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Microbiological quality of food samples from restaurants and sweet shops in developing countries: a case study from the Occupied Palestinian Territory

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The aim of this paper is to review the microbiological quality of food samples taken from a wide range of cooked and raw foods obtained from restaurants and sweet shops in the Ramallah and al-Bireh district, and to identify the gaps in food inspection and handling that can be realistically improved. Utilizing food sample test results of the Palestinian Ministry of Health, records pertaining to the years 1995, 1996, 2000, 2002, and the first 2 months of the year 2003 reveal that only 60.9%, 44.0%, 63.8%, 93.6%, 51.8%, 83.8%, and 50.4% of the food samples tested for total aerobic count, total *Coliform*, faecal *Coliform*, *Staphylococcus aureus*, faecal *Streptococci*, moulds, and yeasts respectively are within the limits of the Palestinian and International standards. None of the tested samples for Salmonellae or Clostridium perfringes were positive. Analysis of the data indicates an irregular rather than systematic process to testing. For example, 60.4% of the tested food samples in 2000 came from sweet shops, while the relative percentage of sweet shops is 21.4% out of the total restaurants and sweet shop figures in the area at the time. In contrast to what would be expected, most of the samples were collected during the cold season, raising questions as to the suitability of testing procedures and guidelines. Systemic and procedural gaps were identified by the analysis that can be addressed to at least contain, if not completely eliminate the presence of foods in the market that are unacceptable for consumption.

Keywords: Microbiological quality; restaurants; sweet shops; food; developing countries; Palestine.

Introduction

Food-borne infections have been the focus of much public health attention over the past century (Light 2000) with the microbiological contamination of food increasingly being recognized as a significant global problem. The most common food infections are related to bacteria, viruses, and parasites (Olsen *et al*. 2000; Northro-Clewes and Shaw 2000).

Illnesses caused by food-borne micro-organisms can present as serious public health problems. Verotoxigenic E. coli, Salmonellae, and Staphylococcus aureus are examples of food-borne pathogens capable of causing disease (Steele *et al*. 1997; US Food & Drug Administration 2003).

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The total aerobic plate count (TAC) is used as an indicator for the level of microorganisms in a product (Maturin and Peeler 1998). Total aerobic plate counts in food samples can sometimes be useful to indicate quality, shelf life and post heat-processing contamination (GuaranTek Analytical Laboratories 2003).

Total coliform organisms are a subgroup of TAC that are present in faeces of all warm-blooded animals and humans and used as faecal indicators for water contamination (The Official State Government Site for the Commonwealth of Kentucky 2003). They are used as a marker of unsanitary conditions or practices during production, processing or storage of food (Raloff 2003). The presence of any of these groups in food, particularly meats, meat products and fresh vegetables is used as an indication of faecal contamination (Jay 1996).

Total coliform bacteria is divided into subgroups, one of which is faecal coliforms. Those are able to grow well at body temperature. Faecal coliforms are more likely to be present in foods as a result of faecal contamination from water or other sources (Yalçin *et al*. 2001; Hernandez 2000).

The genus Salmonella is a typical member of the family enterobacteriacea, that have been recognized as causing enteric diseases for many years, and methods of control are well established. In addition, Salmonellae remains the most important reported cause of food poisoning (Mead *et al*. 1999).

Staphylococcus aureus bacteria is another indicator of food contamination of processed foods. It could come from the skin, mouth, or nose of food handlers (Stehulak 2003). It can be found in the air, dust, water and human faeces, and can be present on clothing and utilities handled by man (Fahed 2003). Foods that are frequently a problem with Staphylococcal food poisoning include milk and dairy products (Fahed 2003). Likewise, foods that require considerable handling during preparation and that are kept at slightly elevated temperatures after preparation are frequently involved in Staphylococcal food poisoning (US Food & Drug Administration 2003).

Yeasts and moulds are also considered indicators of food contamination. They mainly spoil the quality of food (Die 2003). They require sugar and moisture for survival (Steels *et al*. 1999). Normally, due to the presence of moisture and sugar, kitchen areas are particularly at risk to mould and mildew, mainly walls that are adjacent to soiled dish-scraping areas and pot-wash sinks, around steam kettles and braising pans and the walls next to cart- and can-wash areas (Nation's Restaurant News 2002; Action for Biology Education 2003; Good2Eat Food Lab 2003).

In this study, the microbiological quality of food from restaurants and sweet shops is ascertained, focusing on food quality – whether these foods are safe to eat or not – in the Ramallah and al-Bireh district restaurants and sweet shops. The main causes of food contamination are identified. The analysis contained in this paper is based on the results of laboratory tests that the Ministry of Health completed on collected samples of foods from restaurants and sweet shops in the aforementioned district. The presence of some of the classical bacteriological indicators of food contamination, including faecal pollution and total coliforms in addition to yeasts and moulds is the main focus here.

Materials and methods

Data on the microbiological quality of food samples from restaurants and sweet shops was obtained from the records of the Central Public Health Laboratory of the Ministry of Health (MoH) for the Ramallah and al-Bireh district, with a population of 202,759 persons in 1997 (Palestinian Central Bureau of Statistics (PCBS) 1999a). The collected data were for the years 1995, 1996, 2000, 2002, and the first two months of the year 2003. The years 1995 and 1996 represent the initial years when the Palestinian Authority (PA) took over the responsibility of the health of Palestinians living in the OPT from the Israeli Occupying forces. The years 2000, 2002, and 2003 thus represent the changes over time since this handover, and a tentative assessment of the outcome of these changes.

The data was reviewed, cleaned and revised with the help of the Environmental Health Department personnel of the MoH as well as the Central Public Health Laboratory technicians. Food samples were collected from raw materials and ready to eat foods in restaurants and sweet shops from different communities in the district. Food samples were held in sterile boxes and sent to the laboratory of public health in Ramallah city on the same day of collection.

The data was coded and entered into the computer and analysed using SPSS software (Statistical Package for Social Sciences). Data limitations include missing entries, problematic labelling, and un-systematic testing, as not all the samples were uniformly tested for the different indicators.

Decisions regarding whether food samples were deemed acceptable or not acceptable for food preparation and/or human consumption were based on the Palestinian microbiological standards where each type of food is assigned a specific upper limit for the presence of microbes. The bacteriological analytical manual online published by the US Department of Health and Human Services (2001) was used as a reference for sample testing.

Results

Distribution of Restaurants and sweet shops by year and location

Table 1 shows the distribution of restaurants and sweet shops in the Ramallah and al-Bireh district by location and year. In 1995, there were 125 restaurants operating in the district. By the year 2000, the number grew to 145, and by 2002, the number grew further to 163 restaurants, 107 of which were located in Ramallah city, 27 in al-Bireh city and 19 in other communities in the district. The number of sweet shops was 45 in Ramallah and al-Bireh district in 2002. That is, the majority of restaurants and sweet shops were understandably located in the urban twin city area (Ramallah and al-Bireh cities), and have increased in number over time.

Table 1. Distribution of restaurants and sweet shops by location and year in Ramallah and al-Bireh district*

	Location							
	Ramallah Municipality		*Al-Bireh Municipality*		*Other communities in the district*		*Total*	
Year	*Restaurants*	*Sweet shops*	*Restaurants*	*Sweet shops*	*Restaurants*	*Sweet shops*	*Restaurants*	*Sweet shops*
1995	90	–**	35	–	–	–	–	–
1996	90	–	37	–	–	–	–	–
2000	105	26	40	9	19	9	163	44
2002	107	27	40	9	19	9	163	45
2003	107	27	40	9	19	9	163	45

*Source: Ramallah and al-Bireh District health directorate.
**Data is not available.

Distribution of tested samples by sources, years and months

A review of the records for the years 1995, 1996, 2000, 2002, and the first two months of the year 2003 revealed that the Environmental Health Department had tested 637 food samples during this period from restaurants and sweet shops.

As can be seen by examining Table 2, the total number of tested food samples from restaurants and sweet shops in the Ramallah and al-Bireh district slightly decreased over time in the initial years since the MoH took over, as the number of tested samples was 107 in 1995, and decreased to 94 in 1996. This decrease appears to have continued through the year 2000, with a reported 91 samples tested for this year, at a time when the number of restaurants and sweet shops was increasing in the district, and justifying more, not less testing. However, this decreasing testing trend was reversed beginning 2002, with a sharp rise in reports of tested samples to 224 for 2002, and 121 for the first two months of 2003.

The monthly distribution of tested food samples is shown in Table 3. Notice that, for all the years combined, the maximum monthly number of tested samples was completed in February (17.7%), while the minimum number was completed in August (0.0%). These results contrast with the local monthly temperature distribution shown in Table 4, as summer temperatures are much higher than the winter ones.

Table 2. Frequencies and percentages of tested food samples by source and year

	Frequencies and percentages					
Year	*Restaurants*		*Sweet shops*		*Total*	
1995	55	51.4	52	48.6	107	100.0
1996	48	51.1	46	48.9	94	100.0
2000	36	39.6	55	60.4	91	100.0
2002	193	86.2	31	13.8	224	100.0
2003	121	100.0	0	0	121	100.0
Total	453	71.1	184	28.9	637	100.0

(Chi square = 156.581, $P = 0.000$).

Table 3. Frequencies and percentages of all tested food samples by month

Month	*Frequency*	*Percentage*	*Month*	*Frequency*	*Percentage*
January	89	14.0	July	65	10.2
February	113	17.7	August	0	0.0
March	37	5.8	September	46	7.2
April	16	2.5	October	10	1.6
May	54	8.5	November	91	14.3
June	41	6.4	December	75	11.8

(Chi square = 199.643, $P = 0.000$).

Table 4. Monthly distribution of temperatures in Ramallah and al-Bireh district during the year 1998*

Month	*Absolute minimum*	*Absolute maximum*	*Mean*
January	− 3.0	15	7.6
February	0.6	19.5	9.1
March	− 2.3	19	9.8
April	5.7	34.8	17.4
May	6.4	33.6	20.6
June	11.8	33.6	22.4
July	15.2	37	25.6
August	15.0	36.4	26.6
September	15.5	37.2	24.1
October	17.6	33.8	21.2
November	15.2	29.4	17.8
December	9.4	26	11.7

*PCBS (1999b).

Distribution of tested samples according to the microbial parameters

Yearly variations in results pertaining to food quality and suitability for ingestion were also noted. The results are presented in Table 5. Notice that, for all the years combined, the percentages of unacceptable samples examined for total aerobic count (TAC), total *Coliforms* (TC), faecal *Coliforms* (FC), *Staphylococcus* aureus (Sa), faecal *Streptococci* (FS), moulds and yeasts were 39.1, 56, 36.2, 6.4, 48.2, 26.2 and 49.6% respectively. All of the examined samples tested negative for Clostridium (Clos) and Salmonellae (S). None of the samples were tested for faecal *Coliforms* during the years 1995, 1996, and 2000. Since the establishment of the Public Health Central Laboratory in 2002, however, testing of food samples for faecal *Streptococci* was replaced with the faecal *Coliforms* test. Routine testing of food samples for Clostridium was also ended in 2002 and considered as a special test to be used in specific circumstances only.

Examining the data by year, a significant statistical relationship between the sampling year and the level contamination of food samples is noted, with a generally rising trend of contamination over time with TAC (chi square = 26.623 and $P = 0.000$), TC (chi square = 21.609 and $P = 0.000$), Yeasts (chi square = 10.185 and $P = 0.037$), and Sa (chi square = 35.565 and $P = 0.000$). For example, the percentage of contaminated food samples with TAC was 22.4% in 1996, and increases with time to reach 30.8 and 50.4% in 2000 and 2002 respectively. For TC, the percentage of contaminated samples was 40.2% in 1995 and increased to reach 60.6 and 65.6% in 1996 and 2002 respectively. For yeasts, the percentage of contaminated samples was 40.3% in 1995, and reached 53.3, 50.9 and 57.9% in 1996, 2002 and the first 2 months of 2003 respectively.

Discussion

Data analysis indicates that restaurants and sweet shops in the district have increased in number over time, while the number of tested samples decreased up till the year 2000 and suddenly increased in 2002, and considerably so in the first 2 months of 2003. Part of the

Table 5. Frequencies and percentages of total aerobic count, total *Coliforms*, faecal *Coliforms*, *Staphylococcus* aureus, faecal *Streptococci*, Clostridium perfringes, Moulds, Yeasts (TAC, TC, FC, Sa, FS, Clos, Moulds, and Yeasts) (n/100 ml) and Salmonellae (S)(+/−/25 gm)

	Frequencies and percentages (%)																	
	TAC		*TC*		*FC*		*Sa*		*FS*		*Clos*		*Moulds*		*Yeasts*		*S*	
Year	*Not Acce**	*Acce***	*Not Acce*	*Acce*	*Not Acce*	*Acce*	*Not Acce*	*Acce*	*Not Acce*	*Acce*	*Not Acce*	*Acce*	*Not Acce*	*Acce*	*Not Acce*	*Acce*	+	−
1995	24	71	43	64	–***	–	12	94	12	18	0	64	27	41	25	37	0	97
	25.3	74.7	40.2	59.8	–		11.3	88.7	40.0	60.0		100	39.7	60.3	40.3	59.7		100
1996	11	38	57	37	–	–	9	84	25	24	0	31	31	32	32	28	0	71
	22.4	77.6	60.6	39.4			9.7	90.3	51.0	49.0		100	49.2	50.8	53.3	46.7		100
2000	12	27	48	43	–	–	14	69	18	17	0	26	28	49	30	49	0	69
	30.8	69.2	52.7	47.3			16.9	83.1	51.4	48.0		100	36.4	63.6	38.0	62.0		100
2002	113	11	147	77	93	131	2	221	–	–	–	–	35	189	114	110	0	223
	50.4	49.6	65.6	34.4	41.5	58.5	0.9	99.1					15.6	84.4	50.9	49.1		100
2003	46	74	62	59	32	89	3	118	–	–	–	–	24	97	70	51	0	121
	38.3	61.7	51.2	48.8	26.4	73.6	2.5	97.5					19.8	80.2	57.9	42.1		100
Total	206	321	357	280	125	220	40	568	55	59	0	121	145	408	271	275	0	581
	39.1	60.9	56.0	44.0	36.2	63.8	6.4	93.6	48.2	51.8		100	26.2	83.8	49.6	50.4		100
Total no. of tested samples	527		637		345		608		114		121		553		546		581	

*Not accepted.
**Accepted.
***no tested samples.

reasons which can explain the sudden increase in testing beginning 2002 is the establishment of the MOH's Central Public Health Laboratory in 2002, where it became possible for food inspectors to collect and analyse samples relatively easily, and on locale. The fact that the MOH food inspectors did not have the means for analysing samples within the MOH previous to 2002 can explain the decrease in sampling over time in the 1995–2000 period, a period where the MOH exerted substantial efforts in the system building area.

However, the monthly distribution of tested samples is problematic. Table 3 demonstrates that most of the samples were tested during winter (from November to February), while during the remaining months, testing was variable with the minimum number of tested samples noted for August, where none of the samples were tested during this month for the years 1995, 1996, 2000 and 2002 (Chi square = 199.643, $P = 0.000$). These results contrast with what one would expect given the hot local summer temperatures, reaching up to 35–37 degrees centigrade during the August days especially, as shown in Table 4, and as microorganisms grow and multiply in warm temperature conditions more than cold ones. The fact that testing does not take place adequately during the hot summer months is especially relevant locally, as restaurants and sweet shops routinely display foods outside refrigerators for long periods of time, thus encouraging the growth and multiplication of microorganisms. These results indicate a need to carefully re-examine the scheduling of food sampling so that sampling can rationally cover all months of the year, and in particular the crucial summer months.

Sampling selection seems to also require re-assessment. Analysis of the data demonstrates that 60.4% of the tested food samples in 2000 came from sweet shops. This percentage does not correspond to the relative percentage of sweet shops (21.4%) out of the total restaurants and sweet shop figures in the area at the time, and indicates an erratic rather than systematic process to testing. The percentage of tested samples from sweet shops relative to their proportion in the overall figures was reduced in 2002 and in the first two months of 2003, to become 13.8 and 0.0% respectively (Chi square = 156.581, $P = 0.000$). However, once again, testing did not correspond to the proportion of sweet shops in the tested group. These results raise concerns over the randomness of testing, and call for an examination of the processes through which decisions for testing are made.

TC results indicate that only 44% of the tested samples were found acceptable and within the Palestinian standard limits. Since TC are generally considered quality indicators, it can be concluded that the quality of tested food samples was below standard.

Tested samples for both FC and FS revealed a high percentage of foods that were deemed not acceptable for food preparation and/or consumption. These organisms can cause illness in humans, and usually, mainly originate from faecal sources and the inadequate procedures followed when preparing and serving foods, including the problems of food handler hygiene and kitchen cleanliness. Indeed, field observations indicate a serious problem in food handling in general, beginning with unsanitary kitchens, questionably sanitary equipment and utensils, inadequate food handler personal hygiene, unsanitary preparation of food, and un-safe display, to name only some of the visible factors that can contribute to food contamination. For example, hand-washing soap for use by workers and customers is often not available in restaurants and sweet shops. Some food handlers' fingernails are not only long, but far from clean as well. Field observation also indicates that food handlers are allowed to eat, drink, chew gum and even smoke while preparing and serving foods, habits that clearly denote the lack of awareness of the accepted routines of food handling that prevent contamination. It is even possible sometimes to see a wounded employee handling food without properly cleaning and covering the wound, while it is well known that any cuts, sores, skin infections or infected wounds must be kept clean and covered with a bandage especially when handling foods. These observations may explain the contamination of 6.4% of the tested food samples with Sa, as wounds are one of the main sources of food contamination with Sa in addition to air, dust, water and human faeces.

The yeast test results indicate a lack of improvement in the level of contamination of food with yeast over time. On average, 49.6% of tested samples were contaminated. 40.3% and 53.3% of tested samples were contaminated by yeasts in 1995 and 1996. Yeast contamination levels declined slightly for 2000 where 38.0% of the samples were found contaminated, but increased to reach 50.9 and 57.9% in the year 2002 and the first two months of the year 2003 respectively. Normally yeasts require a high moisture level, and grow with or without oxygen (Kuntz 2003). In view of field observations denoting inadequate ventilation and high moisture levels in some of these restaurants kitchens, efforts must also be made to ensure that adequate ventilation systems are installed in these restaurants and food shops.

Data analysis reveals a general improvement of the level of contamination with moulds over time (chi square = 43.243 and $P = 0.000$), as the percentage of contaminated food samples with moulds was 39.7 and 49.2% in the years 1995 and 1996, and declined to 36.4, 15.6, and 19.8% for the years 2000, 2002 and the first 2 months of the year 2003 respectively. As mentioned previously, most of the more recently opened restaurants and sweet shops are located in the downtown area of Ramallah and al-Bireh twin cities, where new buildings have proliferated since the handing over to the Palestinian Authority in 1994. Such buildings have been constructed according to Palestinian specification, and rarely have construction defects or damage to building components which allow moisture to be trapped within the buildings and moulds to be encountered (Harvey 2002).

None of the 121 tested food samples for Clostridium perfringes were positive. Normally illness caused by this microorganism takes place when canned foods are ingested, as Clostridium perfringes is an anaerobe. Canned foods are not normally served in restaurants in the district, explaining the absence of Clostridium perfringes in the samples.

Conclusions and recommendations

The results of this study demonstrate a rise in the number of restaurants and sweet shops in the Ramallah/al-Bireh urban area over time, ongoing and unacceptably high levels of contamination of tested food samples, erratic sampling procedures to ascertain food quality, and the absence of clear guidelines and regulations for food handling in general. While serious efforts have been made by the MOH to improve food quality, such efforts have so far been severely constrained by the exceptional conditions in a country engulfed with rising poverty, ongoing conflict, destruction of infrastructure and limited PA ability to control and adequately supervise food quality.

Nevertheless, there are some steps that can and need to be taken that may at least alleviate the problem, if not solve it altogether. This study has identified some of the gaps that the MOH can realistically fill, including the development of rational schedules for food sampling and inspection, to include all months, especially the summer months. Other immediately needed measures include the development of sanitary food handling procedures and guidelines and their distribution to restaurant owners and food handlers. Educating restaurant owners and food handlers is also important prior to the enforcement of these procedures and regulations. Kitchen facilities need to be routinely inspected to ensure they are sanitary, as such steps should go hand in hand with the sampling and testing of foods. Finally, the general education of the public, including the use of the media is also important in assisting in the community to actively participate in containing the problem through public and customer pressure.

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