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Assessment of microbiological quality of foodstuffs served in college cafeterias

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catering practices; college cafeterias; food handlers; HACCP; microbiological quality; surface sanitation.

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Abstract

Introduction With tremendous economic growth taking place in India, 'Eating Out' has assumed great importance for the younger generation resulting in proliferation of the college cafeteria industry. *Objective* The study was conducted to assess the microbiological safety of food served in the cafeterias of two colleges (C-1 and C-2) of University of Delhi. *Methods* Information was gathered regarding catering operations and microbiological quality of water and 13 common food items was assessed. *Results* There were lacunae in all aspects of catering operations. C-1 and C-2 obtained values of 41.9% and 63.9% for overall desirable practices for catering and food material handling practices. Water from source was generally satisfactory in quality. Almost all the food items showed high standard plate count and coliform count. Further, 37% and 46% of the food samples tested positive for *Escherichia coli* and *Staphylococcus aureus*, respectively. Hazard Analysis and Critical Control Point study revealed that contamination occurred at several points during the course of preparation. *Conclusion* The study indicated that the sanitary and hygiene practices followed in the cafeterias of the two colleges were extremely unsatisfactory. It is imperative that the concerned authorities take speedy appropriate remedial action and ensure that safe food is provided in the college cafeterias.

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Introduction

A major determinant of health is the consumption of wholesome food. Wholesomeness has two important dimensions. Firstly, the food should be of good nutritive value. Secondly, and equally importantly, the food should be free from contamination of toxic agents and noxious substances that would undermine health and cause disease. Ensuring food safety is therefore an important cornerstone in maintaining public health (NFI, 2003).

Unparalleled economic growth occurring in India has led to a tremendous increase in buying power, particularly among the vast middle socioeconomic families (Ablett *et al.*, 2007; Economic Survey, 2009–2010). One outcome of this is that 'eating out' has become an important part of daily life, particularly in the metro cities. Students are no exception to this and thus eating in college cafeterias has become very common (Kashyap *et al.*, 2004), leading to a rapid proliferation of the college cafeteria food industry.

College cafeterias offer a wide variety of foodstuffs that are fresh and very tasty, generally nutritious, available quickly and reasonably priced. However, the safety of these foods could become a matter of concern if essential hygiene practices are not followed during their preparation and their subsequent storage until sale (WHO, 2002). Therefore, it is necessary to apply sanitary practices at every stage of food production (NIN, 1992; Sharma & Sundararaj, 2002). No study has critically evaluated the same. Implementation of Hazard Analysis and Critical Control Point (HACCP) programmes by food service establishments would dramatically

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improve the level of food safety (Gangahar, 2000; FAO/WHO, 2003; Giorgi & Lindner, 2009). Hence the present study was envisaged to critically evaluate the microbiological quality of foodstuffs available in cafeterias of two colleges of University of Delhi. The specific objectives included obtaining a general profile of the food handlers, gaining an insight into catering operations and food material handling practices, assessing the hygiene practices of the food handlers, determining the level of surface sanitation, evaluating the microbiological quality of water and various foodstuffs served and conducting a HACCP study on high-risk foods. Additionally, a food safety awareness programme was conducted among the food handlers to create awareness about potential food safety problems. Consumer perception regarding the food served was also obtained.

Methodology

The study was conducted in the cafeterias of two colleges (C-1 and C-2) of the University of Delhi based on the willingness of the concerned authorities, cooperation promised by the cafeteria personnel to participate in the study and the easy accessibility of both the institutions.

Data pertaining to sociodemographic profile and education level of all the food handlers was collected using a proforma, which was developed and pretested. Information was also elicited about the various food items sold, popular items and their turnover, factors affecting sale and timing of operations. Catering operations and food material handling practices were recorded with the aid of questionnaire-cum-interview schedule. Information was obtained on various aspects of layout, physical facilities, equipments and utensils, accessories, water supply, waste disposal, procedures for buying raw materials, storage of raw materials, prepreparation and preparation of food items, holding conditions, service, dishwashing and left over management (Appendix I). Personal observations were also recorded. A desirable practice was given a score of one while no score was allotted for an undesirable practice. The scores obtained for each individual operation were added and the total score was arrived at for each operation. This was compared with the maximum score obtainable for that relevant operation and the percentage scores were calculated for each operation in each cafeteria.

A pretested observation checklist was administered to facilitate recording of personal hygiene practices of the individual food handlers.

Microbiological testing of surface sanitation, water and foods was conducted in duplicate to ascertain their microbiological safety. In the present study Swab Rinse Method (Rangana, 1995) was used for the assessment of level of sanitation of 16 equipments/surfaces from each cafeteria. Water samples (six) from source and following storage were tested for plate count of bacteria as per Indian Standard (BIS. IS: 5402, 1969b) method and for the most probable number of coliform bacteria as per Indian Standard (BIS. IS:5401, 1969a) method.

Only vegetarian food items were prepared in the cafeterias. A total of 13 food items common to both the cafeterias were selected for microbiological analysis. These included:

- *kachori*-whole wheat flour dough shaped into balls filled with soaked, ground and spiced green gram (dehusked and split) and deep-fried,
- *vada*-soaked, ground and salted dehusked black gram dough shaped into balls and deep-fried,
- *aloo-sabzi*-boiled, diced, spiced and stir fried potato preparation,
- *sambhar*-red gram spiced curry containing seasonal vegetables,
- *samosa*-refined wheat flour dough shaped into triangle, filled with boiled, mashed and spiced potato and deep-fried,
- *masala dosa*-soaked and ground batter of mixture of rice and dehusked, split black gram (3:1), fermented, spread like pan cakes, shallow fried and with a filling,
- *chutney*-an accompaniment of tamarind water or tomatoes, cooked and spiced and served with snacks,
- *chole*-boiled, spiced and stir fried chik-peas garnished with tomatoes, onions and fried potatoes,
- *bread roll*-boiled, mashed, spiced potato filling placed on a slice of damp bread and shaped into a roll with the edges sealed and deep-fried,
- rice-steamed,
- *chowmein*-stir-fried preparation of boiled noodles and spiced vegetables and soy sauce,
- *bhatura*-deep-fried leavened Indian flat bread made with refined wheat flour, yoghurt and baking soda,
- *bread pakora*-triangular shaped bread slices dipped into spiced Bengal gram batter and deep-fried.

Each food item was tested twice and the time interval between collections of the same food item for repeat analysis was 15–20 days. Each time analyses were done in duplicate and up to three dilutions and the value presented for each food sample is a mean of duplicate analysis The food samples were tested for standard plate count (SPC) as per Indian Standard method (BIS. IS:5401, 1969a) and for presence of coliform bacteria as per Indian Standard method (BIS. IS: 5402, 1969b). Additionally, all the food samples

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were subjected to tests for the presence of two main pathogenic organisms, *Escherichia coli* (presumptive, confirmatory and complete coliform tests) and *Staphylococcus aureus* (enrichment and isolation). Various biochemical tests performed for confirming the presence of these pathogens included lactose and glucose utilization, indole, citrate utilization and triple sugar iron tests for *E. coli* and nitrate reduction, anaerobic and aerobic utilization of glucose and Voges Proskauer test for *S. aureus*. For conducting the above tests, the relevant dehydrated bacteriological culture media were procured from HiMedia Laboratories Limited (Mumbai, India). Each dehydrated culture medium was reconstituted using distilled water as per the directions listed and the final pH was checked using a pH metre. The reconstituted medium was sterilized by autoclaving at 15 psi and 121 °C for 15 min unless otherwise indicated. All chemicals and solvents were of analytical grade and were purchased from Qualigens Fine Chemicals (Mumbai, India)/Merck Chemicals (Mumbai, India)/Sigma Aldrich (New Delhi, India). Presence of *S. aureus* was also confirmed using STAPHY test 16 kit procured from Neugen Diagnostics (Hyderabad, India). This is a ready to use microwell plate system for the performance of 16 biochemical tests. The identification was supplemented by the paper strip test for Voges-Proskauer reaction and cytochrome oxidase.

It was of interest to see the microbiological quality of food products when prepared under hygienic conditions. Hence *vada* and rice were prepared in the Food Science Laboratory of Lady Irwin College.

HACCP study was conducted for high-risk foods (foods having high microbiological count and presence of pathogens) as per the protocol given by Codex Alimentarius Commission (1997) and the Bureau of Indian Standards (BIS. IS:15000, 1998). These included *aloo sabzi* and *masala dosa* from C-1 and rice and *vada* from C-2. For each food item the stages in the preparation were listed through a flow diagram, which was confirmed on site. The HACCP worksheet was then prepared which included the process step, hazards to be controlled, control measures, critical limit, monitoring procedure and corrective action. For each process step, all the details were listed for the above criteria. Samples of food in different stages of preparation (from raw materials till sale of final product to the consumers) were subjected to microbiological analysis to determine SPC, coliform count and the presence of *E. coli* and *S. aureus* as per the methods mentioned above. From the data obtained, the information on hazards and conditions which were important for the safety of the food item were addressed in the HACCP plan (Appendix II).

A pretested questionnaire was used to get consumer response regarding the food items commonly consumed by them, frequency of consumption, reasons for consumption and suggestions for improvement of food quality and service.

Food safety awareness programme was conducted for both the college cafeteria employees. The information was imparted in *Hindi*, which is the local language understood by all the employees. Posters with short, catchy and easy to understand messages were displayed and explained. Bacterial cultures were shown to them to give them the concept of microbes.

Analysis of data

Data obtained from the various proforma were tabulated. Means and percentages were calculated as described earlier. Microbiological count obtained for surface sanitation was interpreted and evaluated as per given standards (West *et al*., 1977). The number of microorganisms present in a test sample was calculated as the weighted mean from two successive dilutions using the ISO 7218:1996(E) equation.

Results and discussion

General information

The cafeterias in both the colleges are managed by private contractors. The infrastructure within the college premises is provided by the college authorities. Apart from students, academic faculty, laboratory staff and administrative staff use the cafeteria facility. Each college has the services of a cafeteria committee consisting of six to seven faculty members.

Sociodemographic profile and educational background of food handlers

A large majority (62%) of the food handlers employed was adults; however, it was disconcerting to find that 38% of the employees were adolescents, below 18 years of age. Illiteracy among the food handlers at both the cafeterias was very high (53%); 28.5% of the cooks and all the helpers were illiterate. Only 19.0% and 14.3% of the staff were educated up to eighth and 12th grade, respectively. Majority of the food handlers belonged to the low socioeconomic group. Over 80% of the employees were untrained; none of the cooks had received any formal training and had learnt the job by experience. A statistically significant association has been reported between education and personal hygiene of food handlers in Bijapur city (Udgiri & Masali, 2007). Incentives to invest in food safety in the private sector remain the

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major public health challenges in China which is also facing rapid pace of both economic growth and transition to market economy (Liu *et al*., 2009).

Catering operations and food material handling practices

The percentage desirable practices followed by each cafeteria are presented in Table 1. The layout showed that both the cafeterias had adequate space, sufficiently lit and ventilated, and there was generally a demarcation between different areas. Both maintained a clean service counter as that was visible to the customer. Many of the other areas, like the storage area, were untidy, cluttered with empty cartons/bottles/utensils not in use and in most cases dirty too. Prepreparation and preparation areas were not cleared of spillage and food waste as and when necessary and remained untidy. Dishwashing area was dirty and wet, even when not in use. Signs of pests were observed and no pest control measures were adopted.

While running water was available in C-1 and C-2, soap for washing hands was available only at C-2. Aluminium utensils having pits and crevices were being used at C-1 while stainless steel utensils were used in C-2. Interior surface of utensils had food and detergent residues. Cloth dusters, which were used were dirty because they were washed in cold water without soap. In C-1, dusters used for dusting purposes were often also used for covering food items. Inactivation of microorganisms transferred to cleaning cloth from surfaces of food preparation sites by effective procedure is essential to avoid cross-contamination (Kusumaningrum *et al*., 2003). About 53% of catering establishments in United Kingdom, which used cloth dusters for cleaning had unacceptable microbiological quality of food as compared with those who used disposable dusters (Gillespie *et al*., 2000).

Table 1 Cumulative desirable practices (%) followed by college cafeterias

		Desirable practice (%) followed by cafeterias	
Sl. No.	Practice	C-1	C-2
1.	Layout	75.0	66.6
2.	Physical facilities	42.8	57.1
3.	Use of equipment/utensils	33.3	66.6
4.	Use of dusters	20.0	40.0
5.	Water supply	42.8	50.0
6.	Waste disposal	45.5	81.8
7.	Storage	29.4	82.3
9.	Prepreparation	0.0	25.0
10	Preparation	14.2	42.8
11.	Service	75	100
12.	Dishwashing	40.0	60.0

Both the cafeterias had taps with municipal water supply; no water filtration/purification system had been installed. Neither cafeteria had facility for supply of hot water for washing utensils. Waste collection bins were not lined with garbage disposal bags and were not cleaned each time they were emptied; additionally in C-1 they did not have lids and were not emptied regularly.

Raw materials like cereals, pulses and spices purchased from reputed wholesale suppliers in both the cafeterias were well known brands carrying appropriate Indian grading standard and within the best before date. Raw foodstuffs were kept apart from cooked foods which would help in preventing cross-contamination. In C-1, contents from bulk purchases were not transferred into storage containers; in C-2 they were transferred into containers without lids. Refrigerators in both the units were not clean and the shelves had spillage leading to objectionable odour. Cooked food was kept uncovered. Vegetables were not washed thoroughly in both the cafeterias and cut vegetables were left uncovered/on the floor. In C-1 wooden chopping boards with splits, cuts and holes were being used. C-1 did not get any score for desirable practices of prepreparation (Table 1). Hands were used instead of spoons to pick up ingredients while cooking. Work surfaces were not found to be clean in both the places as clearing of spillage occurring during preparation of food items was delayed. Contamination can occur in processing environmental surfaces which are difficult to clean and sanitize (Keeratipibul *et al*., 2010).

Holding practices needed to be vastly improved to ensure safety in both the cafeterias. The golden rule of food protection called time and temperature principle (Roday, 1999) was grossly violated. Prepared food was held at room temperature for 7–8 h; while some items were prepared on demand, other food items prepared by 09:00 hours were served throughout the day. Adequacy of reheating was also doubtful. Both the cafeterias had clean service counters and scored well on service, with C-1 scoring lower (75%) due to cracked chinaware as compared with C-2 (100%) (Table 1). While leftover food was generally discarded, on occasions it was observed that the leftover filling for *masala dosa* was added to the fresh filling in C-1.

Thus of the total 86 desirable practices in 12 different operations (Table 1) that were looked into, only 36 (41.9%) were followed in C-1 and 55 (63.9%) in C-2. Hence vast improvements need to be initiated in both the cafeterias in an effort to provide safe food to its customers.

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Personal hygiene practices of food handlers

It was observed that none of the food handlers wore apron/headgear/gloves. Majority of the food handlers had short and clean fingernails. No food handler was found to be suffering from infectious conditions like cold, cough, boils, cuts, sores or any other skin disease. None of them washed their hands with soap after smoking/eating/visiting toilet/touching waste foods/performing any cleaning operations/handling money. Applying Fault Tree Analysis to hand washing process, Park and Lee (2009) identified insufficient scrubbing of hands, failure to use hygienic towels for hand drying and unhygienic storage of towels as causes of faults in hygiene management. Correct hand hygiene practice which is a primary measure to prevent transmission of pathogens necessitates the creation of a culture to promote it at all levels of society and should be given priority as part of early education (IFH, 2002; Jumaa, 2005; WHO, 2005).

Microbiological analysis

Surface sanitation

The results of the microbial testing of equipments/surfaces are given in Table 2. The level of bacterial count on equipments and surfaces of production, dishwashing and service areas was unsatisfactory. Equipment and cutlery like cooking utensil, spoon, cup and glasses which were cleaned regularly had much lower count as compared with those that were cleaned occasionally like cutting board, table shelves and refrigerator shelves. Clothes and hands of the food handlers were very unsatisfactory because they did not maintain good personal hygiene. These findings show that no area in the food production unit was free from contamination. Table 2 shows that more than half (56%) of the total surfaces tested had unsatisfactory/highly unsatisfactory level of acceptance of bacterial counts. *E. coli* and enterococci detected on food contact surfaces throughout the

Table 2 Bacterial counts on equipments/surfaces

Sl. No.	Equipments/surfaces	Cafeteria	Average count (CFU g^{-1})	Growth	Level of acceptance
1.	Cutting board	C-1	10^5	++++	Highly unsatisfactory
		C-2	10^5	++++	Highly unsatisfactory
2.	Frying pan	C-1	10	+	Good
		C-2	0	Nil	Excellent
3.	Plate	C-1	10^5	++++	Highly unsatisfactory
		C-2	32	++	Satisfactory
4.	Spoon	C-1	74	++	Satisfactory
		C-2	52	++	Satisfactory
5.	Glass	C-1	25	+	Good
		C-2	17	+	Good
6.	Cooking utensil	C-1	51	++	Satisfactory
		C-2	60	++	Satisfactory
7.	Cup	C-1	91	++	Satisfactory
		C-2	82	++	Satisfactory
8.	Table shelf	C-1	120	+++	Unsatisfactory
		C-2	10^5	++++	Highly unsatisfactory
9.	Working area	C-1	10^5	++++	Highly unsatisfactory
		C-2	10^5	++++	Highly unsatisfactory
10.	Refrigerator shelves	C-1	10^5	++++	Highly unsatisfactory
		C-2	10	Nil	Excellent
11.	Dishwashing area	C-1	10^5	++++	Highly unsatisfactory
		C-2	10^5	++++	Highly unsatisfactory
12.	Duster	C-1	10^5	++++	Highly unsatisfactory
		C-2	10^5	++++	Highly unsatisfactory
13.	Cook's shirt	C-1	315	+++	Unsatisfactory
		C-2	73	++	Satisfactory
14.	Food server's shirt	C-1	10^5	++++	Highly unsatisfactory
		C-2	10^5	++++	Highly unsatisfactory
15.	Cook's hand	C-1	130	+++	Unsatisfactory
		C-2	120	+++	Unsatisfactory
16.	Food server's hand	C-1	10^5	++++	Highly unsatisfactory
		C-2	10^5	++++	Highly unsatisfactory

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production period of frozen ready-to-eat (RTE) chicken products, indicated the correlation between surface sanitation and contamination in food products (Keeratipibul *et al.*, 2009).

A checklist evaluation of catering in 15 public schools in Salvador, Brazil for layout, utensils and equipment maintenance, employee personal hygiene practices, quality of raw and RTE foods, production flow, food handler practices and quality control, showed that 13 schools (86.7%) were classified as poor on the basis of the total scores obtained (Santana *et al.*, 2009).

Water quality

Both the cafeterias had water supply from New Delhi Municipal Corporation. In C-1 water was improperly stored in an open bucket placed on the floor and was used for cooking and washing purposes. Accordingly, Table 3 shows that while water from source as obtained from tap was highly satisfactory, quality of stored water was unsatisfactory. In C-1, water for use was obtained by dipping a container along with the food handler's hand into the stored water. Further, Table 2 has shown that the sanitation level of hands of the food handlers was unsatisfactory with high bacterial count. In C-2, tap water as obtained from New Delhi Municipal Corporation was directly used for cooking and was found to be highly satisfactory. However, water supply from an overhead storage tank, which was used for dish washing was found to be unsatisfactory.

Microbiological quality of food items prepared in the cafeterias

The data obtained for the 13 food items tested twice in each cafeteria is presented in Table 4.

All the food samples tested showed high SPC to the order of 10^3–10^6, indicative of extensive presence of microorganisms. These values are very high as compared with permissible limits in ISO 9002 standards. Zero coliform count was only observed in both the samples of *kachori* from both the cafeterias, both the samples of bread *pakora* from C-1 and one sample of bread *pakora* from C-2. Coliform group of organisms are uniformly present in the intestinal tract and hence the presence outside of the intestines is regarded as contamination from faecal discharges of man or animals (Jay, 2000).

It is disconcerting to note that of the 52 food samples (13 in each cafeteria, twice) tested in the present study, 37% of the samples showed growth for *E. coli* on eosin methylene blue agar (Table 4). The percentage distribution was quite similar (34.6% in C-1 and 38.6% in C-2) in the two cafeterias. All the biochemical tests performed for *E. coli* gave positive results, confirming the presence of the microorganism. Sero-typing of *E. coli* was not done. However, all sero-types are not pathogenic in nature and only some are enteropathogenic. At the same time the presence of *E. coli* is a pointer to gross negligence and improper food handling practices. In a study conducted by Souza and Santos (2009), *E. coli* was isolated from the hands of 6.8% of the food handlers working in elementary schools in Brazil.

Table 4 also shows that 46.1% of all the food samples analysed were contaminated with the presence of *S. aureus*, of which 42.3% and 50.0% were from C-1 and C-2, respectively. All the biochemical tests performed for *S. aureus* gave positive results. Additionally *S. aureus* was also confirmed using STAPHY 16 test kit. *S. aureus* can cause food poisoning only when present in numbers sufficient to produce enterotoxin. Quantification of *S. aureus* has not been done in the present study. However, the presence of the organism is indicative of very poor hygiene and sanitary practices followed in both the cafeterias. Soriano *et al.* (2002) reported the presence of *S. aureus* in 85 samples (11.1%) from a total of 705 meals tested from several cafeterias.

The highly inadequate microbial quality of the foodstuffs prepared in the cafeterias in the present study could

Table 3 Microbiological quality of water

Cafeteria	Water sample	SPC (CFU mL^{-1})	Coliform (count mL^{-1}), McGrady probability	Water quality
C-1	Water from tap	< 15	0	Highly satisfactory
	Stored water	6.5×10^5	0	Unsatisfactory
	Water for cooking	7.0×10^5	0	Unsatisfactory
	Water for dishwashing	7.8×10^5	0	Unsatisfactory
C-2	Tap water for preparation	< 15	0	Highly satisfactory
	Tap water for dishwashing	6.8×10^5	5	Unsatisfactory

SPC, standard plate count.

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Table 4 Microbiological quality of food items sold in the cafeterias

		Cafeteria 1				Cafeteria 2			
			Coliform	Growth for			Coliform	Growth for	
Sl. No.	Food product	SPC (CFU g^{-1})	count (CFU g^{-1})	*E. coli*[1]	*S. aureus*[2]	SPC (CFU g^{-1})	count (CFU g^{-1})	*E. coli*[1]	*S. aureus*[2]
1.	*Kachori*	2×10^4	0	–	+	3×10^3	0	–	–
	Kachori	6.6×10^5	0	–	–	4×10^3	0	–	–
2.	*Vada*	9.0×10^4	2.0×10^4	–	–	1.5×10^6	6.6×10^5	+	+
	Vada	9.5×10^5	1.5×10^4	–	+	1.2×10^6	5.1×10^5	+	+
3.	*Aloo sabzi*	9.3×10^4	1.6×10^4	+	+	9.2×10^3	1.0×10^4	–	–
	Aloo sabzi	1.5×10^5	1.8×10^4	+	+	1.2×10^3	1.2×10^4	–	–
4.	*Sambhar*	4.9×10^4	1.2×10^4	–	+	1.0×10^4	1.0×10^4	+	–
	Sambhar	8.7×10^5	1.5×10^4	–	–	1.5×10^4	1.5×10^4	+	–
5.	*Samosa*	1.1×10^4	1.2×10^4	–	–	2.0×10^4	1.7×10^4	+	+
	Samosa	3.2×10^5	1.0×10^4	+	–	1.1×10^5	1.0×10^4	–	+
6.	*Masala dosa*	1.2×10^6	6.9×10^5	+	+	1.2×10^6	7.1×10^4	+	–
	Masala dosa	9.0×10^5	9.9×10^5	+	+	1.7×10^6	6.0×10^4	+	+
7.	*Chutney*	3.9×10^4	1.0×10^4	+	–	1.5×10^5	1.6×10^4	+	+
	Chutney	4.5×10^4	1.5×10^4	+	–	1.7×10^5	1.0×10^4	+	+
8.	*Chole*	10.5×10^5	2.2×10^4	+	+	4.3×10^6	1.5×10^3	–	–
	Chole	9.7×10^4	2.4×10^4	–	–	6.8×10^5	1.7×10^3	–	–
9.	Bread roll	1.7×10^4	3.6×10^4	–	+	3.0×10^5	0	–	+
	Bread roll	9.3×10^5	2.9×10^4	–	–	1.0×10^5	1.4×10^3	–	+
10.	Rice	9.5×10^5	2.7×10^4	+	–	5.9×10^5	4.5×10^4	–	+
	Rice	6.6×10^5	2.4×10^4	–	–	6.0×10^5	3.9×10^4	–	+
11.	*Chowmein*	9.7×10^5	1.5×10^4	–	+	1.7×10^5	1.3×10^5	+	+
	Chowmein	1.0×10^6	4.9×10^4	–	–	8.6×10^5	1.5×10^5	–	+
12.	*Bhatura*	1.0×10^5	5.3×10^3	–	–	2.3×10^6	1.6×10^4	–	–
	Bhatura	9.6×10^5	4.2×10^3	–	–	1.1×10^6	1.3×10^4	–	–
13.	Bread *pakora*	0.4×10^3	0	–	–	6.5×10^4	0	–	–
	Bread *pakora*	0.6×10^3	0	–	–	8.8×10^4	2.9×10^3	–	–

[1]*E. coli* on eosin methylene blue agar.
[2]*S. aureus* on Baird Parker agar.
–, Growth absent; + growth present; SPC, standard plate count.

be attributed to a combination of the poor catering operations discussed above. However, a critical look at all the lacunae detected shows that simple remedial measures which can be easily adopted will go a long way in improving the sanitary and hygiene status practiced in the cafeterias. Further the financial implications would be negligible.

Several studies have reported poor microbial quality of various food products. The microbiological quality of sweetened dairy product, *pedha* from B grade retail shops in Mumbai, India, was very poor as compared with *pedha* from A grade shop as evidenced by the very high total bacterial counts (6×10^7 CFU g^{-1}), high counts of *S. aureus* (as high as 7×10^6 CFU g^{-1}) and presence of coliform, *Listeria* and *Yersinia* sp. in 33% of the samples. The A grade shops used better raw materials, maintained better hygienic conditions during preparation and storage, had better display, rapid turnover and higher prices as compared with B grade shops (Bandekar *et al.*, 1998). Microbial evaluation of Spanish potato omelet and cooked meat samples in university restaurants showed the presence of high microbial counts which included coliform, *E. coli* and *S. aureus* along with a host of other pathogens (Soriano *et al.*, 2000). A 2-year study carried out in Calcutta to improve conditions in the street food trade reported very high SPC count in foods prepared by fermentation (Chakravarty & Canet, 1996). In Nigeria, cereal-based fermented foods (*ogi and kunu-zaki*) showed high bacterial count and presence of various pathogens including *E. coli* (Olasupo *et al.*, 2002). In our study too, *masala dosa*, made from hand mixed fermented batter had high SPC and coliform count and showed the presence of *E. coli* and *S. aureus*.

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Microbiological quality of food items prepared in the Food Science Laboratory of Lady Irwin College

Two food items, *vada* and rice which were prepared under proper hygienic conditions were subjected to microbiological analysis. The results are presented in Table 5 and have been compared with the least values obtained for these two products from C-1 and C-2. *Vada* and rice prepared in the laboratory had very low SPC count, of the magnitude of only 10^2 as compared with 10^4 and 10^6 for C-1 and C-2, respectively. Coliform bacteria were not present in the laboratory *vada* and rice, while the same from C-1 and C-2 had very high counts to the order of 10^4 to 10^6, respectively. More importantly, no pathogens were detected in both the food products prepared in the laboratory unlike the presence of *E. coli* and *S. aureus* detected in these food products of the two cafeterias. The SPC levels that were found in the laboratory samples were even lower than that given as safe in ISO 2002 standards.

HACCP data

Figure 1a–d gives the SPC and coliform counts at various stages of preparation of the four food items (*vada* and *masala dosa* in C-1 and *vada* and *rice* in C-2) selected for the HACCP study. The data indicate that SPC and coliform counts were very high in the raw ingredients used for each food item. Following cooking, the bacterial counts markedly decreased. However, subsequent to garnishing/putting the filling and after holding there was an undesirable increase in SPC and coliform counts. This clearly indicates that improper handling of raw ingredients, low level of hygiene practiced by the food handlers and inadequate holding conditions of the cooked foods were responsible for heavy contamination of foodstuffs in both the cafeterias.

Adegoke *et al.* (2008) applied HACCP system at each step of preparation of RTE foods, from raw materials used till sale of the food product, to identify hazards and critical control points. Presence of high microbial counts and pathogenic organisms were attributed to lack of sanitary practices during the preparation of RTE foods. Other studies too have highlighted similar concerns resulting in poor microbiological quality and safety of foods (Abdulla & Spencer, 1996; Mepba *et al.*, 2007; Golden *et al.*, 2009).

Table 5 Microbiological quality of *vada* and rice

Sl. No.	Food items	Prepared in	SPC (CFU g^{-1})	Coliform count (CFU g^{-1})	Growth for *E. coli*[1]	Growth for *S. aureus*[2]
1.	*Vada*	Laboratory	3.0×10^2	0	−	−
		C-1	9.0×10^4	1.5×10^4	−	+
		C-2	1.2×10^6	5.1×10^5	+	+
2.	Rice	Laboratory	2.0×10^2	0	−	−
		C-1	6.6×10^5	2.4×10^4	+	−
		C-2	5.9×10^5	3.9×10^4	−	+

[1]*E. coli* on eosin methylene blue agar.
[2]*S. aureus* on Baird Parker agar.
−, Growth absent; +, growth present; SPC, standard plate count.

Recommendations

Information regarding the overall status of sanitation and hygiene in each college cafeteria, as found in the present study, was given to the convener of the respective college cafeteria committee. The lacunae found in the various practices were highlighted and recommendations were also made for improving them.

Consumer response

A consumer survey conducted revealed that all the foods served in the cafeterias were very popular among the students. A large number of students in college C-1 supplemented the food they carried from home with the food they bought in the cafeteria; in college C-2, majority of the students ate in the cafeteria and did not bring food from home. The frequency of eating in the cafeterias varied from once/twice a week to even twice a day. According to the respondents, taste, hunger and affordable price list were the compelling reasons for eating in the cafeteria. However, all of them reported that the level of sanitation and hygiene was unsatisfactory and remarked that cleanliness surely needed to be improved. It is also important that various sources of information should be used to increase consumer awareness on food safety (Gurudasani & Sheth, 2009).

Food safety awareness programme

A participatory approach was followed, where the module development was based on an interactive dialogue. The programme was conducted at each college cafeteria and all the food handlers attended it. The contents of the education programme highlighted the importance of sanitation and hygiene in the cafeterias, the right practices in the area of food handling, personal hygiene and cafeteria hygiene with special reference to highly contaminated areas. It was pointed out that while the raw materials purchased were of good quality, the final food product sold showed a high bacterial count indicating that contamination was occurring during preparation and handling of food products. The importance of washing hands with soap and water was particularly highlighted. Keeping in mind that more than half of the food handlers were illiterate, pictorial

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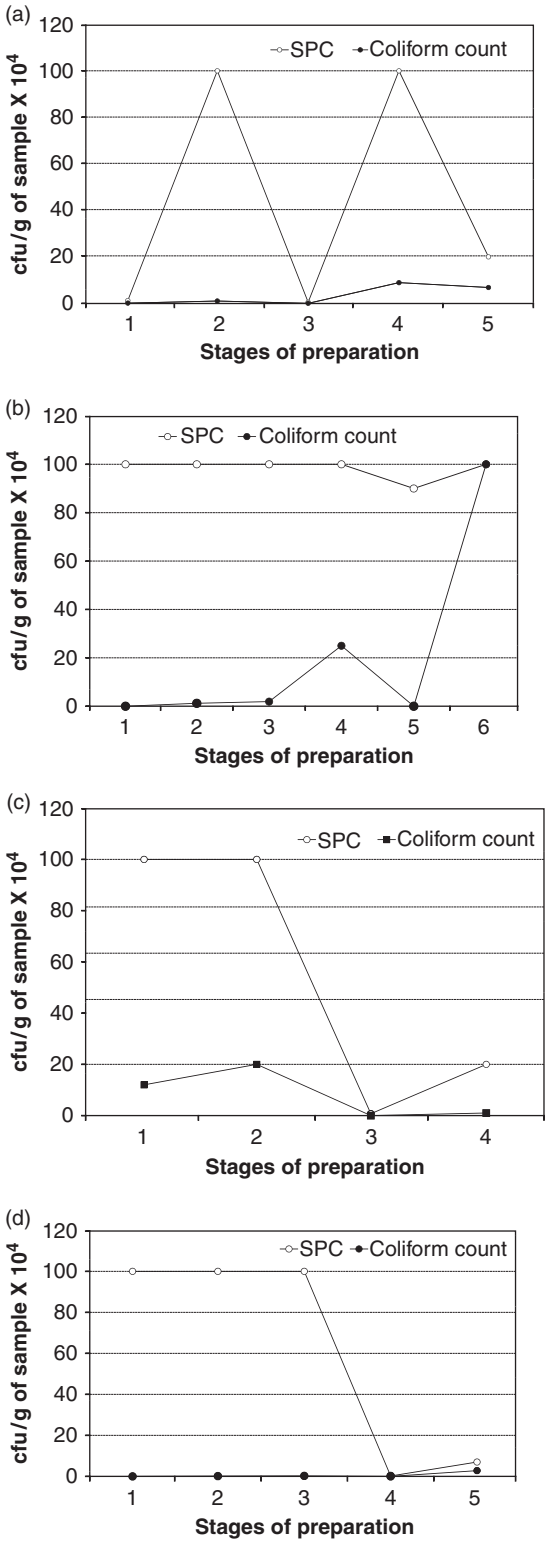
illustrations were largely used. Further, because majority of the food handlers were from low socioeconomic group, generally living in not very hygienic localities, information on basic aspects of hygienic living was imparted. Attitudes may influence food safety behaviours and therefore attitude determination towards food safety is important for development of targeted food safety communication strategies (Redmond & Griffith, 2004).

Reinforcement of food safety awareness needs to be done by holding such programmes at very frequent intervals. Constant monitoring by the cafeteria owners must be a part of the entire system. Additionally, the concerned authorities in each institution should exert more authority in ensuring that better service is provided by the cafeteria contractors. Last but not the least, all the consumers must exert their right to get safe food. Perhaps only this will make the cafeteria owners comply with the demand in order to stay in business.



Conclusions

The data obtained in the present study indicated that the sanitary and hygiene practices followed in the cafeterias of the two colleges were extremely unsatisfactory. There were a lot of lacunae in the catering and food handling practices adopted. Importantly, no training had been imparted to any of the personnel working in the cafeterias and a large number of them were also illiterate. Of the 86 desirable practices that were looked into, only 41.9% in C-1 and 63.9% in C-2 were followed satisfactorily. More than half (56%) of the total surfaces tested had unsatisfactory/highly unsatisfactory level of acceptance of bacterial counts. Water from source was satisfactory but on storage water quality was found to be doubtful/unsatisfactory. Microbiological quality of foodstuffs was very poor with high SPC and coliform count. *E. coli* and *S. aureus* were detected in 37% and 46.1% of food samples tested. HACCP for selected food items showed that except following cooking, microbial contamination increased at every stage of preparation till the sale of the foodstuff. The present study is thus a pointer that regular, ongoing training

Figure 1 Hazard Analysis and Critical Control Point data for selected food items. (a) Standard plate count (SPC) and coliform count at various stages of preparation of *aloo sabzi* in C-1. Stages of preparation: (1) cut tomatoes, (2) boiled, peeled and diced potatoes, (3) cooked *aloo sabzi*, (4) garnished with coriander leaves, (5) *aloo sabzi* on holding. (b) SPC and coliform count at various stages of preparation of *masala dosa* in C-1. Stages of preparation: (1) raw rice and dehusked, split black gram, (2) soaked rice and dehusked, split black gram, (3) ground batter, (4) hand-mixed batter, (5) cooked dosa, (6) dosa with the filling. (c) SPC and coliform count at various stages of preparation of *vada* in C-2. Stages of preparation: (1) ground batter, (2) hand-mixed batter, (3) freshly fried *vada*, (4) *vada* on holding. (d) SPC and coliform count at various stages of preparation of *rice* in C-2. Stages of preparation: (1) raw rice, (2) soaked rice, (3) water used for soaking rice, (4) cooked rice, (5) rice on holding.

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cum monitoring of dissemination of knowledge regarding safe food preparation to all the food handlers must be put in place immediately to prevent college cafeteria food industry from continuing to be a major public health challenge.

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Authors' contribution:

H.G., S.S. and P.S. designed the study; H.G. collected the data; H.G., S.S. and P.S. analysed the data; P.S. wrote the paper.

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APPENDIX I

Proforma for collection of general information of the canteens and food handlers

Name of college:
Name of interviewee:
Interviewee designation:
Qualification:

1. What is the total no of employees?	
Organization Chart:	
2. What are the timings of operations?	
3. What is the minimum eligibility for	
• Cooks	
• Food Handlers	
• Helpers	
• Other staff	
4. Is there a definite division of work between the workers?	Yes/No
5. Are they trained in terms of food safety?	Yes/No
If yes, what is the training given and by whom?	
6. Are there any fluctuations in turnover during different periods of time in a year?	
7. What are the peak hours of sale?	
8. How do you manage during the period of high turnover?	
9. What are the food items sold?	
10. Which are the popular food items?	

General Information about the food handlers:

Name	Age	Sex	Job assigned	Education	Training received	Work experience	Monthly wages

Questionnaire-cum-observation schedule on catering operations and food material handling practices:

LAYOUT

1. Is there adequate space available for different areas in the kitchen:	
• Storage	Yes/No
• Pre-preparation	Yes/No
• Preparation	Yes/No
• Service	
• Dishwashing	Yes/No
2. Is there clear demarcation in the above-mentioned areas?	Yes/No
3. Are the following areas kept clean and dry:	Yes/No
• Storage	Yes/No
• Pre-preparation	Yes/No
• Preparation	Yes/No
• Service	Yes/No
• Dishwashing	Yes/No
4. Are adequate vents and exhaust facilities provided in the above areas?	Yes/No
5. Is there any pest or indicator of pest infestation in any area?	Yes/No

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PHYSICAL FACILITIES

1. Are the work areas adequately lit and ventilated?	Yes/No
2. Are the following hand washing facilities available:	
• Sinks	Yes/No
• Soaps	Yes/No
• Running water	Yes/No
• Clean towels/paper napkin	Yes/No

EQUIPMENTS AND UTENSILS

1. Are surfaces of utensils free from pits and crevices?	Yes/No
2. Are surfaces of equipment free from pits and crevices?	Yes/No
3. Are the interior surfaces of utensils and equipments clean?	Yes/No

DUSTERS

1. Are separate dusters used for different purposes:	
• Drying hands	Yes/No
• Wiping utensils	Yes/No
• Covering	Yes/No
2. Are these dusters clean?	Yes/No
3. Is any soiled linen/dirty rag lying around food preparation area?	Yes/No

WATER SUPPLY AND USAGE

1. Is potable water available?	Yes/No
2. Is it filtered or treated before use?	Yes/No
3. Is the supply of water in the kitchen adequate?	Yes/No
4. Is hot water used to clean utensils?	Yes/No
5. If water is stored:	
• Is the container made of stainless steel/aluminum/brass?	Yes/No
• Does the container have a tight fitting lid?	Yes/No
• Does the container have a tap for drawing water?	Yes/No
6. What is the source of ice?	
7. How is ice being used for the purpose of cooling:	
• External use	Yes/No
• Introduced into food	Yes/No
• Both	Yes/No
• Not used	Yes/No
8. Is ice meant for consumption handled with bare hands?	Yes/No

WASTE DISPOSAL

1. Are garbage bins provided?	Yes/No
2. Are garbage bins adequate in number?	Yes/No
3. Do the garbage bins have lids?	Yes/No
4. Are they lined with disposable bags?	Yes/No
5. Are the bins in the kitchen self-closing?	Yes/No
6. Are the bins cleaned well after emptying?	Yes/No
7. Is garbage removed from premises at frequent intervals?	Yes/No

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8. Is any food or liquid spillage seen near the garbage bins?	Yes/No
9. Do the garbage bins look clean from outside?	Yes/No
10. Is any garbage lying around the various work areas?	Yes/No

PURCHASING

1. Fill in the following:

Food Items	Source	Brand	Frequency of purchase
• Cereals			
• Pulses			
• Vegetables			
• Spices			
• Fats and oils			
• Canned food			
• Bread			
• Butter			
• Milk			
• Ice			

2. What are the criteria you use to assess the quality of the following items at the time of purchase:

a) Cereals and pulses	
• Insect infestation	Yes/No
• Stones, straw, dust	Yes/No
• Any other	Yes/No
• None	Yes/No
b) Vegetables	
• Appearance, color, size	Yes/No
• Insect infestation	Yes/No
• Ripeness	Yes/No
• Bruises	Yes/No
• Foul smelling	Yes/No
• Presence of Dirt	Yes/No
• Any other	Yes/No
• None	Yes/No
c) Spices	
• Stones, straw, dust	Yes/No
• Artificial colors	Yes/No
• Any other	Yes/No
• None	Yes/No
d) Fats and oils	
• Smell-flavor/off flavor	Yes/No
• Any other	Yes/No
• None	Yes/No
e) Bread	
• Smell	Yes/No
• Softness	Yes/No
• Proper wrapping	Yes/No

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• Any other	Yes/No
• None	Yes/No
f) Milk	
• Fat content	Yes/No
• Pasteurized	Yes/No
• Packaging	Yes/No
• Any other	Yes/No
• None	Yes/No

3. Do you look for food safety marks (AGMARK, FPO, and ISI)?	Yes/No
4. Do you check the date of manufacture/expiry?	Yes/No

STORAGE

1. Are cooked foods kept apart from raw foods?	Yes/No
2. Are all stored foods covered to protect them from contamination?	Yes/No
3. Is visibly spoilt food kept in the refrigerator?	Yes/No
4. Are refrigerators defrosted regularly?	Yes/No
5. Are refrigerator shelves clean and free of spills?	Yes/No
6. Are refrigerator interiors free from objectionable odors?	Yes/No
7. Are the freezer compartments cleaned regularly?	Yes/No
8. Are the frozen foods labeled for date of preparation?	Yes/No
9. Is milk boiled before storage?	Yes/No
10. Are vegetables not requiring refrigeration stored:	
• In ventilated condition	Yes/No
• On elevated platform	Yes/No
11. Do you check the following stored items for pest infestation:	
• Cereals	Yes/No
• Pulses	Yes/No
• Spices	Yes/No
12. Are ingredients from bulk packaging transferred to containers for use?	Yes/No
13. Do the storage containers have appropriate lids?	Yes/No
14. Is the storage area cluttered with unwanted items like packaging materials, empty containers or bottles?	Yes/No
15. Are non-food items stored separately from food supplies?	Yes/No
16. Are all poisonous substances like pesticides, cleaning agents etc stored in their original containers bearing appropriate labels	Yes/No

PRE-PREPARATION

1. Are various food ingredients washed and cleaned before use?	Yes/No
2. Are all food ingredients kept covered?	Yes/No
3. Is cutting area clean and free from objectionable odor?	Yes/No
4. Are the chopping boards in good condition without splits, cuts or holes?	Yes/No

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PREPARATION

1. Are all work surfaces clean?	Yes/No
2. Are all work surfaces made of impervious materials?	Yes/No
3. Are all work surfaces free from cracks?	Yes/No
4. Are food stuffs or utensils containing food placed on the floor?	Yes/No
5. Are all prepared food items kept covered?	Yes/No
6. Are all containers/bottles with ingredients capped immediately after use?	Yes/No
7. Are hands used instead of spoons to pick up ingredients like sugar/ salt/spices?	Yes/No

HOLDING

1. What is the time lapse between preparation and service?	Yes/No
2. What is the holding temperature?	Yes/No
3. Are prepared food items kept in utensils made of approved materials (glass, stainless steel)?	Yes/No
4. Are acidic products stored in copper/brass/aluminum containers?	Yes/No

SERVICE

1. Are serving utensils clean?	Yes/No
2. Is chipped or cracked chinaware in use?	Yes/No
3. Are disposable service items (plates, glasses) used more than once?	Yes/No
4. Are appropriate utensils used for portioning out?	Yes/No

DISHWASHING

1. Is the dishwashing area equipped with	
• Sink	Yes/No
• Draining board	Yes/No
2. Is a scouring agent/detergent used for cleaning utensils?	Yes/No
3. If no, then what is used for cleaning utensils?	
4. Are cleaned utensils stored in a sanitary manner to prevent subsequent contamination?	Yes/No
5. Is any food residue, detergent residue or food odor present on washed wares?	Yes/No

LEFTOVER MANAGEMENT

1. Are the leftover unsold food items	
• Discarded	Yes/No
• Sold the next day	Yes/No
• Reused in some other form next day	Yes/No
• Used in any other way.	Yes/No

Checklist for food handlers on personal hygiene practices

1. Personal appearance:
   - Shaving regularly
   - Keeping finger nails short
   - Hair kept tidy and covered
   - Wearing uniform/apron
   - Cleanliness of uniform/apron
   - Wearing disposable gloves
   - Not allowing clothes and accessories to come in contact with food
   - Not suffering from cold, sore throat, vomiting, diarrhea, cuts, sores or any other skin disease

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2. Undesirable activity performed while engaged at work:
   - Combing hair
   - Blowing nose
   - Scratching head or face
   - Eating or smoking
   - Tasting food with fingers
   - Sneezing or coughing onto or near food
   - Spitting in any work area or near any food material
   - Cleaning ear or any other body orifice
   - Chewing betel leaves, tobacco, chewing gum
   - Blowing into polythene or paper bags to open them
   - Inserting fingers inside utensils to pick up contents

3. Hygiene practices (wash hands with soap and water/wash hands with only water/ did not wash hands) followed after performing the following activities:
   - Visiting toilet
   - Touching waste food and garbage
   - Handling toxic materials (detergents/cleaning agents)
   - Scratching head or combing hair
   - Handling money
   - Eating or smoking
   - Doing any cleaning operation

Questionnaire for consumer response:

Name-

Age-

Educational qualification-

1. How often do you eat in your college cafeteria:

- Daily
- Two to three times in a week
- Weekly Occasionally
- Any other

2. Do you carry food from home too or only eat in cafeteria?
3. Which food items do you normally consume:

Food items	Frequency of purchase	Reason for consumption

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4. You eat in the cafeteria because:

- Food is cheap
- Food is tasty
- Food is nutritious
- You are hungry
- Any other reason

5. How will you rate the food available:

- Good
- Fair
- Satisfactory
- Unsatisfactory

6. Have you experienced any of these symptoms after consuming foods in the cafeteria

Symptoms	Yes/No
• Stomach pain	
• Nausea	
• Vomiting	
• Bloating	
• Headache	
• Rash	
• Any other	

7. How do you find the level of sanitation/hygiene in the cafeteria:

- Satisfactory
- Unsatisfactory

8. What suggestions do you have for the improvement of food quality and service/hygiene?

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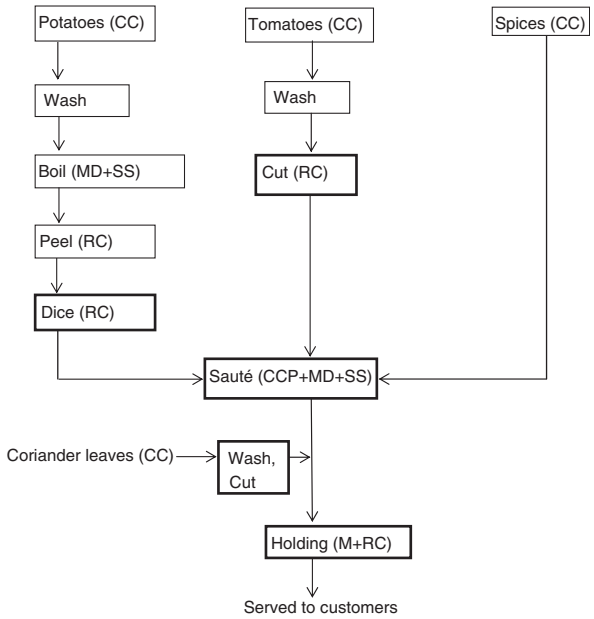
APPENDIX II

HACCP Study- *Aloo Sabzi* in C-1

1. FLOW DIAGRAM FOR PREPARATION OF *ALOO SABZI*



Key

- Sampling stages are indicated by bold frames
- CC-Contamination likely to be present
- RC-Recontamination likely
- MD-Microbial destruction likely
- M-Microbes likely to multiply
- SS-Spores survival likely
- CCP-Critical control point

2. HACCP WORKSHEET

Process step	Hazards to be controlled	Control measures	Critical limit	Monitoring procedures	Corrective action
Raw potatoes and tomatoes	Physical and microbial	Purchase from good supplier	Absent	Good quality	-Check quality of potatoes -reject spoiled vegetable
Water for washing/ boiling	Microbial	Use of good quality water	Absent	Good quality of water	-Proper water testing facilities
Cut vegetables	Microbial	Washed vegetables	Absent	Clean chopping board, knife, worker's hands	-Good hygiene practices -Use of gloves while handling raw vegetables
Aloo sabzi after cooking	Microbial	Use of clean utensils	Absent	Proper washing and storage of utensils	-Temperature of cooking -Time of cooking -Clean utensils
Addition of raw coriander leaves	Microbial	Clean leaves	Absent Absent	Adequately cleaned leaves Clean utensils	-Proper disinfection of leaves

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Aloo Sabzi on holding	Growth and re-contamination with microbial pathogens	Correct holding conditions		-Covered utensils -Temperature of storage -Time of holding -Reheating -Clean environment

3. HACCP PLAN

Food samples	Standard plate count cfu/g	Colifom count cfu/g	E.coli	S.aureus	Remarks
Cut tomatoes	1.2×10^4	0.9×10^4	−	−	Tomatoes not washed well; cutting board not satisfactorily clean
Boiled, peeled, diced potatoes	100×10^4	1.0×10^4	+	−	Hygiene of hands used for peeling and dicing highly unsatisfactory; cutting board not satisfactorily clean
Cooked *aloo sabzi*	4.6×10^3	0	−	−	Cooking reduced the microbial count
Coriander leaves	100×10^4	8.9×10^4	+	−	Improperly washed coriander leaves
Aloo sabzi on holding	20.0×10^4	6.8×10^4	+	−	Holding conditions highly unsatisfactory

Masala dosa in C-1 and *vad*a and rice in C-2 were subjected to similar HACCP study

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