serving utensils used by the SFVs (N = 41)



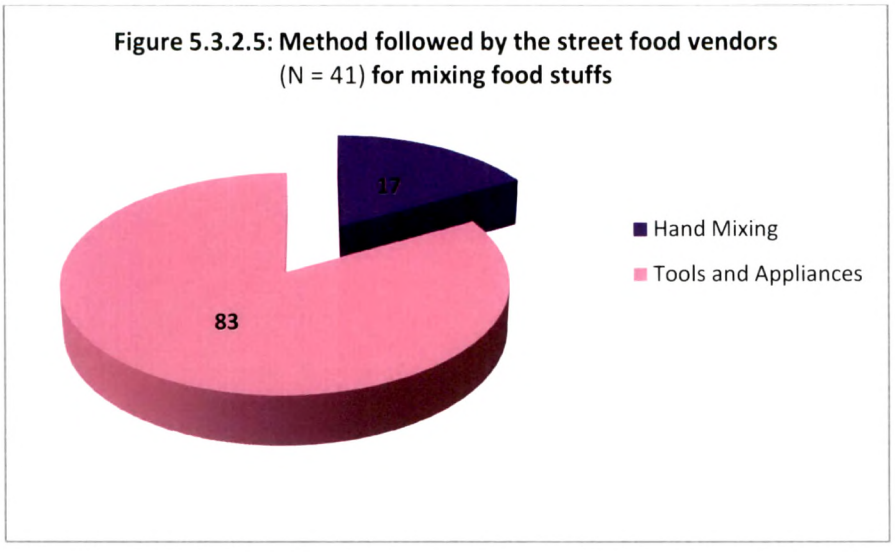
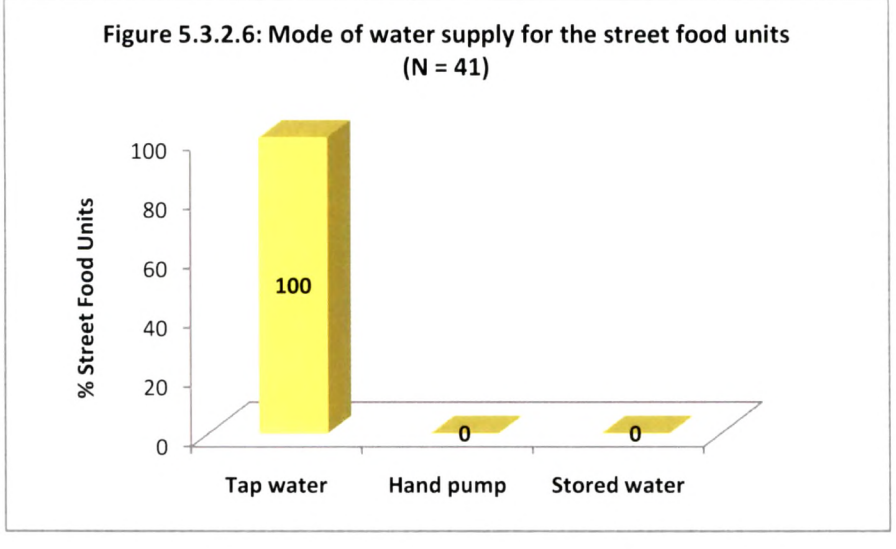
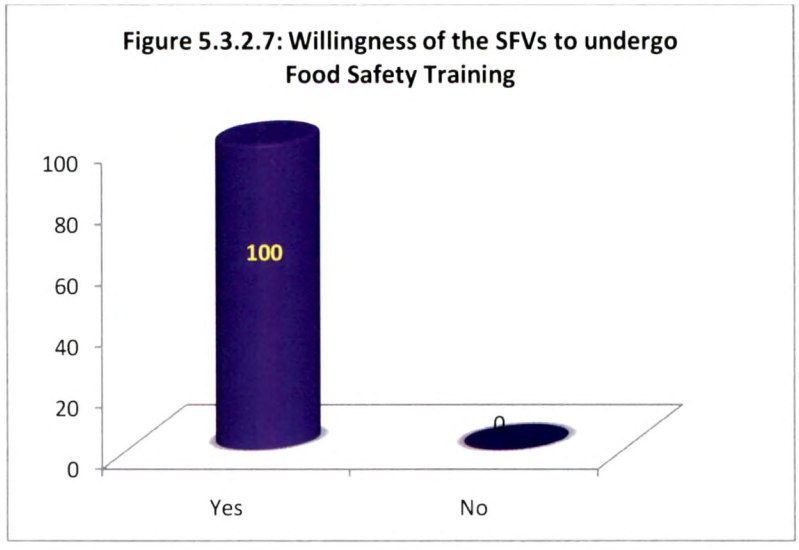


Figure 5.3.2.6 shows the drinking water supply for the street food units. It is clear that, all the street-vending units procured drinking water from the municipal corporation. Figure 5.3.2.7 shows that all the vendors enrolled for the study from both the locations were willing to undergo the training and also there were no dropouts from the study during and also after the training.





Procurement practices of the various food items by the SFVs:

Table 5.3.2.3 depicts the various existing practices followed by the street food vendors while purchasing raw as well as semi processed ingredients. The results revealed that those vendors who prepared non vegetarian items, procured unlabelled and unpacked eggs, meat, fish etc from the retailer. Around 24% of the vendors purchased packed and labeled spices and condiments from the retailer.

Majority (90%) of the vendors reported to purchase packed and labeled oil, butter. Only 12 percent vendors from both the locations made use of semi-processed ingredients, and 10 percent of them preferred to use labeled and packed items.

Cleanliness and maintenance of the street vending units:

The street vending units were observed for the cleanliness of the pushcart, food basket, utensils for serving and storing food, salt and chili powder sprinkler, utensils used for drinking water. The same were also observed for the kind of materials used and also whether they were kept covered or not. Table 5.3.2.4 depicts the observations of the street vending units. The results of the survey showed that as high as 70 percent of the vendors kept their pushcart dirty, all of them kept it uncovered and the cart was made from wood. In 70 percent of the cases the working surface of the cart was made

from metal. A majority of them (80%) kept the working surfaces dirty and uncovered.

A very good practice that was noticed was that all the vendors made used of stainless steel knives. Stainless steel vessels were used for storing drinking water and were kept covered by 80 percent of the vendors. The utensils used for storing the food were not kept covered by all the vendors, but were found to appear neat and clean in 80 percent of the cases.

The chili powder and salt sprinkler were kept uncovered in majority (95%) of the cases and appeared dirty in 60 percent of the cases.

Table 5.3.2.3: Existing practices followed by street food vendors (N = 41) related to the procurement of raw and semi-processed ingredients

Sr. No	Food Supply / Raw Materials	Purchase practices							
		Not procured	Own produce	Retailer / Grocery shop	Hat / Daily Market	Labeled	Unlabelled	Packed	Unpacked
a.	Food grains and semi processed ingredients	14 (34)	0	9 (22)	18 (44)	14 (34)	13 (32)	15 (36)	12 (29)
b.	Condiments and spices, nuts and dry foods	6 (15)	0	22 (54)	13 (31)	10 (24)	16 (39)	10(24)	16 (39)
c.	Leafy and fresh vegetables	9 (22)	0	0	32 (78)	18 (44)	32 (78)	0	32 (78)
d.	Oil, butter, ghee	10 (24)	0	22 (54)	9 (22)	30 (73)	1 (2)	30 (73)	1 (2)
e.	Fruits and salad	35 (85)	0	0	6 (15)	0	6 (15)	0	6 (15)
f.	Eggs, fish and meat	36 (88)	0	1 (2)	4 (10)	3 (7)	5 (12)	0	5 (12)
g.	Semi processed veg, tomato puree, noodles etc.	35 (85)	0	5 (12)	1 (2)	4 (10)	2 (5)	4 (10)	2 (5)

Table 5.3.2.4: Number of subjects observed for cleanliness of the unit, working surface, sanitaries and serving ware

Sr. No	Items	Appearance		Cover		Materials used				
		Neat	Dirty	Covered	Uncovered	Wooden	Metal	St. steel	Plastic	Paper
a.	Push cart	20 (49)	21 (51)	10 (24)	31 (76)	37 (90)	2 (5)	2 (5)	0	0
b.	Food Basket / Container / storage vessels	26 (63)	15 (36)	5 (12)	36 (88)	0	2 (5)	36 (88)	3 (7)	0
c.	Working surface	17 (41)	26 (63)	4 (10)	37 (90)	25 (61)	14 (34)	2 (5)	0	0
d.	Utensils	33 (80)	8 (19)	3 (7)	38 93)	0	1 (2)	39 (95)	1 (2)	0
e.	Chilli powder / paper / salt sprinkler	19 (46)	21 (51)	4 (10)	18 (44)	0	2 (5)	18 (44)	20 (49)	0
f.	Cutleries (knives, spoons, ladles)	30 (73)	11 (27)	2 (5)	39 (95)	0	0	41 (100)	0	0
g.	Vessel for drinking water	31 (76)	9 (22)	34 (83)	6 (15)	0	1 (2)	39 (95)	0	0
h.	Serving dish	29 (71)	12 (29)	4 (10)	37 (90)	0	2 (5)	34 (83)	5 (12)	0
i.	Sanitaries eg. hand towel etc.	24 (58)	17 (41)	0	41 (100)	0	0	0	0	41 (100)

5.3.3: Impact of Food Safety Education on Knowledge of the Street Food vendors (N = 41)

The street food vendors of both the locations were educated on 24 knowledge questions covering all the 5 basic aspects of food safety namely food hygiene, nutrition and health, personal hygiene, unit hygiene and environmental hygiene. Effect of food safety education on their knowledge scores have been depicted in Table 5.3.3.1 and 5.3.3.2 and graphically presented in figure 5.3.3.1. It was seen that prior to the intervention the vendors had poor knowledge on all the aspects of food safety. Post intervention the vendors gained knowledge on names of food borne illness, characteristics of spoiled food, symptoms of food borne illness, etc. (Table 5.3.3.1). The mean per cent scores for knowledge on food hygiene increased from 13 percent to 36 percent ($P<0.001$) (Table 5.3.3.2). A 28 percent increase was seen in the knowledge of the vendors regarding immediate symptoms of food borne diseases. Prior to the intervention the vendors had poor knowledge on nutrition and health with regards to sources of protein, vitamins, minerals, sources of adulterants, harmful effects of excessively reheating oil. The vendors were also unaware of various ways to conserve nutrients while processing as well food sources essential for growth and maintenance. However after the training their mean per cent scores for nutrition and health increased from 7 per cent to 23 per cent. About 22 percent increase was seen in the knowledge of the vendors regarding sources of adulterants. After the intervention, the vendors did not gain much knowledge in the area of sources rich in minerals and vitamins, ways of value addition of food products and harmful effects of excessively reheating oil (Table 5.3.3.1).

A highly significant increase in the knowledge scores of the vendors was also seen in the area of personal hygiene. The knowledge of the street food vendors increased with regards to names of protective clothes for food handlers, bad habits to be prohibited, activities after which hand washing with soap is a must. The mean per cent scores for personal hygiene increased significantly from 37 per cent to 63 per cent ($P<0.001$).

Knowledge of the vendors on unit and environmental hygiene also increased significantly ($P<0.001$). Post intervention the street food vendors could correctly answer questions pertaining to sanitizers to be used by them for

keeping their unit and surroundings clean, names of safe disposables for serving food, etc.

The vendors were ranked based on their knowledge scores before and after the food safety education intervention (Figure 5.3.3.2). All the vendors ranked in the poor category prior to the food safety education. However post intervention only 10 per cent of them ranked in the fair category.

Table 5.3.3.1: Mean values of knowledge scores as affected by Food Safety Education training to Street Food Vendors

Sr. No.	Knowledge of the Street food vendors	Mean ± SD Max score = 8		Statistical 't' Test	% increase
		Pre (N =41)	Post (N =41)		
1	Names of the food borne illnesses	2.10 ± 1.74 (26)	4.10 ± 2.18 (51)	5.69***	25
2	Names of the characteristics of spoiled food	3.05 ± 1.76 (38)	4.15 ± 1.75 (52)	4.54***	14
3	Names of the immediate symptoms of food borne illnesses	1.41 ± 2.01 (18)	3.66 ± 2.46 (46)	6.13***	28
4	Way of preventing bacterial contamination while handling food	0.02 ± 0.16 (0.25)	2.17 ± 1.99 (27)	6.89***	26.75
5	Food contaminations which make a food unsafe and unfit for consumption	0.44 ± 1.05 (26)	3.20 ± 1.81 (40)	9.8***	14
6	Biological sources of food contamination	0.07 ± 0.35 (0.875)	1.17 ± 1.26 (15)	5.11***	14.12
7	Ways to manage left over food	1.12 ± 1.42 (14)	2.49 ± 1.40 (31)	4.93***	17
8	Names of serving safe drinking water	0.20 ± 0.46 (2.5)	2.15 ± 2.13 (27)	5.85***	24.5
9	Names of the energy foods	1.71 ± 1.63 (21)	2.73 ± 1.27 (34)	3.49**	13
10	Ways of conserving nutrients while processing and cooking food	0.39 ± 0.80 (5)	1.39 ± 1.24 (17)	3.89***	12
11	Names of nutrients which are essential for growth and maintenance	0.02 ± 0.16 (0.25)	1.39 ± 1.92 (17)	6.56***	16.75
12	Names of food sources of protein	0.32 ± 0.96 (4)	2.54 ± 1.69 (32)	7.36***	28
13	Names of rich sources of vitamins	0.56 ± 1.10 (7)	2.27 ± 1.41 (28)	5.833***	21
14	Names of food adulterants	1.44 ± 1.76 (18)	3.24 ± 1.50 (40)	5.382***	22
15	Names of common sources of minerals	0	0.56 ± 1.12 (7)	3.2**	7
16	Ways of value addition of the food products	0.22 ± 0.76 (3)	0.44 ± 0.98 (5.5)	1.22*	2.5
17	List of harmful effects of excessive heating of oil	0.46 ± 0.84 (6)	1.20 ± 1.17 (15)	3.19**	9
18	Names of the protective clothes necessary for a food handlers	4.34 ± 2.86 (54)	6.98 ± 1.01 (87)	5.15***	33
19	Names of bad habits prohibited by the food handlers	4.44 ± 3.33 (55.5)	6.63 ± 2.02 (83)	4.17***	27.5
20	Name of the activities which may contaminate food with harmful germs/bacteria	0.29 ± 0.96 (3.62)	2.85 ± 2.25 (36)	6.74***	32.38
21	Activities after which hands wash with soap is a must	2.78 ± 2.01 (35)	3.80 ± 1.60 (47.5)	2.88**	12.5
22	Sanitizes which may be used by street food providers	1.07 ± 1.37 (13)	2.39 ± 1.20 (30)	4.34***	17
23	Names of safe disposable utensils for serving the street food	0.24 ± 0.92 (8)	2.56 ± 1.98 (85)	6.9***	24
24	Benefits to the workers through associations	0.85 ± 0.99 (28)	2.32 ± 0.91 (77)	7.07***	49

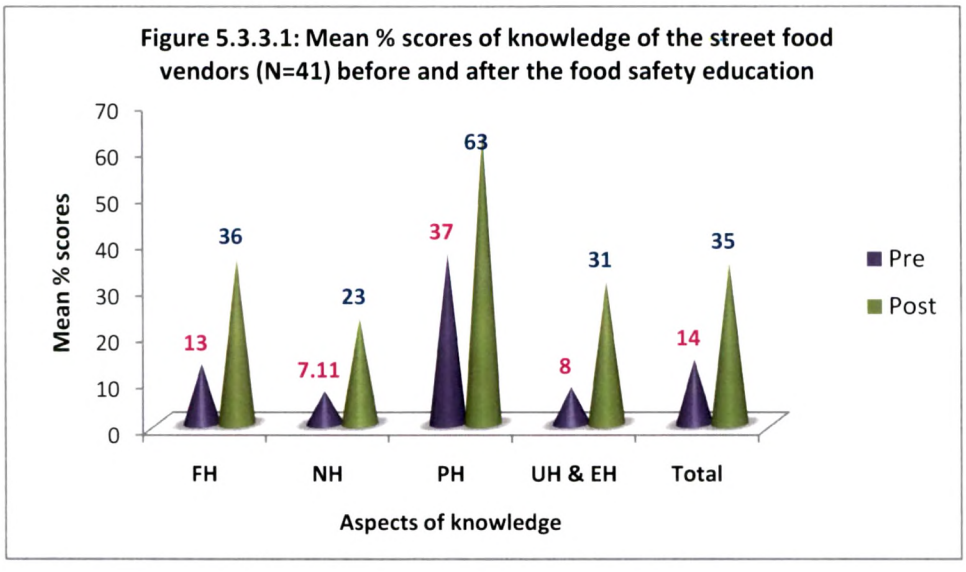
Figures in parenthesis indicate mean percent scores

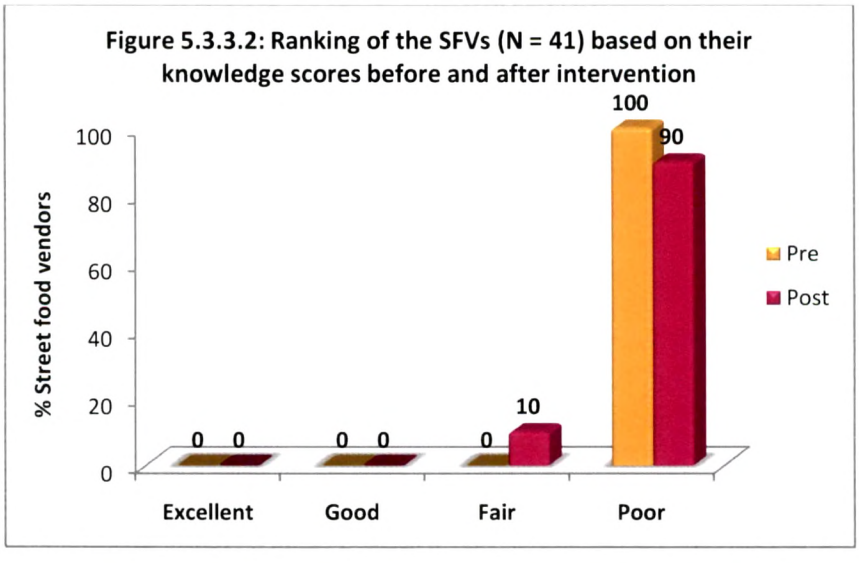
* Significant at P <0.05 ** Significant at P < 0.01 *** Significant at P < 0.001

Table 5.3.3.2: Impact of training on various aspects of food safety related Knowledge of Street Food Vendors (N = 41)

Knowledge scores	Mean ± SD		Paired 't' Test	% increase
	Pre (N = 41)	Post (N = 41)		
Total FH scores Max score = 64	8.41 ± 4.87 (13)	23.07 ± 9.56 (36.04)	10.91***	23.04
Total PH scores Max score = 32	11.80 ± 5.98 (37)	20.27 ± 4.62 (63)	7.7***	26
Total NH scores Max score = 72	5.12 ± 4.05 (7.11)	16.39 ± 5.48 (23)	10.31***	16
Total UH and EH scores Max score = 16	1.32 ± 1.89 (8)	4.93 ± 2.47 (31)	7.03***	23
Total score = 184	26.66 ± 12.60 (14)	64.66 ± 17.88 (35)	12.53***	21

Figures in parenthesis indicate mean percent scores
*** Significant at P < 0.001





5.3.4: Impact of Food Safety Education on Practices of the Street Food vendors (N = 41)

The street food vendors of both the locations were educated on 25 different practices that covered the basic aspects of food safety namely Food hygiene, Personal hygiene, Nutrition and health, Unit and Environmental hygiene.

The impact of training on various aspects of food safety related practices have been depicted in table 5.3.4.1 and 5.3.4.2 and graphically presented in figure 5.3.4.1. The street food vendors were educated on the following practices under food hygiene; such as use of good quality ingredients, covering of cooked food and storing them in clean containers, safe storage of leftover foods, use of refrigerators for storing perishable foods, use of potable water for cooking and drinking, etc. Prior to the intervention, the street food vendors had already high scores of 68 per cent for food hygiene. The training however made a little but a non significant improvement in the practices related to food hygiene.

The vendors had poor scores on personal hygiene (47%), prior to the intervention. They were educated on wearing of protective clothes, refraining from bad habits while working, use of liquid soap at wash basin that should have regular water supply with appropriate drainage facility. Post intervention, the practices of the vendors increased non significantly from 47 per cent to 49 per cent.

Before the food safety education intervention, the street food vendors had high practice scores of unit hygiene (61%) and environmental hygiene (75%). The training made a little but a non significant improvement in the practices related to unit and environmental hygiene of the vendors. These practices were washing of utensils using three tub method, serving of food in good quality disposable and not in colored newspapers or cracked dishes, use of garbage bins for disposing off waste, etc. There was no increase in the mean per cent scores for the practices related to unit and environmental hygiene after the food safety training.

Table 5.3.4.1: Mean values of Practice scores as affected by Food Safety Education training to Street Food Vendors (N =41)

Sr. No.	Practices of the Street food vendors	Mean ± SD Max score = 3		Statistical 't' Test	% increase
		Pre (N =41)	Post (N =41)		
1	Ingredients to be used should be of good quality and free from adulterants, kept covered to avoid contamination from dirt and microorganisms	1.98 ± 0.27 (66)	2 ± 0.39 (67)	0.44NS	1
2	Cooked food and drinks should be stored in clean vessels with proper lids. Display items should be covered with transparent glass and clear plastics etc.	1.98 ± 0.42 (66)	2.05 ± 0.50 (68)	1.35NS	2
3	Perishable foods should be held at proper temperature and out of danger zone	1.44 ± 0.87 (48)	1.49 ± 0.90 (50)	0.57 NS	2
4	Potable water should be used for washing and cooking.	2.66 ± 0.48 (89)	2.66 ± 0.48 (89)	0 NS	0
5	Left over food should be stored safely and not mixed with fresh food/ingredients	2 ± 1.26 (67)	2.15 ± 1.17 (72)	1.54 NS	5
6	Reuse of leftover oil should be avoided.	2.07 ± 1.27 (69)	2.15 ± 1.24 (72)	1.13 NS	5
7	Raw materials should be washed with clean/chlorinated water before preparing uncooked items like chutney, fruits chat, salad etc. The equipments and accessories should be properly sanitized and stored with proper cover.	1.51 ± 0.87 (50)	1.54 ± 0.90 (51)	1 NS	1
8	Potable water should be kept in clean container and served through tap/long handled utensils and thoroughly washed glasses should be used for drinking.	2 ± 0.67 (67)	2.10 ± 0.62 (70)	0.94 NS	3
9	Ice for human consumption should be prepared from potable water and not handled bare hands, should be kept separate from food in a clean container. Ice crushing should be done in clean container.	0.76 ± 0.83 (25)	0.76 ± 0.83 (25)	0 NS	0
10	The food handlers should wear protective clothes.	1.17 ± 0.38 (39)	1.29 ± 0.46 (43)	2.35*	4
11	Overall looks of the food handlers should be clean and bad habits like chewing pan, guthka, tobacco should be avoided.	2.02 ± 0.27 (67)	2.07 ± 0.41 (69)	1NS	2
12	The cart should be clean with steel surface and provision for heating, cooling and storage of food water, utensils, and ingredients separately.	1.54 ± 0.55 (51)	1.59 ± 0.55 (53)	1.43NS	2

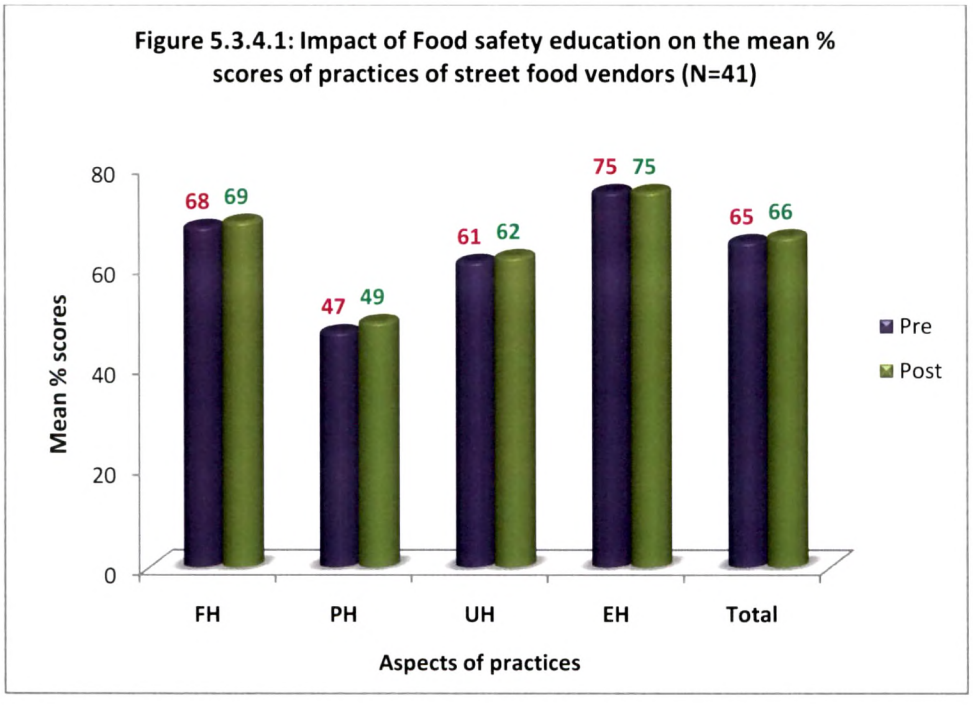
13	Unit should be covered from all sides.	2.49 ± 0.75 (83)	2.54 ± 0.71 (85)	1.43 NS	2
14	The foods should be served in properly washed, drained and dried utensils.	2.22 ± 0.42 (74)	2.2 ± 0.71 (73)	1.43 NS	1
15	Wash utensils using proper detergent and three tub system	1.93 ± 0.41 (64)	1.95 ± 0.44 (65)	1 NS	1
16	Utensils should be washed and drained at portable racks above 60cm ground level and should keep them upside down and spoons, forks, etc with handles up.	1.85 ± 0.42 (62)	1.85 ± 0.42 (62)	-	0
17	In the absence of water the food should be served in good quality disposable vessels including green leaves and dry molded leaves with plastic linings.	1.02 ± 0.16 (34)	1.02 ± 0.16 (34)	-	0
18	The surroundings of the food units and also inside space should be free from dust, flies, mosquitoes, insect etc.	2.90 ± 0.30 (97)	2.88 ± 0.33 (96)	1 NS	1
19	Location of the unit away from water logged drains, toilets and street animals.	2.83 ± 0.38 (94)	2.88 ± 0.49 (96)	1.35 NS	2
20	Waste disposal bins should be used for disposal of garbage and other waste material.	1.54 ± 0.50 (51)	1.56 ± 0.50 (52)	1 NS	1
21	Don't serve food in ceramic utensils with cracks, colored utensils, colored papers and newspapers.	2.32 ± 1.25 (77)	2.39 ± 1.20 (80)	1 NS	3
22	All food preparations should be performed using proper fuel at a platform 60-70 cm above ground	3 ± 0 (100)	2.98 ± 0.16 (99)	1 NS	1
23	Mixing of ingredients for batter should be done at platform 80 - 90cm above the ground using proper equipment else do it after washing your hands properly.	3 ± 0 (100)	2.95 ± 0.22 (98)	1.43 NS	2
24	Use of liquid soap at wash basin with regular water supply and drainage at washing point.	1 ± 1 (33)	1.02 ± 0.16 (34)	1 NS	1
25	The dining tables and service counters should be cleaned through sanitized and dry mops and after every mopping hands should be washed.	1.63 ± 0.83 (54)	1.68 ± 0.88 (56)	1.43 NS	2

Figures in parenthesis indicate mean percent scores
*** Significant at P < 0.001; NS – Not signiicant

Table 5.3.4.2: Impact of training on various aspects of food safety related Practices of Street Food Vendors (N = 41)

Practice scores	Mean ± SD		Paired 't' Test	% increase
	Pre (N = 41)	Post (N = 41)		
Total FH scores Max score = 33	22.39 ± 2.95 (68)	22.80 ± 2.89 (69)	2.09*	1
Total PH scores Max score = 9	4.20 ± 0.46 (47)	4.39 ± 0.67 (49)	2.72*	2
Total UH scores Max score = 18	11.05 ± 1.05 (61)	11.15 ± 1.09 (62)	1.66^{NS}	1
Total EH scores Max score = 15	11.22 ± 1.35 (75)	11.27 ± 1.47 (75)	0.70^{NS}	0
Total score = 75	48.85 ± 3.75 (65)	49.61 ± 3.99 (66)	3.06**	1

Figures in parenthesis indicate mean percent scores
* Significant at P <0.05 and ** Significant at P < 0.01; NS – Not significant



The street food vendors were given ranks based on their performance before and after food safety education (Figure 5.3.4.2). Results revealed that before the intervention, about 61 percent of the vendors had poor scores and 39 percent scored in the fair category. Post intervention, none of the vendors had poor scores. On the contrary, 59 percent and 39 percent of the vendors ranked in the good and fair category respectively.

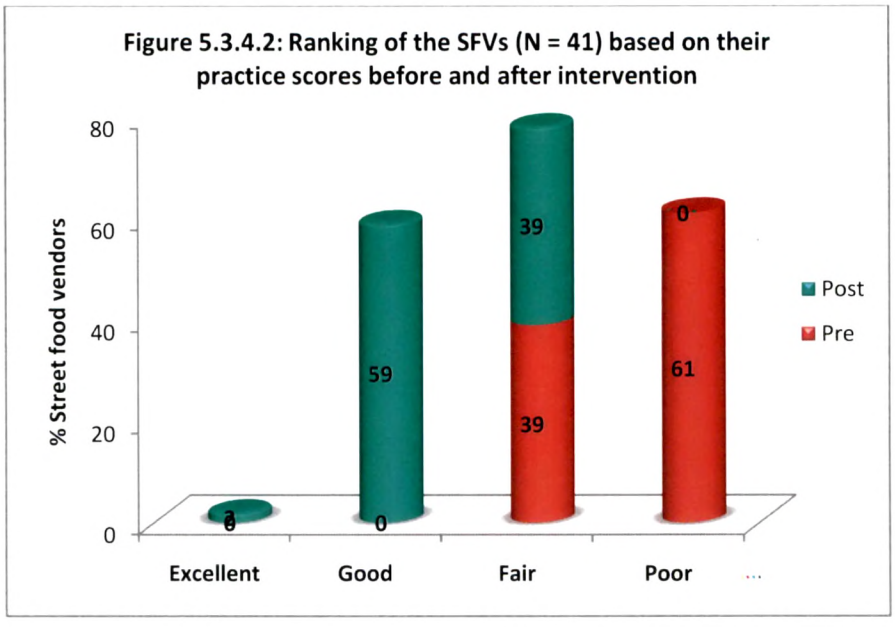


Table 5.3.4.3 shows association between the average number of consumers visiting the street food unit and the practices of the street food vendors. Although the units having good food safety practices had greater number of consumers visiting them (88%) as compared to the units having poor practices (56%); however the chi square test did not reveal a statistically significant association between these two aspects.

When the income level was compared with the ranks given to the vendors based on their practice scores (Table 5.3.4.4), it was seen that there was no significant association between the two aspects.

Even though the analysis revealed that higher the income better was the practices; however this association was not found to be significant.

No association was found in between the income level and availability of cover for the push cart (Table 5.3.4.5).

The practices of the vendors did not have any significant association with their education, ownership, years of experience in food industry as well as their age (Table 5.3.4.6).

Table 5.3.4.3: Average number of consumers v/s Practice ranks (N = 41)

Ranks for Practice	Average no. of consumers / day				λ^2
	30-60	60-90	90-120	>120	
Good	3 (12)	10 (40)	7 (28)	5 (20)	5.78^{NS}
Fair	7 (43.75)	3 (18.75)	4 (25)	2 (12.5)	

Figures in parenthesis indicate percentages; NS – Not significant

Table 5.3.4.4: Income level v/s Practice ranks (N = 41)

Ranks for Practice	Income level / day (in ₹)			λ^2
	< 400	400 - 600	600 - 1000	3.86^{NS}
Good	6 (24)	5 (20)	14 (56)	
Fair	6 (37.5)	6 (37.5)	4 (25)	

Figures in parenthesis indicate percentages; NS – Not significant

Table 5.3.4.5: Income v/s availability of cover for push cart

Availability of cover for push cart	Income / day (₹)			Chi square value
	< 400	400 – 800	> 800	1.83 NS
Permanent cover	5 (26.31)	7 (36.84)	7 (36.84)	
Uncovered	7 (31.81)	11 (50)	4 (18.18)	

Figures in parenthesis indicate percentages; NS – Not significant

Table 5.3.4.6: Association amongst the various socio economic parameters with the food safety practices (N = 41)

Educational status	Practice		Chi square value
	Good	Fair	
Illiterate	3 (42.85)	4 (57.14)	1.25 NS
Up to primary	8 (61.53)	5 (38.46)	
Primary to HS	14 (66.66)	7 (33.33)	
Ownership	**Practice**		**Chi square value**
	Good	Fair	
Owner	16 (53.33)	14 (46.66)	2.74 NS
Employed	9 (81.81)	2 (18.18)	
Years of experience	**Practice**		**Chi square value**
	Good	Fair	
< 10 y	13 (54.16)	11 (45.83)	1.13 NS
> 10 y	12 (70.58)	5 (29.41)	
Age (yrs.)	**Practice**		**Chi square value**
	Good	Fair	
< 25 y	3 (18.75)	13 (81.25)	0.36 NS
> 25 y	22 (62.85)	13 (37.14)	

Figures in parenthesis indicate percentages
NS – Not significant

5.3.5 RESULTS OF FOLLOW UP TRAINING TO STREET FOOD VENDORS ON THEIR FOOD SAFETY KNOWLEDGE AND PRACTICE

The follow up training program was conducted after a period of 1 year for the already trained 40 street food vendors for reinforcement of some practices related to food safety. They were imparted education on 20 most important practices for safe food handling and preparation. Each food handler was given at least 10 items important for safe food preparation and services. These included tubs for washing fruits and vegetables with disinfectant, $KMnO_4$ (potassium permanganate) powder, cloth napkins for wiping hands, mop cloth, wire with springs to hang these napkins, stainless steel knife, tissue paper for wiping sweat, glass tumbler to keep the knife dipped in the $KMnO_4$ solution when not in use, a small container for storing the disinfectant and a spoon.

The results of this phase are presented under the following heads:

5.3.5.1: Impact of follow up training on the individual practices of the street food vendors

5.3.5.2: Ranking of the street food vendors based on their total scores

5.3.5.1: Impact of follow up training on the individual practices of the street food vendors

The Follow-up training program was conducted in 14 sessions on the various aspects such as Food hygiene, Personal hygiene, Unit hygiene and Environment hygiene was conducted for the already trained 40 street food vendors. The practices of vendors were rated in category of excellent (>80%) to poor (<49%) and these vendors who were rated as fair and above were awarded prizes to motivate them for continuation of good manufacturing practices at the Iaari.

The SFVs were evaluated using an observation checklist that included practices related to the various categories of food safety. This checklist included the facilities at the vending site as well as practices followed by the vendors. Each of the vendors were given scores based on the adoption of the

practices. The desirable practices were given a score of 1 whereas the undesirable practices were scored 0. The maximum marks that the vendor could score were 20.

The impact of food safety education on various categories of practices is shown in table 5.3.5.1.1 and 5.3.5.1.2 and graphically depicted in figure 5.3.5.1.1.

The follow up training for the street food vendors brought about a positive impact on all the practices related to food hygiene, personal hygiene, unit hygiene and environmental hygiene. The mean scores for food hygiene significantly increased from 2.48 to 3.08. the practices under food hygiene included provision of tank with tap or washing hands, ice box for keeping perishables safe, washing of fruits and vegetables with sanitizer, use of only stainless steel knives, avoiding excessive use of refried oil, covering of cut fruits and cooked foods. It was observed that none of the street food vendors had the habit of dipping their knife (when not in use) in a disinfectant solution (Plate 5.3.5.1.1), however a majority (32.5%) of them began to do so (Plate 5.3.5.1.2).

A majority of the vendors (55%) had the positive practice of not using excessively refried oil for cooking. The results also revealed that before the training only 35 per cent of the vendors had the habit of keeping cut fruits and vegetables uncovered, but after the intervention 50 percent of them discontinued the practice and this increase were statistically significant. 52.5 percent of the food handlers were found to have a positive practice of using icebox before the intervention, however only 17.5 percent of them kept them clean before the training, but after the training 22.5 percent started keeping their old iceboxes clean or purchased new ones.

Post intervention, a highly significant increase e ($P<0.001$) was noticed in the practices related to personal hygiene. The training made a significant impact on the practices related to nail cutting, wearing of aprons and head gear (Plate 5.3.5.1.3 & Plate 5.3.5.1.4). Results revealed that after the follow up

training, bout 62.5 per cent of the vendors appeared to be clean. None of the vendors made use of tissue papers for wiping sweat. The mean scores for practice on provision for separate hand towel for wiping hands increased significantly from 0.28 to 0.38.

The mean scores for practices related to unit and environmental hygiene before the training were 0.68 and 0.08 respectively. After the training the scores increased to 0.85 and 0.35 respectively for unit and environmental hygiene. The rise in the scores was found to be statistically significant. The mean scores for practice of keeping a separate mop cloth for cleaning food cart increased significantly from 0.4 to 0.58 ($P<0.01$) (Plate 5.3.5.1.5 & Plate 5.3.5.1.6).

About 20 percent of the vendors made a provision for a big covered dustbin at the site after the training (Plate 5.3.5.1.7 & Plate 5.3.5.1.8) as against only 2.5 percent before the training program and this increase was found to be highly significant ($P<0.01$). The condition of the dustbins before the training was found to be dirty in 5 percent of the cases, however after the training, 15 percent of the SFVs started keeping their dustbins clean and this increase was statistically significant ($P<0.05$).

However, post intervention the vendors continued to wash utensils at vending site and did not make ant efforts or making provision for extra disposable wares for serving food.

Thus it can be concluded that the food safety follow up training brought about a positive impact on majority of the practices of the street food vendors.

Table 5.3.5.1.1: Mean scores for individual practices adopted by SFVs before and after training program

Sr. No.	Practices of the Street Food Vendors	Mean ± SD (N = 40) Max score = 1		Paired 't' Test
		Pre	Post	
1	Provision for tank with tap for washing hands	0.15 ± 0.36 (15)	0.23 ± 0.42 (22.5)	1.77NS
2	Provision for ice box for preventing spoilage of foods	0.53 ± 0.51 (52.5)	0.5 ± 0.51 (50)	1NS
3	Condition of ice box	0.18 ± 0.38 (17.5)	0.23 ± 0.42 (22.5)	1.43NS
4	Practice of washing vegetables/fruits daily with a sanitizer	0.05 ± 0.22 (5)	0.13 ± 0.33 (12.5)	1.35NS
5	Source of drinking water	0.3 ± 0.46 (30)	0.35 ± 0.48 (35)	1.43NS
6	Nails cut and clean	0.18 ± 0.38 (17.5)	0.45 ± 0.50 (45)	3.84*
7	Apron worn	0.08 ± 0.27 (7.5)	0.2 ± 0.41 (20)	2.36*
8	Head cap worn	0.1 ± 0.3 (10)	0.23 ± 0.42 (22.5)	2.36*
9	Clean appearance of the food handler	0.5 ± 0.51 (50)	0.63 ± 0.49 (62.5)	2.36*
10	Provision for a separate mop cloth for cleaning the food cart before starting work	0.4 ± 0.5 (40)	0.58 ± 0.50 (57.5)	2.87**
11	Provision for a separate and clean hand towel for wiping hands	0.28 ± 0.45 (25)	0.38 ± 0.49 (37.5)	2.08*
12	Provision for tissue papers for wiping sweat	0 ± 0 (0)	0 ± 0 (0)	0NS
13	Washing of utensils at site	0.1 ± 0.30 (10)	0.1 ± 0.30 (10)	-
14	Provision for extra serving utensils/disposables	0.18 ± 0.38 (17.5)	0.18 ± 0.38 (17.5)	0
15	Provision for a big covered dustbin	0.03 ± 0.16 (2.5)	0.2 ± 0.41 (20)	2.87**
16	Satisfactory condition of the dustbin	0.05 ± 0.22 (5)	0.15 ± 0.36 (15)	2.08*
17	knife dipped in KMnO4	0.15 ± 0.36 (15)	0.373 ± 0.47 (32.5)	2.87**
18	Excessive use of refried oil OR Quality of fruits used by juice vendors	0.55 ± 0.50 (55)	0.58 ± 0.5 (57.5)	1.0NS
19	Cut fruits/ Vegetables kept covered	0.35 ± 0.48 (35)	0.5 ± 0.51 (50)	2.62*
20	Cooked food / Spices / Powdered sugar kept open	0.53 ± 0.51 (52.5)	0.55 ± 0.50 (55)	0.57NS

* Significant at P < 0.05 ** Significant at P < 0.01 NS - Not Significant
The figures in parenthesis indicate percentages of the SFVs

Table 5.3.5.1.2: Impact of training on total scores and various categories of practices i.e. food hygiene, personal hygiene, unit hygiene and environment hygiene followed by 40 Street food Vendors

Scores for the Practices	Pre	Post	Paired 't' test
	Mean ± SD		
Total Scores Max score = 20	4.65 ± 2.67 (23.25)	6.48 ± 4.56 (32.4)	3.37***
Total Food Hygiene Scores Max score = 8	2.48 ± 1.77 (31)	3.03 ± 2.09 (37.87)	2.67*
Total Personal Hygiene Scores Max score = 7	1.43 ± 1.06 (20.42)	2.25 ± 1.84 (32.14)	4.21***
Total Unit Hygiene Scores Max score = 3	0.68 ± 0.62 (22.66)	0.85 ± 0.74 (28.33)	2.22*
Total Environmental Hygiene Scores Max score = 2	0.08 ± 0.27 (4)	0.35 ± 0.7 (17.5)	2.71**

* Significant at P < 0.05 ** Significant at P < 0.01 *** Significant at P < 0.001
NS - Not Significant

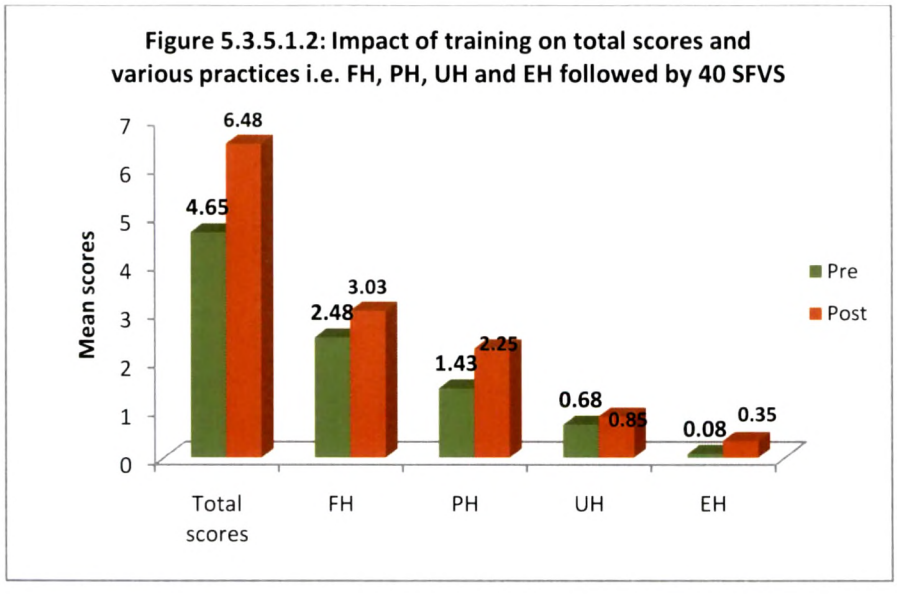


Plate 5.3.5.1.1: Trainer explaining the preparation of disinfectant solution

Plate 5.3.5.1.2: Knives dipped in wate with disinfectant

Plate 5.3.5.1.3: Trainer explaining the importance of wearing head gear

Plate 5.3.5.1.4: Vendor wearing protective clothing

Plate 5.3.5.1.5: Mop cloths scattered on the laari before training

Plate 5.3.5.1.6: Mop cloths hung on string after the training

Plate 5.3.5.1.7: Dustbin kept uncovered before the training

Plate 5.3.5.1.8: Dustbin kept covered after the training

5.3.5.2: Ranking of the street food vendors based on their total scores

The street food vendors were given scores on basis of their adoption of practices before and after the intervention. They were ranked as excellent, good, fair, poor and extremely poor based on their performance. Results revealed that none of the handlers ranked in the excellent, good and fair category before the food safety education intervention as compared to about 7.5, 5 and 10 percent of the handlers ranked in the excellent, good and fair category respectively after intervention. As high as 70% of the food handlers ranked in the extremely poor category before intervention as compared to 52.5 percent after the intervention (Figure 5.3.5.2.1).

Figure 5.3.5.2.1: Ranking of the street food vendors based on their total scores before and after follow up training on food safety

Plate 5.3.5.3.1 shows some of the clippings of street food vendors receiving prizes for adopting good manufacturing practices.

Plate 5.3.5.3.1: Street Vendors receiving prices for adopting many of the Good Manufacturing Practices

HIGHLIGHTS OF PHASE III

- Majority of the vendors owned the units, and were between the age group of 25 - 50 y.
- Majority of the vendors were literate, had below 10yrs of experience in street food service and did not have employees below 16 y of age.
- Not all (35%) the street food-vending units were licensed. All the street vending units had electric lamps as mode of lighting and majority of the units were licensed.
- In most cases, the average number of customers visiting the units during weekdays and weekends ranged from 30 –120.
- All the street-vending units procured drinking water from the municipal corporation.
- Majority of the vendors purchased packed and labeled oil, butter,
- As high as 70 percent of the vendors kept their pushcart, working surface, chili powder and salt sprinklers uncovered and dirty.
- A very good practice that was noticed was that all the vendors made used of stainless steel knives.
- At baseline, the street food vendors had poor scores for knowledge on food safety, but had good food handling practices.

- After the intervention, the knowledge scores of the vendors increased with respect to names and symptoms of food borne diseases, characteristics of spoiled food, factors that contaminate food and sources of food contamination.
- The street food vendors gained knowledge on personal hygiene and nutrition and health like, names of protective clothes to be worn by food handler, activities after which hand washing with soap is must, names of food sources rich in vitamins, minerals, protein, etc., names of food adulterants and harmful effects of excessively reheating oil.
- Knowledge of the street food vendors also increased for unit and environmental hygiene on aspects like, names of sanitizers to be used

by food handlers, names of safe disposables available in market, and ideal way of serving drinking water.

- Post intervention, the practices of the vendors improved with regards to food hygiene and personal hygiene.
- The training made a little but a non significant improvement in the practices related to unit hygiene and environmental hygiene as the street food vendors had already high scores prior to the intervention.
- The practices of the street food vendors had no association with their income level and the average number of consumers visiting their units.
- A significant increase in the mean scores of the street food vendors was observed for keeping a separate tank for hand washing, made a provision for a big covered and clean dustbin, wearing of apron and head cap.
- Prior to the training, only 35 per cent of the vendors had the habit of keeping cut fruits and vegetables uncovered, however after the intervention, 50 per cent of them discontinued the practice and this increase was statistically significant.
- None of the street food vendors had the habit of dipping their knife (when not in use) in a disinfectant solution, however a majority (32.5%) of them began to do so.
- None of the handlers ranked in the excellent, good and fair category before the food safety education intervention as compared to about 7.5, 5 and 10 percent of the handlers ranked in the excellent, good and fair category respectively after intervention.
- As high as 70% of the food handlers ranked in the extremely poor category before intervention as compared to 52.5 percent after the intervention.

DISCUSSION

The street food industry has an important role in the cities and towns of many developing countries in meeting the food demands of the urban dwellers. It feeds millions of people daily with a wide variety of foods that are relatively cheap and easily accessible. Street food vendors of Vadodara city operate in an unstable and unsafe state because this sector lacks legal recognition. More and more street food vendors are flourishing in the city that pose a great risk to the consumer as the vendors work without any regulations governing the preparation and serving of food.

Rate of illiteracy among the workers is known to worsen the situation of the increasing incidence of food borne diseases. In the present study, 54 per cent of the vendors were educated up to the higher secondary level; while 32 per cent had education only up to the primary level. About 15 per cent of the vendors from both the locations were found to be illiterate. High illiteracy rates amongst the food handlers have been also reported by other investigators (Sheth, Sukul and Patel 2007; Abdalla et al, 2009; Zain, M.M. and Naing, 2002).

One of the guidelines laid down by the Codex Alimentarius Commission (2007), is the licensing of the vendors. Under the guideline the vendors should be prohibited from performing any task relating to the preparation, packaging, storage, display or sale of street foods unless he or she is in possession of a license issued by relevant authority. It is also essential for the relevant authority to require every street food vendors to take a training program in food hygiene before issuing or renewing a license. The present report reveals that majority (65%) of the street vending units were operating without any license and that none of the vendors had received any training so far in food safety. The remaining licensed vendors had not undergone any training in food safety thus violating the Codex guidelines.

The results revealed that 29 per cent of the food stall were either left open, or were covered with umbrellas (24%) implying that they had no permanent cover. In a study conducted by Muinde and Kuria (2005) on the hygienic and sanitary practices of street foods in Nairobi reported that the food stalls were

poorly constructed. They could not give proper protection of the street foods from dust and smoke from vehicles.

One of the most critical problems in street vending is the supply of water of acceptable quality and in sufficient quantities for drinking, washing, cleaning and other operations (WHO 1996). Present research showed that water for street food preparation was not enough. All the street-vending units procured drinking water in cans from their homes; the source being the taps supplying water treated by Municipal Corporation. However due to this, the vendors used very little water for washing the utensils. Very minimal water was used for washing hands at site. The results of this study is in agreement with a study done in Accra on the safety of street food, which found that running water was not available (Mensah et al 2002). Latham (1997) emphasizes that personal hygiene can only be achieved if adequate water is available.

About 58 per cent of the vendors had below 10yrs of experience in street food service, which implies majority of them were new to the street food industry and were less experienced. The findings of the research were agreement to the study on action research of street food safety that was carried out in 18 cities of India. The data revealed that out of the 805 vendors surveyed, 49 per cent of them were having less than 10 years of experience in street food business (National Report 2007).

Majority of the street food vendors under the study followed rules regarding the purchase of inputs and ingredients under the Section 4.1 of Code of Hygiene Practice for the preparation and sale of street foods (2001).

Unwashed hands are an important vehicle for the transmission of pathogens from raw to cooked foods. Hands is also considered as a critical source of cross contamination according to other studies that have found contamination with *Campylobacter* and *Staphylococcus aureus* microorganisms coming from hands (Bidawid et al 2000; Gorman et al 2002; Aarnisalo et al., 2006). Majority of the vendors under study made use of tools / appliances for mixing of food stuffs, thus minimizing the risk of cross contamination. Kinton and Ceserani (1992) recommend that food stuffs of all kinds should be kept covered as much as possible to prevent contamination from dust and flies. In our study majority of the vendors failed to cover the chili and salt sprinklers thereby contaminating them with the various microbes in the surroundings.

The present study showed that the food handlers had poor knowledge on food safety prior to the intervention. A study on the knowledge, attitude and practices of food service staff regarding food hygiene in Iran reported that the personnel had little knowledge regarding pathogens that cause food borne diseases and the correct temperatures for the storage of hot or cold ready to eat food (Askarin et al, 2004) The food safety education intervention brought about a significant increase (21%) in the knowledge scores of the street food vendors. The study undertaken by Malhotra et al, (2008) also reported that food safety education was imparted to 136 food handlers and their knowledge on food borne diseases increased up to 65%. Another study conducted showed that after a short educational intervention, a significant increase in knowledge about hygienic habits was demonstrated in food handlers (Zacarius et al,1991).

Olsen et al found that annually from 1993 to 1997, poor personal hygiene of food workers was a contributing factor in 27 to 38% of food borne illness outbreaks. In our study none of vendors of both the locations were observed to wear the complete set of protective clothes and all of them handled money and food together. This could be due to lack of staff, as they managed the vending unit single handedly. Multi tasking can be a potential source of contamination. 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.

Our study revealed that the vendors made use of spoons and bare hands to serve foods. Several authors have shown that serving stage is a critical point in the street food industries (Bryan et al., 1988; Bryan, 1988; El-Sherbeeny et al., 1985). Enteropathogens can survive on the hands for three hours or longer. The risk increases when vendors during vending use bare hands to serve.

The practice of using 3 tub method for washing of utensils also did not show a significant improvement after the food safety education. Unrenewal of dish washing waters explains their poor bacterial quality (Mensah et al., 2002; Mosupye and Van Holy, 1999; Muinde and Kuria, 2005). Similar finding were

also reported by Barro et al (2006) wherein most of the vendors of Ouagadougou used dish washing waters placed n the floor the waters for washing and rinsing were rarely renewed and generally were observed to be dirty.

Inadequate refuse disposal facilities lead to the accumulation of refuse at food vending sites. This leads to an increased risk of food contamination. In our study the vendors did not have proper waste disposal facilities. The vendors. Such a practice can be a serious health hazard. Under the outlined in the Section 9

The Section 9 of Code of Hygiene Practice for the preparation and sale of street foods (2001) clearly provides various guidelines for handling and disposal of waste and pest control. Under this section, the waste bins should be kept far away from the food handling area, have a lid and where possible should be fitted with an automatic closing device. The vendors in the present study were not observed to follow any of the above mentioned guidelines. They threw waste either in the open or in plastic uncovered bins that were located very near to the food handling area. This could be due to the limited available space for them to place their stalls and prepare food. This could be due to the fact that the vendors were non licensed and therefore there were no specific place allotted for their selling of food.

Various reasons can be attributed to poor improvement in the practices of food preparation and service. Some of these could be low incentive for them to follow the practices, lack of mass power and time. In a study by Deborah et al (2002), out of 95% of respondents receiving food hygiene training, 63% admitted to sometimes not carrying out food safety behaviors due to lack of time, lack of staff and a lack of resources.

During the discussion sessions with the vendors it was revealed that they would take these steps especially in terms of improving the laari hygiene provided they are assured by the VMSS that they would be provided with license. Moreover lack of running water facility, increased cost of disposable utensils and dustbins were some other reasons cited for non compliance of food safety measures. The major reason is the lack of consumer demand for following safe preparations practices. Many consumers are unaware of potential hazards of food borne illnesses.

Last but most important the local government bodies should legalize and given recognition to the street food business as they are an important part for fulfilling the dietary needs of urban dwellers. The need to set up a street vending zone with appropriate facilities should be considered. The vendors who have received complete food safety training from a certified authority should be allowed to do business in the zone. Therefore a concerted effort is required on the part of the local government bodies to develop a street vending zone, bring together the academic bodies to provide training, the consumer cell to educate the consumer and sanitation department to enforce food safety norms and take preventive action if not followed. Such an effort will go a long way to reduce the occurrence of food borne illness.

5.4 PHASE IV – IMPARTING FOOD SAFETY EDUCATION TO RESTAURANT OWNERS AND HANDLERS

Baseline data (Phase I results) revealed that the respondents of the small and medium restaurants had poor food safety knowledge and practices as compared to the other food service establishments. Thus in view of this, 30 owners of small and medium restaurants and their food handlers (N = 30) were selected for imparting food safety education on the 5 basic aspects of food safety using the methods outlined in Methods and Material chapter.

The results of this phase are presented under the following heads:

5.4.1: Baseline information of the restaurants
5.4.2: Socio economic profile of the restaurant owners
5.4.3: Background information of the food handlers
5.4.4: Raw food procurement and storage practices by restaurant owners
5.4.5: Perception of the restaurant owners on food safety training
5.4.6: Perception of the restaurant food handlers on food safety training
5.4.7: Baseline knowledge of the owners and food handlers regarding food safety
5.4.8: Impact of Food Safety Education (FSE) Intervention on knowledge of the restaurant owners
5.4.9: Impact of Food Safety Education (FSE) Intervention on practices of the restaurant owners
5.4.10: Impact of Food Safety Education (FSE) on the Knowledge and practices of the food handlers.

5.4.1: Baseline information of the restaurants

As shown in the Table 5.4.1.1, all the restaurants surveyed were licensed, and nearly 73 per cent of them were self employed (self run and self managed). Majority (90%) of the restaurants were having the sitting capacity above 20.

Figure 5.4.1.1 shows that most (63%) of the restaurants were being run for more than 20 years and very few (10%) were less than 5 years old. For most

(67%) of the restaurants, the working hours were between 8-12 hours. Moreover all the restaurants were having electricity as mode of lighting at night and its availability was above 16 hours for all of them. 37 per cent of the restaurants were having stored water as a source of water supply and 37 per cent had running water supply for 24 hours (Table 5.4.1.1).

Table 5.4.1.1: Baseline information of the small and medium restaurants (n=30) of Urban Vadodara

Sr. No.	Details	Number (n=30)
1.	Self employment venture	
	a) Yes	22 (73)
	b) No	8 (27)
2.	Is the restaurant licensed?	
	a) Yes	30 (100)
	b) No	0
3.	Sitting Capacity	
	a) 10-20 persons	3 (10)
	b) ≤ 20	27 (90)
4.	Working hours	
	a) Up to 8 hrs	8 (27)
	b) 8-12 hrs	20 (66)
	c) Above 12 hrs	2 (7)
5.	Any employees below 16 yrs age?	
	a) Yes	0
	b) No	30 (100)
6.	Mode of lighting at night	
	a) Electricity	30 (100)
	b) Gas light	0
	c) Generator	0
	d) Mix	0
7.	Availability of water supply	
	a) Running water for 24 hours	11(37)
	b) Running water + Stored water	8 (26)
	c) All stored water	11(37)
8.	Availability of electricity	
	a) Up to 8 hrs	0
	b) 9-12hrs	0
	c) 13-16 hrs	0
	d) Above 16 hrs	30 (100)

Figures in parenthesis indicate percentages.

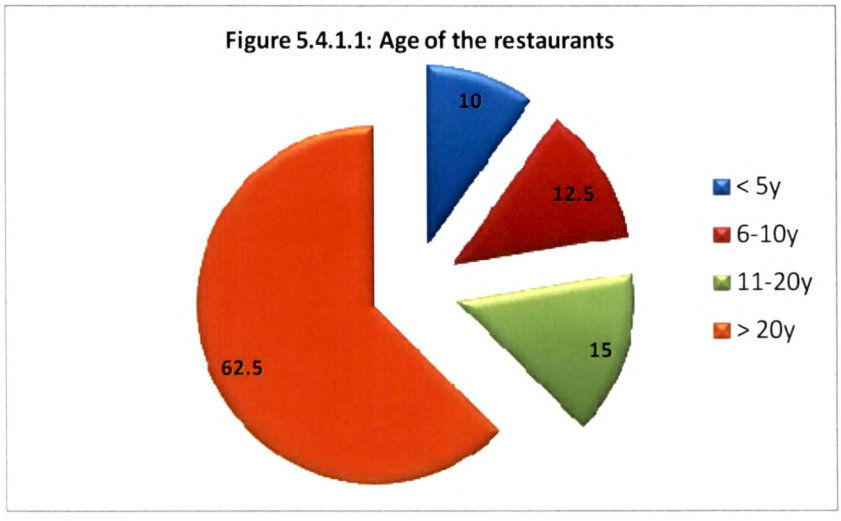
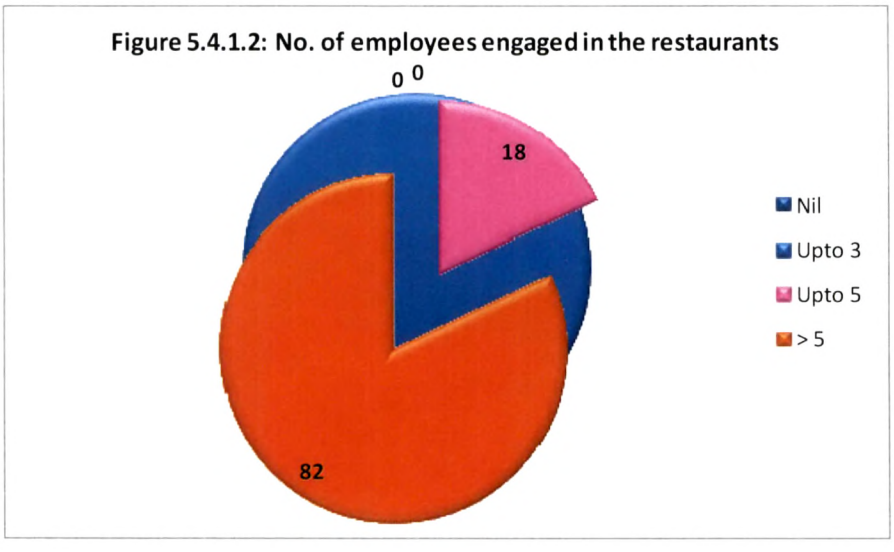
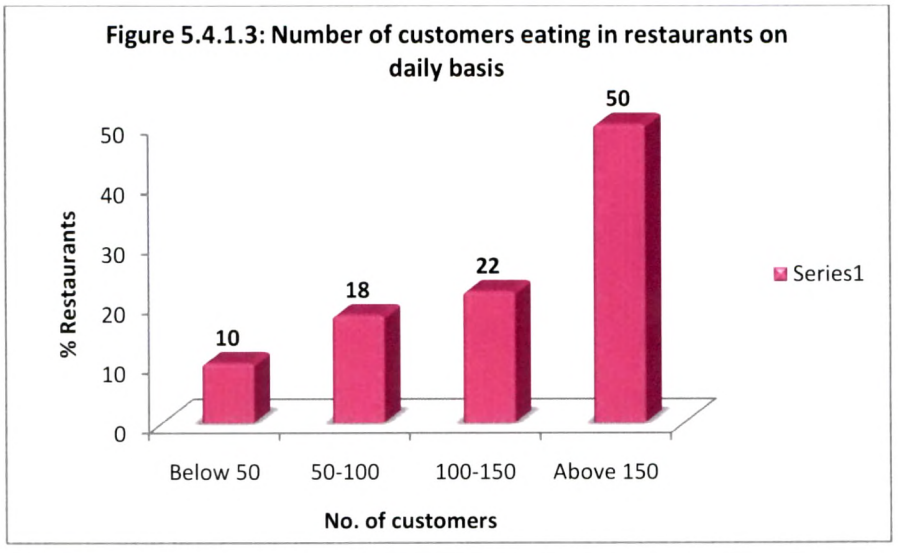


Figure 5.4.1.2 shows that most (82%) of the restaurants had more than 5 employees, while the remaining (18%) had up to 5 employees. Only one of the restaurants (as shown in table 5.4.1.1) had an employee below 16y of age.



In half of the restaurants, the daily average number of customers was above 150 and it was below 50 in only 10 % of the restaurants (Figure 5.4.1.3).



5.4.2: Socio economic profile of the restaurant owners

The survey on socio-economic profile of the owners of the restaurants (Table 5.4.2.1) showed that all the restaurants were owned by the owners themselves. Majority (77%) of the owners belonged to the age group of 25-50 yrs, whereas only few i.e. 6 per cent and 17 per cent were below 25 yrs and above 50 yrs of age respectively. All of them were males, and food service was the main occupation for most (94%) of them.

Table 5.4.2.1: Socio-economic profile of owners of the small and medium restaurants (n=30) of Urban Vadodara

Sr. No.	Details	Number (n=30)
1.	Ownership of the restaurant	
	a) Owner	30 (100)
	b) Rental	0
	c) Employed	0
2.	Age of the owner	
	a) Below 25 yrs	2 (6)
	b) 25-50 yrs	23 (77)
	c) Above 50 yrs	5 (17)
3.	Gender	
	a) Male	30 (100)
	b) Female	0
4.	Is food service the main occupation?	
	a) Yes	28 (93)
	b) No	2 (7)

Figures in parenthesis indicate percent values.

As shown in the figure 5.4.2.1, majority of the restaurant owners (57% per cent) were educated between higher secondary and graduation, followed by 30 per cent who had received education between primary and higher secondary. Besides this, nearly 10 per cent of the owners had received education above graduation level. Only 3 per cent of the owners were educated up to primary level and none of the owners were illiterate (Figure 5.4.2.1).

Figure 5.4.2.1: Educational status of the restaurant owners

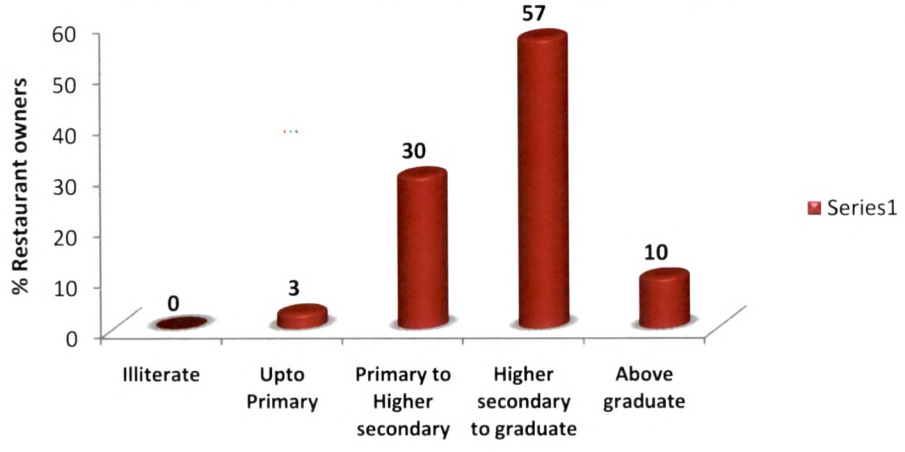
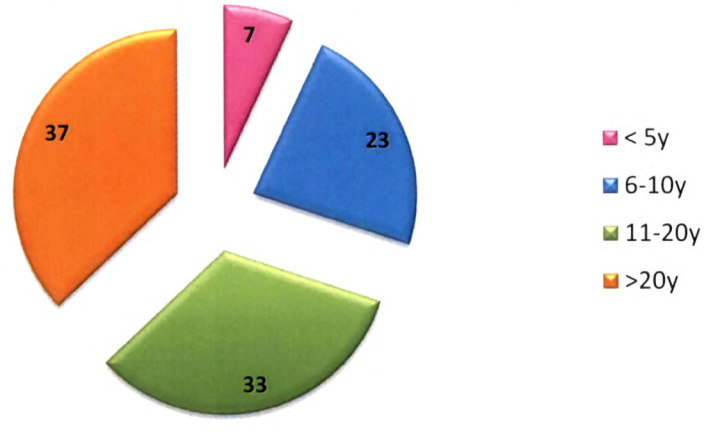
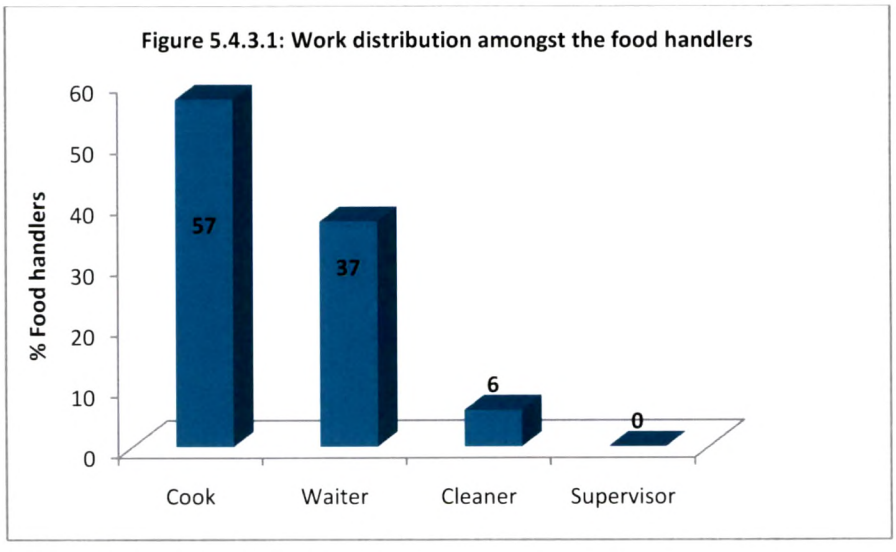


Figure 5.4.2.2: Experience of the restaurant owners



5.4.3: Background information of the food handlers

The employment status of the food handlers of the restaurants showed that 56 per cent were cooks, 27 per cent were waiters and 6 per cent were cleaners (Figure 5.4.3.1).



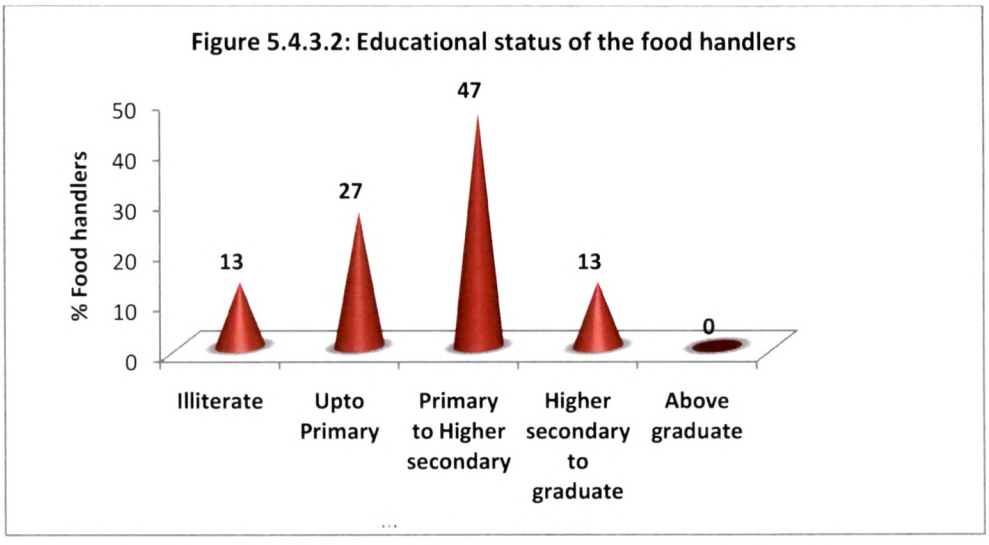
Majority (57%) of the food handlers were in the age group of 31-45y whereas 40 per cent were in the young age group (17-30y). Only 3 per cent of them were above 45y of age (Table 5.4.3.1).

Table 5.4.3.1: Age group distribution amongst the food handlers

Age group	Number (%)
Below 16 yrs	0
17-30 yrs	12 (40)
31-45 yrs	17 (57)
Above 45 yrs	1 (3)

The figures in parenthesis indicate percentages

The educational status revealed that about 13 per cent of the food handlers were illiterate, 47 per cent were either educated up to primary or higher secondary level and 27 per cent were educated up to the primary level (Figure 5.4.3.2).



5.4.4: Raw food procurement and storage practices of restaurant owners

As seen from table 5.4.4.1, majority (83%), of the owners did not purchase labeled and packaged food grains. However, most (93) of the owners reported procuring packed condiments and spices, from which 97 per cent purchased labeled condiments and spices. Almost all owners reported purchasing packed and labeled oil and butter, except for one owner.

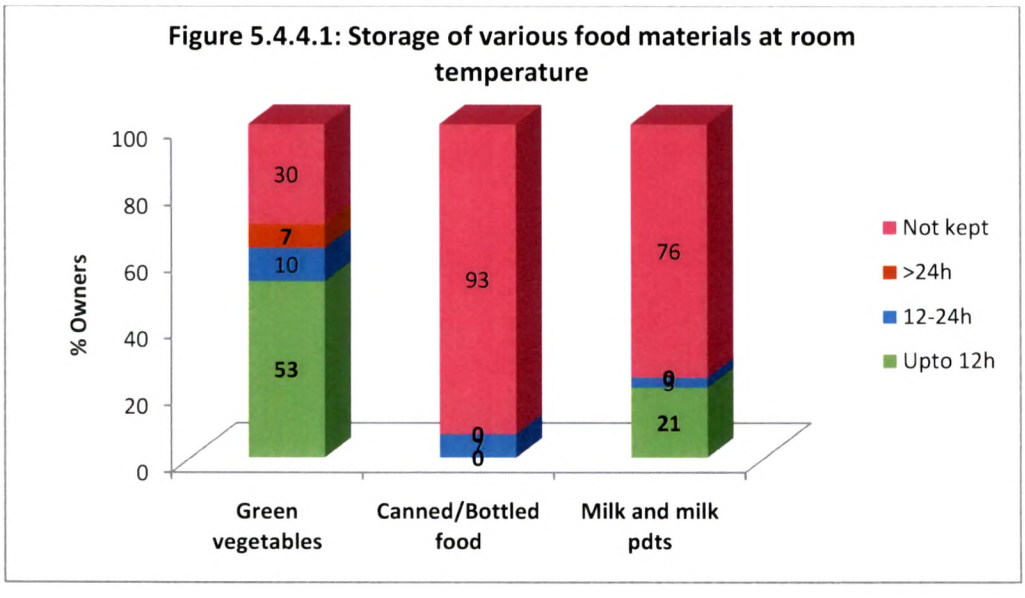
Table 5.4.4.1: Raw food procurement practices of the owners of small and medium restaurants (n=30) of Urban Vadodara

Raw materials	Purchase of labeled items by the owners (n=30)			Purchase of packed items by the owners (n=30)		
	Yes	No	NP	Yes	No	NP
Food grains	5 (17)	25 (83)	-	23 (77)	7 (23)	-
Condiments and spices	28 (93)	1 (3)	1* (3)	29 (97)	--	1* (3)
Fresh vegetables and GLVs	--	21 (70)	9 (30)	1 (3)	20 (67)	9 (30)
Oil, Butter, Ghee	29 (97)	1 (3)	--	29 (97)	1 (3)	-
Fresh fruits	--	2(7)	28 (93)	--	2(7)	28 (93)
Eggs, fish and meat	--	2(7)	-	--	2(7)	-
Semi processed vegetables, noodles etc	1 (3)	3 (10)	26 (87)	1 (3)	3 (10)	26 (87)

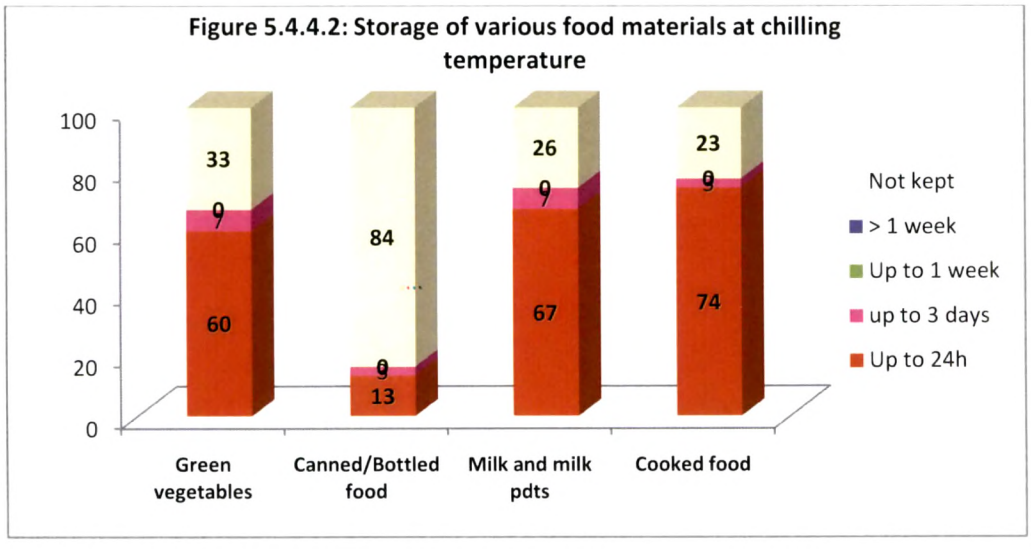
Figures in parenthesis indicate percent values
NP = Not procured ✳ = Own produce

Figure 5.4.4.1 and 5.4.4.2 shows the storage practices followed by the owners for various food materials. As seen from the figure 5.4.4.1, most (53%) of the owners reported storing green leafy vegetables at room temperature for less than 12 hours, and a very few (7%) stored it above 24 hours. Similarly, majority (70%) of the owners reported storing milk only up to 12 hours at room temperature.

Figure 5.4.4.1: Storage of various food materials at room temperature



Further, a higher percent (60%) of the owners reported storing green leafy vegetables at chilling temperatures up to 24 hours. Majority (74%) of the owners stored cooked food at chilling temperature up to 24 hours, while 23 per cent did not store cooked food (Figure 5.4.4.2).



5.4.5: Perception of the restaurant owners on food safety training

The restaurant owners were asked to opine regarding their perception on food safety training. As shown in table 5.4.5.1, majority of the owners (57%) thought that training of the staff is essential for food safety and for rendering better service to the customers. Of these, a majority (94%) were willing to pay more to the trained staff. Moreover all of them preferred ≤ 15 days training for all categories of employees (i.e. manager, cook, waiter and cleaner). A higher percent (57%) of the owners preferred selected restaurants in the city as the venue for the training.

Furthermore, when the owners where asked about their perception on food safety training, 87% of them showed their willingness to undergo training in food safety (Figure 5.4.5.1). The most preferred source of information on food safety was reported as food inspectors followed by customers, friends or relatives.

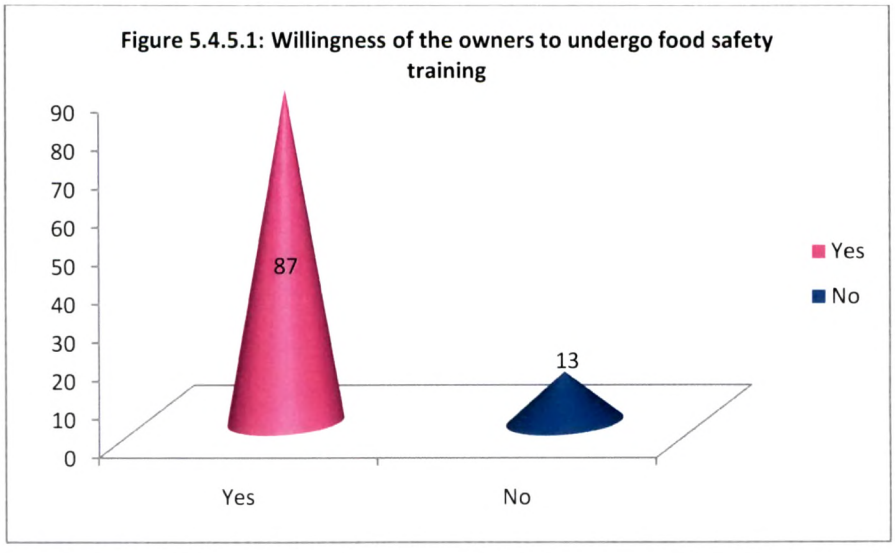


Table 5.4.5.1: Perceptions of owners (n=30) regarding Food Safety Training

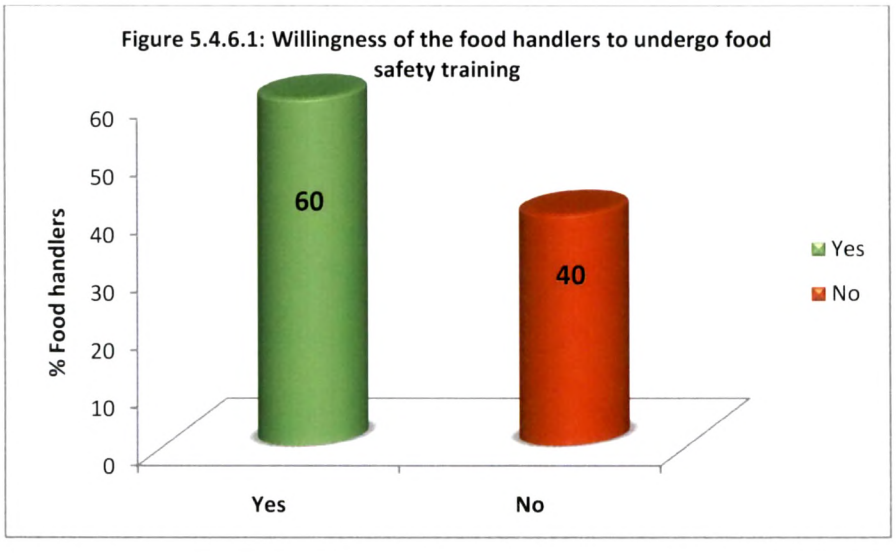
Sr. No.	Details	Number (%)
1.	Do you think training of staff is essential for food safety and better service to the customers? a) Yes b) No	(n=30) 17 (57) 13 (43)
	If yes, then	**(n=17)**
2.	Are you willing to pay more to the trained staff? a) Yes b) No	 16 (94) 1 (6)
3.	Duration of training to be preferred for: Manager a) Up to 15 days b) 15-30 days c) Above 30 days d) NA	 27 (90) 0 0 3 (10)
	Cook a) Up to 15 days b) 15-30 days c) Above 30 days	 30 (100) 0 0
	Waiter a) Up to 15 days b) 15-30 days c) Above 30 days	 30 (100) 0 0
	Cleaner a) Up to 15 days b) 15-30 days c) Above 30 days	 30 (100) 0 0

4.	Preferred location for training a) Community centre b) Schools and colleges c) Selected restaurants in the city	 0 13 (43) 17 (57)
5.	Are you willing to have information on food safety and management? a) Yes b) No	(n=30) 24 (80) 6 (20)
6.	Most Preferred source of information * a) Books and magazines b) Radio programs c) TV programs d) Newspapers e) Customers/friends/relatives f) Food inspectors/sanitary inspectors	(n=30) 4 (26) 1 (29) 7 (23) 2 (27) 7 (22) 15 (14)

* Note: The total percent of subjects may exceed 100% because of multiple preferences.

5.4.6: Perception of the restaurant food handlers on food safety training

None of the food handlers of the small and medium restaurants ever received any kind of job related training in the past. However, 60 per cent of them agreed to attend training if given a chance (Figure 5.4.6.1). The reasons given by 40 per cent of the handlers for not attending the training program were that they would not receive any incentives like leave, etc during the training program as well as they may not be able to afford the training expenses.



Fifty seven per cent of them felt that they would get better job and better wages after attending the food safety training (Figure 5.4.6.2).

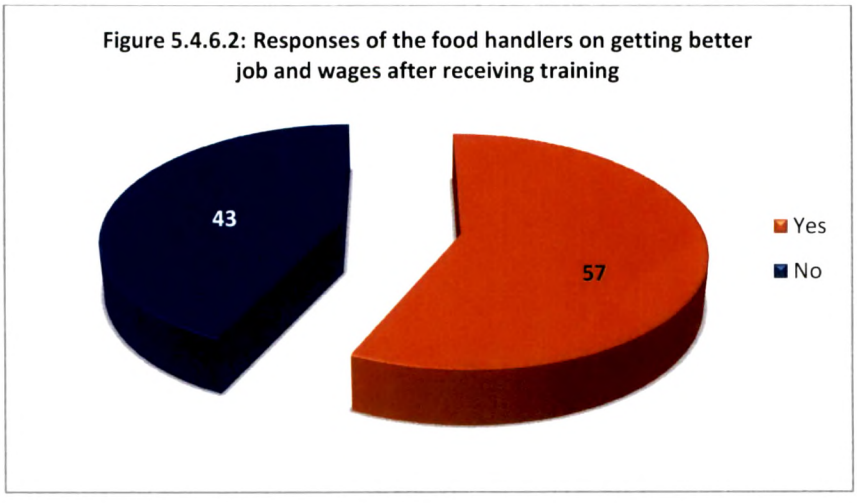


Figure 5.4.6.2: Responses of the food handlers on getting better job and wages after receiving training

A majority (89%) of the food handlers preferred only 15 days of training program (Figure 5.4.6.3). Sixty seven per cent of them responded that their owners would allow them for only 2 h. for attending the training program. All of them preferred the afternoon time slot for attending the training program.

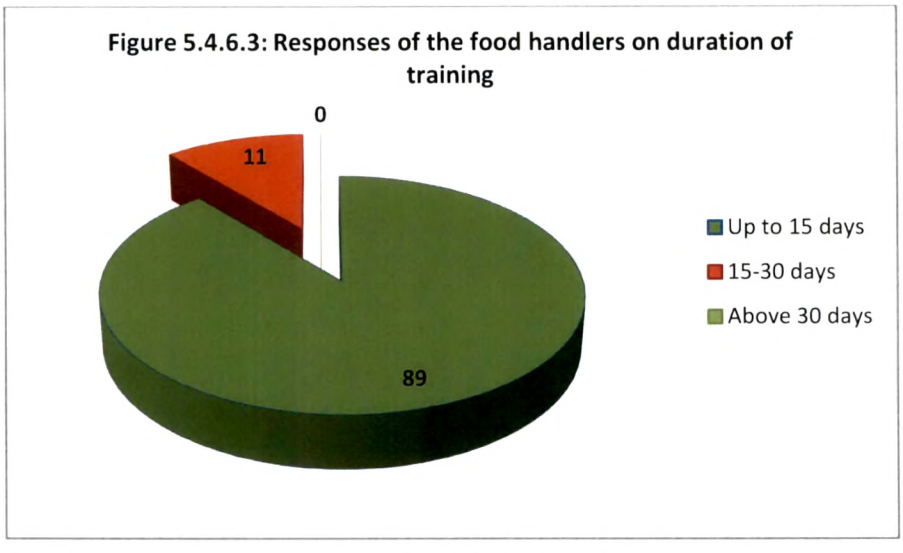


Figure 5.4.6.3: Responses of the food handlers on duration of training

5.4.7: Baseline knowledge of the owners and food handlers regarding food safety

The knowledge of the owners and food handlers was tested on the 5 basic aspects of food safety namely food hygiene, personal hygiene, nutrition and health, unit and environmental hygiene.

Table 5.4.7.1 provides the baseline information of the knowledge scores of the owners and food handlers on food safety. Results revealed that prior to the intervention the owners and food handlers scored poorly on the knowledge related to food and personal hygiene and that there existed no statistical significant difference in their scores. As far as nutrition and health is concerned, both the groups had poor knowledge, but the food handlers had scored very less as compared to the owners and this difference in the scores was statistically significant.

In the area of unit and environmental hygiene the owners and food handlers scored as less as 6.73 and 5.77 respectively. There was significant difference in the total scores of the owners and handlers with the owners having higher score as compared to their counterparts.

Table 5.4.7.1: Baseline mean knowledge scores of the owners and food handlers on food safety

Knowledge scores	Mean ± SD		Statistical 't' Test
	Owners (N = 30)	Food handlers (N = 30)	
Total FH scores Max score = 64	19.07 ± 7.40 (30)	16.17 ± 7.86 (25)	1.47^{NS}
Total PH scores Max score = 32	11.2 ± 4.33 (35)	11.53 ± 4.11 (36)	0.31^{NS}
Total NH scores Max score = 72	12.37 ± 8.86 (17)	6.17 ± 4.50 (8.56)	3.42**
Total UH and EH scores Max score = 16	6.73 ± 4.19 (42)	5.77 ± 3.61 (36)	0.96^{NS}
Total score = 184	49.37 ± 20.34 (27)	39.63 ± 16.31 (21.5)	2.04*

Figures in parenthesis indicate mean percent scores
* Significant at P <0.05 ** Significant at P < 0.01 NS – Not significant

5.4.8: Impact of Food Safety Education (FSE) Intervention on knowledge of the restaurant owners

The table below shows the impact of food safety on the knowledge scores of the owners. As discussed earlier the knowledge was divided into the 5 basic areas of food safety. Results revealed that the food safety made a positive impact on the knowledge of the owners. A highly significant improvement was seen in the knowledge scores of the owners with regards to all the aspects of food safety. The mean percent scores increased from 30 per cent to 50 percent for food hygiene, from 35 per cent to 61 per cent for personal

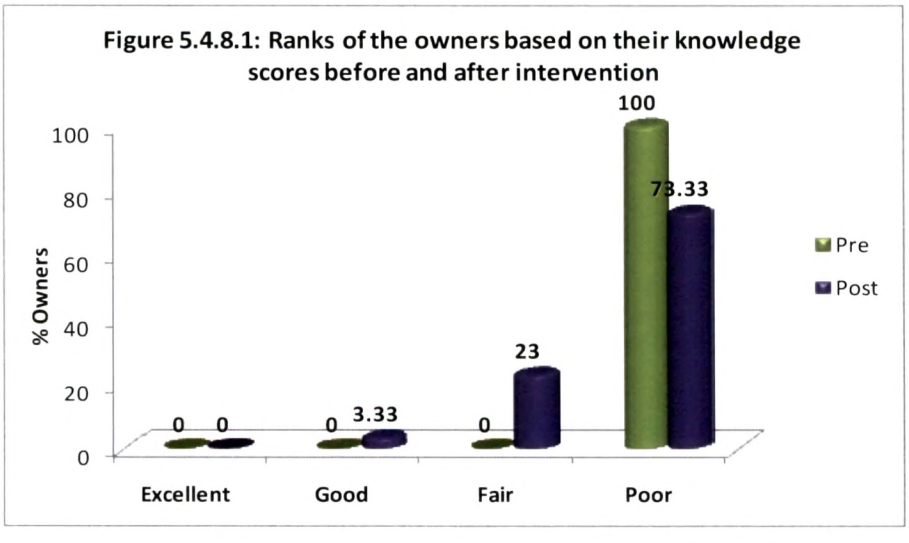
hygiene, from 17 per cent to as high as 36 per cent for nutrition and health. In the area of unit and environmental hygiene, an increase of 21 per cent was seen which was statistically significant (P<0.001).

When the owners were given ranks based on their knowledge scores, a shift was observed from the poor to fair category after the intervention. Even though the food safety education brought about an significant impact on the knowledge scores of the owners, about 73% of them still ranked in the poor category after the intervention (Figure 5.4.8.1).

Table 5.4.8.1: Impact of food safety training on the mean knowledge scores of the owners

Knowledge scores	Mean ± SD		Statistical 't' Test
	Pre	Post	
Total FH scores Max score = 64	19.07 ± 7.40 (30)	31.93 ± 7.86 (50)	7.69***
Total PH scores Max score = 32	11.2 ± 4.33 (35)	19.6 ± 4.58 (61)	8.88***
Total NH scores Max score = 72	12.37 ± 8.86 (17)	25.9 ± 11.16 (36)	6.91***
Total UH and EH scores Max score = 16	6.73 ± 4.19 (42)	10.13 ± 2.15 (63)	6.25***
Total score = 184	49.37 ± 20.34 (27)	87.57 ± 20.58 (47)	9.26 ***

Figures in parenthesis indicate mean percent scores
*** Significant at P < 0.001



5.4.9: Impact of Food Safety Education (FSE) Intervention on existing facilities of the restaurant

Table 5.4.9.1 shows the impact of food safety education on the existing facilities in the restaurants for hygienic preparation and serving of food as well as the unit and environmental hygiene of the restaurants. The table clearly reflects that the restaurants had already good practice scores (> 70% mean percent scores) prior to the food safety education with regards to purchase of good quality ingredients (82%), use of potable water for cooking and drinking (83%), use of proper fuel for cooking (97.5%), adequate height of the platform for food preparation (97.5%), availability of exhaust fans and ventilators in the kitchen (77%) and location of unit at clean place away from logged drains (94%). After the food safety education the owners made no significant changes in the facilities available in their restaurants. The intervention made about 1 – 2% non significant increase in the practices. Only 2 percent increase was seen in the availability of water purifier for drinking water. The owners did not get their medical examination done and even failed to get it done for their handlers.

Even though the owners had good practices, however they made no extra efforts to further improve the hygiene and sanitation of the restaurants.

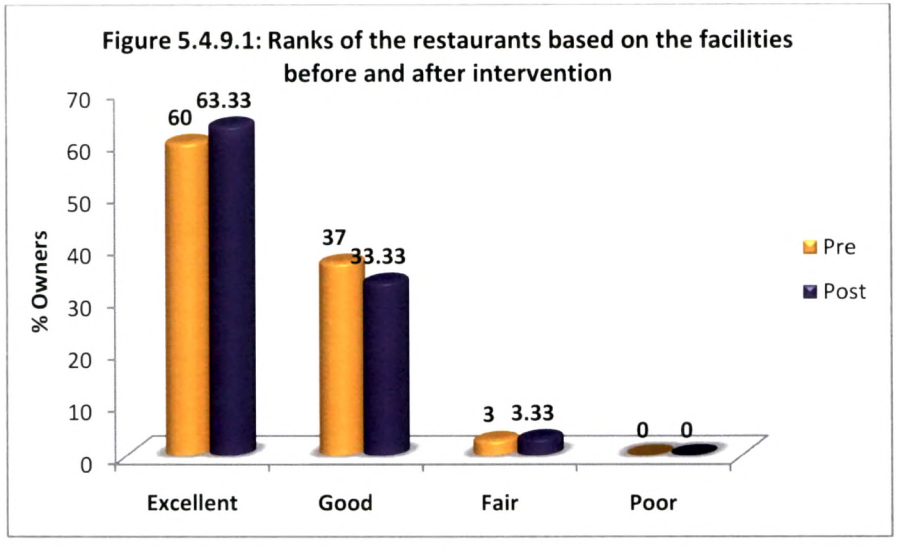
Table 5.4.9.1: Mean values of scores of existing facilities in the restaurants as affected by Food Safety Education Training

Sr. No.	Practices of the Restaurant owners	Mean ± SD Max score = 4		% Increase	Statistical 't' Test
		Pre (N =30)	Post (N =30)		
1.	Ingredients to be used were of good quality, free from adulterants and kept covered	3.27 ± 0.52 (82)	3.33 ± 0.48 (83)	1%	1.43 NS
2.	Potable water was used for washing and cooking	3.33 ± 0.55 (83)	3.33 ± 0.55 (83)	0	0 NS
3.	Owner had got medical up of himself and his food handlers	2.17 ± 0.46 (54)	2.17 ± 0.53 (54)	0	0 NS
4.	Location of the unit was away from water logged drains, toilets and street animals	3.77 ± 0.43 (94)	3.80 ± 0.41 (95)	1%	1 NS
5.	Waste disposal bins with tight lids were used for disposal of garbage and other waste material	2.70 ± 0.53 (67.5)	2.77 ± 0.57 (69)	2.5%	1.43 NS
6.	Utensils were washed, drained and stacked at portable racks above 60 cm ground level	3.07 ±0.52 (77)	3.07 ± 0.52 (77)	0	0 NS

7.	All food preparations were performed using proper fuel at a platform 60-70 cm. above ground	3.90 ± 0.31 (97.5)	3.90 ± 0.31 (97.5)	0	0 NS
8.	The kitchen had exhaust fan, ventilators and chimney	3.07 ± 0.78 (77)	3.07 ± 0.78 (77)	0	0 NS
9.	Hot water/ geysers facility is available	2.20 ± 0.61 (55)	2.13 ± 0.51 (53)	2%	1 NS
10.	Acqua Guard facility was provided for drinking water	2.37 ± 0.85 (59)	2.43 ± 0.90 (61)	2%	1 NS
	Total (Max score = 120)	89.5 ± 18.47 (74.5)	90 ± 18.71 (75)	1.5%	1.24 NS

Figures in parenthesis indicate mean percent scores.
NS- Not significant

Prior to the intervention, as high as 60% of the restaurants ranked in the excellent category and 37 per cent ranked in the good category. Food safety education brought about an increase of 3% in the excellent category (Figure 5.4.9.1).



5.4.10: Impact of Food Safety Education (FSE) on the Knowledge and practices of the food handlers

The food handlers were imparted food safety education on their knowledge on food safety. They were educated on the various aspects of food safety such as food hygiene, personal hygiene, nutrition and health, unit and environmental hygiene.

Table 5.4.10.1 shows the impact of food safety education in the knowledge scores of the food handlers. Results revealed a very little improvement in the knowledge of the handlers. However they gained knowledge in some of the aspects of food hygiene and nutrition and health. The mean percent scores increased significantly from 6.25 to17 for the various activities which may contaminate food with harmful germs/bacteria, 0.75 to 56.62 for names of the immediate symptoms of food borne illnesses and from 11.66 to 26.25 for names of the food borne illnesses. There was a little but a non significant increase in the knowledge of the food handlers with regards to washing of hands with soap, wearing of protective clothes while handling food, refraining from bad habits, etc.

There was about an increase of 18.75% in the knowledge regarding food adulterants, and this increase was found to be statistically significant.

Moreover, the mean percent scores for overall knowledge increased from 24.06 per cent to 31.42 per cent after the intervention. The food handlers also gained knowledge about the benefits of the training program.

In order to study the impact of education on the 5 basic areas of food safety, the knowledge was divided into areas namely food hygiene, personal hygiene, nutrition and health, unit hygiene and environmental hygiene (Table 5.4.10.2). Results showed that the food safety education was successful to bring about an improvement in the knowledge scores only in the area of nutrition and health and in the total knowledge scores.

The intervention also improved the knowledge of the food handlers in the area of food hygiene as well as personal hygiene; however the increase in the scores were not statistically significant.

Table 5.4.10.1: Mean values of knowledge scores as affected by Food Safety Education training to Restaurant food handlers

Sr. No.	Knowledge of the Restaurant food handlers	Mean ± SD (Max score = 8)		Statistical 't' Test
		Pre (N =30)	Post (N =30)	
1	Names of the food borne illnesses	0.933 ± 1.65 (11.66)	2.1 ± 1.80 (26.25)	2.53*
2	Names of the characteristics of spoiled food	3.73 ± 1.79	4.36 ± 2.00	1.22 NS
3	Names of the immediate symptoms of food borne illnesses	0.06 ± 0.36 (0.75)	4.53 ± 1.92 (56.62)	2.99**
4	Way of preventing bacterial contamination while handling food	2.56 ± 2.25	2.66 ± 1.86	0.16 NS
5	Food contaminations which make a food unsafe and unfit for consumption	1.4 ± 1.92	1.56 ±.67	0.344 NS
6	Biological sources of food contamination	0.13 ± 0.50	0.4 ± 0.96	1.43 NS
7	Ways to manage left over food	2 ± 0.87	2.06 ± 0.86	0.37 NS
8	Names of serving safe drinking water	2.63 ± 1.62	2.86 ± 1.27	0.62 NS
9	Names of the energy foods	1.3 ± 1.48	1.8 ±1.82	1.24 NS
10	Ways of conserving nutrients while processing and cooking food	0	0.2 ±0.61	1.79 NS
11	Names of nutrients which are essential for growth and maintenance	0.4 ± 0.96	0.13 ± 0.50	1.27 NS
12	Names of food sources of protein	0.6 ± 1.42	1.33 ± 1.88	1.54 NS
13	Names of rich sources of vitamins	0.63 ± 1.44	0.93 ± 1.36	0.87 NS
14	Names of food adulterants	2.23 ± 1.95 (27.87)	3.73 ± 2.37 (46.62)	2.3*
15	Names of common sources of minerals	0	0.03 ±0.18	1 NS
16	Ways of value addition of the food products	0	0	0 NS
17	List of harmful effects of excessive heating of oil	1 ± 1.08	1.23 ± 1.16	0.8 NS
18	Names of the protective clothes necessary for a food handlers	3.63 ± 1.69	3.66 ± 2.02	0.05 NS
19	Names of bad habits prohibited by the food handlers	4.8 ± 2.24	4.83 ± 1.62	0.06 NS
20	Name of the activities which may contaminate food with harmful germs/bacteria	0.5 ± 0.97 (6.25)	1.36 ± 1.82 (17)	2.11**
21	Activities after which hands wash with soap is a must	2.6 ± 1.56	3.46 ± 1.79	2.10 NS
22	Sanitizes which may be used by street food providers	3.7 ± 2.35	4.63 ± 2.04	1.5 NS
23	Names of safe disposable utensils for serving the street food	2.06 ± 2.06	2.5 ± 1.79	0.832 NS
24	Benefits to the workers through associations	0.06 ± 0.36	0.06 ± 0.36	0 NS
25	Benefits of the training program	0.4 ± 0.96 (5)	1.86 ± 1.38 (23.25)	4.25***
	Total	48.12 ±42.25 (24.06)	62.84 ± 47.37 (31.42)	4.52***

Figures in parenthesis indicate mean % scores; NS – Not significant

* Significant at P <0.05 ** Significant at P < 0.01 *** Significant at P < 0.001

Table 5.4.10.2: Mean values of knowledge scores as affected by Food Safety Education Training to restaurant food handlers

Knowledge scores	Mean ± SD (Food Handlers N = 30)		Statistical 't' Test
	Pre	Post	
Total FH scores Max score = 64	16.17 ± 7.86 (25)	20.57 ± 6.72 (32)	1.94^{NS}
Total PH scores Max score = 32	11.53 ± 4.11 (36)	13.33 ± 4.44 (42)	1.45^{NS}
Total NH scores Max score = 72	6.17 ± 4.50 (8.56)	9.4 ± 4.16 (13)	2.48*
Total UH and EH scores Max score = 16	5.77 ± 3.61 (36)	7.13 ± 3.50 (44)	1.33^{NS}
Total score = 184	39.63 ± 16.31 (21.5)	50.43 ± 15.22 (27)	2.16*

Figures in parenthesis indicate mean percent scores
*Significant at P <0.05 and NS – Not significant

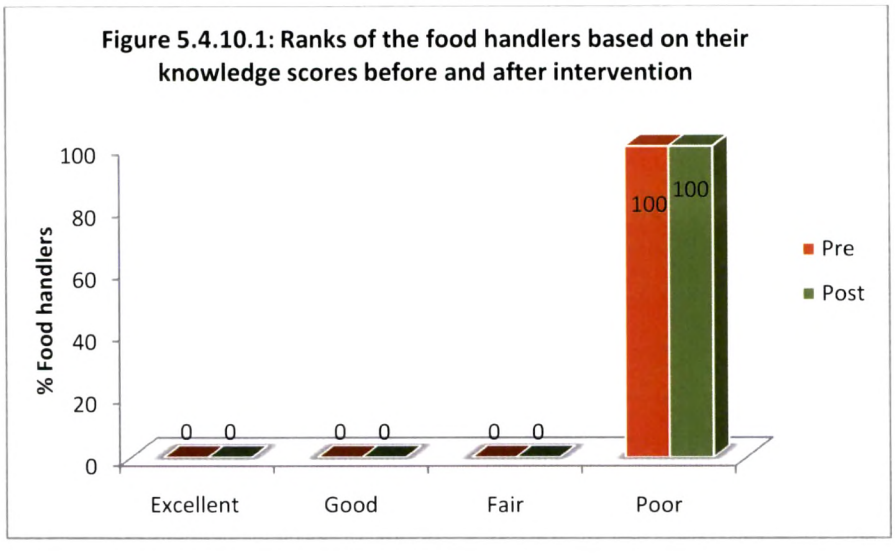


Table 5.4.10.3 shows the mean values of practice scores as affected by Food Safety Education training to restaurant food handlers. The food handlers employed in small and medium restaurants were trained on 15 different practices related to food safety and evaluated on the same. Food safety education showed a positive impact on the practices related to food hygiene. The mean percent scores increased from 62 percent to 65 percent for covering of cooked food and display items, from 88 percent to 97 per cent for use of potable water for drinking and cooking and its safe handling. The

results showed a highly significant increase form 68 percent to 72.5 per cent for the practice related to grooming of the food handlers and refraining from bad habits. A 3.5 per cent increase was noticed in the practice of using clean chopping board after the food safety education.

The education was less effective in convincing the food handlers for wearing protective clothes while working and also making them use spoons, forks, etc while serving of food.

The results also revealed that in 8 out of 15 practices the intervention made a non significant improvement or no improvement at all as the food handlers had scores above 70% prior to the intervention. These included avoiding use of leftover oil (99%), handling of ice wearing gloves (72.5%), foods without cooking handled safely (76%), use of three tub method for washing utensils (72.5%), surrounding of the unit away from dirt, flies (77.5), perishable foods kept out of danger zone (91%), regular cleaning of the dining tables and service counters (72.5%) and serving of food in properly washed and dried utensils (92%).

Table 5.4.10.3: Mean values of Practice scores as affected by Food Safety Education Training to Restaurant food handlers

Sr. No.	Practices of the Restaurant Food handlers	Mean ± SD Max score = 4		Statistical 't' Test
		Pre (N =30)	Post (N =30)	
1	Cooked food, display items and drinks were kept in clean vessels and properly covered	2.47 ± 0.57 (62)	2.6 ± 0.67 (65)	2.11*
2	Reuse of leftover oil was avoided	3.97 ± 0.18 (99)	4 ± 0 (100)	1 NS
3	Foods without cooking like chutney, fruit chat, salads were prepared after thorough washing of raw material in clean/ chlorinated water, the equipment and accessories including containers were properly sanitized and separate spoons were provided for each container	3.03 ± 0.18 (76)	3.03 ± 0.18 (76)	0 NS
4	Potable water was kept in clean container and served through tap/ long handled utensil and food handlers were properly holding the water glasses	3.53 ± 0.51 (88)	3.87 ± 0.35 (97)	3.8***
5	Ice for human consumption was kept in clean container and not handled bare hands; Ice crushing was done in clean container/white canvas bags	2.90 ± 1.35 (72.5)	2.87 ± 1.38 (72)	0.57 NS
6	The food handlers wore proper protective clothes and served the food using gloves/ fork/ tongs/ spoons	2.17 ± 0.46 (54)	2.37 ± 0.67 (59)	1.36 NS
7	Food handlers were smart, well groomed and kept themselves free from bad habits like smoking, chewing, pan, gutkha, tobacco	2.73 ± 0.45 (68)	2.90 ± 0.31 (72.5)	2.4**
8	Proper detergents were applied for washing of utensils using three tub system	2.90 ± 0.40 (72.5)	3.00 ± 0.37 (75)	1.13 NS
9	The surrounding of the food unit and inside space was free from dust, flies, mosquitoes, insect etc.	3.10 ± 0.40 (77.5)	3.13 ± 0.35 (78)	0.57 NS
10	Perishable foods were kept at proper temperature and avoiding the danger zone 40^0C - 70^0 C	3.63 ± 0.72 (91)	3.73 ± 0.64 (93)	1.36 NS
11	Mixing of ingredients for batter was done after proper washing of hands with preference on using proper equipment	1.43 ± 1.04 (36)	1.53 ± 1.14 (38)	1 NS
12	The liquid soap was used at wash basin with regular water supply and drainage at washing point.	2.63 ± 0.81 (66)	2.87 ± 1.01 (72)	1.88 NS
13	The dining tables and service counters were clean through sanitized and dry mops. The food handlers had been instructed to wash their hands properly after every mopping.	2.90 ± 0.40 (72.5)	2.87 ± 0.43 (72)	0.57 NS
14	The food was served in properly washed, drained and dried utensils; ceramic utensils with cracks were not used	3.67 ± 0.66 (92)	3.70 ±0.60 (92.5)	1 NS
15	Use of clean chopping board for vegetables, salads	2.37 ± 0.49 (59)	2.50 ± 0.51 (62.5)	2.11*
	Total	86.87 ± 19.61 (72)	90.07 ± 19.82 (75)	3.8**

Figures in parenthesis indicate mean percent scores.
* Significant at P <0.05 ** Significant at P < 0.01 *** Significant at P < 0.001
NS- Not significant

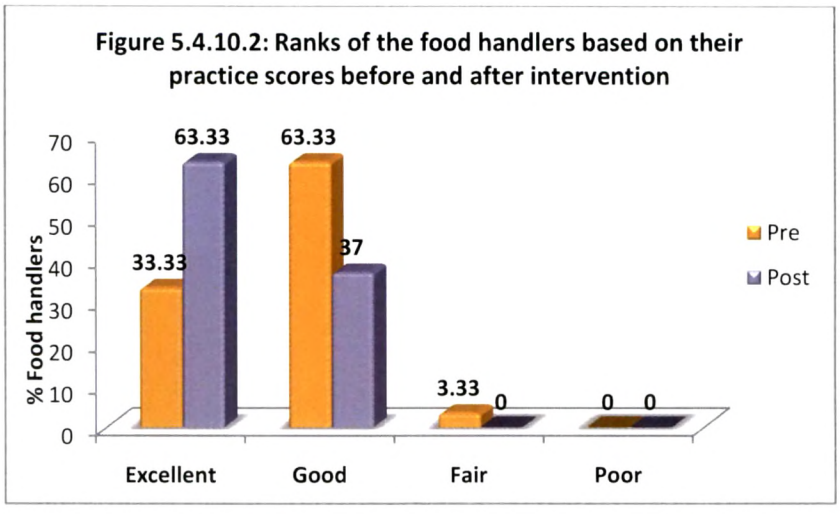


Figure 5.4.10.2 shows the ranks of the food handlers based on their practice scores before and after intervention. It is clear from the figure that after the intervention, a shift was noticed from the good to the excellent category. An additional of 30 per cent of the food handlers ranked in the excellent category.

Table 5.4.10.4: Comparison of the mean knowledge scores after the food safety training of the owners and food handlers

Knowledge scores	Mean ± SD (Post values)		Statistical 't' Test
	Owners (N = 30)	Food handlers (N = 30)	
Total FH scores Max score = 64	31.93 ± 7.86 (50)	20.57 ± 6.72 (32)	6.02***
Total PH scores Max score = 32	19.6 ± 4.58 (61)	13.33 ± 4.44 (42)	5.39***
Total NH scores Max score = 72	25.9 ± 11.16 (36)	9.4 ± 4.16 (13)	7.59***
Total UH and EH scores Max score = 16	10.13 ± 2.15 (64)	7.13 ± 3.50 (44)	4.00***
Total score = 184	87.57 ± 20.58 (47.5)	50.43 ± 15.22 (27)	7.94***

Figures in parenthesis indicate mean percent scores.
***Significant at P < 0.001 NS- Not significant

The of mean knowledge scores of owners and food handlers post intervention were compared to see whether there existed any difference in the scores of both the groups (Table 5.4.10.4). Results revealed that the owners scored better in all the aspects of food safety after the food safety education as compared to the food handlers, and this difference was found to be statistically significant.

HIGHLIGHTS OF PHASE IV

- Majority of the restaurants were licensed, had availability of running water for 24 h and had more than 5 employees working in their units.
- None of the owners under study were illiterate, and were between the age group of 25 – 50y.
- About 57 per cent of the food handlers were in the age group of 31 – 45y.
- Majority of the food handlers were literate, and were between the age group of 31 – 45y.
- Majority (83%) of the owners reported not purchasing labeled and packed food grains.
- Labeled and packed oil, butter and condiments were purchased by majority of the owners.
- Most of the owners (53%) stored green leafy vegetables at room temperature for less than 24h, stored milk up to 12 hours at room temperature and also stored cooked food under chilling for up to 24 h.
- Majority of the owners were willing to undergo the food safety training program and were ready to allow their food handlers for only 2 h for attending the training program.
- Majority of the food handlers agreed for training and felt that would get better job and wages after the training.
- The owners had significantly higher mean knowledge scores as compared to the food handlers only the area of nutrition and health. In rest of the areas, they had similar knowledge scores.
- The food safety education made a highly significant improvement in the knowledge scores of the owners in the areas of food hygiene, personal hygiene, nutrition and health and unit and environmental hygiene.
- Majority of the restaurant had more than 70 per cent mean per cent scores for practices. The food safety education made a little but a non significant increase in the practices.
- The knowledge of the food handlers after the education improved with respect to names and symptoms of food borne diseases, names of

adulterants in foods and names of activities that contaminate food with bacteria.

- Food safety education imparted to food handlers showed a positive impact on the practices related to food hygiene like covering of cooked food and display items, use of potable water for drinking and cooking and its safe handling and use of clean chopping board for cutting vegetables.
- The education was less effective in convincing the food handlers for wearing proper protective clothes while working.
- In some of the practices, the intervention made a non significant improvement or no improvement at all as the food handlers had scores above 70 per cent prior to intervention. These included avoiding use of leftover oil, handling of ice wearing gloves, foods without cooking handled safely, use of three tub method for washing utensils, surrounding of the unit away from dirt, flies, perishable foods kept out of danger zone, regular cleaning of the dining tables and service counters and serving of food in properly washed and dried utensils.

DISCUSSION

Small and medium restaurants represent that part of food service establishments that offers food at cheaper rates to millions of consumers daily. City of Vadodara has many small and medium restaurants that serve food to a variety of consumers coming from poor socio economic background. As these establishments serve food at cheaper rates they often compromise on its quality. This phase of the study was designed to educate the restaurants owners and handlers on food safety. During the preliminary phase of enrolling the respondents, it was found that none of the food handlers of small and medium restaurants of Vadodara city had ever received any training in the area of food safety.

It was noted that majority of the owners were educated between higher secondary and graduation. None of the owners were illiterate whereas about 13 per cent of the food handlers were found to be illiterate. High rate of illiteracy amongst the food handlers is known to worsen the situation. In a study by Rekha and Masali (2007) reported that 29 per cent of the food handlers of food establishments of Bijapur city were illiterate. However, contradictory to our research findings, a study conducted by Sung – Hee Park et al (2010) reported that none of the food handlers employed in restaurants were illiterate.

When the work distribution amongst the food handlers was studied, it was found that majority of the food handlers were cooks followed by waiters and cleaners. In this context, food safety education to food handlers becomes necessary as majority of them are involved in cooking and serving practices. Therefore they need to be taught about the various ways of preparing and serving safe and hygienic food.

With regards to the storage practices of the restaurant owners, it was observed that majority of them stored green leafy vegetables as well as cooked food under chilling for up to 24 h. This shows a positive practice of the owners, wherein they avoid storing leftovers for more than 24 h as well as avoid spoilage of high moisture foods.

In our study, majority of the owners felt that food safety training of the staff is essential and were also willing to pay more to their trained staff. The positive attitude of the owners resulted in 100 per cent attendance during our training sessions for the owners as well as the handlers. The positive attitude of the owners can also result in better retention of knowledge and better practices after the food safety education.

About 67 per cent of the food handlers felt that their owners would not allow them for more than 2 h for the training program. Contradictory to our findings, in a study by Fenton et al (2006), the food handlers under study reported that the management would not allow the employees or more than 1 h of work time to participate in the training.

A highly significant improvement was seen in the knowledge scores of the owners with regards to all the aspects of food safety. Food safety education (FSE) imparted to mothers of young children with diarrhea also revealed significant improvements in the knowledge scores of the mothers (Sheth and Mistry, 2000; Sheth, Parnami and Arora, 2007).

While there was a substantial improvement in the knowledge of the owners, as far as practices are concerned, only slight improvement was seen. The Food safety education intervention conducted in Vadodara under the Street food Survey project had also shown a positive impact on the knowledge of the street food vendors with little improvement on the practices (Sheth, Jaju and Sukul 2007).

However various studies have reported change in practices of the beneficiaries on receiving food safety education training. Sheth and Obrah (2004) provided Food safety education (FSE) intervention to mothers using various IEC materials and the intervention resulted in a positive impact on feeding practices of the mothers, thus leading to 52% reduction in the incidence of diarrhea in the children. Similarly Anding et al (2007) reported increase in frequency of practicing behaviors related to hand washing, maintaining safe food temperatures, preventing cross contamination, and pest management etc by the participants from food establishments, after a food safety education program.

Our study could bring about only few changes in the practices of the owners. Also during the training and evaluation of the training component imparted, resistance was reported by many owners to follow some of the practices. These practices were related to keeping soap for hand washing, provision of clean hand towels for staff etc. Some of the reasons given for this were theft of soap and hand towel and rapid turn over of staff.

Food safety education brought about a non significant improvement in the knowledge of the food handlers with regards to food hygiene, personal hygiene, unit and environmental hygiene. The poor improvement in the knowledge scores of the food handlers can be attributed to their low educational level and poor socio economic status. Walker and others (2003) demonstrated that employees in the food industry were difficult to train because they were often from poor socio-economic classes and lower education levels and were subject to rapid turnover of employees, especially when seasonal staff was employed. In addition, the result from the study on the hygiene management practice and knowledge with the hospital food handlers showed that the effect of hygiene knowledge on food safety management practices was minor (Angelillo et al 2000; Kim et al 2008; Chang et al 2003).

Contradictory to our research findings, food safety education to food handlers has shown a significant improvement in their knowledge in many other studies. In a study by Park et al (2010), showed that after training, sanitation knowledge of the employees increased to a total score of 66.6 points at post test up from 49.3 points at pre test.

Contrary to our expectations, food safety education did not bring about any significant improvement in the food safety practices of the food handlers. Similar to the findings of our study, food safety education did not bring about improvement in the practice of food handlers of Korean style restaurants Park et al (2010).

In our study, even tough no significant changes in the practices were detected, the potential effect of training was verified. If continuous and specific-goal oriented training is provided to employees, sanitation practices such as proper hand washing, proper uniform code, and prevention of cross contamination or proper sanitation techniques could be improved.

5.5 PHASE V – MICROBIAL LOAD OF FRESH CORIANDER BROUGHT FROM DIFFERENT MARKETS OF VADODARA CITY AFTER TREATMENT WITH DIFFERENT LEVELS DISINFECTANTS NAMELY NAOCL AND $KMNO_4$

Use of raw fruits and vegetables such as onions, coriander, tomatoes, etc by the vendors for the purpose of garnishing the foods or for salad is a common practice. These vegetables are either served raw or undergo very little cooking. Surveillance of vegetables has indicated that they can be contaminated with various bacterial pathogens including *Salmonella, Shigella, E coli O157H7, Listeria monocytogenes* and *Campylobacter.* Therefore in order to ensure complete removal of pathogens from fruits and vegetables it is necessary that they are treated with waters having adequate amount of disinfectant. Various sanitizers such as chlorine, $KMnO_4$, chlorine dioxide, bromine, iodine, tri sodium phosphate, quaternary ammonium compounds, organic acids, hydrogen peroxide, etc have been known to disinfect fruits and vegetables. For the present study, coriander was selected to study the effectiveness of disinfectants as it is primarily used for garnishing purpose in most of the Indian culinary dishes. In the discussion sessions during the training program, the vendors revealed that the coriander leaves brought from the market are directly added to the cooked product without washing. Such a practice may pose a high risk to the consumers for contracting food borne diseases. Also a need was felt to establish the type and level of disinfectant for washing raw foods especially coriander.

Coriander leaves were brought from 5 different markets of Vadodara city and were treated with two different disinfectants namely sodium hypochlorite (NaOCl) and potassium permanganate ($KMnO_4$) at two different levels. These were then analyzed for Total Plate Count (TPC), *Salmonella, Shigella,* Total coliforms, *S aureus* and *Listeria monocytogenes.*

The results of this phase are presented as per the following parameters:

5.5.1: Total Plate Count

5.5.2: Total Coliforms

5.5.3: Staphylococcus aureus

5.5.4: Listeria monocytogenes

5.5.5: Salmonella

5.5.6: Shigella

5.5.1: Total Plate Count (TPC): The TPC counts of fresh coriander and its treatment with various disinfectants are depicted in Table 5.5.1.1 and Table 5.5.1.2 and graphically represented in Figure 5.5.1.1. Results showed that market III had the highest TPC counts of $\log_{10}$ 9.59 CFU/gm. However no statistical significant difference was noticed amongst the markets in the initial counts of coriander leaves (Table 5.5.1.1). It is also clear from the table that there was a significant difference in the TPC counts of fresh coriander amongst all the 5 markets after treatment with 100ppm of $KMnO_4$.
Upon bulk washing, the counts showed a reduction of 0.7, however they were not statistically significant (Table 5.5.1.2). A significant decrease was noticed when the coriander was washed with 100ppm of NaOCl. The market with the highest TPC counts showed less than 1 log reduction when treated with disinfectants as compared to the other markets.

When $KMnO_4$ was used as disinfectant at level of 50 ppm, there was no significant difference seen in TPC counts of coriander leaves, however when the level was increased to 100 ppm the counts decreased from $\log_{10}$7.88 CFU/gm to $\log_{10}$6.5 CFU/gm.

TPC decreased significantly by more than 1 log when the sample was treated with 200 ppm sodium chloride and 100 ppm $KMnO_4$.

Table 5.5.1.1: Mean log counts (CFU/gm) of TPC for coriander leaves bought from various markets of Vadodara

Markets	Treatments					
	Fresh coriander (unwashed)	Bulk tap water washing	NaOCl Level (100 ppm)	NaOCl Level (200 ppm)	$KMnO_4$ Level (50 ppm)	$KMnO_4$ Level (100 ppm)
1	7.27 ± 0.05	7.39 ± 2.28	7.16 ± 2.07	7.04 ± 2.03	7.17 ± 1.95	6 ± 0^{a}
2	7.09 ± 1.18	7.15 ± 1.37	5.70 ± 0.05	5.69 ± 0.24	5.79 ± 0.13	5.85 ± 0.07^{c}
3	9.59 ± 0.58	8.94 ± 0.03	8.78 ± 0.11	8.75 ± 0.05	8.87 ± 0.04	8.80 ± 0.05^{bde}
4	7.94 ± 0.34	6.09 ± 0.12	6.04 ± 0.23	6.00 ± 0.25	5.92 ± 0.11	5.82 ± 0.18^{f}
5	7.53 ± 1.59	6.32 ± 0.13	6.18 ± 0.03	5.79 ± 0.23	5.87 ± 0.19	6.03 ± 0.03^{g}
Total	7.88 ± 1.18	7.18 ± 1.39	6.77 ± 1.37	6.65 ± 1.40	6.73 ± 1.41	6.50 ± 1.22
F test	2.30^{NS}	1.79^{NS}	3.6^{NS}	3.87^{NS}	4.54^{NS}	407.23***

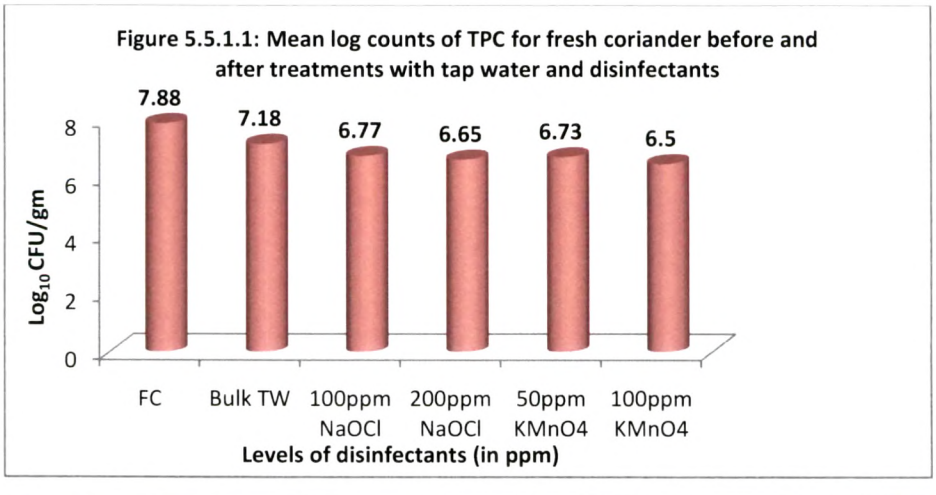
Note: *** Significant at p<0.001 and NS Not significant
The superscripts with dissimilar alphabets indicate significant difference between the values.

Table 5.5.1.2: Mean log counts (CFU/gm) of TPC on using different washing treatments

Samples	Mean ± SD	Reduction in log counts	't' test
Fresh coriander	7.88 ± 1.18	0.7	2.10^{NS}
Bulk Tap Water	7.18 ± 1.39		
Fresh coriander	7.88 ± 1.18	1.11	1.94^{NS}
NaOCl (100 ppm)	6.77 ± 1.37		
Fresh coriander	7.88 ± 1.18	1.23	2.12*
NaOCl (200 ppm)	6.65 ± 1.40		
Fresh coriander	7.88 ± 1.18	1.15	1.98^{NS}
$KMnO_4$ (50 ppm)	6.73 ± 1.41		
Fresh coriander	7.88 ± 1.18	1.38	2.57*
$KMnO_4$ (100 ppm)	6.50 ± 1.22		

Note: * Significant at p<0.5 and NS Not significant

It is clear from the graph that 200ppm NaOCl and 100ppm $KMnO_4$ were effective in significantly reducing the counts of TPC of fresh coriander.



5.5.2: Total Coliforms: The mean coliform count was $\log_{10}5.85$ CFU/gm for all the 5 markets, with market III having the lowest coliform count of 4.82 $\log_{10}$ CFU/gm and market I having the highest counts $\log_{10}6.22$ CFU/gm (Table 5.5.2.1). It also clear from the table that there existed a significant difference in between coliforms counts of market I ($\log_{10}5.62$ CFU/gm), market III ($\log_{10}4.63$ CFU/gm) and market V ($\log_{10}6.02$ CFU/gm) after treatment with 100ppm of potassium permanganate. However, no significant difference was noticed in the coliform counts between the markets after treatment with tap water, 100ppm and 200ppm NaOCl and 50ppm $KMnO_4$.

Table 5.5.2.1: Mean log counts (CFU/gm) of Coliforms for coriander leaves bought from various markets of Vadodara

Markets	Treatment					
	Fresh coriander (unwashed)	Bulk tap water washing	NaOCl Level (100 ppm)	NaOCl Level (200 ppm)	$KMnO_4$ Level (50 ppm)	$KMnO_4$ Level (100 ppm)
1	6.22 ± 0.06	5.47 ± 0.66	5.32 ± 0.45	5.45 ± 0.64	5.52 ± 0.12	5.62 ± 0.20[a]
2	5.64 ± 0.34	5.16 ± 1.08	4.93 ± 0.63	4.54 ± 0.23	5.21 ± 0.88	4.87 ± 0.56
3	4.82 ± 0.20	4.63 ± 0.21	4.48 ± 0.04	4.57 ± 0.04	4.83 ± 0.06	4.63 ± 0.21[b]
4	6.41 ± 0.01	5.68 ± 0.41	5.02 ± 0.16	5.66 ± 0.20	5.15 ± 0.21	5.49 ± 0.45
5	6.14 ± 0.25	6.18 ± 0.10	5.89 ± 0.27	5.51 ± 0.87	6.11 ± 0.10	6.02 ± 0.06[c]
Total	5.85 ± 0.62	5.42 ± 0.71	5.13 ± 0.57	5.15 ± 0.64	5.36 ± 0.55	5.33 ± 0.59
F test	18.18[NS]	1.84[NS]	3.86[NS]	2.35[NS]	2.75[NS]	5.40*

Note: * Significant at p<0.5 and NS Not significant
The superscripts with dissimilar alphabets indicate significant difference between the values.

Results (Table 5.5.2.2) revealed that both the levels of NaOCl i.e., 100 and 200 ppm showed a significant reduction in the counts for coliforms. Treatment of fresh coriander with $KMnO_4$ was not as effective as NaOCl in reducing the coliform count. Significant reductions in coliforms were not noticed when fresh coriander was dipped in tap water for 5 mins.

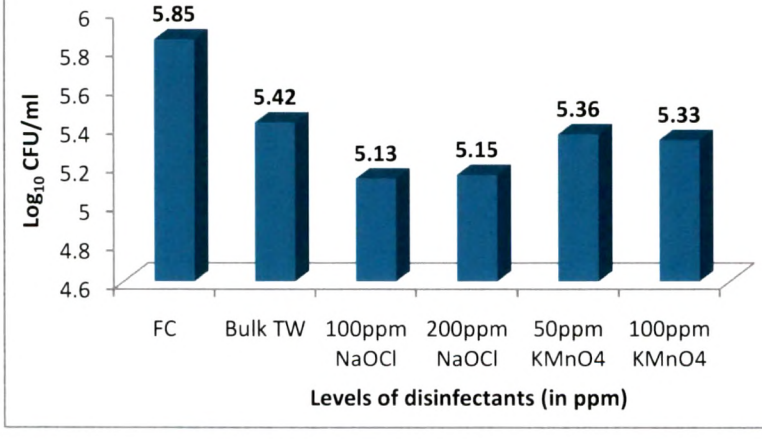
Table 5.5.2.2: Mean log counts (CFU/gm) of Coliforms on using different washing treatments

Samples	Mean ± SD	Reduction in log counts	't' test
Fresh coriander	5.85 ± 0.62	0.43	1.41^{NS}
Bulk Tap Water	5.42 ± 0.71		
Fresh coriander	5.85 ± 0.62	0.72	2.70*
NaOCl (100 ppm)	5.13 ± 0.57		
Fresh coriander	5.85 ± 0.62	0.7	2.48*
NaOCl (200 ppm)	5.15 ± 0.64		
Fresh coriander	5.85 ± 0.62	0.49	1.82^{NS}
$KMnO_4$ (50 ppm)	5.36 ± 0.55		
Fresh coriander	5.85 ± 0.62	0.52	1.90^{NS}
$KMnO_4$ (100 ppm)	5.33 ± 0.59		

Note: * Significant at p<0.5 and NS Not significant

It is clear from the graph (Figure 5.5.2.1) that 100ppm of sodium chloride was most effective in reducing the coliform counts on fresh coriander. Therefore it can be concluded that NaOCl proved to be highly effective in reducing the coliform counts. Plate 5.5.2.1 and 5.5.2.2 depicts the typical colonies of coliform on unwashed fresh coriander and fresh coriander upon treatment with 200 ppm NaOCl.

Figure 5.5.2.1: Mean log counts of Coliforms for fresh coriander before and after treatments with tap water and disinfectants



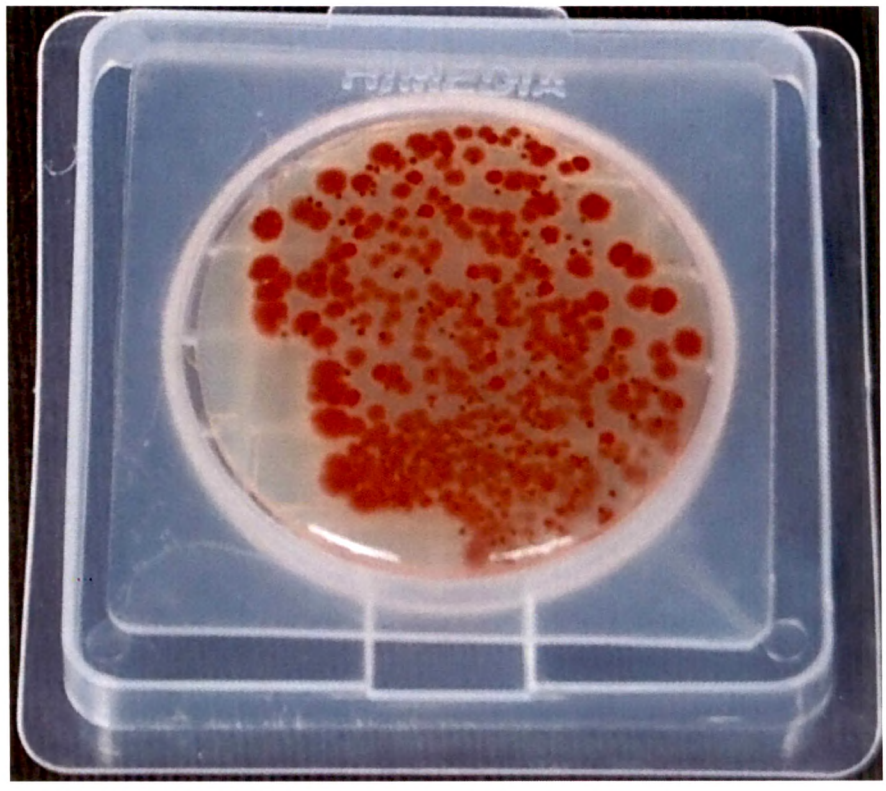


Plate 5.5.2.1: Typical red colonies of coliforms in unwashed fresh coriander sample

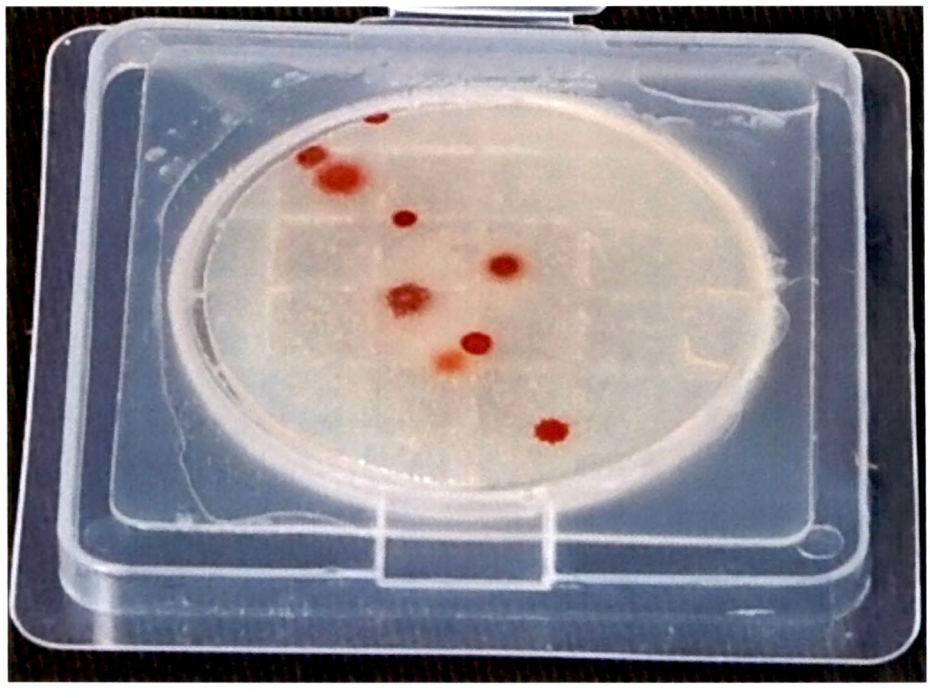


Plate 5.5.2.2: Typical red colonies of coliforms in fresh coriander sample treated with 200 ppm NaOCl

5.5.3: Staphylococcus aureus: The mean *staphylococcus aureus* was $\log_{10}$4.73 CFU/gm with market V having the highest *staphylococcus aureus* counts of $\log_{10}$5.23 CFU/gm (Table 5.5.3.1). However no statistical difference was found in the counts amongst the markets. When washed with 100ppm NaOCl market II ($\log_{10}$3.63 CFU/gm) showed maximum reduction as compared to market IV ($\log_{10}$3.76 CFU/gm) and market V ($\log_{10}$4.82 CFU/gm)and this reduction in the counts was found to be statistically significant.

Table 5.5.3.1: Mean log counts (CFU/gm) of *Staphylococcus aureus* for coriander leaves bought from various markets of Vadodara

Markets	Treatment					
	Fresh coriander (unwashed)	Bulk tap water washing	NaOCl Level (100 ppm)	NaOCl Level (200 ppm)	$KMnO_4$ Level (50 ppm)	$KMnO_4$ Level (100 ppm)
1	4.78 ± 0.18	4.68 ± 0.13	4.64 ±0.45	4.53 ± 0.35	4.60 ± 0.26	4.72 ± 0.60
2	4.37 ± 0.33	4.22 ± 0.25	3.63 ± 0.26^{a}	3.70 ± 0.16	4.06 ± 0.48	3.81 ±0.55
3	4.61 ± 0.33	4.35 ± 0.07	4.29 ± 0.16	3.80 ± 0.71	3.96 ± 0.61	3.80 ± 0.54
4	4.68 ± 0.71	4.22 ± 0.88	3.76 ± 0.20^{c}	4.45 ± 0.63	4.22 ± 0.88	3.98 ± 0.29
5	5.23 ± 0.07	4.88 ± 0.43	4.82 ± 0.20^{b}	4.36 ± 0.57	4.69 ± 0.22	4.36 ± 0.21
Total	4.73 ± 0.42	4.47 ± 0.44	4.23 ± 0.53	4.17 ± 0.53	4.31 ± 0.51	4.13 ± 0.51
F test	1.33^{NS}	0.85^{NS}	7.34*	1.09^{NS}	0.69^{NS}	1.50^{NS}

Note: * Significant at p<0.5 and NS Not significant
The superscripts with dissimilar alphabets indicate significant difference between the values.

The counts for *staphylococcus aureus* on fresh coriander decreased from 4.73 $\log_{10}$ CFU/gm to 4.23 $\log_{10}$ CFU/gm when washed with 100 ppm NaOCl and the count further reduced to 4.17 $\log_{10}$ CFU/gm when treated with 200 ppm (Table 5.5.3.2). When washed with tap water containing 100 ppm $KMnO_4$ the count reduced from 4.73 $\log_{10}$ CFU/gm to 4.13 $\log_{10}$ CFU/gm. The reduction in counts was found to be statistically significant. However when fresh coriander was washed with tap water the counts did not show a significant reduction. Plate 5.5.3.1 and 5.5.3.2 depicts the typical colonies of Staphylococcus aureus in unwashed fresh coriander and coriander treated with 100 ppm NaOCl.

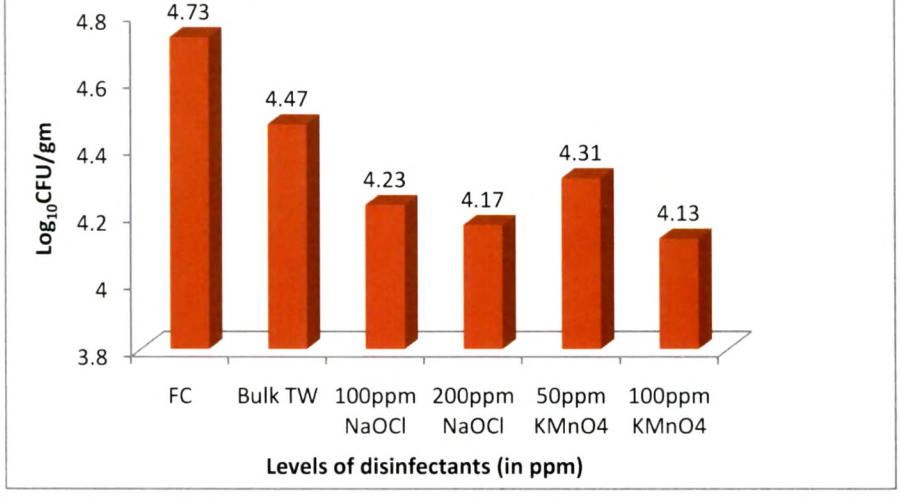
Table 5.5.3.2: Mean log counts (CFU/gm) of *Staphylococcus aureus* on using different washing treatments

Samples	Mean ± SD	Reduction in log counts	't' test
Fresh coriander	4.73 ± 0.42	0.26	1.36^{NS}
Bulk Tap Water	4.47 ± 0.44		
Fresh coriander	4.73 ± 0.42	0.5	2.63*
NaOCl (100 ppm)	4.23 ± 0.53		
Fresh coriander	4.73 ± 0.42	0.56	2.65*
NaOCl (200 ppm)	4.17 ± 0.53		
Fresh coriander	4.73 ± 0.42	0.42	2.06^{NS}
$KMnO_4$ (50 ppm)	4.31 ± 0.51		
Fresh coriander	4.73 ± 0.42	0.6	2.88**
$KMnO_4$ (100 ppm)	4.13 ± 0.51		

Note: * Significant at p<0.5 ** Significant at p<0.01 and NS - Not significant

It is clear from the figure 5.5.3.1 that maximum reduction in counts was obtained after treatment with 100ppm $KMnO_4$. Thus, it can be concluded that 100ppm $KMnO_4$ was most effective in reducing the counts of *Staphylococcus aureus* on fresh coriander.

Figure 5.5.3.1: Mean log counts of SA for fresh coriander before and after treatments with tap water and disinfectants



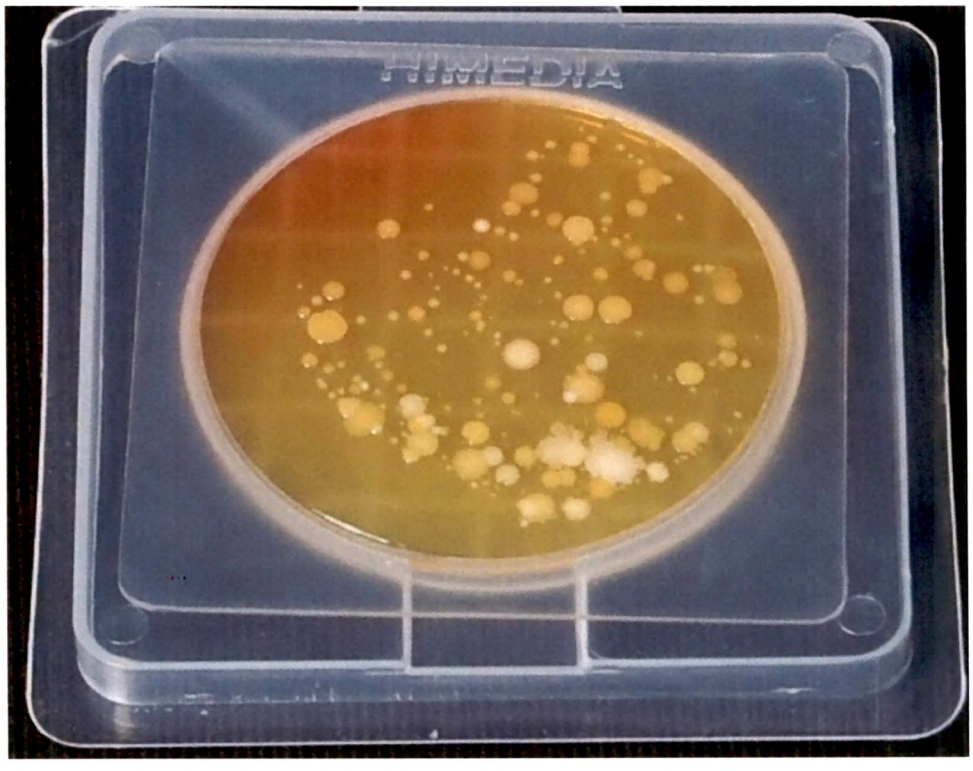


Plate 5.5.3.1: Typical red colonies of *Staphylococcus aureus* in unwashed fresh coriander sample

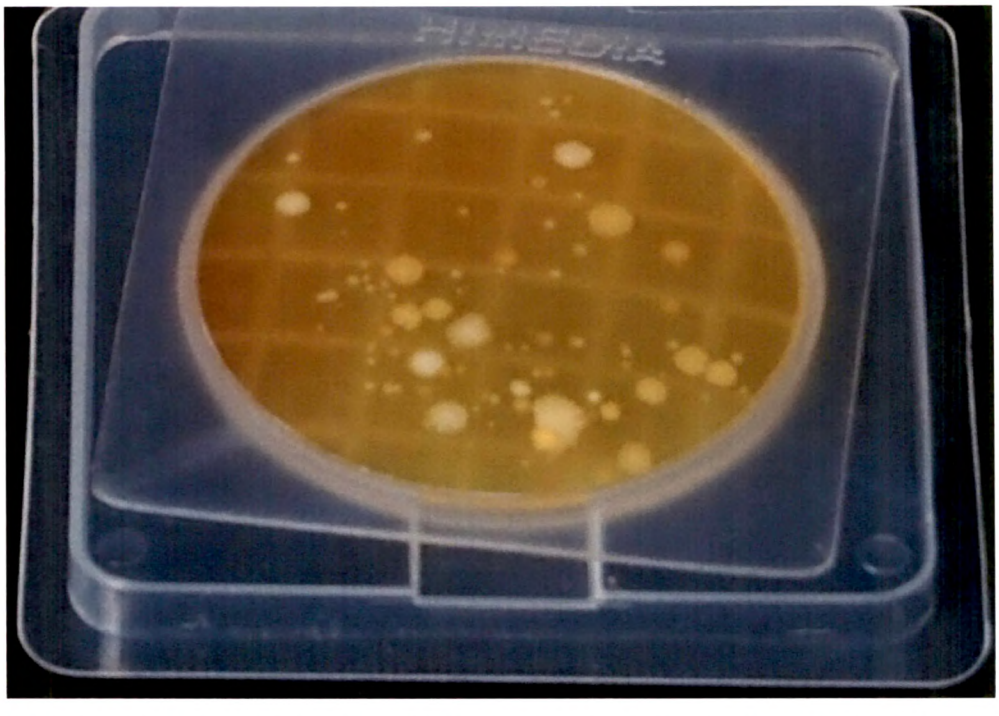


Plate 5.5.3.2: Typical red colonies of *Staphylococcus aureus* in fresh coriander sample treated with 100 ppm NaOCl

5.5.4: Listeria monocytogenes: Table 5.5.4.1 shows the mean counts for *Listeria monocytogenes.* It was found that market I had highest counts of $\log_{10}$5.69 CFU/gm as compared to other markets. However this difference in the mean counts for fresh coriander was not statistically significant. The table also shows that no significant difference was noticed for the mean *Listeria monocytogenes* for bulk tap water washing and washing with 200 ppm sodium chloride. The reduction in the mean counts of *Listeria monocytogenes* after treatment with 100 ppm NaOCl showed that market III (4.27 $\log_{10}$ CFU/gm) had lower counts as compared to market I (5.28 $\log_{10}$ CFU/gm) and this difference was found to be statically significant. When given wash treatments with 50 ppm $KMnO_4$, results showed that market I had higher mean counts of $\log_{10}$5.10 CFU/gm as compared to the other markets and this difference was found to be statistically significant.

Table 5.5.4.1: Mean log counts (CFU/gm) of *Listeria monocytogenes* for coriander leaves bought from various markets of Vadodara

Markets	Treatments					
	Fresh coriander (unwashed)	Bulk tap water washing	NaOCl Level (100 ppm)	NaOCl Level (200 ppm)	$KMnO_4$ Level (50 ppm)	$KMnO_4$ Level (100 ppm)
1	5.69 ± 0.30	5.47 ± 0.67	5.02 ± 0.03^{ac}	5.28 ± 0.40	5.10 ± 0.28	5.22 ± 0.11
2	5.05 ± 0.30	4.69 ± 0.20	4.11 ± 0.56	3.92 ± 0.32	4.39 ± 0.12	4.36 ± 0.26
3	4.63 ± 0.03	4.42 ± 0.17	4.28 ± 0.23^{be}	4.27 ± 0.38	4.36 ± 0.26	4.03 ± 0.39
4	5.58 ± 0.44	4.84 ± 0.07	4.17 ± 0.24^{dg}	4.84 ± 0.47	4.90 ± 0.13	4.56 ± 0.03
5	5.45 ± 0.07	5.03 ± 0.18	5.28 ± 0.08^{fh}	4.78 ± 0.25	4.63 ± 0.02	5.63 ± 0.10
Total	5.28 ± 0.46	4.89 ± 0.45	4.57 ± 0.55	4.62 ± 0.57	4.68 ± 0.34	4.76 ± 0.64
F test	4.99^{NS}	2.82^{NS}	6.77*	4.03^{NS}	5.77*	17.93**

Note: * Significant at p<0.5 ** Significant at p<0.01 and NS - Not significant
The superscripts with dissimilar alphabets indicate significant difference between the values.

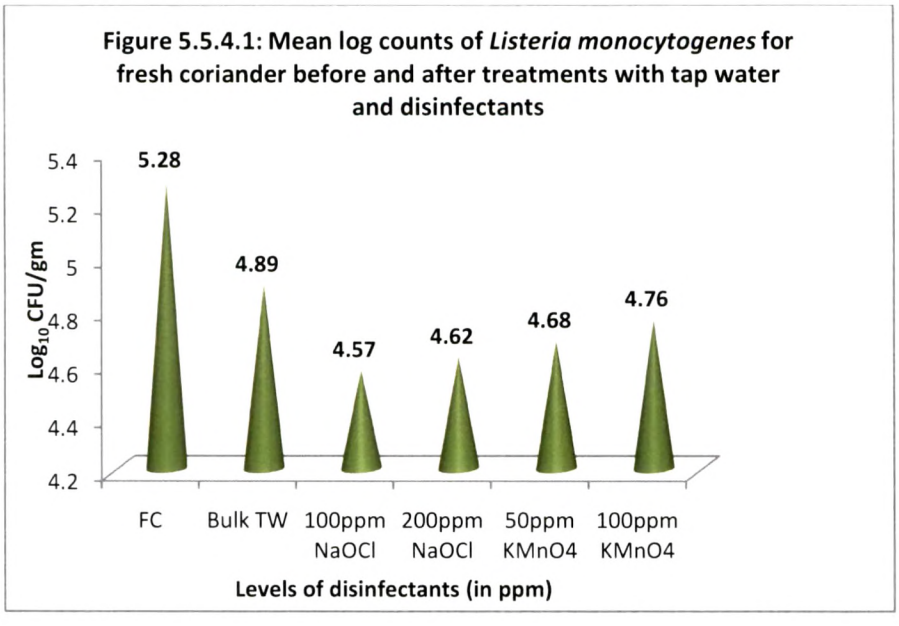
The counts for *Listeria monocytogenes* on fresh coriander decreased from 5.28 $\log_{10}$ CFU/gm to 4.57 $\log_{10}$ CFU/gm when washed with 100 ppm NaOCl and the count further reduced to 4.62 $\log_{10}$ CFU/gm when treated with 200 ppm (Table 5.5.4.2). When washed with tap water containing 100 ppm $KMnO_4$ the count reduced from 5.28 $\log_{10}$ CFU/gm to 4.76 $\log_{10}$ CFU/gm. The reduction in counts was found to be statistically significant. However when fresh coriander was washed with tap water the counts did not show a significant reduction. Plate 5.5.4.1 and 5.5.4.2 depicts the typical colonies of *Listeria monocytogenes* in unwashed fresh coriander and coriander treated with 200 ppm NaOCl.

Table 5.5.4.2: Mean log counts (CFU/gm) of *Listeria monocytogenes* on using different washing treatments

Samples	Mean ± SD	Reduction in log counts	't' test
Fresh coriander	5.28 ± 0.46	0.39	1.94^{NS}
Bulk Tap Water	4.89 ± 0.45		
Fresh coriander	5.28 ± 0.46	0.71	3.12**
NaOCl (100 ppm)	4.57 ± 0.55		
Fresh coriander	5.28 ± 0.46	0.66	2.86*
NaOCl (200 ppm)	4.62 ± 0.57		
Fresh coriander	5.28 ± 0.46	0.6	3.27**
$KMnO_4$ (50 ppm)	4.68 ± 0.34		
Fresh coriander	5.28 ± 0.46	0.52	2.10*
$KMnO_4$ (100 ppm)	4.76 ± 0.64		

Note: * Significant at p<0.5 ** Significant at p<0.01 and NS - Not significant

Figure 5.5.4.1 shows that 100ppm of NaOCl was most effective in reducing the counts of *Listeria monocytogenes* on fresh coriander followed by 200ppm of NaOCl.



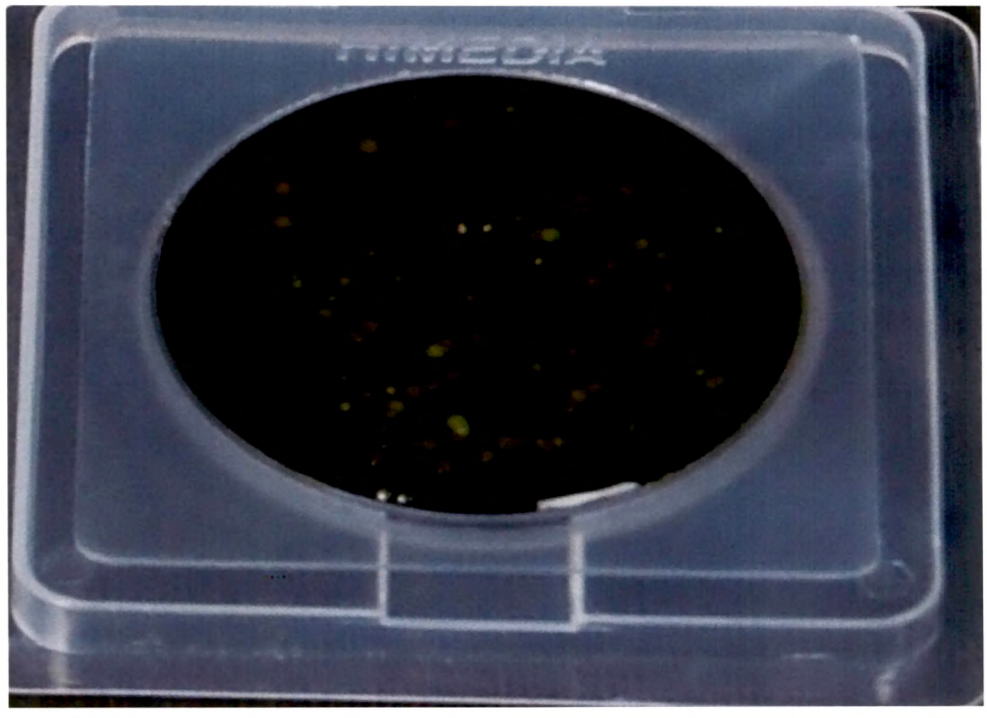


Plate 5.5.4.1: Typical black buttery colonies of Listeria monocytogenes in unwashed fresh coriander sample

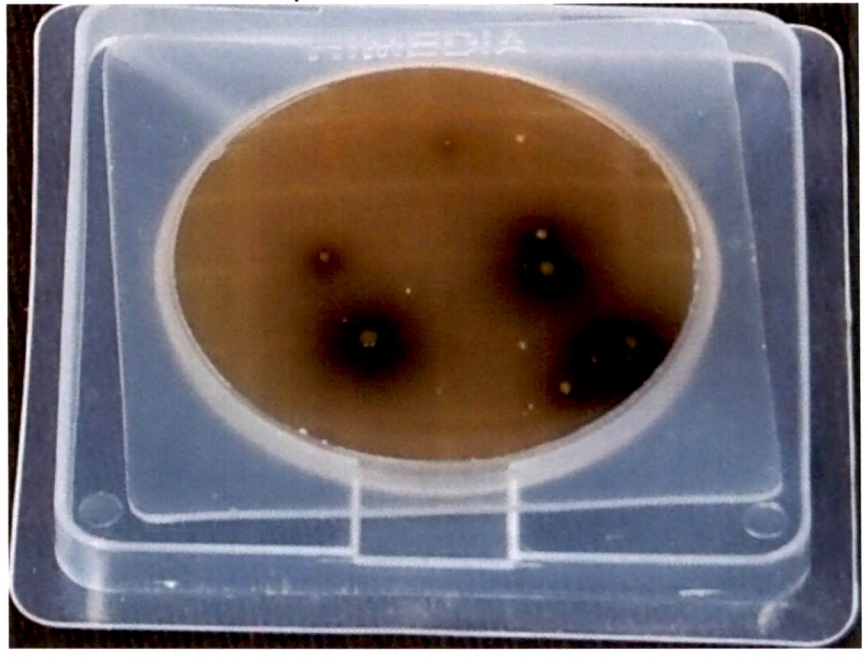


Plate 5.5.4.2: Typical black buttery colonies of Listeria monocytogenes in Fresh coriander sample treated with 200 ppm of NaOCl

5.5.5: Salmonella: The sample brought from market III was found to be highly contaminated with *Salmonella* having counts of 5.29 log_{10} CFU/gm. The mean *Salmonella* counts for coriander leaves for all markets were 4.65 log_{10} CFU/gm. Treatment with disinfectants brought about reduction in the counts of *Salmonella* for coriander samples brought from all the markets, but the counts were not significantly different from each other.

Table 5.5.5.1: Mean log counts (CFU/ml) of *Salmonella* for coriander leaves bought from various markets of Vadodara

Markets	Treatments					
	Fresh coriander (unwashed)	Bulk tap water washing	NaOCl Level (100 ppm)	NaOCl Level (200 ppm)	$KMnO_4$ Level (50 ppm)	$KMnO_4$ Level (100 ppm)
1	4.70 ± 1.41	4.54 ± 1.29	3.45 ± 0.21	3.34 ± 0.23	3.44 ± 0.06	3.55 ± 0.21^{a}
2	4.18 ± 0.38	3.93 ± 0.56	3.44 ±0.23	3.35 ± 0.49	3.51 ±0.19	3.18 ± 0.48^{c}
3	5.29 ± 2.13	4.85 ± 2.19	3.81 ± 0.52	3.65 ± 0.49	3.81 ±0.09	3.70 ± 0^{e}
4	4.89 ± 0.41	4.11 ± 1.03	4.09 ± 0.55	4.3 ± 0.85	4.07 ± 0.76	4.72 ± 0.08^{bdf}
5	4.20 ± 0.63	3.63 ± 0.01	3.6 ± 0.23	4.07 ± 1.65	4.17 ± 1.29	3.46 ± 0.17^{g}
Total	4.65 ± 1.00	4.21 ± 1.04	3.68 ± 0.38	3.74 ± 0.78	3.80 ± 0.59	3.72 ± 0.59
F test	0.31^{NS}	0.30^{NS}	1.04^{NS}	0.47^{NS}	0.46^{NS}	11.30*

Note: * Significant at p<0.5 and NS - Not significant
The superscripts with dissimilar alphabets indicate significant difference between the values.

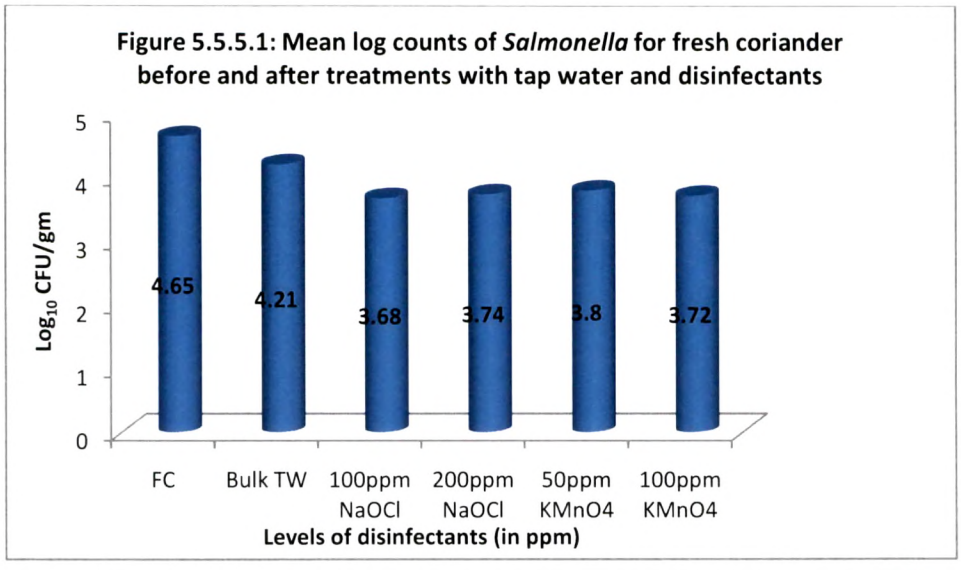
Both the levels of both the sanitizers were effective in reducing the counts for *Salmonella*. It was also seen that tap water was not effective in reducing the microbial load of coriander leaves (Table 5.5.5.2).

Table 5.5.5.2: Mean log counts (CFU/gm) of *Salmonella* on using different washing treatments

Samples	Mean ± SD	Reduction in log counts	't' test
Fresh coriander	4.65 ± 1.00	0.44	0.96^{NS}
Bulk Tap Water	4.21 ± 1.04		
Fresh coriander	4.65 ± 1.00	0.97	2.86*
NaOCl (100 ppm)	3.68 ± 0.38		
Fresh coriander	4.65 ± 1.00	0.91	2.26*
NaOCl (200 ppm)	3.74 ± 0.78		
Fresh coriander	4.65 ± 1.00	0.85	2.31*
$KMnO_4$ (50 ppm)	3.80 ± 0.59		
Fresh coriander	4.65 ± 1.00	0.93	2.52*
$KMnO_4$ (100 ppm)	3.72 ± 0.59		

Note: * Significant at p<0.5 and NS - Not significant

The graph (Figure 5.5.5.1) shows that 200ppm NaOCl and 100ppm $KMnO_4$ were effective in reducing the load of salmonella from fresh coriander.



5.5.6: Shigella: Table 5.5.6.1 shows the mean values of Shigella on coriander leaves brought from various markets. Results revealed that market IV showed the highest counts of Shigella as compared to the rest of the markets, but the difference in the counts in between the five markets were not statistically significant. The mean *Shigella* count for coriander samples was 5.50 $\log_{10}$ CFU/gm.

Table 5.5.6.1: Mean log counts (CFU/ml) of *Shigella* for coriander leaves bought from various markets of Vadodara

Markets	Samples					
	Fresh coriander	Bulk tap water washing	NaOCl Level (100 ppm)	NaOCl Level (200 ppm)	$KMnO_4$ Level (50 ppm)	$KMnO_4$ Level (100 ppm)
1	5.51 ± 0.47	4.31 ±1.18	5.20 ± 0.35	5.22 ± 0.46	5.15 ± 0.64	4.20±0.82
2	5.31 ± 0.50	5.08 ± 0.67	4.33 ±0.21	4.81 ±0.52	4.63 ±0.21	4.45 ±0.64
3	5.47 ± 1.47	6.57 ± 0.07	5.54 ± 1.49	5.34 ±1.47	4.30 ± 0.14	4.02 ± 0.03
4	5.66 ± 0.72	5.24 ± 0.56	4.14 ±0.51	4.81 ±0.05	4.18 ±0.90	4.34 ±0.06
5	5.27 ± 0.16	5.37 ± 0.32	5.21 ±0.13	5.36 ±0.25	5.00 ± 0.61	4.97 ± 0.58
Total	5.50 ± 0.63	5.31 ± 0.92	4.87 ± 0.78	5.11 ± 0.61	4.65 ± 0.59	4.40 ± 0.52
F test	0.14^{NS}	2.88^{NS}	1.30^{NS}	0.28^{NS}	1.08^{NS}	0.90^{NS}

Note: NS - Not significant

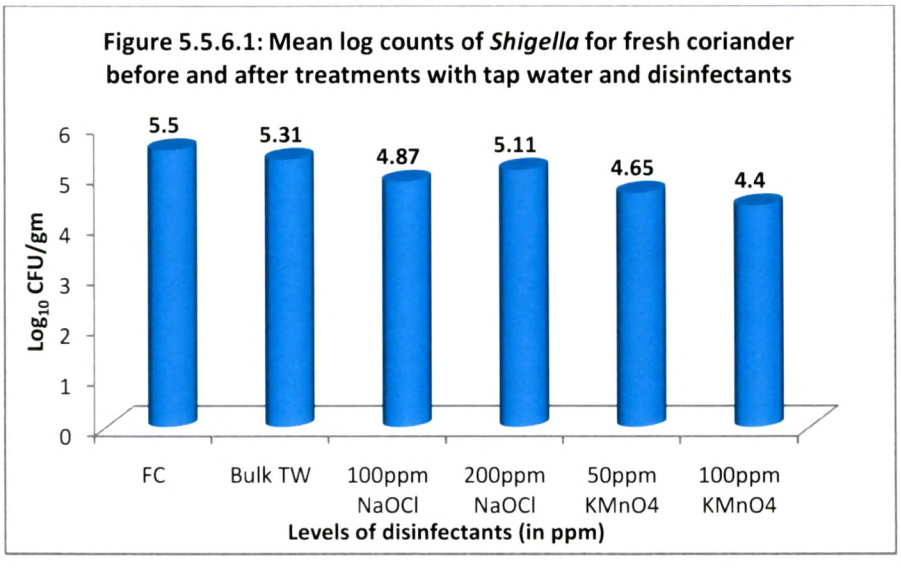
However NaOCl was not found to be effective in reducing the counts of *Shigella,* whereas when treated with 50 ppm $KMnO_4$ the counts decreased from 5.50 $\log_{10}$ CFU/gm to 4.65 $\log_{10}$ CFU/gm. The counts further reduced to 4.40 $\log_{10}$ CFU/gm when fresh coriander was treated with 100ppm $KMnO_4$ (Table 5.5.6.2).

Table 5.5.6.2: Mean log counts (CFU/gm) of *Shigella* on using different washing treatments

Samples	Mean ± SD	Reduction in log counts	't' test
Fresh coriander	5.50 ± 0.63	0.19	0.52^{NS}
Bulk Tap Water	5.31 ± 0.92		
Fresh coriander	5.50 ± 0.63	0.63	1.99^{NS}
NaOCl (100 ppm)	4.87 ± 0.78		
Fresh coriander	5.50 ± 0.63	0.39	1.41^{NS}
NaOCl (200 ppm)	5.11 ± 0.61		
Fresh coriander	5.50 ± 0.63	0.85	3.11**
$KMnO_4$ (50 ppm)	4.65 ± 0.59		
Fresh coriander	5.50 ± 0.63	1.10	4.27***
$KMnO_4$ (100 ppm)	4.40 ± 0.52		

Note: ** Significant at p<0.01 and *** Significant at p<0.001 NS - Not significant

It is clear from the graph (figure 5.5.6.1) that 100ppm $KMnO_4$ was most effective in reducing the counts of Shigella on fresh coriander. It was also noticed that even 50ppm $KMnO_4$ and 100ppm NaOCl was also effective to a certain extent in reducing the microbial load.



When the levels of sanitizers were compared for their effectiveness, it was seen that there existed no statistical significant difference between the two levels; even though there existed differences in the mean counts in between the two levels of sanitizers but they were not statistically significant (Table 5.5.6.3).

Thus to conclude, bulk washing (10 g of sample dipped in 1 litre tap water for 5 mins) of unwashed fresh coriander with tap water did not significantly reduce the counts of coliforms, *staphylococcus aureus, Listeria monocytogenes, Salmonella* and *Shigella.*

Therefore tap water alone will not be sufficient to reduce the microbial load of fresh coriander. Either sodium chloride (NaOCl) or potassium permanganate ($KMnO_4$) should be used to reduce the microbial load, but none of the disinfectants were successful to completely remove the pathogens from fresh coriander.

Table 5.5.6.3: Mean log counts for TPC, Coliforms, *Staphylococcus aureus, Listeria monocytogenes, Shigella and Salmonella as affected by various levels of sanitizers*

TOTAL PLATE COUNT (log_{10})		
Levels of sanitizers	**Mean ± SD**	**T test**
NaOCl (100 ppm)	6.77 ± 1.37	0.19 ^{NS}
NaOCl (200 ppm)	6.65 ± 1.40	
$KMnO_4$ (50 ppm)	6.73 ± 1.41	0.38 ^{NS}
$KMnO_4$ (100 ppm)	6.50 ± 1.22	
COLIFORMS (log_{10})		
Levels of sanitizers	**Mean ± SD**	**T test**
NaOCl (100 ppm)	5.13 ± 0.57	0.07 ^{NS}
NaOCl (200 ppm)	5.15 ± 0.64	
$KMnO_4$ (50 ppm)	5.36 ± 0.55	0.14 ^{NS}
$KMnO_4$ (100 ppm)	5.33 ± 0.59	
STAPHYLOCOCCUS AUREUS (log_{10})		
Levels of sanitizers	**Mean ± SD**	**T test**
NaOCl (100 ppm)	4.23 ± 0.53	0.26 ^{NS}
NaOCl (200 ppm)	4.17 ± 0.53	
$KMnO_4$ (50 ppm)	4.31 ± 0.51	0.76 ^{NS}
$KMnO_4$ (100 ppm)	4.13 ± 0.51	
LISTERIA MONOCYTOGENES (log_{10})		
Levels of sanitizers	**Mean ± SD**	**T test**
NaOCl (100 ppm)	4.57 ± 0.55	0.18 ^{NS}
NaOCl (200 ppm)	4.62 ± 0.57	
$KMnO_4$ (50 ppm)	4.68 ± 0.34	0.37 ^{NS}
$KMnO_4$ (100 ppm)	4.76 ± 0.64	
SALMONELLA (log_{10})		
Levels of sanitizers	**Mean ± SD**	**T test**
NaOCl (100 ppm)	3.68 ± 0.38	0.23 ^{NS}
NaOCl (200 ppm)	3.74 ± 0.78	
$KMnO_4$ (50 ppm)	3.80 ± 0.59	0.29 ^{NS}
$KMnO_4$ (100 ppm)	3.72 ± 0.59	

SHIGELLA (log_{10})		
Levels of sanitizers	**Mean ± SD**	**T test**
NaOCl (100 ppm)	4.87 ± 0.78	0.77 NS
NaOCl (200 ppm)	5.11 ± 0.61	
$KMnO_4$ (50 ppm)	4.65 ± 0.59	1.02 NS
$KMnO_4$ (100 ppm)	4.40 ± 0.52	

Note: NS – Not significant

Table 5.5.6.4 shows the level and type of the disinfectants for different parameters effective for reducing the counts of microorganisms on the sample of coriander. It is clear from the table that, there existed no significant difference in between the levels of the two disinfectants for all the parameters except *Shigella*. Results revealed that 100 ppm $KMnO_4$ was significantly more effective in reducing the counts of Shigella for coriander leaves as compared to 200 ppm NaOCl.

Table 5.5.6.4: Effectiveness of type of disinfectants for reducing the counts

Levels of disinfectants	Mean ± SD	't' test
TPC (log_{10})		
NaOCl (100 ppm)	6.77 ± 1.37	0.07 NS
$KMnO_4$ (50 ppm)	6.73 ± 1.41	
NaOCl (200 ppm)	6.65 ± 1.40	0.26 NS
$KMnO_4$ (100 ppm)	6.50 ± 1.22	
COLIFORMS (log_{10})		
NaOCl (100 ppm)	5.13 ± 0.57	0.95 NS
$KMnO_4$ (50 ppm)	5.36 ± 0.55	
NaOCl (200 ppm)	5.15 ± 0.64	0.65 NS
$KMnO_4$ (100 ppm)	5.33 ± 0.59	
STAPHYLOCOCCUS AUREUS (log_{10})		
NaOCl (100 ppm)	4.23 ± 0.53	0.33 NS
$KMnO_4$ (50 ppm)	4.31 ± 0.51	
NaOCl (200 ppm)	4.17 ± 0.53	0.13 NS
$KMnO_4$ (100 ppm)	4.13 ± 0.51	
LISTERIA MONOCYTOGENES (log_{10})		
NaOCl (100 ppm)	4.57 ± 0.55	0.50 NS
$KMnO_4$ (50 ppm)	4.68 ± 0.34	
NaOCl (200 ppm)	4.62 ± 0.57	0.52 NS
$KMnO_4$ (100 ppm)	4.76 ± 0.64	
SALMONELLA (log_{10})		
NaOCl (100 ppm)	3.68 ± 0.38	0.54 NS
$KMnO_4$ (50 ppm)	3.80 ± 0.59	
NaOCl (200 ppm)	3.74 ± 0.78	0.06 NS
$KMnO_4$ (100 ppm)	3.72 ± 0.59	
SHIGELLA (log_{10})		
NaOCl (100 ppm)	4.87 ± 0.78	0.69 NS
$KMnO_4$ (50 ppm)	4.65 ± 0.59	
NaOCl (200 ppm)	5.11 ± 0.61	2.81*
$KMnO_4$ (100 ppm)	4.40 ± 0.52	

NS – Not Significant; * Significant at $p<0.5$

HIGHLIGHTS OF PHASE VI

- Coriander brought from market III had the highest counts of TPC and was also found to be highly contaminated with Salmonella.
- TPC and Salmonella decreased significantly when the sample was treated with 200 ppm sodium chloride and 100 ppm $KMnO_4$.
- Coriander brought from Market I was found to be highly contaminated with coliform and Listeria monocytogenes.
- 100ppm of NaOCl was most effective in reducing the counts of coliforms and *Listeria monocytogenes* on fresh coriander.
- Sample of coriander brought from Market V was found to highly contaminated with *Staphylococcus aureus* and maximum reduction in counts of was obtained after treatment with 100 ppm $KMnO_4$.
- Coriander brought from market IV had the highest counts of *Shigella* and 100ppm $KMnO_4$ was most effective in reducing the counts of *Shigella* by more than 1 log.
- Tap water alone was not sufficient to reduce the microbial load of fresh coriander. Either sodium hypochlorite (NaOCl) or potassium permanganate ($KMnO_4$) should be used to reduce the microbial load, but none of the disinfectants were successful to completely remove the pathogens from fresh coriander.

DISCUSSION

Ready to eat or ready to use vegetables are subjected to minimal or no processing prior to consumption. They can be used as ingredients in cooked dishes, but many are consumed raw without any treatment that would normally destroy the pathogenic microorganisms (Richard et al, 2002). Coriander leaves are used in many culinary Indian dishes, for garnishing of cooked foods, or used in the preparation of chutney that under go no thermal treatment. Coriander leaves used in green chutney has been responsible for the outbreak of several food borne diseases (Roday S, 1999).

Food borne diseases outbreaks have also been attributed to sprouted seeds, leafy .vegetables, tomatoes, melons, berries an unpasteurized juices (NACMCF, 1999). In the present report, fresh coriander had high counts of pathogenic bacteria such as *Salmonella, Shigella, Coliforms, Listeria monocytogenes and Staphylococcus aureus.* In Mexico City 20% coriander samples were found to be contaminated with *E coli O157:H7* (Zepeda-Lopez et al 1995). Various pathogens such as *S.aureus, E coli, Enterobacter sp, Klebsilia sp, S. typhi, Serratia sp, Providencia sp and P aeruginosa* were isolated from 120 samples of raw foods comprising of different types of raw vegetables, fruits and sprouts (Viswanathan and Kaur, 2001). Such contamination of raw produce with pathogenic bacteria can arise as a consequence of treating soil with organic fertilizers such as manure and sewage sludge from irrigation water (European Commission, 2002).

In order to remove the pathogens from coriander leaves, they were administered to wash treatments with tap water (water supplied by the municipal corporation of Vadodara and tested for its microbial quality did not show presence of any pathogens and had low counts of TPC). The microbial load on the coriander leaves reduced after washing; however the reduction in counts was not statistically significant. Washing of raw produce with tap water cannot be relied upon to remove pathogenic bacteria completely (Brackett 1992 and Nguyen and Carlin, 1994), or they result in very low reductions of 0.1 to 1 $\log_{10}$ units (Beuchat 1998).

Numerous sanitizers have been evaluated for their effectiveness in killing or removing pathogens such as *Escherichia coli O157:H7, Salmonella* and *Listeria monocytogenes* (Beuchat L. R. 1998). Various sanitizers such as chlorine, $KMnO_4$, chlorine dioxide, bromine, iodine, tri sodium phosphate, quaternary ammonium compounds, organic acids, hydrogen peroxide, etc have been known to disinfect fruits and vegetables. Chlorinated water is the most frequently used sanitizer for washing of fresh produce. Legally, agricultural chlorine is commercially available in three forms viz., Chlorine gas, calcium hypochlorite and sodium hypochlorite. These forms of chlorine have been approved for use (registered) by the U.S. Environmental Protection Agency (EPA) and by individual states such as California (California Department of Pesticide Registration). Amongst these forms, sodium hypochlorite along with potassium permanganate was used as sanitizers in our study.

TPC decreased significantly by more than 1 log unit in the present investigation when the sample was treated with 200 ppm sodium chloride and 100 ppm $KMnO_4$. A study by Soriano et al (2000) showed that washing 144 samples of lettuce with sodium hypochlorite or $KMnO_4$ solutions reduced the microbial counts by more than two log units, and total coliforms by at least one log.

Present finding revealed that coliforms, *Listeria monocytogenes* and *Salmonella* better responded to sodium hypochlorite. 100ppm of NaOCl was most effective in reducing the counts of coliforms and *Listeria monocytogenes* on fresh coriander. Washing lettuce for 2min in sodium hypochlorite at 70 ppm or $KMnO_4$ at 25 ppm reduced populations of aerobic bacteria and total coliforms by nearly 2 logs (Mathews 2006). The effect of washing lettuce and cabbage with 200 ppm chlorine was studied for 10 minutes. The maximum observed $\log_{10}$ reduction of *Listeria monocytogenes* at $4^{o}C$ and $22^{o}C$ was 1.3 and 1.7 for lettuce and 0.9 and 1.2 for cabbage respectively (Zhang and Farber 1996). When coriander leaves were given wash treatments with 200 ppm sodium chloride for 5 minutes, *Salmonella* decreased significantly by almost 1 log. Washing of cantaloupes in chlorinated (1000 ppm) water within 24h after inoculation reduced the population of attached *Salmonella Stanley*

on the cantaloupe surface and the possibility of transfer during fresh cut produce (Ukuku and Gerald 2001).

Pathogens also vary in their sensitivity to sanitizers. Present report showed that some of the pathogens behaved differently for same sanitizers, for eg. *Shigella* showed significant reductions when coriander was treated with 50 and 100 ppm of potassium permanganate, while total coliforms responded better to sodium hypochlorite. Such differential behavior of the sanitizers to the various pathogens have been reported by another investigator (Beuchat 1998).

A threshold for a reduction in counts of pathogens is generally reached beyond a certain limit. This was evident from the current investigation, when the statistical analysis revealed no significant difference between the two levels of the sanitizers; which meant a lower level of sanitizer can be used for disinfecting the vegetables. Populations of pathogens markedly reduced when the concentration of chlorine was increased to 50 ppm, but an additional increase of concentration to 200 ppm did not bring about a substantial decrease in pathogens (Beuchat 1998).

In conclusion, present investigations have proved that tap water alone would not be sufficient to reduce the microbial load of fresh coriander. Limitation of the sanitizers to completely remove or kill the pathogens was highlighted in the present investigation. In addition, some of the pathogens were sensitive to certain sanitizers,which further complicates the removal of microbial load from raw produce by use of a single disinfectant. All of these should prompt the use of methods that would arrest the initial contamination of raw produce during the pre harvesting stages.