

SURFACE SANITATION AND MICROBIOLOGICAL FOOD QUALITY OF A UNIVERSITY FOODSERVICE OPERATION

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ABSTRACT

A microbiological testing and support surveillance program monitors the sanitary state of food contact surfaces and performs food audits of the Rutgers Dining Services facilities. Analysis of the data over a recent two year period revealed that unacceptable surface sanitation was correlated with the physical presence of food debris (23.4%), water (45.9%), or both (57.8%). Follow up testing revealed that the program was able to consistently reduce the probability of surface failure reoccurrence. Poor equipment design was often contributory to especially problematic surfaces. Lunch meat (36.4% unacceptable) and raw meat (34.1% unacceptable) were found to be the most problematic types of food according to university guidelines. Foods failures were most frequently due to unacceptable levels of indicator bacteria including total coliforms (59.4% of failures, 15.4% of total samples), total aerobic counts (43.4% of failures, 11.2% of total samples) and Escherichia coli (24.5% of failures, 6.3% of total samples). The most common type of failure due to an unacceptable level of a foodborne pathogen was due to unacceptable levels of Staphylococcus aureus (12.6% of failures, 3.3% of total food samples).

INTRODUCTION

There have been no foodborne outbreaks, nor even a single reported case of foodborne illness associated with any of the more than 75 million meals that have

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been served over the past 21 years by the 18 Dining Services facilities located on the Rutgers University, New Brunswick, NJ Campuses. This is due in part to the adoption of a food safety surveillance program designed and implemented by the Rutgers Food Science Department. Key components of this program are the staff microbiologists who perform food contact surface sanitation surveillance and ready-to-eat and "requires further cooking" food audits. The staff reports the results of these tests to a Rutgers sanitarian who then takes appropriate action to ensure a proper margin of safety at the dining facilities.

During the past several years a relational database (Paradox, Borland Inc., Scotts CA) has been designed and used to manage the data accumulated by the project. This database allows for both convenient weekly reporting and also periodic analysis of the accumulated data. Analysis of the data collected recently (5/1/91-4/30/93) has revealed several interesting characteristics of the food safety surveillance program which may be universally applicable to many foodservice operations.

MATERIALS AND METHODS

Surface Testing

The methods used for surface sanitation testing were originally described by Solberg *et al.* (1976) and have been recently updated (Solberg *et al.* 1990). A gamma irradiation sterilized adhesive tape (Con-Tact-It Tape, Birko Corp., Henderson, Colo.) was utilized to transfer surface samples to petri plates containing plate count agar. This method has been described in detail previously (Solberg *et al.* 1976) and was subsequently shown to correlate with the more common swab testing (Stinson and Tiwari 1978). Practical guidelines for surface sanitation have been used since the inception of the program (Table 1).

TABLE 1.
SURVEILLANCE STANDARDS FOR SURFACE CONTAMINATION AS APPLIED FOR CLEAN AND IN-USE ITEMS BEING EVALUATED BY THE ADHESIVE CONTACT TAPE METHOD

Condition	CFU ¹ / 0.75 in.	
	Clean	In-use ²
Acceptable	< 5	< 20
Level of Concern	5-10	20-40
Potential Hazard	> 10	> 40

¹Colony forming units

²In-use is defined within the context of this project to mean in direct contact with food. Some surfaces, (utensil storage pans for example) should never be in direct contact with food, and are not classified as "in-use."

Initial surface sanitation inspections were performed randomly throughout dining facilities hours of operation. Each of the 18 dining facilities was inspected at least once a month with the six large dining halls inspected two to four times per month. More than 12,000 surface tests were performed for this study.

The presence of food debris, water or other undesirable characteristics associated with the surface sampled was defined as an objectionable observation and was recorded on a written form which cross referenced the surfaces sampled with the appropriate coded petri plates. When sampling was completed, the form was taken to the facility manager prior to leaving the inspected facility. Objectionable observations were pointed out to the facility manager and procedural changes were suggested in an effort to correct the situation.

The completed form containing the results of all surface tests along with recommendations for correction of problems were FAXed or hand delivered to the office of the dining services sanitarian within 24 h after sampling.

When a tested surface was shown to have an unacceptable number of microorganisms, the appropriate facility was notified by the university sanitarian. This surface was re-sampled within seven days to determine whether the prior failure was either a random occurrence, or if a change in procedure had remedied the situation which led to the original failure. If this surface remained unacceptable, it was labeled as a two time (2X) failure and regarded as a procedural problem rather than a random occurrence. The facility was again notified of the surface failure along with written instructions which in detail recommended procedural changes to rectify or eliminate the problem. This procedure was repeated until a follow up visitation yielded a satisfactory test for the surface. Any subsequent failures during this follow up period were recorded as three time (3X), four time (4X), etc. failures and treated with increasing amounts of on site training for food service managers and staff to ensure that the written advice was fully understood and properly implemented. If the surface failed at the potential hazard level, follow up testing was performed within a seven day period. If the surface failed at the concern level, testing was followed up at the next random inspection. Items that demonstrated a high incidence of failure were tested in a nonrandom, more intensive manner.

Traditionally % failure has been used to track the performance of either a surface or facility (Eq. 1).

$$\% \text{ Failure} = \frac{\text{Concerns} + \text{Potential Hazards}}{\text{Total Surfaces}} * 100 \quad (1)$$

This indicator, however, gives both concerns and potential hazards equal weight. More recently a different indicator, Weighted Overall Failure Ratio (WOFR) has been used that gives potential hazard occurrences at least twice the gravity of concerns (Eq. 2).

$$\text{WOFR} = \frac{\text{Concerns} + (2 * \text{Potential Hazards})}{\text{Total Surfaces}} * 100 \quad (2)$$

Since the lower limit of potential hazards is approximately twice the lower limit for concerns this indicator gives a better measure of relative performance. Percent follow up failure (Eq. 3) is also used to track repeat performance.

$$\% \text{ Follow Up Failure} = \frac{\text{Follow Up Failures}}{\text{Total Follow Ups}} * 100 \quad (3)$$

Food Testing

At least six food samples per week were picked up on site at the 18 dining facilities. These "in-house" samples were taken from the receiving, service, preparation or storage areas of the dining facilities. The temperature of these foods at the time of sampling along with any failure to follow standard procedures that were observed during sample pick up were recorded. These samples were transported back to the microbiology lab in an insulated container which was refrigerated by frozen ice packs.

New food items or brands from outside vendors are also tested. These "outside" samples must meet or exceed university standards prior to being purchased for use by dining services.

The methods for food testing have been described previously (Solberg *et al.* 1976). All food samples were stored at -20C for less than six days prior to testing. While it is generally understood that freezing may reduce the bacterial load in some food samples (Jay 1992), a single freeze/thaw cycle under these conditions was evaluated in both ground beef and tuna salad. The treatment did not significantly change aerobic plate count levels (data not shown). The guidelines for limits of acceptability were set with an adequate margin of error such that the safety of the food would not be compromised even if there were a slight reduction in bacterial levels due to a single freeze/thaw cycle. Food samples were tested to determine the level of indicator bacteria, including: total aerobic bacteria, total coliform bacterial and *Escherichia coli*. The samples were also tested to determine the level of pathogenic bacteria, including: *Staphylococcus aureus*, *Clostridium perfringens*, and *Salmonella*. Practical guidelines have been established for food samples since the inception of the program (Table 2). Tests for the pathogen, *Escherichia coli* O157:H7 were recently added to the program. While the standards shown in Tables 1 and 2 are strict, they are also clearly obtainable, as the projects 21 years of experience have shown.

TABLE 2.
MICROBIAL GUIDELINES FOR ACCEPTABILITY OF "REQUIRES FURTHER COOKING" AND
"READY-TO-EAT" FOODS

Microbial test	Units	Ready-to-eat	Requires further cooking
Standard Aerobic Plate Count	CFU/gm ¹	$\leq 10^{5.2}$	$\leq 10^6$
Coliforms	MPN/gm ³	$\leq 10^2$	$\leq 10^3$
<i>Escherichia coli</i>	MPN/gm	0	≤ 50
<i>Staphylococcus aureus</i>	CFU/gm	≤ 20	≤ 50
<i>Salmonella</i>	MPN/gm	≤ 3	≤ 3
<i>Clostridium perfringens</i>	CFU/gm	≤ 20	≤ 50

¹Colony Forming Unit

²It should be noted that fermented foods will pass this criterion unless they are time and temperature abused.

³Most Probable Number

RESULTS

Surface Testing

Follow Up Failure Rate. The surface sanitation surveillance follow up process was successful in rapidly reducing the follow up failure rate (Fig. 1). This figure shows that there is a dramatic decrease in the number of surfaces that remain at an unacceptable bacterial level after any follow up testing cycle. Figure 1 also shows that the ratio of potential hazards to concerns significantly increases with each follow up cycle.

Microbes and Food Debris or Water. Analysis of the accumulated data shows a good correspondence between unacceptable microbial levels (% Failure and WOFR) and objectionable observations recorded during surface testing (Table 3). The most frequent objectionable observation, the presence of food debris (observed 1,025 times), corresponded well with unacceptable microbial levels (~ 23% failure, ~ 34 WOFR), while an even stronger correlation is seen for the presence of either water (229 observations, ~ 45% failure, ~ 82 WOFR) or food debris in combination with water (45 observations, ~ 57% failure, ~ 104 WOFR).

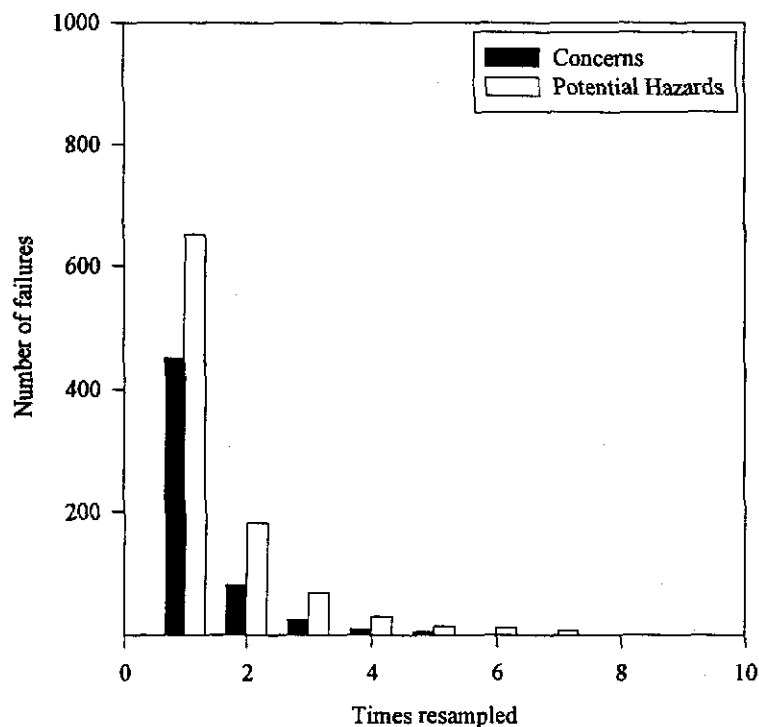


FIG. 1. RELATIONSHIP BETWEEN REPEATED SAMPLING AND SURFACE FAILURES

Surface Type Influence on Failure Rates. The surfaces of over 300 different items were tested on a regular basis. Seven of the eleven surfaces with the worst WOFR were juice dispenser tips (Table 4). Other problematic surfaces include pastry brushes, buffalo chopper bowls and stainless steel counter tops. While procedural changes usually eliminated follow up failures, some items possessed a high Follow Up Failure rate (Table 5). Most of these items were also items with high failure rates. There were some surfaces, however, that had higher Follow Up Failures rates compared to surfaces with similar general Failure rates (Table 4). Buffalo Chopper Bowls and Stainless Steel Counter tops for example, had similar Failure rates but more than a 25% difference in Follow Up Failure rates. In these and similar cases the procedural changes recommended in the surface sanitation reports and on site at the dining facility were changed to better rectify persistent surface failures. The most difficult and persistently problematic surfaces, were either refurbished, replaced, substituted for or eliminated.

TABLE 3.
SANITARY QUALITY OF SURFACES AS RELATED TO INSPECTOR COMMENTS

Surfaces	Total	Concerns	Potential hazards	% Failure	WOFR	Follow Ups	Follow Up Failures	% Follow Up Failure
RUTGERS DINING SERVICES (All Surfaces)								
All	12,816	579	970	12.09	19.66	1,042	447	42.90
Dispenser Tips	1,916	147	382	27.61	47.55	500	236	47.20
All Except Dispenser Tips	10,900	432	588	9.36	14.75	542	211	38.93
RUTGERS DINING SERVICES (All Except Dispenser Tips)								
No Appearance Comments	9,235	271	344	6.66	10.38	216	126	58.33
Any Negative comments	1,665	161	244	24.32	38.98	226	85	37.61
Food Debris Comments	1,025	123	117	23.41	34.83	137	41	29.93
Wet Comments	229	20	85	45.85	82.97	43	24	55.81
Wet & Food Debris Comments	45	5	21	57.78	104.44	16	11	68.75
Facilities Other Than Rutgers Dining Services								
All	210	23	41	30.48	50.00	40	18	45.00

TABLE 4.
RANKING OF SURFACE TYPES BY WOFR FOR SURFACES THAT HAVE BEEN TESTED 50 OR MORE TIMES

EQUIPMENT	Total	Concern	Potential hazard	% Failure	WOFR	Follow Up	Follow Up Failure	% Follow Up Failure
Dispenser Tip, Pineapple	124	20	68	71.0	125.8	74	56	75.7
Dispenser Tip, Orange	76	5	39	57.9	109.2	44	28	63.6
Dispenser Tip, Hot Cocoa	293	26	106	45.1	81.2	126	65	51.6
Dispenser Tip, Grapefruit	107	11	31	39.3	68.2	40	17	42.5
Pastry Brush	217	11	67	35.9	66.8	64	28	43.8
Dispenser Tip, Grape Juice	163	18	31	30.1	49.1	48	18	37.5
Buffalo Chopper Bowl	196	5	45	25.5	48.5	47	14	29.8
Dispenser Tip, Apple	210	25	30	26.2	40.5	52	18	34.6
Countertop, Stainless Steel	239	25	35	25.1	39.7	55	24	43.6
Dispenser Tip, Cranberry	74	8	9	23.0	35.1	15	6	40.0
Dispenser Tip, Lemonade	193	13	27	20.7	34.7	42	12	28.6
Shelf, Metal	82	13	7	24.4	32.9	20	7	35.0
Buffalo Chopper Shaft	198	14	22	18.2	29.3	32	8	25.0
Shelf, Stainless Steel	539	26	56	15.2	25.6	84	19	22.6
Utensil Storage Tray	61	3	6	14.8	24.6	5	0	0.0
Cutting Board, Plastic	364	23	33	15.4	24.5	56	17	30.4
Utensil Storage Pan	391	37	28	16.6	23.8	60	15	25.0
Shelf, Aluminum Bar	97	13	4	17.5	21.6	17	6	35.3
Pan, 1/4 Holed	232	4	23	11.6	21.6	31	5	16.1
Scale Pan, Pelouze	94	10	5	16.0	21.3	15	3	20.0
Buffalo Chopper Blade	161	6	14	12.4	21.1	17	3	17.6
Dispenser Tip, Fruit Punch	128	8	9	13.3	20.3	17	6	35.3
Dispenser Tip, Iced Tea	169	7	13	11.8	19.5	20	5	25.0
Scale Pan, Portion	366	30	18	13.1	18.0	47	5	10.6
Bain Marie Insert	95	3	7	10.5	17.9	11	2	18.2
Pan, 1/2 Holed Long	140	3	10	9.3	16.4	12	4	33.3
Tomato Slicer Bed	139	6	8	10.1	15.8	16	3	18.8
Utensil Storage Pan,	203	16	8	11.8	15.8	30	6	20.0
Drawer Floor	632	33	30	10.0	14.7	63	4	6.3
Spoon, Serving	105	3	6	8.6	14.3	9	2	22.2

Food Testing

More than 500 food samples were tested by the Food Science microbiological surveillance team during this project (Table 6). Approximately 1/4 of these samples contain an unacceptable level of bacteria in accordance with the strict university parameters (Table 2). Potentially hazardous salad items were the most commonly tested and the most common failure. Both lunch meat and raw meat food samples were more problematic on a percentage basis.

The majority of these failures were due to unacceptable levels of indicator bacteria (Table 7). In 85 of the 143 total food failures (59.4%) there was an unacceptable level of total coliform bacteria making up the most frequent type of food

TABLE 5.
RANKING OF SURFACE TYPES BY HIGHEST PERCENT FOLLOW UP FAILURE RATE FOR SURFACES THAT
HAVE BEEN FOLLOWED UP MORE THAN 20 TIMES

EQUIPMENT	Total	Concern	Potential hazard	%failure	WOFR	Follow Up	Follow Up Failure	% Follow Up Failure
Dispenser Tip, Pineapple Juice	124	20	68	71.0	125.8	74	56	75.7
Dispenser Tip, Orange Juice	76	5	39	57.9	109.2	44	28	63.6
Dispenser Tip, Hot Cocoa	293	26	106	45.1	81.2	126	65	51.6
Pastry Brush	217	11	67	35.9	66.8	64	28	43.8
Countertop, Stainless Steel	239	25	35	25.1	39.7	55	24	43.6
Dispenser Tip, Grapefruit Juice	107	11	31	39.3	68.2	40	17	42.5
Dispenser Tip, Grape Juice	163	18	31	30.1	49.1	48	18	37.5
Shelf, Metal	82	13	7	24.4	32.9	20	7	35.0
Dispenser Tip, Apple	210	25	30	26.2	40.5	52	18	34.6
Cutting Board, Plastic	364	23	33	15.4	24.5	56	17	30.4
Buffalo Chopper Bowl	196	5	45	25.5	48.5	47	14	29.8
Dispenser Tip, Lemonade	193	13	27	20.7	34.7	42	12	28.6
Utensil Storage Pan	391	37	28	16.6	23.8	60	15	25.0
Buffalo Chopper Shaft	198	14	22	18.2	29.3	32	8	25.0
Dispenser Tip, Iced Tea	169	7	13	11.8	19.5	20	5	25.0
Shelf, Stainless Steel	539	26	56	15.2	25.6	84	19	22.6
Utensil Storage Pan, Perforated	203	16	8	11.8	15.8	30	6	20.0
Pan, 1/4 Hotel	232	4	23	11.6	21.6	31	5	16.1
Scale Pan, Portion	366	30	18	13.1	18.0	47	5	10.6
Drawer Floor	632	33	30	10.0	14.7	63	4	6.3

TABLE 6.
FOOD SAMPLE TESTING RESULTS SUMMARY BY FOOD TYPE AND PICK UP TEMPERATURE

Food Type	Total					Sample Pickup Temperature							
	Total	Accept.	Unacc.	% Failure	% Failure	Unacceptable Temperature ¹			Unknown Temperature				
						Total	Accept.	Unacc.	% Failure	Total	Accept.	Unacc.	% Failure
All	552	409	143	25.9	25.9	225	163	44	19.6	26	15	11	42.3
Outside Vendor	22	17	5	22.7	0	0	0	0	-	6	3	3	50.0
In-House	530	392	138	26.0	26.0	227	163	64	28.2	20	12	8	40.0
Beverage	7	7	0	0.0	0.0	2	2	0	0.0	0	0	0	-
Dessert	6	4	2	33.3	33.3	5	3	2	40.0	0	0	0	-
Entree	37	34	3	8.1	8.1	22	21	1	4.5	4	2	2	50.0
Pre-Cooked Meat	8	7	1	12.5	12.5	0	0	0	-	0	0	0	-
Raw Meat	85	56	29	34.1	34.1	11	8	3	27.3	12	6	6	50.0
Lunch Meat	88	56	32	36.4	36.4	66	42	24	36.4	1	1	0	0.0
Potentially Hazardous Salad	286	216	70	24.5	24.5	121	87	34	28.1	3	3	0	0.0
Nonmeat Ingredient	13	12	1	7.7	7.7	0	0	0	-	0	0	0	-

¹ Unacceptable temperature is > 4 C and < 60 C

TABLE 7.
FOOD SAMPLE TESTING RESULTS SUMMARY BY FOOD TYPE AND PICK UP TEMPERATURE

Food Type	Total Failures ¹	Failure due to unacceptable levels of:					
		TPC	Coli.	E. coli	Staph.	Salm.	C. per.
Lunch Meat	32	23	15	6	2	0	0
Raw Meat	29	8	10	16	7	0	1
Salad	70	24	54	12	4	1	0
Precooked Meat Ingredients	1	1	1	1	0	0	0
Non meat Ingredient	1	0	0	0	1	0	0
Entree	1	0	1	0	0	0	0
Dessert	2	2	2	0	0	0	0
Outside	7	4	2	0	4	1	0
Total	143	62	85	35	18	2	1

TPC Total Aerobic Plate Count
Coli. Total Coliforms Bacteria
E.coli. *Escherichia coli*
Staph. *Staphylococcus aureus*
Salm. *Salmonella*
C. per. *Clostridium perfringens*

¹Failures due to specific tests do not sum to total failures since one item may fail for more than one reason.

failure. Unacceptable levels of total aerobic bacteria were also commonly observed (62 of 143 failure or 43.4%).

Unacceptable levels of pathogen bacteria were much less commonly observed, occurring in only 21 of the 552 total food samples (3.8%). The most commonly observed foodborne pathogen was *Staphylococcus aureus* accounting for 12.6% of the total food failures and 85.7% of the pathogen food failures.

DISCUSSION

Surface Testing

A sanitary surface is achieved by a combination of proper cleaning and sanitization techniques, surface composition and surface design. While surfaces fail microbiological sampling due to incomplete, infrequent or improper cleaning and sanitization, the frequency of these problems can be influenced by the design of the surface.

The influence of design on the sanitary quality of a surface can be simply demonstrated by comparing utensil storage containers (Table 4). Pans were frequently used to store utensils of all types. These utensil storage pans need to be emptied, cleaned and sanitized on a routine basis. In 1992 the microbiological surveillance team recommended to the Rutgers Division of Dining Services that perforated rather than unperforated pans be used for the storage of utensils. The perforated pans can be run through a dish washing machine without the need to empty the pans of their utensils. The perforations promote drainage and facilitate drying of the contents. Perforated utensil storage pans were therefore easier to clean and sanitize than the unperforated pans and hence, had a lower (~12% vs ~17%) failure rate. More recently, a second switch to wire baskets had been recommended as an even better replacement for both the perforated and the unperforated pans. The baskets have the same desirable attributes as the perforated pans, and possess even larger openings which allow more rapid drainage and drying. These larger openings also facilitate removal of debris during routine use and cleaning. Only smaller particles of food debris can pass through the perforated pans, while all food debris is retained by the unperforated utensil storage pans. Thus the failure rate for utensil storage baskets (0%, data not shown) is even lower than that of perforated utensil pans.

The sanitary quality of stainless steel shelving is also influenced by design in an analogous manner to the storage pans. Shelving made from stainless steel wire allows rapid drainage and does not collect food debris as easily as unperforated stainless steel shelves. Thus, a much lower Failure rate is observed for the stainless steel wire shelves (~8%, not shown in Table 4), versus stainless steel shelves (~15%).

Design is also a major factor in the cleanup problems experienced with juice dispenser tips (Table 3). Consistent microbial failure of dispenser tips led the microbiological surveillance team to search for the cause of the problem. While the tips themselves were relatively easy to disassemble, clean and sanitize, the dispenser itself contains components which can not be disassembled. Thus, the problem lies in the design of the internal working parts of the device. These internal parts include a plastic manifold where mixing and dilution takes place and the attached plastic tubing connects. Removal of this manifold and tubing showed an accumulation of food debris within the tubes and on the manifold at connecting surfaces. The plastic manifold was sectioned and split to reveal even more debris accumulated in the channels that conduct both the diluted juice and concentrate. High levels of microbial growth were observed in samples taken from the surfaces taken from the internal channels of the plastic manifold. Juice, especially juice that is thick and/or pulpy, gets trapped in the plastic tubing and within the plastic channels of the manifold in the interior of the machine. This retained debris provides favorable conditions for microbial attachment and growth.

Despite more thorough and more frequent cleaning and sanitization procedures, there was little improvement in the failure rate. Possible solutions to this problem include a single use dispenser or one which allows full disassembly of the juice dispenser parts. The latter design should allow mechanical scrubbing of all beverage contact parts.

The juice dispenser problem also points out a need for inspection by qualified personnel of equipment prior to purchase to ensure that it is designed for easy cleaning and sanitization. Such a change in purchasing procedure was recently adopted at Rutgers as result of the problems experienced with the juice dispensers.

If the surface testing results for dispenser tips is subtracted out from the total of the data for all other surfaces, the balance is equal to a 9.4% Failure rate and a 14.8 WOFR (Table 3). This falls within the project goals (% Failure rate < 10% and WOFR < 15%).

Analysis of the balance of the surface sanitation data (excluding dispenser tips) can be further broken down into surface appearance comment categories (Table 3). The first category contains the data for which there was no visually observed problems recorded during sampling. The sanitary quality of these surfaces is much better than those in other categories containing various recorded negative observations. This suggests that inspectors can detect some problematic surfaces visually and highlights the importance of on site corrections. It should be pointed out, however, that although the failure rate of visually acceptable surfaces (~6.7%) was much lower than those that were visually unacceptable (~24.3%) the total number of failures (271 concerns + 344 potential hazards, and hence the percentage of all failures $615/(432 + 588) = 60.3\%$) is still greatest for surfaces that outwardly appear acceptable. These data along with the juice dispenser problems discussed above indicate a true need for a complimentary microbiological testing program.

Follow up testing is a crucial part of a surface sanitation surveillance program. This is indicated by the data which show that follow up testing accounted for 28.9% ($447/(579 + 970)$) of the total failures (Table 3) and by the increasing tendency of a surface to fail at the potential hazard versus concern level with each round of follow up testing (Fig. 1). This indicates that surface failures that had not been rectified had a tendency to get worse. This latter data indicates both the need for persistent follow up testing and cooperation by those that clean and sanitize the item to achieve rectification. Indeed, personnel appear more eager to correct discovered problems with the anticipation of an impending follow up test. Also, the on-site verbal recommendations (provided during testing) and the written instructions (after follow up test failures) have proved to be very useful in correcting problems.

Upon request, our microbiological surveillance program has also been briefly applied to Rutgers dining facilities not under the control of Rutgers Dining Ser-

vices Department. Although the results yielded a failure rate much worse (~30%) than that observed for Rutgers Dining Services facilities (~9%), this result is not surprising, since there is a significant lag period as personnel becoming increasingly educated in proper storage, cleaning and sanitization procedures. Nevertheless, consistent improvement in the Failure rate was observed and a similar decrease with each round of follow up sampling was also observed.

Food Testing

The category corresponding to lunch meat was the most problematic on a percentage basis (Table 6). It can be seen that unlike the other categories, the failures in this category were predominantly in samples that were picked up at unacceptable temperatures (above 4C). The majority of these lunch meat failures were due to unacceptable levels of total aerobic and total coliform bacteria (Table 7). This emphasizes that, despite the preservatives contained in these food items, proper temperature is a critical control when serving or storing this item to prevent spoilage.

Raw meat is also quite problematic overall, with a ~34% failure rate (Table 6). This type of food most frequently failed (16 of 29 failures) due to unacceptable levels of the indicator bacteria, *Escherichia coli* (Table 7). These failures often corresponded to either high levels from the source or extended in-house storage times. The program guidelines require that raw meat which is to be used within 48 h must be stored at less than 4.4C. Any raw meat that is stored more than 48 h should be kept below -17.8C. It is recommended that raw meat be ordered so that it is used up within 14 days and preferably within 48 h. This retraction is not problematic, as raw meat is delivered to Rutgers Dining Facilities three times a week by the distributor.

Recent events have increased the public awareness of the importance of detection of *Escherichia coli* O157:H7 in meats. Testing for this emerging pathogen was added to the program in 1989. This addition was both timely and convenient, since *Escherichia coli* levels were already being determined and this preceded the most recent outbreak in the pacific northwest region of the US. Regardless, this pathogen has not been detected in any of the 85 raw meat samples tested by the program.

Raw sausage was the most problematic raw meat. Due to consistent sausage failures Rutgers now serves a precooked sausage patty instead of the raw Italian style sausage. Ground beef and hamburger patties had also been historically problematic but a switch in vendors for these two items have greatly reduced the frequency of failures.

On a percentage basis desserts was the third most problematic food category (Table 6). This was totally due to the test results for two rind-on cantaloupe

samples, however, which were used as examples to demonstrate the high bacterial content of this item to the dining facility managers and therefore, the need for refrigeration following cutting of the rind.

Most foodservice personnel want to have a sanitary facility. A program such as that described above provides the education, training and feedback which are instrumental in both achieving and maintaining this goal.

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